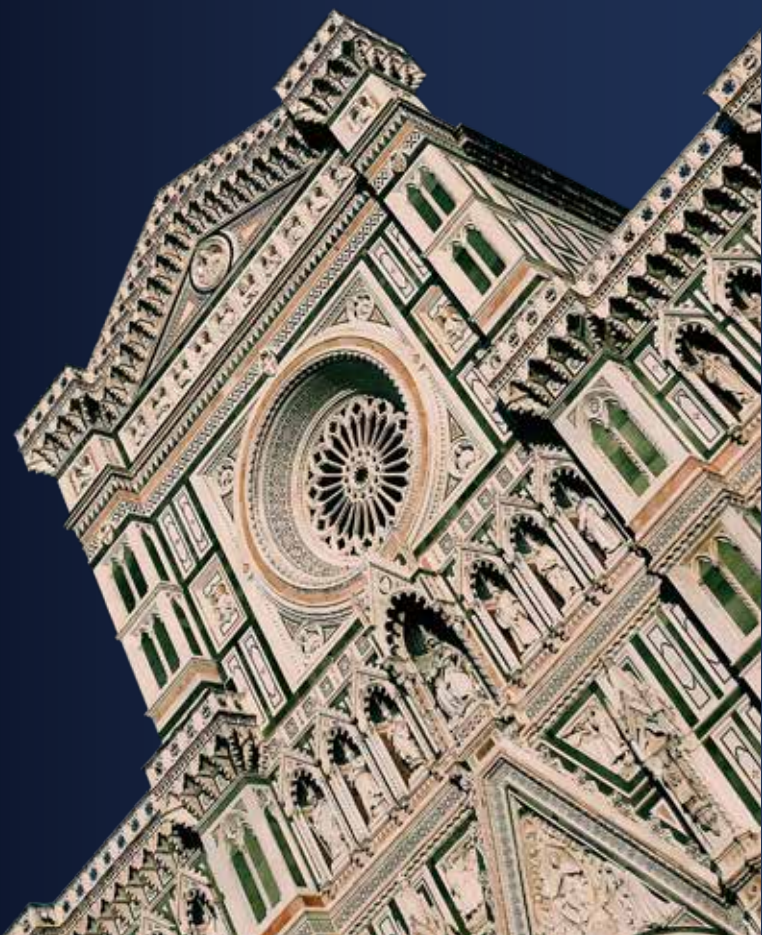
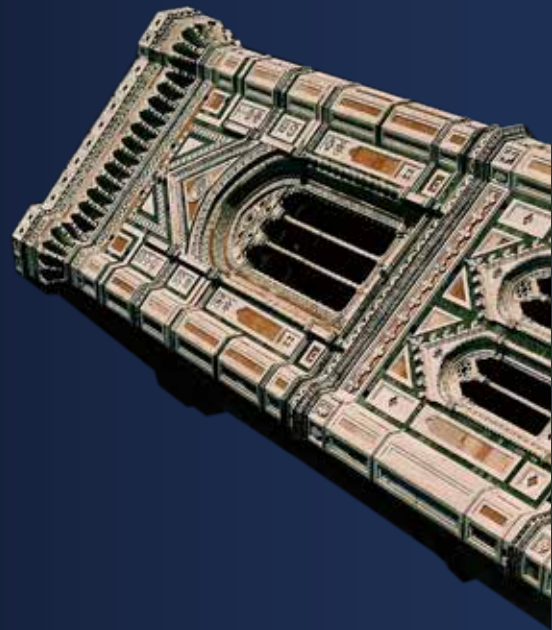


# 32<sup>ND</sup> ANNUAL MEETING OF THE EUROPEAN MUSCULO SKELETAL ONCOLOGY SOCIETY

20<sup>TH</sup> EMSOS NURSE AND ALLIED PROFESSIONS GROUP MEETING

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## ABSTRACT BOOK



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# **SESSION 01 NEW STRATEGIES IN SARCOMA THERAPY: CHEMOTHERAPY, TARGET THERAPY, IMMUNOTHERAPY AND RADIATION THERAPY**

2297

**Neoadjuvant/adjuvant chemotherapy with doxorubicin, cisplatin, high-dose ifosfamide, and high-dose methotrexate for patients with osteosarcoma of the extremity**

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**Introduction and Purpose:** The prognosis for patients with osteosarcoma (OS) has greatly improved with the introduction of multi-drug chemotherapy. It is generally accepted that there are four active drugs against OS: doxorubicin, cisplatin, methotrexate, and ifosfamide. However, there is a controversy as to which combination is the most effective. The purpose of this study is to evaluate the efficacy of a four-drug regimen neoadjuvant/adjuvant chemotherapy for patients ≤40 years of age with nonmetastatic OS of the extremity.

**Methods:** Eligibility criteria for this study were diagnosis of primary high-grade OS of the extremity, age ≤40 years, and no known metastasis at presentation. 95 patients from 1997 to 2016 were evaluated. Treatment consisted of ten cycles of chemotherapy and wide resection surgery. Preoperatively, patients received two cycles each of doxorubicin (90 mg/m<sup>2</sup>) /cisplatin (120 mg/m<sup>2</sup>) combination (AP) and high-dose ifosfamide (15 g/m<sup>2</sup>) (HD-IFM). Postoperatively, patients received two cycles each of AP, HD-IFM and high-dose methotrexate (12g/m<sup>2</sup> on consecutive weeks).

**Results:** Patient characteristics: age range was 5-37 years (median 15 years), 60 male, 35 female. Primary tumor sites were femur 50, tibia 28, humerus 10, fibula 6 and radius 1. Follow-up period was 17-252 months (median 118 months). At last follow-up, 75 cases were CDF, 11 were NED, 1 was AWD and 8 DOD. There were 3 local recurrences, 16 lung metastasis, and one bone metastasis. There was no death related to treatment toxicity. The 5-year and 10-year event-free survival rate was 81% and 78%. The 5-year and 10-year overall survival rate was 95% and 90%.

**Conclusion:** A four-drug regimen chemotherapy for OS with doxorubicin, cisplatin, methotrexate, and lipoamide was feasible with no major treatment-related toxicity. The survival rates were similar or better than previous studies. This study shows that this four-drug 10 cycle regimen can be an effective treatment for OS.

## 2253

### Is there a role for chemotherapy after local relapse in high grade osteosarcoma?

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**Background:** High-grade bone osteosarcoma has a high relapse rate. Best treatment of local recurrence (LR) is under discussion. Aim of this study is to analyse LR patterns and factors prognostic for survival.

**Methods:** LR diagnostic modality (clinical or imaging), pattern of recurrence and post-LR survival (PLRS) were assessed.

**Results:** Sixty-two patients identified. With a median age of 21 years (range 9-75 years) at recurrence 11 (18%) had up to 15 years, 30 (48%) from 16 to 29 years and 21 (34%) were older. Pattern of relapse: LR only: 58%; LR + distant metastases (DM): 42%. 79% relapsed within 24 months and diagnosis was clinical in 88%. Treatment at LR was: surgery 85%, chemotherapy 55%, chemotherapy + surgery 45%. Surgical complete remission after LR (CR2) was achieved in 60% (LR: 86%; LR + DM: 23%). With a median follow-up of 43 months (range 5-235 months) 5-year PLRS was 37%, significantly better for patients with longer LR-free interval (LRFI) ( $\leq 24$  months 31% vs  $> 24$  months 61.5%,  $p = 0.03$ ), absence of DM (no DM 56% vs DM 11.5%,  $p = 0.0001$ ) and achievement of CR2 (no CR2 0% vs CR2 58.5%,  $p = 0.0001$ ), and no difference according to age and the use of chemotherapy (LR only: 5-year PLRS: 53% without chemotherapy vs 58% with chemotherapy,  $p = 0.9$ ; LR+DM: 5-year PLRS: 25% without chemotherapy vs 9% with chemotherapy,  $p = 0.7$ ).

**Conclusions:** Better survival was demonstrated for patients with LR only, as compared with DM. Early relapse is detected by clinical findings in about 90% of the cases, and it is associated with worse outcome. Achievement of CR2 is crucial for survival, while chemotherapy and age do not affect PLRS.



## 2411

### Quantitative assessment of off-label use of immunomodulatory, targeted or other non-cytotoxic agents for recurrent osteosarcoma in Germany: Data from the Cooperative Osteosarcoma Study Group (COSS)

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**Introduction and Purposes:** In Germany, „recurrent osteosarcoma“ is not a labeled indication for any targeted, immunomodulatory, or other non-cytotoxic medication. We set out to investigate if and to which extent patients were none the less exposed to such off-label therapies.

**Materials and Methods:** The COSS registry was searched for German patients with a 1st osteosarcoma recurrence 06/05-12/18. Among these, data on off-label use covering 555 recurrences (326 1st, 229 ≥2nd) in 333 patients could be evaluated.

**Results:** Overall, 209 instances of off-label use of 24 distinct agents were documented in 162/555 recurrences (29%; with conventional chemotherapy 106/162). To our knowledge, only 8 treatments were within prospective trials. Among 200 deceased patients, off-label use was documented for 90 (45%). Overall, targeted agents were used against 68 recurrences: kinase-inhibitors 53 (40 sorafenib, 8 dasatinib, 2 pazopanib, 2 lenvatinib, 5 others), mTOR-inhibitors 22 (22 everolimus), monoclonal-antibodies 14 (7 denosumab, 6 anti-IGF1, 1 bevacizumab), PARP-inhibitors (olaparib) 3. Immunomodulatory agents were employed against 86 recurrences: cytokines 46 (45 interferon alpha, 2 others), macrophage-activators (mifamurtide) 35, checkpoint-inhibitors 6 (4 pembrolizumab, 2 nivolumab). Other non-cytotoxic agents were used in 25 recurrences (17 bisphosphonates, 4 thalidomide, 3 ascorbic acid, 1 valproic acid). Off-label use was more common when no complete remission was achieved ( $p < 0.01$ ), there was no difference in off-label use between 1<sup>st</sup> and ≥2<sup>nd</sup> recurrences ( $p = 0.054$ ) or between those diagnosed 2005-2011 vs. 2012-2018 ( $p = 0.56$ ).

**Conclusions:** Access to off-label therapies may be easier in Germany than elsewhere: Despite often limited or even completely lacking disease-specific efficacy data, German osteosarcoma patients were exposed to a wide variety of off-label drugs at recurrence. Treatment within appropriately designed trials would clearly be preferable.

2287

## A potential repurposing drug (Mycophenolate mofetil) from organ transplantation to osteosarcoma treatment

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**Introduction:** Our previous review of proteomics data showed that some proteins overexpressed in osteosarcoma were targets of FDA-approved non-anticancer drugs including Mycophenolic acid (MPA), Ribavirin, Leflunomide, Azathioprine, and Digoxin.

**Purposes:** Here, these drugs were screened for growth inhibitory effect against human osteosarcoma in vitro and animal studies.

**Materials and Methods:** Five osteosarcoma cell lines were used for screening efficacy and anti-oncological function of drugs. Xenograft implantation and tail vein injection in BALB/c nude mice was used for efficacy study of selected drug in controlling tumor growth and metastasis.

**Results:** Only mycophenolic acid (MPA) in therapeutic range showed efficient inhibition of osteosarcoma cell growth, and comparable in efficacy to standard chemotherapeutic drugs (Figure1). MPA at a sub-therapeutic dose significantly inhibited oncological function of all osteosarcoma cell lines. Tumor was significantly suppressed, achieving  $57.4 \pm 11.1\%$  growth inhibition in xenograft model (Figure2A), and significantly reduced the number of lung metastatic nodules compared with the vehicle group (Figure2B).

**Conclusions:** Doses of MMF 200 mg/kg/day (equivalence to subtherapeutic dose in organ transplantation used) can effectively control tumor growth and metastasis of osteosarcoma. Thus, MPA would be of great interest as a drug repurposing candidate in osteosarcoma.

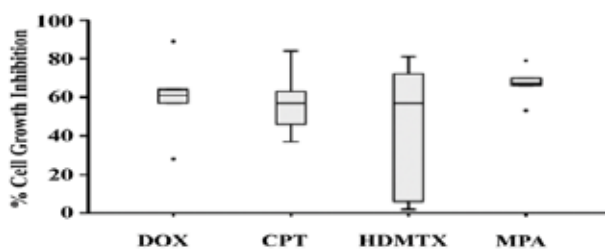


Figure 1 - The percentages of cell growth inhibition of each drug on osteosarcoma cell lines were calculated from the dose-response curve. DOX: Doxorubicin, CPT: Cisplatin, HDMTX: High-Dose Methotrexate and MPA: Mycophenolic acid.

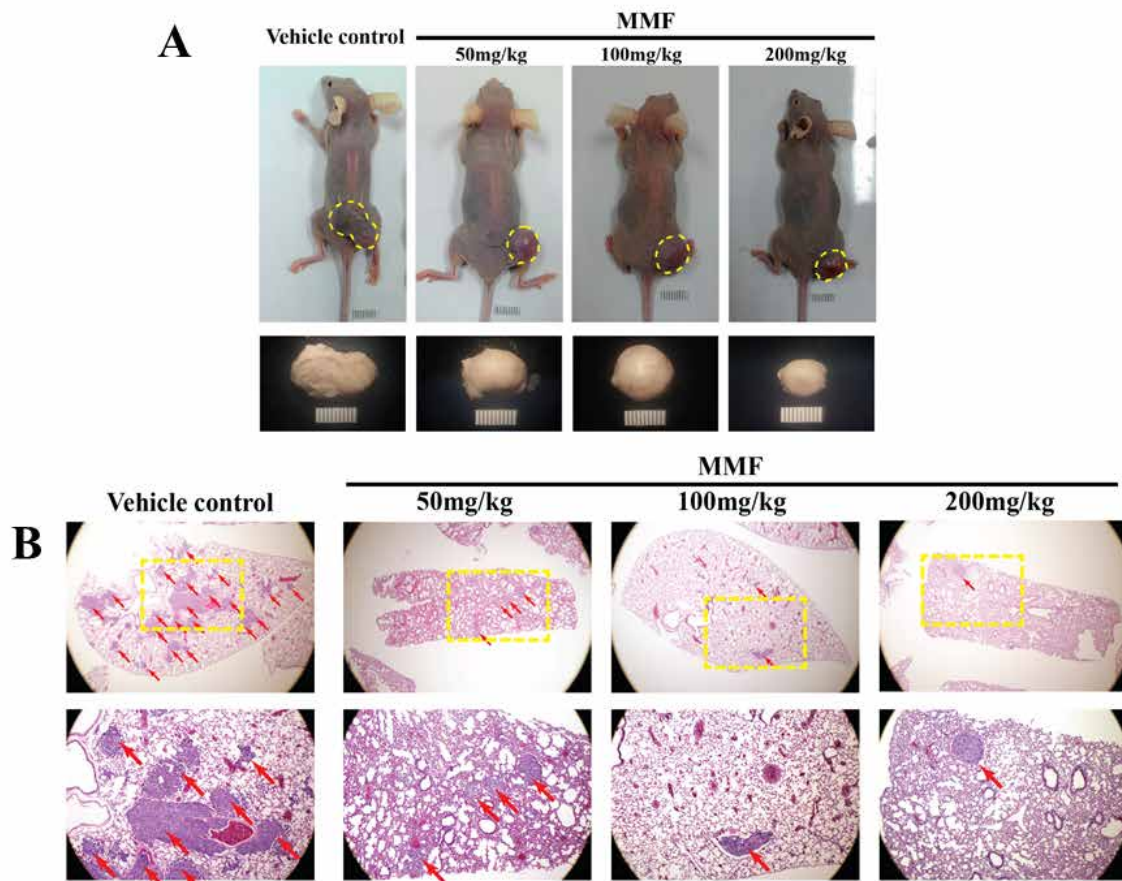


Figure 2 - In vivo antitumor and antimetastatic effects of MMF (a prodrug of MPA) in mice, tumor growth inhibition (A), and metastatic nodules (B).

**2702**

### **The impact of local control strategies in Ewing sarcoma of bone in children**

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In children with Ewing sarcomas, both surgery and radiotherapy (RT) are effective for local treatment inside the chemotherapeutic systemic protocols. Combination of both techniques in different sequences is available but the choice is individualized and depends on tumor patterns (site, size), patient age, family compliance and institutional practice. In this contest the impact of local control strategies on the oncological outcome is still unclear. Long-term oncological results in a series of 144 children (age range 1-15, median 11) consecutively treated for a localized Ewing sarcoma at Rizzoli Institute from January 2000 to December 2016 were analyzed, focusing on local control modalities. All patients received induction chemotherapy according to various protocols and were then discussed in a multidisciplinary meeting for local control strategy. Axial tumors (spine and ribs), relapses after previous surgery, and metastatic patients were excluded. Main locations were Femur (37), Pelvic bones (27), Tibia (26), Humerus (21) Radius (9), Fibula (7). Local treatment was obtained by surgery in 128 cases :6 amputations, 1 A1Rotation plasty and 121 limb-salvage(LS) procedures (Group.A) and by intended definitive RT (>54Gy) in 10 cases :8 pelvis, 1 radius, 1 foot (Group.B). In 6 patients :3 pelvis and 3 humerus, 54Gy RT was performed after 4-6 cycles of induction chemotherapy and LS was planned and performed after the completion of the protocol (Group C). In 8 LS patients, PORT (postoperative radiotherapy) > 42 Gy was delivered : in 4 because inadequate surgical margins and in 4 because poor histological response. At a mean follow-up of 8,5 years, 79 % of the patients of Group A are alive without evidence of disease (73% CDF). In Group B, the % is 50 and in Group C 100%. During follow-up a local recurrence was observed in 12 cases, nine in Group A(7%) and 3 in the Group B (30%).. Prognosis after local recurrence was always fatal. No local failure was observed in Group C and in the 8 cases after PORT. The authors suggest to expand also in children patients with Ewing, the use of PORT after inadequate surgical margins and after the assessment of poor response to induction chemotherapy. In large pelvic lesions or in selected cases of the limbs, a two-step strategy (first local radiotherapy, and then surgery after all the chemotherapy regimen ) seems a promising approach.



2576

### The role of neoadjuvant radiotherapy in Ewing sarcoma patients

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**Introduction and Purposes:** Local wide excision subsequent to induction chemotherapy(CT) with or without preoperative radiotherapy(RT) gained popularity in the local control of Ewing's Sarcoma of bones in the last decade. We aimed to investigate the effect of neoadjuvant preoperative RT to survival, local recurrence and complication rates.

**Materials and Methods:** 75 patients with Ewing's Sarcoma with a mean age of 19.1 were treated in our institution during last 25 years. 35 patients received preoperative CT and local wide excision (Group 1). 40 patients received preoperative RT in addition to CT before local wide excision (Group 2). Preoperative RT was applied when the tumor's response to the induction CT was not sufficient (e.g. less soft tissue component shrinkage or progression under chemotherapy). All patients were operated by the senior surgeon. CT protocol was a modification of VACA with addition of phosphamide and etoposide.

**Results:** Mean follow-up was 47,7 months. 51 patients were NED, 4 were AWD and 20 patients were DOD in mean 47 months follow-up. 5-years survival rate was 73.3% according to Kaplan-Meier method. Event free survival was 74.2% in Group 1 which was slightly better than Group 2 (67.5%). Local recurrence was 8.5% in Group 1, 2.5% in Group 2. Infection rate was 5.7% in Group 1 and 12.5% in Group 2. Wound problem rate was 8.5% in Group 1 and 27.5% in Group 2. 25.7% lung metastasis and 11.4% skeletal metastasis in Group 1 versus 22.5% lung metastasis and 2.5% skeletal metastasis in Group 2 were observed. Even though the higher rate of local complications in Group 2; such as infection which caused the loss of allograft in 2 of 4 infected cases; local recurrence was lower in Group 2 compared to Group 1, in these relatively less-sensitive tumors to the systemic therapy.

**Conclusions:** Preoperative RT provides better local control but causes higher complication rate. The response to the induction CT can propose the need of preoperative RT.

2351

## Larotrectinib as neoadjuvant therapy in the treatment of pediatric Tropomyosin Receptor Kinase fusion sarcomas

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**Introduction:** TRK fusions involving NTRK1, NTRK2, and NTRK3 are oncogenic drivers in an array of cancers. Larotrectinib is a selective TRK inhibitor with an overall response rate of 75% in TRK fusion tumors and 93% in pediatric TRK fusion tumors.<sup>1,2</sup> A recent report indicated that larotrectinib could be used in the neoadjuvant setting to facilitate surgeries with decreased morbidity.<sup>3</sup> Here we present updated efficacy and safety results of the neoadjuvant use of larotrectinib in pediatric sarcoma patients (pts).

**Methods:** Pediatric pts with initially unresectable TRK fusion sarcomas who were enrolled in a clinical trial (NCT02637687) or were provided larotrectinib through compassionate use (NCT03025360) were included. Most received 100 mg/m<sup>2</sup>/dose (maximum:100 mg) twice daily. Response was assessed by investigators using RECIST v1.1. Surgery occurred when the tumors became resectable without significant morbidity.

**Results:** Ten clinical trial pts and 5 compassionate use pts (age:0.1-12.8 years) were evaluable (10 infantile fibrosarcomas, 5 other soft tissue sarcomas). Six pts had NTRK1 and 9 pts had NTRK3 fusions. Previous therapies included surgery (n=2), chemotherapy (n=6), both (n=3), or none (n=4). Larotrectinib treatment resulted in 1 complete (CR) and 13 partial responses; 1 stable disease. Pts (n=13) underwent surgery (1 surgery pending) without major complications and achieved margin status of R0 (n=10), R1 (n=2), or R2 (n=1). The 3 pts with positive margins continued therapy and 2 experienced a CR. Ten pts have stopped larotrectinib and remain in CR ranging from 2-23+ months. Adverse effects were primarily grade 1 and 2.

**Conclusions:** Larotrectinib is an active and well-tolerated treatment for NTRK fusion sarcomas and effective as neoadjuvant therapy for pts who would otherwise be subjected to amputation or disfiguring surgeries.

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2484

## The efficacy and safety of apatinib in metastatic alveolar soft part sarcoma: a case series of six patients in one institution

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**Introduction and Purposes:** Alveolar soft part sarcoma (ASPS) is a rare, mostly chemo-resistant soft tissue sarcoma (STS) subtype characterized by the unbalanced translocation t(X; 17) (p11.2; q25.3), which results in the ASPACR1-TFE3 fusion gene, accounting for only for 0.5-1% of all STS. With a paradoxical high metastatic rate, characteristic metastatic sites include lungs, lymph nodes and bone. ASPS usually have an indolent course and occurs in the lower extremities, especially the lower limb, also some patients have already been diagnosed with distant metastasis and invasion at the initial visiting. However, metastatic patients have only 20% of the 5-year survival. The National Comprehensive Cancer Network suggests chemotherapy for advanced, inoperable and/or metastatic STS, advanced or metastatic ASPS are generally not sensitive to conventional cytotoxic chemotherapy. Because of the key role of pathological angiogenesis in STS progression, invasion and metastasis, upregulation of angiogenic and metastatic targets, such as vascular endothelial growth factor (VEGF) and c-Met, were revealed in ASPS by transcriptomic analysis. In addition, ASPS is highly vascular, so the use of angiogenesis inhibitors may be a considerable choice in metastatic ASPS. A number of targeted agents have been demonstrated in ASPS such as pazopanib, crizotinib, sorafenib and anlotinib. Due to the previous studies, there are no prior reports on the effects and safety of apatinib in metastatic ASPS on case series. Thus, the aim of this study was to investigate the efficacy of apatinib, in patients with metastatic ASPS.

**Materials and Methods:** This retrospective analysis involved 6 patients with metastatic ASPS not amenable to curative treatment. Apatinib 500 mg was given per day. Tumor responses were assessed according to the Response Evaluation Criteria in Solid Tumors. Survival analysis was performed by the Kaplan–Meier test. The safety profile was further recorded.

**Results:** The mean age of the patients was 26.5 years (range, 17-32 y). The median PFS was 31.54 months (95% CI, 8.44-31.54). However, median OS has not been reached. The 24-month PFS and OS rates were 80.0% and 100.0%, respectively. One patient achieved a complete response, and the rest of five patients achieved a partial response, with an objective response rate of 100%. The median follow-up was 20.6 months (range, 12.43-34.13 m). The most common adverse events included gastrointestinal discomfort (4/6[66.7%]), hair hypopigmentation (4/6[66.7%]) and hand-foot skin reaction (3/6[50.0%]).

**Conclusion:** Our study provides the first evidence of the efficacy and safety of apatinib in patients with metastatic ASPS as first-line medical options. Though the astonishing result we have made, there are controversial problems in drug resistance and AEs of apatinib.

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Table 1 - Patient characteristics

Characteristics	Number of patients(percentage & range)
Sex	
Male	5(83.3)
Female	1(16.7)
Age(years)	
Median	26.5(17-32)
10-17	1(16.7)
>17	5(83.3)
Metastatic site	
Lung only	6(100)
Number of previous treatment lines	
1	5(83.3)
2	1(16.7)
Primary tumor site	
Extremities	4(83.3)
Trunk	2(16.7)
Primary tumor size	
>5cm	5(83.3)
<5cm	1(16.7)

Table 2 - Patients' clinical evaluations

Clinical evaluation	Number of patients(percentage & range)
N (missing)	6(0)
CR	1(16.67%)
PR	5(83.33%)
SD	0(0.00%)
PD	0(0.00%)
ORR(95% CI)	100.00(54.07,100.00)
DCR(95% CI)	100.00(54.07,100.00)

Table 3 - Clinical characteristics of 6 patients with metastatic ASPS treated with apatinib

patients	gender	age	ECOG PS	Primary site	Metastatic site	Surgery before apatinib	Treatment line	Initial does(mg)	Overall survival (m)	progression free survival(m)	medication time(m)	Duration of response(m)	Best response
1	male	26	1	Left thigh	Lung	Yes	2	500	NA	NA	22.8	NA	CR
2	male	32	1	Right thigh	Lung	No	1	500	NA	NA	12.8	NA	PR
3	male	29	1	Pelvis	Lung,	No	1	500	NA	18.5	18.9	17.4	PR
4	female	27	2	Right thigh	Lung	No	1	500	NA	6.2	4.5	14.7	PR
5	male	22	2	Right shoulder	Lung	No	1	500	NA	12.2	12.2	9.6	PR
6	male	17	1	Right thigh	Lung	No	1	500	NA	NA	5.8	NA	PR

Table 4 - Adverse Events

	Total N (%)	Grade		
AE		1	2	3-4
Gastrointestinal discomfort <sup>a</sup>	4	3	1	0
Hair hypopigmentation	4	2	2	0
Hand-foot skin reaction	3	1	2	0
Anorexia	2	2	0	0
Oral ulcers	2	2	0	0
Fatigue	2	1	1	0
Wound-healing problems	1	1	0	0
Proteinuria	1	1	0	0
Hypothyroidism	1	0	2	0
Hypertension	1	1	0	0



Table 5 - Anti-angiogenic agents for advanced or metastatic ASPS

Drug (Reference)	No. of patients	Age (years)	Tumor site (primary/metastasis)	Best response	Response duration (month)	Objective response Rate (%)
Anlotinib <sup>14</sup>	13	>18	NA	NA	Median PFS 21.0 Median OS NA 24m OSR 92%	46.0
Cediranib <sup>13</sup>	2	12 and 17	Shoulder/lung, brain Calf/lung	One SD	10.5	0
Crizotinib <sup>12</sup>	45	Median 30(16-69)	NA	Two PR	Median PFS 8.1 Median OS NA 24m OSR 81.2%	4.4
Pazopanib						
Ricardo J. <sup>27</sup>	4	18-29	Trunk and extremities/ lung	One SD	Median PFS 24.5	0
Funakoshi et al <sup>28</sup>	1	11	Thigh/lung	One PR	8	100
Sorafenib <sup>13</sup>	2	12 and 17	Shoulder/lung, brain Calf/lung	One PR	22	50.0
Sunitinib <sup>26</sup>	15	Median 32	Trunk and extremities/ pelvis and lung	Six PR	Median PFS 19	40.0

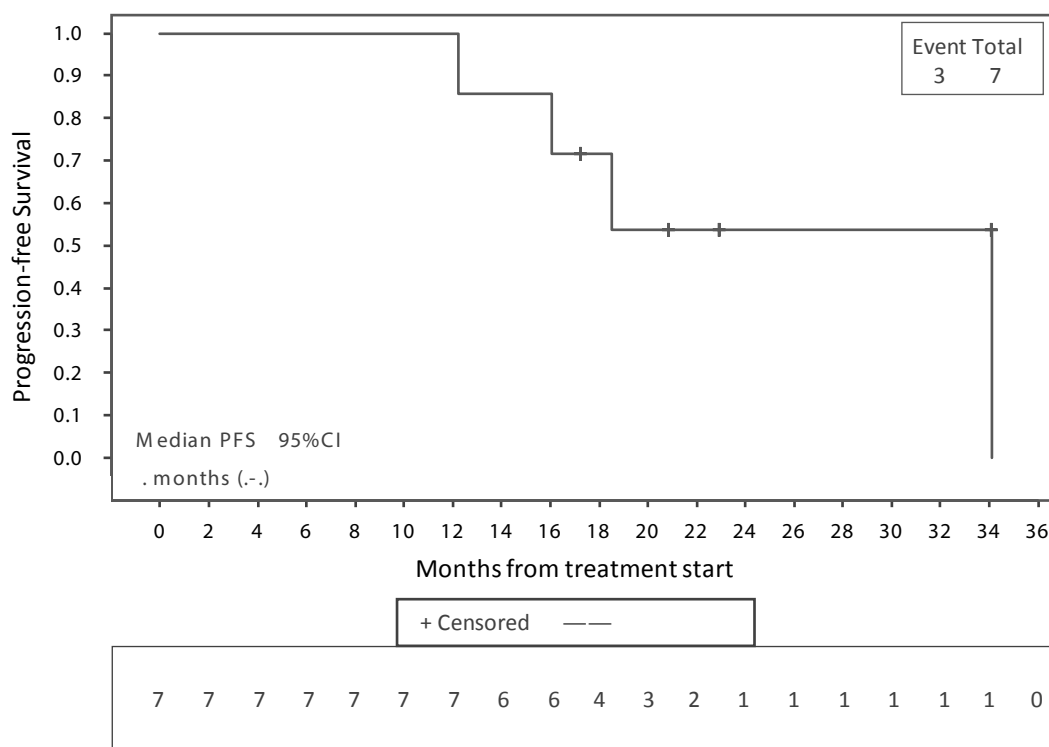


Figure 1 - Kaplan-Meier estimates of progression free survival for all patients.

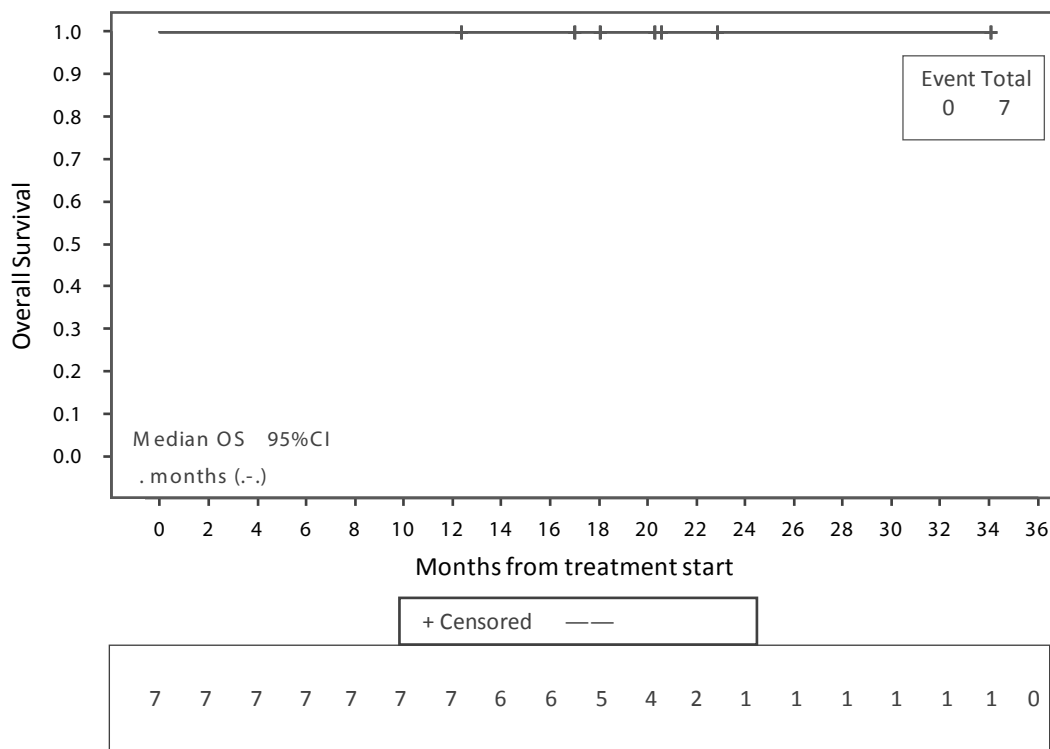


Figure 2- Kaplan-Meier estimates of overall survival for all patients.

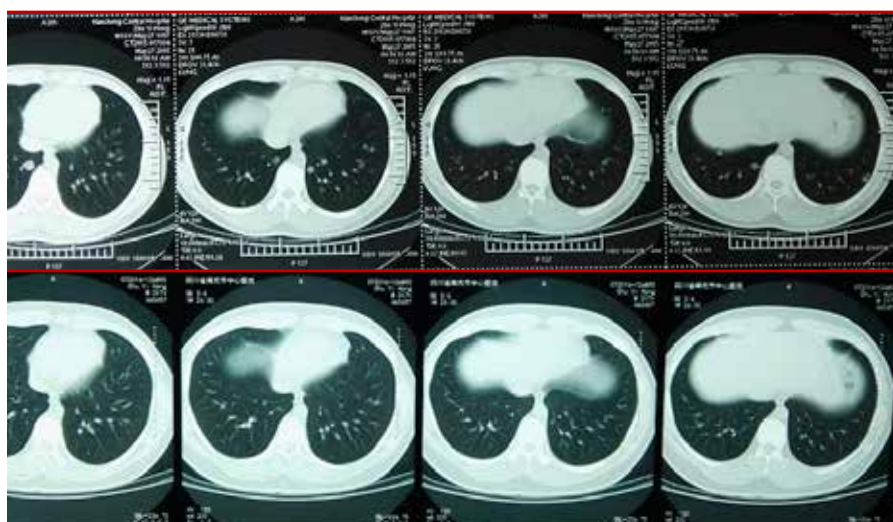


Figure 3 - The patient with best response of CR in apatinib. CT of chest are shown before and after treatment.

2473

### Stereotactic ablative radiotherapy for oligometastatic soft tissue sarcoma patients

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**Background:** Stereotactic Body Radiotherapy (SBRT) is emerging as a novel treatment option in oligometastatic cancer. It is unclear whether SBRT could be applied to bone and soft tissue sarcoma due to theoretical intrinsic radioresistance. The aim of our study was to evaluate the effectiveness and safety of SBRT in oligometastatic sarcoma.

**Material and Methods:** We collected data from a consecutive cohort of oligometastatic sarcoma patients treated in our Institution. Toxicity, Local Control (LC) rates and prognostic role of clinical and treatment-related characteristics (primary tumor type and location, synchronous or metachronous onset, SBRT site, Biologically Effective Dose [BED], concurrent chemotherapy) were assessed.

**Results:** 34 consecutive patients, accounting for 56 metastases (38 lung, 16 bone and 2 lymph node), were treated at our institution with SBRT. 8 (23.5%) had metastatic disease at diagnosis. 9 (26.5%) patients received SBRT associated with chemotherapy for metastatic disease. Median follow-up from first SBRT was 10 months (range 1-112). Median number of metastases treated per radiation course was 2 (range 1-3). Median SBRT fractions was 4.5 (range 3-12), median prescribed dose was 40Gy (range 25-54), median BED was 75Gy (range 48-151). LC at 6 months, 1 and 2 years was 85.4% [CI95% 73.8-92.4], 82.3% [CI95% 69.1-90.6], and 73.6% [CI95% 56.8-86.5], respectively. Only trunk primary tumor identified poorer LC (p=0.02). 15 patients received 2 SBRT courses, 1 received 3 courses. No acute or chronic grade  $\geq 3$  toxicity was observed. 2 patients experienced grade 1 toxicity.

**Conclusions:** In patients with oligometastatic sarcoma, SBRT yields satisfying LC with minimal toxicity regardless of concurrent treatment, metastasis timing and location, dose schedule. Repeated SBRT is feasible and may extend disease-free interval.

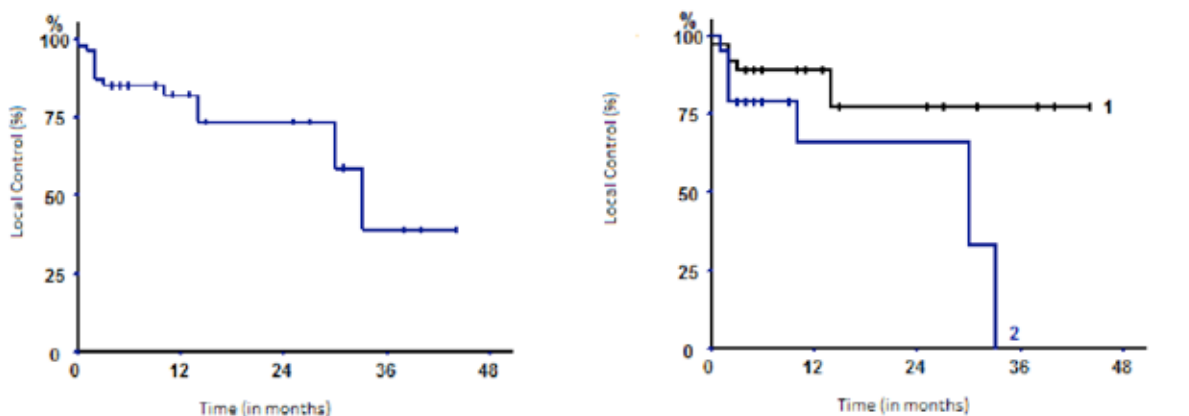


Figure 1 - Left:Kaplan-Meier plot for LC. Right: Kaplan-Meier plot for LC in metastases from trunk-located (2, n=19) vs limb-located primary (1, n=37).

2524

### **Stereotactic ablative body radiotherapy (SABR) for lung metastases from soft tissue sarcoma: preliminary results of a perspective phase II study**

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**Introduction and Purposes:** Patients with lung metastases (LM) from soft-tissue sarcomas (STS) have been treated with surgery and/or chemotherapy in the last decades. With the improvement of radiotherapy (RT) techniques, stereotactic ablative body radiotherapy (SABR) has been included in the management of metastatic disease. Aim of our study is to appraise the role of stereotactic body radiation therapy (SABR) in patients with lung metastasis from primary STS.

**Materials and Methods:** Patients in good performance status (ECOG 1-2), unsuitable for surgical resection, with controlled primary tumor were enrolled and treated with SABR. The number of lung metastases for every patient was 4. In a risk adaptive scheme, the dose prescription was: 30 Gy/1 fr, 60 Gy/3 fr, 60 Gy/8 fr and 48 Gy/4 fr. Treatments were performed with Volumetric Modulated Arc Therapy (VMAT). Clinical outcome was evaluated by thoracic and abdominal computed tomography (CT) scan performed before SBRT and then every 3 months. Toxicity was evaluated with Common Terminology Criteria for Adverse Events (CTCAE) scale version 4.0.

**Results:** Forty-eight patients for 101 lung lesions treated were analyzed. Leiomyosarcoma (38%) and synovial sarcoma (27%) were the most common histologies. Nine patients (19%) initially presented with pulmonary metastasis, whereas 44 (81%) developed them at a median time of 37 months (range 11–53 months) from the first diagnosis. The median follow-up time from initial diagnosis was 41 months (12–71 months) and from SABR was 21 months (12–36 months). No severe toxicity (grades III–IV) was recorded. The 2-years local control rate (from SBRT treatment) was 95%. Overall survival at 1 and 2 years was 95% and 87%, respectively. At the last follow-up 36 patients (75%) are alive.

**Conclusions:** SABR provides good local control of pulmonary metastasis from STS and may improve survival. SABR should be considered for all patients with pulmonary metastasis and evaluated in a multidisciplinary team.

2668

### **Carbon ion therapy alone for the treatment of sacral chordoma. The histological, PET and MRI response**

**Valerio Pipola<sup>1</sup>, Gisberto Evangelisti<sup>1</sup>, Maria Rosaria Fiore<sup>2</sup>, Stefano Bandiera<sup>1</sup>, Giovanni Barbanti Brodano<sup>1</sup>, Riccardo Ghermandi<sup>1</sup>, Marco Girolami<sup>1</sup>, Giuseppe Tedesco<sup>1</sup>, Silvia Terzi<sup>1</sup>, Roberto Orecchia<sup>2</sup>, Alessandro Gasbarrini<sup>1</sup>**

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**Introduction and Purposes:** Chordoma is the most frequent primary malignant tumor of the spine. En-bloc surgical resection with wide margins is the mainstay of treatment for these tumors. However, surgery with adequate oncological margins is difficult to be achieved because of voluminous mass due to late diagnosis. The advances in the fields of high-energy particles therapy has been showing new opportunity of less invasive approach. Thus, we started a clinical trial to evaluate the use of carbon ion therapy (CIRT) for the treatment of sacral chordoma.

**Materials and Methods:** Between January 2013 and December 2016 18 patients, 12 males and 6 females, with sacral chordoma histologically proven, were prospectively enrolled for CIRT treatment. All 18 patients underwent to carbon ion radiotherapy using active scanning beam delivery system. The total dose was 70.4 GyE, once daily fraction dose of 4.4 GyE, for a total of 16 fractions within 4 weeks. MRI was performed every three months after treatment. FDG PET-CT scan and biopsy were performed after 6-12 months after CIRT. The incidence of complications (intra- and postoperative), local control (LC), overall survival (OS) and progression-free survival (PFS), changes in neurological status, clinical outcomes and toxicity were considered.

**Results:** Radiological partial response (PR) was observed in 10 patients (56.3%) and stable disease (SD) in 5 patients (28.3%). Two patients (11%) had local relapse. One patient had progression disease. Overall survival rate was 100% at 24 months. FDG PET-CT after CIRT showed uptake decreasing compared to baseline exam in all but one patient. CT-guided biopsy was performed after 6-12 months from the end of the CIRT. All histological analysis but 2 reported signs of necrosis. Mean pain numeric rating score (NRS) score before treatment and at the end of radiotherapy was 5.7 and 3.6 respectively with a statistically significant difference ( $p=0.02$ ).

**Conclusions:** In conclusion our preliminary results seem to confirm the efficacy of carbon ion therapy for the control of unresectable sacral chordoma.

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## 2502

### Short-term neoadjuvant denosumab and surgery compared to long-term including adjuvant denosumab in advanced giant cell tumor of bone

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**Introduction:** Neoadjuvant denosumab was introduced to reduce surgical morbidity and hypothesized to reduce recurrence rate for giant cell tumor of bone (GCTB). We compared the outcome of different regimens of denosumab therapy and surgery.

**Methods:** We retrospectively reviewed all 44 patients with neoadjuvant denosumab and surgery for GCTB in one tertiary center (2009-2016). Median age was 32 years (17-67). Median follow-up was 45 months (13-95). 34 were localized in the long bones, 10 in the axial skeleton. Patients received 120mg denosumab s.c. at day1/8/15/29 and every 4 weeks thereafter, with Ca/vit-D supplements. Two had zoledronic acid in the past.

**Results:** 21 patients received neoadjuvant denosumab (median 12 months (6-24)), surgery (curettage with local adjuvants 17, isolated curettage 2 or resection 2) AND adjuvant denosumab (all 6 months). Nine had local recurrence (43%, median 14 months (3-28)). One developed high-grade osteosarcoma and metastases after 12 months of denosumab and resection. Four had osteonecrosis of the jaw (ONJ; 2 with zoledronic acid) and 1 serious dental problems without ONJ. Two had lung noduli; denosumab was stopped after a long-lasting response and remained stable. 23 patients received only neoadjuvant denosumab. Initially, 7 patients received long neoadjuvant denosumab (median 12 months (9-14)) and surgery (curettage with local adjuvants 5, isolated curettage 2). Three had local recurrence (43%, median 18 months (15-23)). One had lung noduli that remained stable after stopping denosumab. One had ONJ. More recently, 16 patients received short neoadjuvant denosumab (median 4 months (3-6)) and surgery (curettage with local adjuvants 11, resection 5). Six had local recurrence (38%, median 8 months (6-15)). There were no complications or long noduli in this group.

**Conclusion:** Although high, recurrence rate was not different for patients receiving neoadjuvant and adjuvant denosumab and those receiving only neoadjuvant denosumab. Shorter neoadjuvant therapy duration resulted in a lower rate of drug-induced complications.

## 2250

### Pexidartinib for advanced tenosynovial giant cell tumor: patient subgroup results from the phase 3 ENLIVEN study

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**Introduction and Purposes:** Tenosynovial giant cell tumor (TGCT), a rare, debilitating neoplasm of the joint/tendon sheath, overexpresses colony-stimulating factor 1 (CSF1). Pexidartinib (pex), a selective CSF1 receptor inhibitor, had a robust tumor response in TGCT patients (pts) in the phase 3 ENLIVEN study (NCT02371369). Here we present exploratory subgroup analyses by prior treatment, disease type, and tumor site.

**Materials and Methods:** Pts  $\geq 18$  y with symptomatic TGCT, for whom surgery would be associated with potentially worse function or severe morbidity, were randomized (1:1) to pex 1000 mg/d PO  $\times$  2 wk then 800 mg/d PO  $\times$  22 wk or placebo (pbo) (part 1). The primary endpoint was blinded, centrally reviewed overall response rate (ORR: complete or partial response) by RECIST version 1.1 at week 25; secondary endpoints included pain response at week 25.

**Results:** 120 pts were treated (pex=61; pbo=59); the majority had diffuse disease. In the total population, ORR by RECIST was higher for pex vs pbo at week 25 (39% vs 0%;  $P < 0.0001$ ); pain response improved numerically (31% vs 15%;  $P = \text{not significant}$ ). Pex efficacy (ORR and pain response) was consistent across subgroups (Table). Pex was generally well tolerated; the most frequent adverse events were hair color changes, liver enzyme increase, and fatigue.

**Conclusions:** Pex decreased tumor size consistently across subgroups. Pex may benefit pts regardless of prior surgery, prior radiation, disease type, or tumor site.

Pt Subgroup	n		ORR by RECIST, %		Pain Response*, %	
	Pex	Pbo	Pex	Pbo	Pex	Pbo
Prior surgery						
Yes	32	31	34	0	28	19
No	29	28	45	0	35	11
Prior radiation						
Yes	5	2	60	0	20	0
No	56	57	38	0	32	16
Disease type						
Diffuse	52	53	37	0	27	17
Localized	9	6	56	0	56	0
Tumor site						
Lower extremity	56	54	38	0	29	15
Upper extremity	5	5	60	0	60	20
Large joint <sup>†</sup>	42	47	36	0	19	17
Small joint	19	12	47	0	58	8

\* $\geq 3$  0% decrease in mean Brief Pain Inventory score without  $\geq 30\%$  increase in narcotic analgesics; not all pts were evaluable

<sup>†</sup>Knee, shoulder, elbow, or hip

<sup>‡</sup>All other joints

# SESSION 02

## SOFT TISSUE SARCOMAS 1

**2500**

### **Lymph node metastasis from extremity soft tissue sarcomas**

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**Introduction and Purposes:** Lymph node metastasis are a rare occurrence in soft tissue sarcomas of the extremity, arising in less than 5% of patients. Few studies have evaluated the prognosis and survival of patients with a lymph node metastasis. The purpose of this study was to evaluate the impact of lymph node metastasis on patient survival and to investigate the histologic and clinical features associated with lymph node involvement.

**Materials and Method:** A retrospective review was done of the prospectively collected soft tissue sarcoma database at our institution. Two thousand forty-five patients had surgery for soft tissue sarcoma of an extremity between January 1986 and August 2017. Included patients either presented with a synchronous lymph node metastasis or were diagnosed with a lymph node metastasis after their initial treatment. Demographic, treatment, and outcome data for patients with lymph node involvement were obtained from the clinical and radiographic records. Lymph node metastases were identified as palpable adenopathy by physical examination and were further characterized on cross-sectional imaging by computed tomography (CT) or magnetic resonance imaging (MRI) scans. All cases were confirmed by pathologic examination of biopsy specimens.

**Results:** One hundred eighteen patients with a mean age of 55.7 (SD=18.9) were included in our study. Seventy-two (61.3%) out of 119 patients were male. Thirty six patients (57.1%) had lymph node involvement at diagnosis. The mean follow-up from the date of the first surgery was 56.3 months. The most common histological diagnoses were malignant fibrous histiocytoma (35) and liposarcoma (12). Eighty nine patients (89%) underwent surgical treatment of the lymph node metastasis while 21 (17.6%) were treated with chemotherapy and/or radiation therapy. The mean survival was 52.6 months (range 1-307).

**Conclusion:** Our results suggest that patients with a lymph node metastasis have a better prognosis than previously described. Their overall survival is superior to patients diagnosed with lung metastasis. Furthermore, our study also indicates that different histological subtypes such as liposarcoma or malignant peripheral nerve sheath tumor (MPNST) may also be responsible for lymph node metastasis.

2565

## Oncologic and clinical outcomes of limb sparing surgery in soft tissue sarcoma

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**Introduction:** Soft tissue sarcomas (STS) are a malignant tumors that origins from mesenchymal and connective tissue. More than 50 histological subtypes of STS had been described and they represent approximately 1% of all adult cancers.<sup>1,2</sup> It can develop at any age and in any anatomical region of the body. According to the current literature, survival is between 60 and 70%. Surgery with free margins is the treatment of choice but with respect to adjuvant the results are controversial<sup>3-5</sup>. The objective of our study was evaluated the outcomes of limb sparing surgery in patients with STS and analyzed: 1) oncologic outcomes; 2) prognostic factor; 3) functional results; 4) non oncologic complications.

**Methods:** We retrospectively reviewed a group of patients with soft tissue sarcoma that were treated with limb sparing surgery at a single institution between 2004 and 2012. 400 soft tissue extremity sarcoma were treated and 328 matched the inclusion criterias. The mean follow-up of the series was 85 months and the median age was 45 years. The primary site of tumor location were the lower extremity. 220 patients received adjuvant radiotherapy and 81 patients received adjuvant chemotherapy. Patients were divided in two groups for the analysis: 1- high grade STS (HGSTS) and 2-low grade STS (LGSTS). The functional evaluation was performed with the use the Musculoskeletal Tumour Score Society. We analysed survival according to the Kaplan-Meier method with 95% confidence intervals(CI), comparing survival between groups using the log-rank test. OS was defined as the time interval from the date of diagnosis to the date of death from any cause or to the date of the last follow-up. EFS was defined as the time from diagnosis to either the date of the last follow-up, death, local or distant recurrence. Statistical significance was set at a p-value ≤ 0.05.

**Results:** One year overall survival (1yOS) of the series was 96 % (95% CI: 81-89) and 5 years overall survival (5yOS) was 67% (95% CI: 64-75). Five year local recurrence free survival (5yLRFS) was 74% (95% CI:68-78) and 5 year metastasis free survival (5yMFS) was 71,6 (95% CI:68-78). 1 (HGSTS): 1yOS was 96 % (95% CI:92-98) and 5yOS was 61% (95% CI: 55-68). 5yLRFS was 69% (IC95% 63/76) and 5yMFS was 63% (IC95% 56/68). 2 (LGSTS): 1yOS was 98 % (95% CI: 95-100) and 5yOS was 87 % (95% CI: 80-93). 5yLRFS was 84 % (95% CI:75-90) and 5yMFS was 84% (95% CI:89/98). Neoadjuvant radiotherapy had been a positive prognosis factor for local recurrence in high grade sarcomas (p=0.032) but it was not significant in terms of metastasis development (p=0.41). Neoadjuvant chemotherapy had not demonstrated to reduce the local recurrence rate (p=0.14) or survival prognosis (p=0.29) for high grade soft tissue sarcomas. 8,5% patients had amputation. 1 (HGSTS): Mean MSTS was 26 (23-29) and the median time for returning to patinets habitual activity was 8 months (range:6-16). 2 (LGSTS): Mean MSTS was 28 (26-30) and he median time for returning to patinets' habitual activity was 4 months. 18% (60/328) of the serie presented with a non oncological complication. Deep infection and surgical wound dehiscence had been the most prevalent (35/60) and most of them occurred in the group that received neoadjuvant radiotherapy. Limb salvage surgery was possible for 92% of the series at last follow up.

**Conclusions:** Five year overall survival for extremities soft tissue sarcomas is 67% and significantly affected by grade (61% vs 87%). For high grade soft tissue sarcomas, neoadjuvant radiotherapy seems to reduce the risk of local recurrence but increase non oncological complications.

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### Leiomyosarcomas of the musculoskeletal system. Therapy and prognosis

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Sarcomas of the musculoskeletal system are a group of heterogeneous lesions. Leiomyosarcomas are a known less favorable variant. The aim of this retrospective one center study was to evaluate prognostic factors.

**Patients and Methods:** From 1986 to 2018, 103 patients with leiomyosarcomas were surgically treated. 96 of them primary tumors, 7 metastases of visceral tumors. The average age was 59 years (16-90 years). The localization in the bone was 4 pelvis, 3 femur, 3 tibia, 2 foot and humerus, and once the spine. In the soft tissue this was 34 thigh, 17 lower leg, 13 pelvis, 8 foot, 6 upper arm and other lesions. 88 lesions were resected and reconstructed. 4 patients had to be amputated. In 9 cases biopsy only was performed, in 2 cases a stabilization. 23 patients (22%) showed initially metastatic disease.

**Results:** The follow-up was 28 months in median for survivors. 19% developed local recurrence (LR). LR occurred in 18% in R0, in 25% in R1 and in 63% in R2 resections ( $p = 0.0273$ ). 28% of patients developed metastatic disease, in 35% simultaneously to LR. At follow-up, 43 (42%) of the patients had died, 15 (15%) were alive with and 45 (44%) were alive without tumor. After 5 years still 50%, after 10 years still 40% of the patients survived. There was no difference between primary visceral tumors and primary lesions of the musculoskeletal system. With initial metastasis, survival was significantly worse. The occurrence of LR did not change survival. Looking only at the primary leiomyosarcomas, bone lesions showed a clear trend towards poorer survival (Fig 1). There was no survival difference between patients resected R0 or R1. R2 resected patients lived shorter in trend. Patients with G1 leiomyosarcomas survived almost all. In G2/3 patients there was no difference in survival. If metastatic disease occurred at any time, survival was significantly worse at 40% at 5 years and 20% at 10 years (Fig. 2).

**Conclusion:** Leiomyosarcoma is a rare subtype. Important is the clear distinction of G1 tumors. Those are usually superficial with excellent prognosis. Metastasis worsens the prognosis. LR occurred in more than 20%, depending on the resection status. LR was not correlated with metastasis or survival. Primary osseous lesions are rare and show the worst prognosis. With a survival of 50% after 5 years, the prognosis of leiomyosarcomas is overall worse than in other soft-tissue sarcomas but not frustrating.

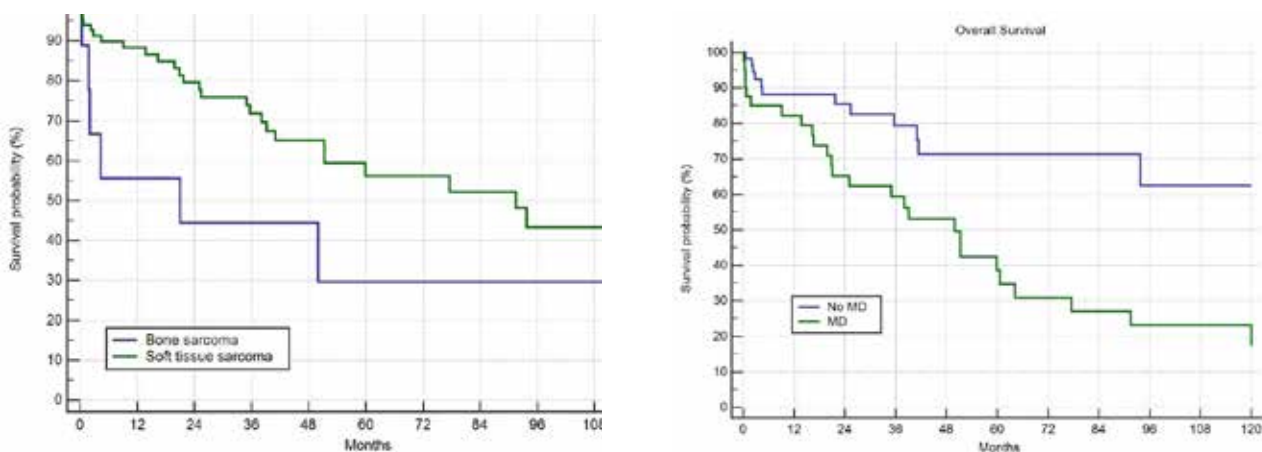


Figure 1

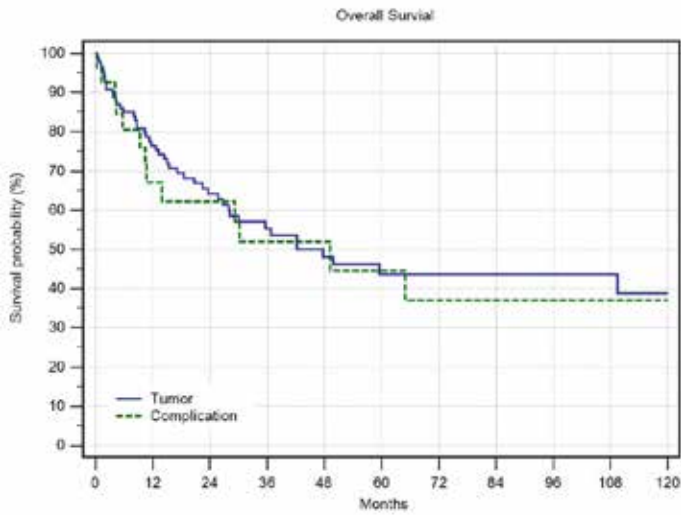


Figure 2

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### **Oncologic outcomes in patients with extraskeletal Ewings sarcoma (EES)**

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**Introduction:** Extraskeletal Ewing's sarcoma (EES) is a rare entity, accounting for 15% of all Ewing's sarcomas. EES is highly aggressive. Local relapse and distant metastases are frequent. It needs aggressive surgical resection, adjuvant chemotherapy and radiotherapy. This retrospective study was performed to assess oncologic outcomes in patients with EES.

**Method:** All operated cases of EES included from January 2005-December 2014 (n=37). Data extracted through surgical audit. Patients were treated by multidisciplinary approach with use of chemotherapy, radiotherapy & surgical excision for all cases. Overall survival (OS) and Event-free survival (EFS) was calculated at 5yrs.

**Result:** Age ranged from 5-52yrs with mean age of 25yrs. M:F ratio was 20:17. 9 patients were <18yrs and 28 patients were >18yrs of age. 30 cases were located in the extremities, while 7 were axial. 5/37 patients (13.5%) were metastatic at presentation. Mean duration of follow-up was 54 months (3-137months). 24 patients were alive, 11 dead and 2 were lost to follow-up. 25 patients had <99% necrosis, 7 patients had 100% necrosis on histopathology. Necrosis could not be evaluated in 5 patients who underwent tumor bed excision. 10/37 patients had recurrence of which 7 were distant recurrence (DR), 3 were both LR (local recurrence) and DR. All are dead. 1 patient died due to adjuvant chemotherapy. 3 patients had R1 resection. OS at 5 yrs for all was 70%. OS for metastatic patients at 5yrs was 20%, while for non-metastatic patients it was 78% (p-value < 0.001). EFS at 5yrs for all was 68%. EFS for metastatic patients at 5yrs was 20%, while for non-metastatic patients it was 76% (p-value < 0.001). 7 patients who had 100% necrosis had 100% OS & EFS at 5 yrs but was not statistically significant (p-value < 0.075).

**Conclusion:** OS at 5yrs in our study was 70%. Metastasis at presentation had overall poor prognosis. Age, site, response to chemotherapy did not impact on survival in our study, possibly due to small number of cases.

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### **Preoperative hypofractionated radiotherapy in patients with primary lower limb myxoid liposarcoma. Single-arm prospective clinical trial**

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**Introduction:** Myxoid liposarcoma (MLPS) is considered to be highly radiosensitive as compared with other soft tissue sarcomas (STS). The main objective of the study is to assess the efficacy of hypofractionated preoperative radiotherapy in patients with localized primary MLPS.

**Study Design:** Single-arm prospective clinical trial

**Methods:** In this single-arm prospective clinical trial patients with locally advanced MLPS undergo preoperative 5x5 Gy RT with 6-8 weeks gap between RT end and surgery. The endpoints of the study are the rate of early wound healing complications and 5-year local control rate.

**Results:** From May 2015 until now 28 patients with primary MLPS finished the whole planned protocol treatment of neoadjuvant hypofractionated radiotherapy for 5 consecutive days; All of the patients had the tumors located in the lower limb. The median size of the tumor was 16 cm, Early RT tolerance was good. Prolonged wound healing occurred in 3 pts. R0 margins were achieved in all but two patients who had R1 resection margin. None of the patient had local recurrence, three patients developed distant metastases. Mean patient age was 48.5.

**Conclusions:** Preoperative hypofractionated RT with a long gap between the radiotherapy and surgery is a reasonable approach to MLPS treatment providing a good local control and low rates of complications

**Keywords:** Myxoid liposarcoma; hypofractionated radiotherapy; neoadjuvant

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### **Adjuvant volumetric modulated arc therapy (VMAT) versus three dimensional conformal radiation therapy (3DCRT) for newly diagnosed extremities Soft Tissue Sarcoma patient. A comparative study**

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**Introduction and Purposes:** To assess the impact of adjuvant volumetric modulated arc therapy (VMAT) compared with three dimensional conformal radiation therapy (3DCRT) in terms of toxicity and local control in patients with soft tissue sarcoma (STS) of the extremities treated with radical surgery and adjuvant radiotherapy.

**Materials and Methods:** From 2004 to 2016, 109 patients were treated, initially using 3DCRT and subsequently with VMAT. Clinical outcome was evaluated by contrast-enhanced MRI, thoracic and abdominal CT 3 months after treatments and then every 6 months. Toxicity was evaluated with Common Terminology Criteria for Adverse Events (CTCAE) scale version 4.3.

**Results:** The vast majority of patients had stage I-III STS disease (95%), liposarcoma (57%) histology, localized at the lower extremity (87%). Surgical resection was performed in all patients, followed by adjuvant 3DCRT in 38 patients, and VMAT in the other 71. The median total dose was 66 Gy/33 fractions (range 60-70 Gy; 25-35 fractions). More successful bone sparing was recorded using VMAT ( $p < 0.01$ ). Median follow-up was 68 months. The 2 and 5 year LC were  $95.3\% \pm 0.02$  and  $87.4\% \pm 0.03$  for the whole cohort,  $92\% \pm 0.05$ ,  $82.9\% \pm 0.06$  for 3DCRT group,  $97.1\% \pm 0.02$ ,  $89.6\% \pm 0.04$  for VMAT group ( $p=0.2$ ). On univariate and multivariate analysis the factors recorded as conditioning LC were the status of the surgical resection margins and the total dose delivered.

**Conclusions:** The availability of modern RT technique permit a better conformity on the target with maximum sparing of normal tissue and acceptable side effects. Our data underline as VMAT is a safe and feasible treatment with limited rate of toxicity, compared to 3DCRT. Results on local control of VMAT are encouraging.



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### **Response rates and local recurrences after TNF-alpha and melphalan based isolated limb perfusion in soft tissue sarcoma**

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#### **Introduction:**

TNF-alpha and Melphalan based isolated limb perfusion (TM-ILP) is still believed to be one of the most effective local treatment methods in primarily non-resectable soft tissue sarcoma (STS) in order to downstage the local tumor, to render it resectable and to avoid amputation (1). The aim of this study was to report the treatment results from our center after 16 years of experience with TM-ILP.

#### **Materials & Methods:**

Data was collected from our prospectively maintained ILP-database. All patients received TM-ILP due to a primarily non-resectable STS followed by a resection of the residual tumor 6 to 8 weeks afterwards. Treatment details (additional neoadjuvant treatment such as radiation therapy or systemic chemotherapy), response rates and local recurrence rates were evaluated.

#### **Results:**

from 02/2002 until 03/2016 212 patients with advanced and primarily non-resectable STS were treated by TM-ILP and subsequent resection 6-8 weeks after TM-ILP. Follow-up data was available from 189 patients. 93% of all tumors were high-grade STS. 75 % of tumors treated by TM-ILP showed a positive response to therapy with < 50 % of vital tumor. 19 % of all patients had a local recurrence of their tumors after a median disease free interval of 17 months (4-80 months).

#### **Conclusion:**

Our data confirms that TM-ILP is of great value in cases of non-resectable and advanced STS. The response rates are remarkably higher than for systemic chemotherapy alone. TM-ILP as part of a multidisciplinary approach can facilitate resectability of primarily non-resectable high-grade STS.

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### Body composition as a predictor of toxicity after treatment with eribulin for advanced soft tissue sarcoma

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**Background:** Despite the clinical benefits of eribulin on overall survival of advanced soft tissue sarcoma (STS) patients, treatment-related toxicity reduces their QOL. Body composition metrics (BCMs) are associated with poor outcome and drug toxicities in several cancers. This study investigated whether BCMs could predict drug toxicity occurrence in advanced STS patients treated with eribulin.

**Methods:** This study included 23 advanced STS patients treated with eribulin between March 2016 and April 2018. BCMs were evaluated using a CT scan obtained within 1 month before or after treatment initiation. The relationship of BCMs and other clinical factors was evaluated and CART analysis used to develop classification models for risk groups of drug toxicity.

**Results:** Sixteen patients (69.6%) experienced any grade 3/4 toxicity. Eleven patients (47.8%) developed G4 hematologic toxicity, which was significantly higher in those with low skeletal muscle gauge (SMG) ( $P = 0.02$ ) and low pretreatment neutrophil count ( $P = 0.0002$ ). Six patients (26.1%) had grade 3/4 non-hematologic toxicity, and was higher in those with low SMG ( $P = 0.004$ ), and low serum albumin level ( $P = 0.02$ ). Five patients with high BMI ( $P = 0.03$ ) experienced febrile neutropenia (FN) and low pretreatment neutrophil count ( $P = 0.02$ ). CART analysis classified 3 risk groups, and area under the receiver operating characteristic curve (AUROC) was 0.92, 0.88, 0.92 in G4 hematologic AE, G3/4 non-hematologic AE, FN, respectively.

**Conclusions:** SMG is a significant predictive factor of eribulin drug toxicity in advanced STS patients. Risk classification of drug toxicity through combining predictive factors, could improve the therapeutic strategy used in chemotherapy.

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### Post-radiation sarcoma: a multi-center study

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**Introduction and Purposes:** The oncologic risk of ionizing radiation is widely known. Sarcomas developing after radiotherapy have been reported, and they are a growing problem because rapid advancements in cancer management and screening have increased the number of long-term survivors.<sup>1</sup> We investigated the feature and prognostic factors of post-radiation sarcomas (PRSs).

**Materials and Methods:** The Eastern Asian Musculoskeletal Oncology Group participated in this project. Cases obtained from 10 centers were retrospectively reviewed. Patients with genetic malignancy predisposition syndrome, or who had more than one type of malignancy before the development of secondary sarcoma were excluded.

**Results:** Forty-two high-grade sarcomas among a total of 43 PRSs were analyzed. There were 29 females and 13 males, with a median age of 58.5 years; 23 patients had bone tumors and 19 had soft tissue tumors. The most common primary lesion was breast cancer. The median latency period was 192 months. There were no differences in radiation dose, latency time, and survival rates between bone and soft tissue PRSs. The most common site and diagnosis were the pelvic area and osteosarcoma and malignant fibrous histiocytoma for bone and soft tissue PRSs. The median follow-up period was 25.5 months. Five-year metastasis-free and overall survival rates were 14.5% and 16.6%, and 39.1% and 49.6% for bone and soft tissue PRSs. Survival differences depending on initial metastasis and surgery were significant in soft tissue sarcomas.

**Conclusions:** Although this study failed to find ethnic differences, it is the largest review on PRS in an Asian population. As early recognition through long-term surveillance is a key to optimal management, clinicians should take efforts to understand the real status of PRS.

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# **SESSION 03 AND SESSION 04 NEW TECHNIQUES IN PEDIATRIC RECONSTRUCTIONS AND LIMB LENGTHENING DEVICES**

## 2241

### Chondrosarcomas in children and adolescents – Are they different?

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**Objectives:** The intent was to evaluate the characteristics and oncologic outcomes of a single institution series of chondrosarcoma of the pelvis and extremities in patients who were 21 years or younger and compare them with the results documented in literature for adult patients of chondrosarcoma

**Methods:** Between January 2006 and December 2016 we operated on 11 (of a total of 249) chondrosarcomas that were 21 years or younger. Four of these occurred in the pelvis. There were 5 primary and 6 (55%) secondary chondrosarcomas. None of the 11 patients received adjuvant chemotherapy or radiotherapy.

**Results:** One patient never followed up after surgery and another was lost to follow up after 32 months. Eight patients were alive and 1 had died. Follow up ranged from 0 to 106 months (mean = 52 months, median = 74 months). All survivors had a minimum follow up of 2 years (range 26 - 106 months, mean = 70 months, median = 77 months). There was one local recurrence. The overall and disease free survival at 5 years for all patients was 89 %. The overall and disease free survival at 5 years for primary chondrosarcomas was 50 % compared to 100 % for secondary chondrosarcomas ( $p = 0.061$ ). The overall and disease free survival at 5 years for pelvic chondrosarcomas was 75 % compared to 100 % for other sites ( $p = 0.264$ ).

**Conclusions:** Chondrosarcomas in children and adolescents are very rare and constitute < 5 % of all chondrosarcomas. Secondary chondrosarcomas constituted more than half the cases. Overall, outcomes in the young were no different from those in adults.



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### Primary lymphoma of bone and soft tissue in childhood

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**Objectives:** Primary bone and soft tissue lymphomas (PBSL) constitute less than 5% of all extra-nodal non-Hodgkin lymphomas (NHL). The objective of this study was to report our institutional experience with bone lymphomas over a 46-year period.

**Methods:** From 1972 to 2018, 1696 children with NHL were admitted to our Pediatric Oncology Department. Of these, 17 children with PBSL (except maxillofacial Burkitt) were evaluated retrospectively.

**Results:** There were eight males and nine females with a median age of 8 years. Most common complaints were pain and swelling. Median duration of symptoms was 2 months. The tumor originated from bone in 12 cases (5 femur, 2 tibia, 1 radius, 1 iliac bone, 3 polyosseous) and soft tissue in 5 (1 leg, 1 scapula, 1 arm, 2 head&neck). Involvement of localized lymph node was present in four cases. Histopathological subtypes were precursor T-cell in four patients, anaplastic large cell in one, precursor B-cell in three, Burkitt in one, diffuse large B-cell in one and unclassified in seven. Subtotal or gross total resection was performed in three cases. Patients were treated with various chemotherapeutic regimens according to histopathological subtype. Seven patients received radiotherapy. Recurrence was observed in nine cases within a median of 8 months, four of which lost the follow-up and four died. One patients died from infection without disease. Seven patients (60%) are alive and disease-free at a median of 172 (18-322) months. Three year overall and event-free survival rates were 70.7% and 34.9 %.

**Conclusion:** Although secondary involvement of bones and soft tissue in lymphomas is not uncommon, PBSL is rare. Most cases are seen in the fifth-sixth decade. Lymph node involvement and polyosseous disease has worse prognosis in adults. Primary bone lymphoma constitutes 1% of our NHL cases. Multicenter studies with more cases are necessary to determine prognostic factors in childhood PBSL lymphoma.

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### Clinical outcome and treatment strategies for Ewing sarcoma patients below 10 years with a minimum follow-up of ten years

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**Introduction & Purposes:** Multimodality therapy in Ewing sarcoma (ES) drastically improved survival but is also associated with significant toxicities and long-term effects, particularly when administered to young children. Aim of this study is to describe clinical characteristics, treatment and outcome of ES patients aged below 10 years old. And secondly to explore which local treatment strategy should be omitted for young ES patients in an attempt to reduce risks of long-term complications without compromising prospects for cure.

**Materials and Methods:** 41 ES pediatric patients with a minimum follow-up of 10 years (or that died within 10 years) were included. Overall survival (OS) was calculated from date of diagnosis using Kaplan-Meyer method.

**Results:** Mean age at diagnosis was 7.3 years (range 9 months to 10 years). Primary tumor site was extremity in 29 (71%); axial in 8 (19%) and pelvis in 4 (10%). 51% had a tumor volume of  $\geq 200$ ml and 75% a tumor size of  $\geq 8$ cm. 6 patients had metastasis at diagnosis. Local treatment consisted of surgery only in 19; surgery with radiotherapy (RT) in 16 and RT only in 6 patients. Median follow-up was 15,9 years (range 0,8–32,4) and OS was 79% (95%CI 67-91%) at 10 years. 9 patients died due to progressive disease, one due to secondary malignancy. Patients that died were  $\geq 6$  years at the time of diagnosis; two presented with metastatic disease at diagnosis; 9 had a tumor size of  $\geq 8$ cm; 7 a tumor volume of  $\geq 200$  ml and 8 had RT  $\pm$ surgery for local treatment. Two patients, both received RT, developed secondary malignancy.

**Conclusion:** ES patients below 10 years present less often with metastatic disease at diagnosis and more often have primary tumors located in the extremities. Since long-term survival of these patients is excellent, local treatment, especially the use of radiotherapy could be minimized thereby focusing on quality of life and reducing the risk to develop secondary malignancy. Further studies are needed to explore this.

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### Growth plate and expandable endoprosthesis: joint saver implants

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**Objective:** Evaluate quality criteria of surgery and quality standards in joint saver implants in children

**Methodology:** Prospective study Jan 2012 to Dec 2018, 10 children affected by malignant bone tumors treated through joint saver implant and mean 2,5y follow up. Quality of surgery: monobloc resection, surgical margins, survival without local recurrence, morbidity, growth and MSTS score. Quality standards: diagnosis, surgical treatment, support and follow-up in children: diagnostic pathways, multidisciplinary teams, publishing information about areas of expertise, surgical skills, key workers. Survival rates: D1 Preventing people from dying prematurely: Reducing deaths in children; D2 Health improvement: Cancer diagnosed at stage 1 and 2; D4 Ensuring that people have a positive experience of care: Improving children and young people's experience of healthcare. Children and young people's of outpatient services.

**Results:** Mean age 6,7. 8 males 2 females, tumor size mean 10,7cm, 8 femur 1 tibia, 1 humerus location, Q Surg: 100% monobloc resection, 100% free surgical margins, 80% survival without local recurrence, 1 death, morbidity: 1 amputation 2 superficial wound infection, 1 desaxation, mean 2,4cm growth and MSTS mean: Pain 3, Function 4, Support 5, Walking 5. Q Stand: 100% full diagnostic path, multidisciplinary teams, publishing information, surgical skills, key workers. Survival rates D1 Reducing deaths in young children. 100% 3 years survival. D2 Health improvement: diagnosed at stage 1-2: 20%, 20% stage 3, stage 4: 60% D4 Ensuring that people have a positive experience of care.

**Conclusions:** Joint saver implants contribute to improve patient experience of care, recurrence rates, survival rates, treatment morbidity, growth, articular function and preservation.

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## Growth pattern of tibias after passive implant insertion in adolescent patients with sarcoma in femur

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**Introduction:** Limb length discrepancy is still the troublesome complication for younger patients with limb salvage even though extendible endoprosthesis has made great progress. Protecting the disease-free epiphysis should always be the first choice to decrease LLD. While the passive implant insertion in the tibia of affected limb for young patients with sarcoma in the femur may influence the growth potential of proximal tibia. Evaluating growth pattern of the tibia after passive implant insertion may help to improve the prosthesis design and operation skill.

**Purposes:** Comparing the normal limb, to what extent the growth potential of the proximal epiphysis of tibia was inhibited after passive implant insertion and if distal epiphysis of tibia could compensate the growth inhibition.

**Materials and Methods:** 32 patients with sarcoma in femur under 12 years old who underwent extendible limb salvage were retrospectively reviewed. The stem of tibia implant used in the current study was biological stem about 10mm in diameter with two thin nail to protect from rotation. Only Patients who survived until skeletal maturation and followed up periodically with full length radiological record of both limbs were included in this study. Patients underwent any revision operation other than periodically lengthening were excluded from this study. The x-ray film of both limbs was taken every half year after the operation. Arrest line is a marker of growth arrest caused by chemotherapy. The growth of each epiphysis was measured by the distance between the arrest line and new epiphysis line. The length of femurs, tibia and the growth of proximal and distal epiphysis and distal femur epiphysis were measured in the x-ray film periodically. The contribution of both proximal and distal epiphysis to lengthen of tibia was evaluated. The length of both tibias was compared and the difference of growth potential of both proximal and distal epiphysis of tibia was compared.

**Results:** Totally 12 patients with all the data required were included in this study. The age was  $9.75 \pm 1.48$  years old and the mean follow-up is  $6.3 \pm 2.1$  years. In most cases the arrest line of proximal tibia was obscure, thus the growth of the proximal epiphysis was difficult to measure. All the distal arrest line at the uninterrupted limb was clear to measure. The mean length ratio of the affected tibia /normal limb was 96.78% 14 months after operation, 94.38% 26 months after operation and 92.31% months after operation; The contribution of the proximal epiphysis to the full length of tibia in the normal limb was  $3.10\% \pm 0.29\%$ ,  $5.45\% \pm 1.86\%$  and  $6.86\% \pm 2.38\%$  accordingly; The contribution of the normal distal epiphysis was  $2.67\% \pm 0.61\%$ ,  $4.31\% \pm 1.64\%$  and  $5.63\% \pm 3.35\%$  accordingly. There is no significant difference between the growth of the normal and affected distal epiphysis (t-test,  $p > 0.05$ ). Thus, the contribution of the affected proximal tibial epiphysis was estimated as 0.55%, 1.31% and 2.06% accordingly.

**Conclusions:** The growth potential of the proximal tibia was greatly inhibited by the passive tibial implant insertion in the current study, while the distal epiphysis did not compensate the growth inhibition of the proximal epiphysis. Thus, improved prosthesis design and operation skills are needed to protect the proximal epiphysis of tibia.

2469

### **Tibial growth after distal femoral megaprosthesis in children: the efficacy of pediatric tibial components**

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**Introduction:** Megaprotheses used for reconstruction after distal femoral bone tumor resection in children commonly have specific pediatric tibial components that minimize the impact on residual proximal tibial growth.

**Methods:** At our Institute, between 1993 and 2016, megaprotheses with a pediatric type tibial component were implanted in 70 children (mean age 10 years; range 5-14 years). In 24 patients an expandable prosthetic body was used. Reconstruction systems from two manufacturers were implanted: HMRS/GMRS (Stryker/Howmedica) and JTS (Stanmore Implants Worldwide). With each system, two different types of tibial components have been implanted. Initially, HMRS/GMRS implants had a small standard fixed hinge (SFH) component. Later, a custom component (CFH) with larger tibial plate was used. JTS implants were initially associated with a rotating hinge (RH), component, more recently a fixed hinge (FH) was preferred. Tibial component survival was calculated using Kaplan-Meier's method. Tibial growth and limb length discrepancy were determined with long leg radiographs.

### **Results**

18 HMRS-SFH stems: 5-year survival 44%.

34 HMRS-CFH stems: 5-year survival 71%.

14 JTS-RH stems: 5-year survival 37%.

4 JTS-FH stems: follow-up (FU) was too short for 5-year analysis, but 2-year survival was 100%.

10 patients underwent contralateral epiphysiodesis.

36 patients had more than 2 years FU and adequate radiographies for growth analysis at skeletal maturity. Tibial length discrepancy for this group was on average -8mm (range +10mm to -30mm). The HMRS-CFH stem allowed for 87% of normal growth (total of 526 months FU). The recently implanted JTS-FH components (total of 125 months FU), showed 92% of growth, as compared to the contralateral tibia.

**Conclusions:** The HMRS-CFH and JTS-FH stems showed good implant survival and allowed for the tibia to maintain most of its normal growth potential.



2328

## Reconstruction of knee joint with semi-joint endoprosthesis in bone malignancies of adolescents

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**Purpose:** To demonstrate semi-joint prosthesis replacement for treating bone malignancies around adolescents' knees and investigate its indications, surgical and functional outcomes.

**Methods:** Retrospectively studied ten patients with bone malignancies aged from 8 to 14 years old (mean: 11.2 years old) who received semi-joint prosthesis reconstruction in our institution from 2016 to 2017. The tumor site included distal femur (1 patient), proximal tibia (8 patients), and proximal fibula involving ipsilateral tibia (1 patient). According to the Enneking staging system, nine of them were assigned to stage II B while one was assigned to stage III. During surgery, we preserved non-contaminated meniscus and normal ligaments to reconstruct knee joint.

**Results:** The mean maximum diameter of the tumors in transverse section is 48mm (range: 43-80 mm). 7 sets of modular endoprotheses and 3 sets of custom-made extendible endoprotheses are used in this study. No local recurrence is observed while two patients experience pulmonary metastasis after surgery. All patients are alive and the median follow-up time is 20 months (range: 13-31 months). One patient of distal femoral osteosarcoma experienced subluxation of knee joint while no dislocation or complication was observed in other patients. The mean MSTS score is 23.6 points (79%) (range: 17-27 points, 57%-90%), which was lower than that of patients who received total knee joint reconstruction (25.7 points, 86%) in the same period.

**Conclusion:** Semi-joint endoprosthesis is more suitable for patients of tibial malignancies who are unable to receive extendible endoprosthesis reconstruction. With the help of artificial patches and postoperative restrictive brace, the incidence of prosthesis-related complications can be reduced. Besides, the preservation of the meniscuses and normal ligaments helps to improve the stability of knee joint. Compared with ordinary prosthesis, the modular semi-joint prosthesis makes it more feasible to perform in these cases due to the advantage of segmental extension.

Key words: Semi-joint endoprosthesis, knee joint, bone malignancy, adolescent

2306

### 18 years experience with growing endoprosthesis in children and adolescents with primary malignant bone tumors

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**Purposes:** Metaanalysis of the patients treated in the Institute of Mother and Child in last 18 years.

**Methods:** In the period 2000-2018 283 children with primary bone tumors were treated. They were 143 boys and 140 girls. The age of the patient was from 4 to 25 years old. Median was 13 yrs. old. The treatment was begun from neoadjuvant chemotherapy. After achievement the regression or stabilization of primary lesion, the patients were qualified to surgery procedures. It was excision of the tumor and reconstruction by the using of the growing endoprosthesis in spite of young age of the patients. After that adjuvant chemotherapy was used with or without metastasis treatment.

**Results:** In this study the own department experience in implantation of variety types of expandable endoprosthesis were shown. The defects and advantages of each type of expandable endoprosthesis were introduced. The all data were displayed as peer analysis of the patients with variety types of endoprosthesis.

**Conclusions:** As the summary the authors published the guidelines according the handling of, service the variety types of expandable endoprostheses. Instead of conclusions (authors' experience) Recommendations for non-invasive limb lengthening: Ø careful qualification to operation Ø implantation receiver in soft tissue no more 2 cm depth Ø start with lengthening procedure quickly after operation Ø repeated procedures in short time intervals (50 impulses) Ø Lengthening procedure in ambulatory manner Ø avoiding of general narcosis Ø risk minimalization of infection in endoprosthesis area

## 2312

### Outcome of extendable prosthesis in children with bone sarcoma

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**Objective:** Limb-salvage surgery of sarcoma in skeletally immature children has become acceptable with the introduction of extendable prosthesis. The purpose of this study is to retrospectively review the outcome of patients who underwent treatment of bone sarcoma and were reconstructed by an extendable prosthesis.

**Methods:** From 1997 to 2016, 28 patients underwent wide resection of bone sarcomas and were reconstructed by an extendable prosthesis. There were 18 boys and 10 girls aged 9 to 15 years (median 12 years). The primary tumors were 27 osteosarcomas and one Ewing sarcoma. Three patients had lung metastasis at presentation. All patients received chemotherapy. Sites of tumor were 1 proximal femur, 1 diaphysis of femur, 22 distal femur, 3 proximal tibia, and 1 proximal fibula. The implant used were HMRS Kotz Growing prostheses. The median follow-up period after resection was 121 months (7 to 248 months). Survival analysis of the patient and primary implant and the functional evaluation using the Musculoskeletal Tumor Society (MSTS) score were performed.

**Results:** At last follow-up, 18 patients were CDF, 5 NED, 1 AWD, and 4 DOD. One patient had local recurrence of tumor and was amputated. One patient was amputated due to deep wound infection and one due to recurrent dislocation. One prosthesis was revised due to aseptic loosening, one due to breakage of the prosthesis and three due to stem fracture. The 5- and 10-year implant survival rate was 87% and 74%. Sixteen prostheses were extended a total of 39 times for a mean of 37.8mm (10 to 86mm). There were no extension related wound complications. Periprosthetic fracture was observed in five patients. There were 4 cases of loss of correction. The median MSTS score was excellent (92%, 48 to 100%).

**Conclusion:** Limb-salvage was achieved in 89% of the patients in our study. The patients also had excellent function. The timing to revise to conventional prosthesis at end of growth or at implant failure is still controversial.

## 2471

### **Preliminary results from EMSOS study on expandable distal femoral megaprotheses**

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**Introduction:** Expandable prosthesis have become popular for reconstruction in children with bone tumors around the knee. However, these implants are expensive and have frequent complications, even in experienced hands. Information on indications and complications is lacking, due to relatively small patient numbers and inhomogeneous groups in the literature. Therefore, it was decided to perform a multicenter EMSOS study, focusing on expandable megaprosthesis of the distal femur. The goal is to provide more accurate information on complications, risks, and functional outcome.

**Methods:** All EMSOS members have been invited to send their data on expandable megaprosthesis, (mini-invasive and non-invasive) of the distal femur. Total femur expandable prosthesis were excluded from the study, as these are expected to be more frequently associated with hip specific complications such as instability and secondary degenerative changes. Complications are recorded according to the ISOLS complication classification. Function was determined according to the MSTS score.

**Results:** So far 215 cases were included from 12 different referral centers. Mean patient age was 8,2 years (range 1-13). Implant related complications were relatively frequent, requiring further surgery in two thirds (66%) of the cases. The most frequent reasons for further surgery were: maximum lengthening achieved, mechanical failure/breakage of the implant, infection, and joint stiffness. Mean MSTS score was 24,6 (82%). Approximately 25% of patients had a limb length discrepancy of more than 2cm.

**Conclusions:** This study is ongoing and further data is welcome for a complete analysis. From these preliminary results we confirm that expandable distal femoral prosthesis can offer good to excellent function. However, the relatively high complication rate warrant significant improvement in the implant design and guidelines for adequate patient selection.

2440

### **Complications after endoprosthetic reconstruction of the knee joint in children and adolescence with bone tumors**

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**Introduction:** Analysis of our experience in endoprosthetic reconstruction of the knee joint in children and adolescents with primary bone tumors.

**Materials and Methods:** From 2012 to 2016 (60 month) 90 endoprosthetic reconstruction of the knee joint in children and adolescents with bone sarcomas were performed. Evaluation of functional results was performed using the MSTS (MusculoSkeletal Tumor Society) scale 6 months after surgery. Postoperative complications were analyzed according to the ISOLS (International Society of Limb Salvage) classification, including special VI type of complications for pediatric patients – joint dysplasia and physeal arrest.

**Results:** The average indicator of the functional result after surgery, according to the MSTS scale, was 72%. Total amount of patients with complications was 19 (21,11%). The most common postoperative complications were structural failures – 6 cases (6.66%) and infections – 5 cases (5,55%). The structural failures include 4 cases of breakage of elongation mechanism, that led to leg length discrepancy. Also, we have 2 patients (2,22%) with physeal arrest. These two complications are very significant for pediatric patients with bone immaturity. Other complications were: soft tissue failure – 3 cases (3,33%), aseptic loosening - 1 case (1,11%), local relapse – 2 cases (2,22%)

**Conclusion:** The using of individual expandable endoprostheses makes possible to perform surgical treatment for patients with skeletal immaturity. We have never observed breakage of elongation mechanism since we have started to use due to magnetic field elongated prosthesis. Endoprosthesis replacement provides good oncological and functional results, and also contribute to the most adequate social adaptation of the child.



2470

## Reconstruction of the proximal femur after bone tumor resection in children

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**Introduction:** Reconstruction of the proximal femur after bone tumor resection in children represents an orthopaedic challenge due to the small and complex anatomy, high functional demands and growth loss. Various reconstruction techniques have been reported, but the available data is scarce due to the rarity of this indication. This study describes the experience of a single referral center for bone tumors with three different techniques of proximal femoral reconstruction in children: megaprosthesis (MP), allograft-prosthetic composite (APC), and allograft associated with vascularised fibula (VF).

**Methods:** Between 1993 and 2017 36 patients under the age of 14 underwent proximal femoral reconstruction after bone tumor resection. 22 for a Ewing sarcoma, 14 for an osteosarcoma. All patients underwent standard neoadjuvant chemotherapy, no patient was treated with radiotherapy for the primary tumor. Thirteen patients died from metastatic disease and two patients were lost to follow-up. Therefore, 21 patients were available for functional and limb length analysis at a mean follow-up of 156 months (range 47-283). MSTS-score and TESS were used for functional analysis.

### Results:

Group	N	Age (years)	Follow-up (months)	N surgeries	MSTS %	TESS %	LLD (cm)
VF	5	4,4	173,6	5,8	81	81	-2,3
APC	12	9,4	153,5	2,4	84	86	-2,1
MP	4	11,3	141,3	2,3	91	91	-1,6

**Conclusions:** The fully biological reconstruction, using a vascularised fibular autograft associated with a massive bone allograft was abandoned because of high failure rates. The allograft-prosthetic composite and megaprosthesis have very similar outcome in terms of function, number of surgeries and final limb length discrepancy. The surgical indication should be based on the extension and stage of the tumor, the age, expected growth and regenerative potential of the patient, availability of bone banking facilities and implants, and personal preferences of the surgeon.

2676

## The use of PRECICE® nail in the management of limb length discrepancy following biological reconstruction with “frozen hotdog” technique

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**Introduction:** Combined use of cryodestructed bone and vascularized fibula (frozen hotdog) is an effective intercalary biological reconstruction method. However, limb length discrepancy (LLD) is an inevitable complication of limb salvage in the growing child. This paper is aimed at presenting femoral lengthening experience with PRECICE® device in frozen hotdog patients.

**Patients & Methods:** Four patients (M/F: 3/1), who underwent primary limb salvage for distal femur osteosarcoma with frozen hotdog technique, were retrospectively reviewed. Mean age was 10,8 (9-13) years and length of resected segment was 195 (150-250) mm at index procedure. Mean limb length discrepancy was 7 (4-10) cm after a mean follow-up of 63 (34-110) months. Excellent bone healing had been achieved in 3 patients while one of them had chronic nonunion.

**Results:** A mean lengthening of 42 (38-48) mm was performed with subtrochanteric osteotomy using the PRECICE® nail in 3 patients, who showed excellent healing of primary reconstruction. Distraction rate was 1 mm/day and consolidation index was 1,83 months/cm. Distal locking screw was revised in one patient due to osteolysis. One patient underwent nail removal and closed plate fixation due to fracture at the distal end of the nail, after full consolidation. Mean MSTs was 26 (25-27) at the last follow-up. Pre-distracted PRECICE® was used for acute compression of the nonunion site in the fourth patient. However, bone healing could not be achieved after 3 cycles of compression-distraction-observation over an 18-month period. No implant-related complication occurred in any of the four.

**Conclusion:** PRECICE® is effective and reliable for the management of LLD associated with frozen hotdog reconstruction, which involves challenging morphological and biological changes related to recycled bone and hypertrophied fibula. The failure in chronic nonunion case cannot be attributed to the device since it performed the desired compression-distraction effect.



2436

### **Methods of limb reconstruction after resection of primary malignant bone tumours of the distal tibia in children and adolescent**

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**Introduction:** Primary malignant bone tumors in children localized in distal tibia are very rare and until 2007 due to the lack of possibility of functional reconstruction we performed amputations in those cases.

**Aim:** The aim of the study is to present the possibilities of surgical treatment and reconstruction of primary bone tumors localized in distal tibia in children and adolescents.

**Material and Methods:** Out of 450 patients treated at our center in years 2009-2018 for primary malignant bone tumors, a group of 14 patients who underwent limb-salvage surgery for neoplasms originally located in distal tibia were selected (7 to 26 years old, three girls and 11 boys). 10 patients were diagnosed with osteosarcoma and four with Ewing sarcoma. Eight patients had no metastases. 12 patient were treated with a MUTARS-System modular endoprosthesis, 11 had modular and one patient had expanding endoprosthesis. Two patients were treated with fibula transfer alone.

**Results:** Of the 14 patients, 13 survived with a follow-up period of 7 to 72 months, one patient died from an undetermined cause. Early complications in form of skin necrosis affecting two patients were treated by a plastic surgeon. Two patients with a fibular graft have an arthrodesis. In one patient, due to deep infection, one stage procedure was performed. In one patient aseptic loosening was treated with cement. MSTs score was 20-35.

**Conclusions:** Primary malignant bone tumors of the distal tibia in pediatric population are extremely rare and it is difficult to collect a large group of affected patients. In our material, pathological fractures and permanent arthrodesis of the ankle occurred after autograph implantation. Endoprosthesis allows immediate loading of the limb, which in children during intensive growth period prevents disorders of the affected limb development. The new manufactured, custom made endoprostheses can be successfully implemented in treatment of young children.

2519

## Vascularized epiphyseal proximal fibula transfer in a 2year old with Ewings sarcoma of proximal tibia

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**Introduction:** Treatment of defects following long bone resection in children is challenging and restoration of longitudinal growth is as essential as filling the osseous defect. A vascularized autograft consisting of the proximal fibular epiphysis along with its blood supply and a variable amount of the proximal diaphysis is an effective biological alternative to serve such purposes. We report a case of vascularized epiphyseal proximal fibula (VEPF) transfer in a 2year old with Ewings sarcoma of proximal tibia.

**Method:** Following transepiphyseal osteotomy, proximal tibia bearing the tumour was resected and recycled in liquid nitrogen. Anterior tibial artery and its epiphyseal recurrent branch supplying the proximal fibula and its physis was carefully dissected. Proximal fibula was mobilized following a transverse osteotomy made 2cms distal to the level of tibia diaphyseal osteotomy. A slot was made in the recycled tibia, which was adequate to host the harvested VEPF and recycled autograft was repositioned along with the VEPF. The construct was stabilized with k-wires and distal radius plate.

**Result:** Patient was immobilized with above knee cast, knee range of motion and non-weight bearing ambulation was started by 2weeks. VEPF showed signs of progressive remodelling and longitudinal growth. Partial weight bearing was started around 3months from surgery. A final follow up of 6months, union was noted at both osteotomy sites and there were no signs of local recurrence.

**Conclusion:** VEPF transfer though a complex procedure, it is the one of the best biological alternative with growth potential, for long bone defects following tumour resection.

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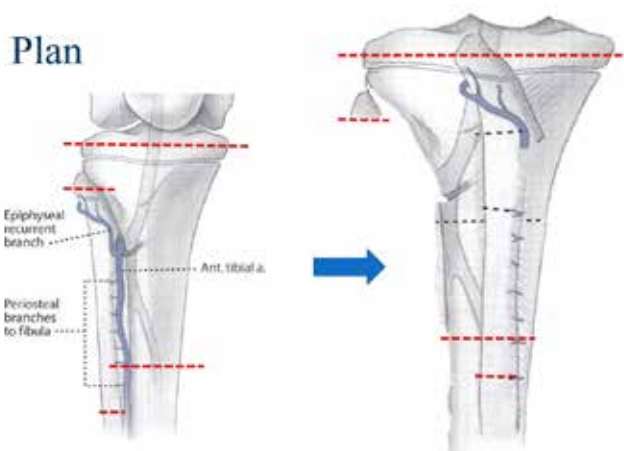


Figure 1

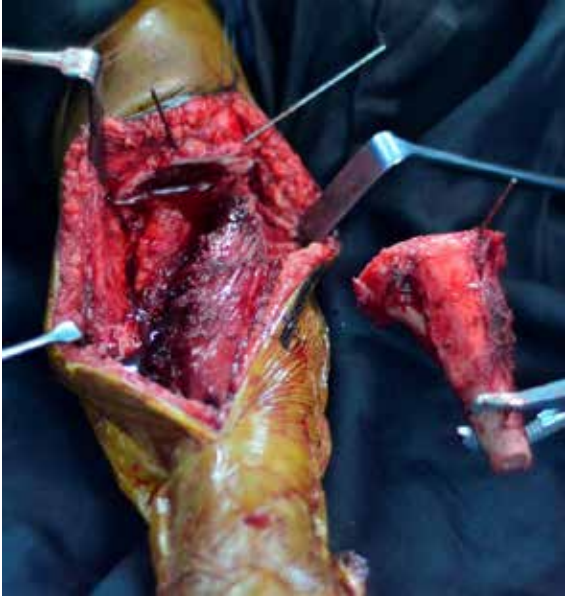


Figure 2



Figure 3

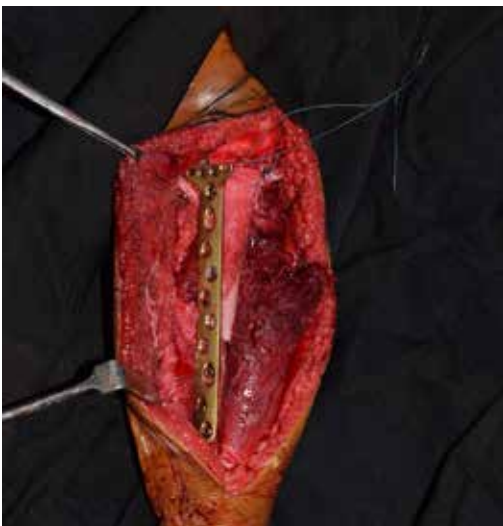


Figure 4



## 2453

### Vascularized fibula graft after bone tumor resection in pediatric age: old or new technique?

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**Introduction and Purposes:** After Primary Bone Tumor Resection (PBTR) in pediatric age (0-14 years), Vascularized Fibular Graft (VFG) is a well-known micro-surgical reconstructive technique. It generally allows wide and effective long diaphysis bone reconstruction, able to fuse and hypertrophy, as well as epiphyseal reconstruction in selected sites (proximal humerus, distal radius, distal fibula). VFG may be a composite flap, able to reconstruct vascularized bone, tendon, muscle, fascia and skin. Furthermore, peroneal artery may revascularize the proximal or distal stump of resected arteries, allowing extreme resection. Despite these advantages, some complication has been described, both from the recipient and from the donor site. Aim of our study is to analyze our experience on FVG in pediatric age, focusing on reconstructive options, complications and overall long term results.

**Material & Methods:** Our experience is based on 41 patients, treated at Department of Orthopedic Oncology of Florence from January 1994 to December 2018. Average age at surgery was 10.4 years (3-14), while diagnosis was always malignant BT (23 osteosarcoma, 16 Ewing sarcoma, 2 low grade sarcoma). The involved sites were diaphysis in 28 cases (9 femur, 16 tibia, 2 humerus, 1 metatarsal bone) and epiphysis in 13 (5 humerus, 3 radius, 2 elbow, 1 hip, 2 distal fibula). VFG alone was employed in 14 cases, and associated to bone massive allograft in 27 cases.

**Results:** At the average follow up of 10 yrs (1-24), 27 patients were continuous disease free, eight were treated for local or distant disease, 4 patients were died of disease, 2 were lost. 13 patients were re-operated for pseudo arthrosis, mechanical complications or deep infection, but all VFG persisted in site at follow up; functional results were rated as satisfactory in more than 80% of our casuistic.

**Conclusion:** After BPTR in pediatric age, vascularized fibula graft offer a solid and definitive biological option, able to fuse and hypertrophy the reconstructed bone. Re-operation are frequent, with high rate of final limb salvage. Despite "new technologies" are growing, the "conventional" VFG in pediatric age, still maintain an important role.

2256

### Joint preservation limb sparing surgery in children with malignant bone tumors about the knee: the biological solution

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**Introduction:** Joint sacrificing limb sparing surgery with megaprosthesis replacement is associated with lifelong disability. The purpose of this study to analyze the long term oncological, functional outcomes of patients undergoing joint preservation limb sparing surgery via transepiphyseal or transtaphyseal resections in children with malignant bone tumors about the knee joint.

**Material and Methods:** From 1990-2015, fifteen patients malignant bone tumors about the knee joint, ages 3 to 40 years treated with joint preservation procedure. Osteosarcoma- nine, Ewing's Sarcoma-six patients. All received chemotherapy. Tumor locations included distal femur- ten patients, proximal tibia five. Transtaphyseal resections performed in 12, transepiphyseal resections performed in three patients. At the level of the distal femur, reconstruction with combined Allograft/VFG performed in five patients. At the level of the proximal tibia, reconstruction used intercalary allograft alone, without the use of VFG.

**Results:** Follow-up period was 4 to 28 years. No immediate complications, no local recurrences. Two tibial allograft stress fractures treated successfully by improved fixation fresh autogenous iliac bone graft. Two distal femoral allograft fractures required revision using VFG. Four broken femoral plates at the level of the proximal junction revised with double stacked plate fixation. One patient who developed distal femoral nonunion underwent resection replacement with distal femur endoprosthesis.

**Conclusion:** Improved radiographic imaging and effective chemotherapy combined with new surgical techniques have enabled an accurate assessment of tumor extension. Saving the knee joint and growth plate allows for continued growth, minimizing limb length discrepancy. This biological solution in selected patients is an effective alternative to a mega-prosthesis. Based on M.S.T.S functional evaluation, excellent results were achieved in 14 patients. Joint preserving limb sparing surgery proved to be the ultimate biological solution to ensure lifelong functional activity. All patients retained their limb, regained full active range of motion of the knee, and returned to normal lifestyle activity.

2563

## Residual epiphysis growth after epiphyseal-preservation surgery for childhood osteosarcoma around the knee joint

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**Introduction and Purposes:** Epiphyseal-preservation surgery for osteosarcoma is an alternative method which has been indicated carefully to selected patients<sup>1</sup>. The tumor-devitalised autograft treated with liquid nitrogen procedure is one of the biological reconstruction methods to reconstruct the defect after tumor excision. The limb length discrepancy is usually appeared in children with their growth after limb-sparing surgery. This study was aimed to investigated the growth of residual epiphysis following epiphyseal-preservation surgery for childhood osteosarcoma around the knee joint.

**Materials and Methods:** We retrospectively reviewed 12 patients with osteosarcoma who underwent epiphysis preserving tumor excision (8 in distal femur and 4 in proximal tibia) and reconstructed by using tumor-devitalized autograft treated with liquid nitrogen. The mean patient age was 11 (range, 6 to 14) years. The mean follow-up period was 63 (range, 41 to 90) months. Epiphysis transverse growth rate, epiphysis-width discrepancy (EWD) and collapse of epiphysis were evaluated by using pre- and post-operative whole standing leg radiographs. A retrospective chart review was performed to investigate functional outcome, complications and oncological status.

**Results:** The mean growth of epiphysis rate was 12.6% (range, 3.3 to 28.0%) of affected side and 12.7% (range, 3.8 to 28.9%) of contralateral side, mean EWD was 0.1 mm (range, - 1.0 to 1.7 mm), mean LLD was + 26.1 mm (range, + 1 to + 48 mm) and two patients with distal femoral reconstruction underwent limb lengthening of tibia. There was no collapse of the residual epiphysis. The mean MSTS score was 27.7 (range, 18 to 30).

**Conclusions:** Epiphysis transverse growth was not diminished, and there was absence of epiphyseal collapse even after epiphyseal-preservation surgery in this small series of childhood osteosarcoma around the knee. With careful assessment for epiphyseal tumor involvement, epiphyseal-preservation surgery shall be possible, and could be an alternative method worth considering.

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## Reconstruction in skeletally immature patients: outcomes of two viable options

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**Introduction:** Limb preservation in children with musculoskeletal tumors presents a unique challenge. Depending on the extent of bone involvement, as well as the potential resulting limb length inequality, surgical treatment may include the use of an expandable prosthesis or rotationplasty. The primary objective of this study is to compare the outcomes and complications of patients treated with the expandable implants and at a single institution.

**Methods:** Fifteen (16 limbs) patients treated with either rotationplasty (6) or expandable endoprostheses (8) at a single institution from 1998-2019 were retrospectively reviewed. Patients were included if (1) they underwent limb salvage surgery with an expandable endoprosthesis and had subsequently been converted to an adult prosthesis. Functional outcome scores were assessed using the MSTS functional scoring system, while complications were described using Henderson's failure modes.

**Results:** Mean age at the time of surgery was  $9.2 \pm 1.3$  years and  $11.6 \pm 5.8$  years for expandable endoprosthesis and rotationplasty groups, respectively. Patients underwent reconstruction for Osteosarcoma (14/15) and Ewing Sarcoma (1/15). Mean follow-up was 75 months in the Rotationplasty patients, and 80 months in the adult converted repiphysis patients. There were 3 complications in each group (Table 1). Mean MSTS scores were  $23 \pm 1.2$  in the Rotationplasty patients, and  $26 \pm 2.5$  in the adult converted repiphysis patients.

**Conclusion:** Limb salvage in skeletally immature patients have several available options. Expandable endoprostheses and rotationplasty remain two viable options for reconstruction, with comparable rates of complication and functional outcome scores.

Table 1 - Demographic data, complications, and functional outcomes of patients

Patient	Age at Dx	Gender	Path	F/U (mo)	Failure mode	MSTS
Rotationplasty						
1a	11	M	Osteosarcoma	16.8	5	
2a	20	M	Osteosarcoma	63.6		
3a	10	M	Osteosarcoma	35.2	3	
4a	17	F	Osteosarcoma	120.4	-	
5a	5	M	Osteosarcoma	83.7	-	
6a	7	M	Osteosarcoma	132.5	3	
Average				75.4		
Repiphysis						
1b	9	M	Osteosarcoma	106.8	2	26
2b	9	F	Osteosarcoma	97	4	27
3b	8	F	Osteosarcoma	67.4	-	28
4b	7	F	Osteosarcoma	123.2	-	24
5b	10	M	Osteosarcoma	54.6	-	26
6b	9	F	Osteosarcoma	51.8	-	20
6b	11	F	Osteosarcoma	51.8	-	25
7b	9	F	Osteosarcoma	60.4	-	26
8b	11	F	Ewing Sarcoma	107.8	3	28
Average				80.1		25.5

2672

### Managing the acetabulum in paediatric proximal femoral replacements

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**Introduction and Purposes:** Proximal femoral endoprosthesis replacements (PFEPs) are rare in children and adolescents. No consensus for the optimal bearing surface in younger children exists and the outcomes following revision of the acetabulum in children is unknown.

**Materials and Methods:** Retrospectively, 45 children (n=17 aged between 4-11.9 years, n=28 aged 12-16 years) who underwent PFEPs with and without total hip replacement (THR) following tumour resection between 1982-2017 were reviewed after thirty five years. Mean age was 11.6 years (range 4 to 16 years). Overall survival, revision of the acetabulum and re-revision of the acetabulum was estimated using the Kaplan-Meier method for PFEPs with hemiarthroplasties vs THRs.

**Results:** At ten years, children > 12 years at the time of index surgery had a rate of failure (defined as revision of the acetabular component) of 52% versus 90% in children <12 years (p=0.006, log rank). The leading indication for revision following hemiarthroplasty was subluxation of the femoral head, followed by painful chondrolysis; aseptic loosening was the leading revision indication in the total hip replacement group. Below 12 years, estimated acetabular survival without revision after 10 years was 20% vs 0% of PFEPs with and without THRs respectively (p=0.96, chi-square). Above 12 years (n=28), estimated acetabular survival without revision after 10 years was 70.0% vs 19.4% of PFEPs with and without THRs respectively (p=0.07, chi-square). The (n=28) first acetabular revisions showed no statistically significant difference between age groups (</>12 years) nor cemented vs. cementless revision acetabulae.

**Conclusions:** Our experience confirms that revision acetabular surgery in children under 12 is almost inevitable after ten years, regardless of acetabular articulation. Over 12 years, total hip replacements have improved survival at 10 years compared to hemiarthroplasties, but this is lost in the long-term. Our experiences would support the use of hemiarthroplasty in the first instance, with the inevitable revision to a total hip replacement at an older age yielding good survival of the prosthesis in the medium term.



# **SESSION 05 PATHOLOGY OF BONE AND SOFT TISSUE TUMORS - BASIC SCIENCE**



2415

## The role of high temperature requirement factor A-1 (HTRA1) positivity in recurrence of giant cell tumor of bone

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**Introduction and Purposes:** High temperature requirement factor A-1 (HTRA1) is a serine protease that acts as tumor suppressor. It is expressed by osteoblasts, thus it plays an important role on osteogenesis and angiogenesis. The aim of this study is to define the role of HTRA1 in giant cell tumor of bone (GCT) and investigate the role in recurrences.

**Materials and Methods:** Thirty-four patients with the diagnosis of GCT who has a follow-up more than 12 months enrolled in this study. Patients who received denosumab treatment prior to surgery excluded from the study. The patients were evaluated for age, gender, localization, treatment modalities, primary or recurrent tumors, Campanacci stage, follow up recurrences and recurrence treatment modalities. The staining of HTRA1 in giant cells and mononuclear tumor cells were evaluated as five tiered system.

**Results:** The mean follow up time was 42,97 months. According to Campanacci staging system, 8 patients had grade 1, 15 patients had grade 2, 11 patients had grade 3 disease. Twenty-two patients were treated with curettage- cement (internal fixation n: 7), 6 patients were treated with resection and reconstruction with prosthesis, 4 patients were treated with curettage-grafting (internal fixation n:2), 1 patient was treated with resection and reconstruction with vascularized fibula and one patient was treated with excision due to his soft tissue recurrences. The HTRA-1 staining of giant cells and mononuclear cells displayed grade 1 (n:2, n:4), grade 2 (n:5, n:12), grade 3 (n:6, n:2), grade 4 (n:7, n:8), grade 5 (n:14, n:8), respectively. There was no correlation with local recurrence and HTRA-1 positivity.

**Conclusions:** Local recurrence is the most important problem in the treatment of GCT. Hence adjuvant therapies such as extensive curettage and cement reduce local recurrence rates, molecular and immunohistochemical markers must be investigated to predict recurrence probability. In this study HTRA-1 did not show any correlations to predict recurrence in GCT.

2687

## Hydrogen-peroxide reduces cell viability and induces apoptosis of giant cell tumor cells – an in vitro model of intraoperative hydrogen-peroxide treatment

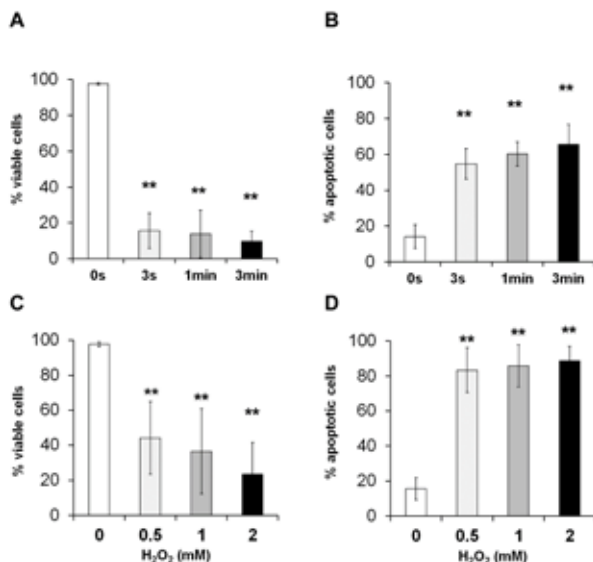
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Surgical treatment of giant cell tumor of the bone (GCT) is challenging due to high local recurrence rates. Adjuncts to clean the tumor cavity after curettage may reduce the risk for recurrence but prove of principle is lacking. We therefore aimed the establishment of an in vitro model to analyze the underlying mechanisms of the commonly used adjunct hydrogen-peroxide.

Five primary GCT derived stromal cell lines were used. Cells were seeded (50.000 cells/well) and cultured in Dulbecco's Modified Eagle's Medium (DMEM) with or without the addition of hydrogen-peroxide. The experiments were adapted to the clinical scenario simulating intraoperative flushing and cleaning with short time administration of highly concentrated ready to use 3%-hydrogen-peroxide (988 mM) which was equally used at surgeries. Hence, cells were incubated in DMEM supplemented with 3% hydrogen-peroxide for 3s, 1min or 3min and further incubated for 24h in DMEM without hydrogen-peroxide. Additional analysis of low-dose but longterm hydrogen-peroxide treatment was performed with 0.5mM, 1mM and 2mM hydrogen-peroxide solution for 4h. To analyze cell viability and apoptosis induction, adherent and detached cells were collected and the number of viable cells was measured by propidium iodide staining (2.5µg/ml) and subsequent flow cytometric quantification of positive cells. Induction of apoptosis was quantified using the caspase-3 substrate NucView-488 for flow cytometry.

Short term treatment with 3%-hydrogen-peroxide-solution simulated intraoperative treatment and quickly induced GCT cell death (A). Quantification of caspase-3 activation verified the apoptotic nature of hydrogen-peroxide induced cell death (B). Longer incubation time (4h) but lower concentrations produced comparable results (C, D).



In conclusion, we successfully established an in vitro cell-culture model for the evaluation of adjuncts in GCT treatment and proved effectiveness of hydrogen-peroxide.

2547

### Female hormone plays a major role in grade 2 chondrosarcoma survival

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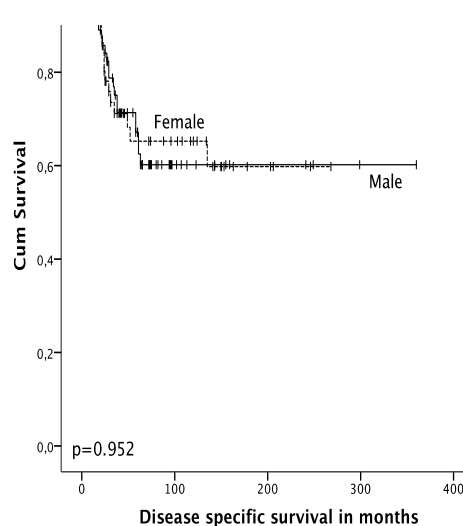
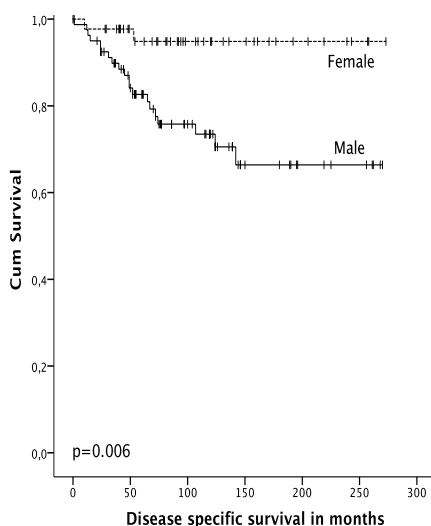
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**Introduction and Purpose:** Chondrosarcoma (CS) is a malignant neoplasm with cartilage differentiation. In general, grade, pathologic fracture, local recurrence, metastasis and age of the patient are significant factors in disease specific survival. Sex hormones, including estrogen, have been widely shown to contribute to the regulation of bone growth and development. The aim of this study was to investigate the role of gender on chondrosarcoma survival.

**Material and Methods:** Data were collected from three tertiary sarcoma units and comprised 701 patients undergoing surgery for primary chondrosarcoma.

**Results:** The mean age was 52 years (range 10-95) in male patients and 53 years (range 7-91) in female patients ( $p=0.425$ ). Mean size was 11 cm in males and 10 cm in females ( $p=0.1$ ). In univariable analysis the disease specific survival (DSS) in grade 2 CS was among females over 55 -years at 5-years 65% (95% CI; 51-79) and at 10-years 65% (95% CI; 69-81) and among males 71% (95% CI; 60-83) and 60% (95% CI; 47-73) at 5-years and at 10-years respectively ( $p=0.952$ ). In females under 55 years, the DSS was 88% (95% CI; 74-101) at 5- and 10-years among females and 51% (95% CI; 33-69) and 18% (95% CI; 1-34) at 5-years and at 10-years respectively ( $p<0.001$ ) among males (Figure). There was no difference in margins achieved ( $p=0.913$ ). In multivariable analysis, statistically significant factors were female gender (HR 1.982 (95%CI 1.399-2.808,  $p=0.000$ )), grade (HR 3.793 (95%CI 3.150-4.568,  $p=0.000$ )), local recurrence (HR 1.866 (95%CI 1.323-2.632,  $p=0.000$ )) and margin (HR 0.733 (95%CI 0.558-0.913,  $p=0.005$ )).

**Conclusions:** It is well known that grade, local recurrence and surgical margin are important factors for patient survival and our results reinforce that finding. However, our results show that young age (under 55 years) and female gender increased the disease specific survival significantly. This may well be attributable to the effect of female sex hormones. It is known that estrogen directly inhibits chondrocyte proliferation, differentiation and extracellular matrix synthesis, and indirectly effects chondrocytes via second messenger pathways secreted by cells in response to estrogen stimulation. Further work is required to identify the mechanism of action between sex hormones and high grade chondrosarcoma. However, this study opens new perspectives for the treatment of high grade chondrosarcoma, which historically has been seen as a surgical disease.



Grade 2 chondrosarcoma in patients under 55 years Grade 2 chondrosarcoma in patients over 55 years

2692

## The balance between osteoclasts and macrophages determines the effectiveness of chemotherapy in osteosarcomas and illustrates the spatial and temporal heterogeneity of these tumors

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**Background:** Osteosarcomas heterogeneity concerns both genetic and tumour microenvironment, rich in macrophages (Mph) and osteoclasts (OCs). CSF-1R is found in the Mph population which are able to differentiate into OCs. Here, the relationship between CSF-1R, Mph and OCs was explored in the OS2006 cohort, to better understand the role of microenvironment cells.

**Methods:** The OS2006 trial aimed to evaluate the efficacy of combining Zoledronate, an inhibitor of the OCs activity, with chemotherapy and surgery. Patients randomized in the zoledronate group (Z+) received 10 injections of zoledronate (4 before surgery and 6 after). OCs were defined by the expression of TRAP and CD68. CSF-1R and TRAP levels were measured in the serum of the patients at diagnosis, at time of surgery and at the end of the protocol. CSF-1R and TRAP levels were correlated with the immunostaining of CSF-1R, Mph, OCs, in 95 biopsies, then with the histologic response to chemotherapy and survival.

**Results:** The median serum level of CSF-1R and TRAP at diagnosis, was respectively of 596.7 ng/ml and 9.7 ng/ml, with no difference between Z+ or Z-. TRAP levels decreased during treatment and were significantly lower in the group of Z+ patients compared to the group of Z- patients at surgery and at the end of the protocol ( $p < 0.0001$  and  $0.0018$ ). By immunochemistry CSF-1R was highly expressed in 58.9% of biopsies at diagnosis with an IRS  $> 2$ . No correlation was found between CSF-1R serum and CSF-1R immunostaining. There was a better response to chemotherapy in Z+ patients with a decreased TRAP level ( $p = 0.0309$ ) and a worse response when the CSF-1R levels lowered ( $p = 0.0365$ ), a reflection of Mph and OCs activity.

**Conclusion:** The regulation of the balance between the action of macrophages and osteoclasts is crucial for the efficacy of therapies. Stratification at the patient's diagnosis by identifying the predominant cell populations of the tumor microenvironment may be of interest for therapy.

2496

## Clinical and molecular correlative analysis of pathologic fracture associated osteosarcoma. Implications from microRNA profiling

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Micro-RNAs are small, non-coding RNAs that regulate post translational gene expression and have previously been shown to be outcome markers in osteosarcoma patients. The purpose of this study is to compare histologically and by miRNA profiling patients with osteosarcomas of the extremities that presented with pathologic fractures vs. those that did not. Secondly, we study the possible correlation between pathologic fracture associated tumors and microRNA markers of poor outcome in osteosarcoma.

Eighty diagnostic, pre-chemotherapy, with high grade osteosarcomas samples of the extremities were submitted to micro-RNA sequencing. Sequencing data was correlated with fractures and oncologic outcomes. Figure 1 shows a scatter plot of miRNA expression relative to the two phenotypes. A total of 72 and 72 miRNAs, were found differentially expressed in DESeq and EdgeR analysis, respectively ( $p < 0.05$ , FDR  $< 0.1$ ).

MicroRNA profiles differ between osteosarcoma patients with or without pathologic fractures and the top differential markers also predict patient outcomes. We found higher different expression of microRNAs previously associated with poor prognosis. These findings suggest that the higher risk of metastasis and poorer overall survival in these patients could be because of inherent aggressive biologic behavior. It is plausible that the fracture is another manifestation of tumor aggressiveness.

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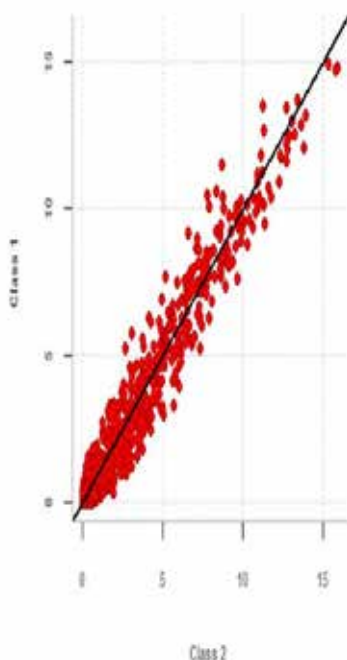


Figure 1

2683

## **APO 10 and TKTL1 are reliable markers for the detection and follow-up of high grade sarcomas**

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**Purpose:** In clinical practice, tumor markers are used in primary diagnostics, for staging or for follow-up in several carcinoma. Some of these markers have high sensitivity and specificity and some have prognostic potential. For soft-tissue and bone sarcomas, no such markers have been established to date. The aim of this pilot study was to evaluate whether an EDIM test (epitope detection in macrophages) of Apo10 and TKTL1 could be a reliable test for the follow-up of soft-tissue and bone sarcomas.

**Methodology:** The EDIM test is based on two biomarkers (Apo10 and TKTL1). Apo10 is an epitope of DNaseX (Desoxyribonuclease X), which plays a role in apoptosis. It accumulates in tumor cells and is associated with apoptosis resistance and proliferation. TKTL1 (Transketolase-like protein 1), on the other hand, plays a crucial role in the anaerobic glycolysis of tumor cells. Increased lactate production leads to destruction of the basal membrane and facilitate metastasis.

**Results:** In total, blood samples from 75 patients with a high-grade (stage III) bone or soft-tissue sarcomas could be included. The mean age of all patients was 58.9 years (14-88). 35 of the patients were male. All patients had an increased EDIM-Apo10 as well as a elevated TKTL1 score before biopsy. After completion of the therapy, the values in the follow-up controls normalized. In an independent control group of healthy volunteers, only normal values were measured.

**Conclusion:** All patients with high-grade sarcoma had an increased EDIM-Apo10 and TKTL1 score. After successful curative therapy, the values normalize. We believe that this approach could to be very useful technique for follow-up monitoring. Further work is being undertaken with a larger cohort.



2501

## Radiotherapy for rhabdomyosarcoma – more than a local treatment in combination with immunotherapy

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**Introduction:** Whereas radiotherapy had been characterised as local treatment, combination with immunotherapy has led to systemic responses after local irradiation (“abscopal effects”). As sarcomas do not seem to be respond well to immune-checkpoint inhibition and there are no reports on abscopal effects in sarcoma patients, the aim of this study was to describe abscopal effects in a preclinical model of rhabdomyosarcoma (RMS) treated with local tumor irradiation and IL-12 based immunotherapy.

**Material and Methods:** In vivo biodistribution of the necrosis-targeting immunocytokine NHS-IL12 was evaluated with small animal PET imaging. Combined treatment of NHS-IL12 and irradiation was performed in bilateral rhabdomyosarcoma xenografts in fully humanized mice. Tumor growth and survival of the animals were recorded, tumor tissue was analysed by immunohistochemistry (IHC). The effects of the combination of radiation with the immune effector cytokine IFN $\gamma$  were studied in vitro.

**Results:** Local tumor irradiation led to accumulation of NHS-IL12 in RMS xenografts. Combination of local tumour irradiation of one tumor and systemic NHS-IL12 led to improved tumor control ipsi- and contralateral and survival of animals compared single modality treatment. IHC showed more infiltration and activation of T-cells after combination treatment correlating with tumor growth and survival. In vitro, the combination of irradiation and the immune effector cytokine IFN $\gamma$  showed reduced clonogenicity based on cellular senescence as demonstrated by  $\beta$ -Galactosidase activity.

**Conclusion:** Despite of limited success of immune checkpoint inhibition in sarcoma, local tumor irradiation led to enhanced bioavailability of NHS-IL12 in RMS xenografts. Combined irradiation and NHS-IL12 led to improved local tumor control and abscopal effects associated with enhanced T-cell infiltration and activation. Thus, immunotherapy, especially in combination with radiotherapy, might improve the outcome of sarcoma patients.

2432

### **Radiation dose deviations by titanium versus carbon fibre/polyether ether ketone (CF/PEEK) implants in long bones**

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**Introduction and Purposes:** Metallic implants show dose modulating effects in radiotherapy and complicate its CT-based planning. Dose deviations might not only affect the surrounding tissues due to backscattering and inadvertent dose increase, but might also compromise the therapeutic effect to the target lesion due to beam attenuation. Later on, follow-up imaging is often obscured by metallic artefacts. This study investigates the dosimetric impact of titanium and radiolucent CF/PEEK implants during planning and administration of adjuvant radiation therapy in long bones.

**Materials and methods:** After CT-based planning, bone models of six ovine femora were irradiated within a water phantom. Radiation dosage and distribution patterns were mapped using dosimetry films. Plates and intramedullary nails of both titanium and CF/PEEK were investigated in two immersion depths to simulate different soft-tissue envelopes. One pair of bones was used for implant-free reference measurements.

**Results:** First, the planned implant-related beam attenuation was lower for the CF/PEEK plate (1 % vs. 5 %) and the CF/PEEK nail (2 % vs. 9 %) when compared to corresponding titanium implants. Secondly, the effective decrease of radiation dosage behind the implants was noticeably weaker when using CF/PEEK implants. Again, the advantages favouring CF/PEEK due to smaller dose deviations were more important in intramedullary nailing (-1 % vs. 7 %) than in plate fixation (2 % vs. 3 %). The radiation dose was not notably affected by the amount of surrounding soft tissues. A significant imaging artefact reduction was seen in all CF/PEEK models.

**Conclusion:** In this experimental cadaver study, CF/PEEK implants showed a lesser beam attenuation than equivalent titanium implants. This leads to a more reliable and more effective delivery of radiation dose to an osseous target volume. With regard to radiation therapy, the use of CF/PEEK implants appears to be particularly beneficial for intramedullary nails.

2622

### Novel germline variants in sporadic schwannomatosis

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**Introduction and Purposes:** Schwannomatosis is characterized by multiple schwannomas. Despite clinical overlap with neurofibromatosis type 2, it is not caused by germline NF2 gene variants but mutations of SMARCB1 or LZTR1 genes have been identified in familial and sporadic schwannomatosis.<sup>1</sup> We hypothesized that other germline variants might carry a predisposition and performed genetic analyses on the patients

**Materials and Methods:** This study was a prospective and a retrospective study of patients with histologically proven schwannomatosis, treated at our institution between 2006 and 2015. Whole exome sequencing, and selection and validation of candidate germline variants were performed.

**Results:** Ten patients were selected for sequencing. Among 26 variants detected by our candidate selection method, 13 were predicted to be pathogenic, which affected 10 genes. Among them, seven mutations were classified as possibly pathogenic variants by American College of Medical Genetics guidelines or Mendelian Clinically Applicable Pathogenicity score. Two predicted pathogenic missense mutations were detected in DNA damage repair genes; MSH6 and MGMT. Of 11 predicted pathogenic mutations detected in cancer predisposition genes, one was frameshift deletion and 10 were missense mutations. Eight cancer predisposition genes were involved; ARID1A, PTCH2, ALPK2, NOTCH1, CIC, NOTCH2, TSC and CDKN2A. Any specific variants in SMARCB1 or LZTR1 were not detected in all patients, and any types of tumor were not reported in their families.

**Conclusions:** Pathogenic candidate variants in this study have no relation with classic genotypic subtypes of schwannomatosis and familial type. They are novel candidates of genetic predisposing factor in sporadic schwannomatosis.

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# SESSION 06 ADVANCES IN IMAGING TECHNIQUES

2491

### Is there a correlation between radiology experience and final histological diagnosis in bone & soft tissue tumours?

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**Aim and Introduction:** The purpose of our study was to assess whether or not more experienced radiologists can provide more accurate differential diagnoses by comparing their imaging reports with final, definitive histological diagnosis.

**Methods:** Four Consultant Radiologists work at our tertiary orthopaedic oncology center, each with a different length of experience (AMD: 34 years, SJ: 12 years, RB: 5 years, AP: 2 years). The radiology reports of consecutive patients discussed at a sarcoma diagnostic MDT over a 6 week period were reviewed. Each report was compared with the histological diagnosis obtained by biopsy of the soft tissue or bone lesion to assess the diagnostic accuracy of the original report.

**Results:** 146 patients were included in our study (89 males; 57 females). The median age of our cohort was 50 years (7-88 years). AMD correctly correlated 31/32 (96.9%) diagnoses, SJ 34/35 (97.1%), RB 29/32 (90.6%) and AP 42/47 (89.4%). These differences are not statistically significant.

**Conclusion:** This study demonstrates that there is a trend to higher diagnostic accuracy, in orthopaedic oncology diagnosis in a tertiary referral centre, if Consultant Musculoskeletal Radiologists have more than 10 years experience. Orthopaedic oncological imaging has a steep learning curve.

2693

### Which indeterminate pulmonary nodules represent lung metastases in primary bone sarcoma?

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**Introduction:** Identification of indeterminate pulmonary nodules (IPNs) on staging chest CT in patients newly diagnosed with a primary bone sarcoma presents a diagnostic and management challenge. Patients with metastatic disease are treated less aggressively as the intent is palliative rather than curative. It is currently unclear which indeterminate pulmonary nodules (IPNs) represent true lung metastases.

**Methods:** All patients diagnosed with a primary bone sarcoma at the Royal Orthopaedic Hospital (Birmingham, UK) between January 1<sup>st</sup> 2008 and December 31<sup>st</sup> 2012 were reviewed using our institution's prospectively collected database and film library.

**Results:** 505 patients diagnosed with high-grade osteosarcoma, Ewing sarcoma, high-grade chondrosarcoma and chordoma met our inclusion criteria. Average follow-up was 64.5 months (range 13-130). Sixty-six patients (13.1%) had IPNs on presentation while 14.8% had metastatic disease. Overall 5-year survival for patients with isolated disease, IPN and metastases on presentation was 75.0%, 53.1% and 36.9%, respectively ( $p < 0.0001$ ). IPNs either improved with chemotherapy or progressed to metastatic disease in 71.2% of patients with progression occurring in an average of 16.0 months (range 1.4-70.1). IPNs were more likely to represent metastatic deposits in patients with a diagnosis of Ewing sarcoma or osteosarcoma and if they were greater than 5mm in diameter. Patient age, number and laterality of IPNs did not correlate with progression.

**Conclusion:** Patient and radiological factors can be utilized to predict which indeterminate pulmonary nodules on staging chest CT represent true metastatic disease in primary bone sarcoma.



2325

## Evaluation of lateral extent of the reactive layer around subcutaneous soft tissue sarcomas by ultrasonography

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**Introduction:** Subcutaneous soft tissue sarcomas (STS) tend to have a reactive layer that might contain tumor cells. Wider resection including the reactive layer is recommended to achieve complete tumor resection. Contrast-enhanced magnetic resonance imaging (MRI) is widely used for evaluating the extent of subcutaneous STS. Since the imaging direction of MRI is limited, it is difficult to evaluate the lateral extent of the reactive layer in all directions, except for axial and sagittal plane. Ultrasonography (US) is widely used as an image evaluation method of inflammation or edema of subcutaneous tissues. US can evaluate the condition of subcutaneous tissue in any cross section.

**Purposes:** In this study, the utility of ultrasonography in the evaluation of lateral extent of the reactive layer around the subcutaneous STS was examined.

**Patients and Methods:** Patients who underwent surgery with subcutaneous STS with infiltrative border on T1 enhanced MRI from January 2015 to October 2018 were included. Patients who underwent adjuvant therapy before surgery were excluded. Ultrasound examination was done 1 or 2 days before surgery. The distance from the tumor surface to the outer edge of the region where the increased subcutaneous tissue echogenicity is observed in 3, 6, 9, and 12 o'clock direction was measured (E-dist). Similarly, the distances from the tumor surface to the outer edge of the radiological infiltrated area on T1 enhanced MRI were measured in 3, 6, 9, and 12 o'clock direction (R-dist). E-dist and R-dist of the same section were compared statistically.

**Results:** Eleven patients were enrolled (male/female:10/1), ranging in age from 23 to 87 years (mean age 64 years). There were 7 myxofibrosarcoma and 4 others. Increased echogenicity was observed in the subcutaneous tissues around the tumor in all directions except for one direction of one case in which an infiltrated area was not visible on MRI. The mean E-dist and R-dist, were 23 (0 -58) mm and 17 (0 -40) mm respectively. E-dist were strongly correlated with R-dist ( $R^2=0.60$ ), and E-dist were significantly longer than R-dist ( $p<0.01$ , paired t-test).

**Conclusions:** US can evaluate the lateral extent of the reactive layer in subcutaneous tissue. Moreover, US is less likely to underestimate the size of reactive layer than MRI.

2638

## 18F-FDG PET/CT in the evaluation of cartilaginous bone neoplasms: the added value of tumor grading

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**Introduction and Purposes:** Cartilaginous bone tumors represent a wide variety of neoplasms ranging from benign to extremely aggressive malignant lesions. Unlike other tumors, the biopsy cannot easily predict the histological grade, sometimes not allowing choosing the best therapeutic approach. Our aim is to evaluate the ability of <sup>18</sup>F-FDG PET/CT to differentiate enchondroma from chondrosarcoma and to predict the histological grade as compared to biopsy and CT imaging.

**Materials and Methods:** From 2012 to 2017, 95 consecutive patients who performed a <sup>18</sup>F-FDG PET/CT for pre-treatment evaluation of cartilaginous bone lesions were retrospectively evaluated. The best SUV<sub>max</sub> cut-off to predict the post-surgical histological grade were calculated by Receiver Operating Characteristic curves and correlated to those of pre-operative biopsy and to several radiologic aggressiveness features.

**Results:** A concordance between the preoperative biopsy and the definitive histological grade was observed overall in 78.3% of patients, the lowest accuracy (58.6%) being in the identification of intermediate/high-grade chondrosarcoma (G2/G3). The best SUV<sub>max</sub> cut-off were 2.6 to discriminate Enchondroma vs. low-grade chondrosarcoma (sensitivity 0.68, specificity 0.86), 3.7 to differentiate low-grade vs. intermediate/high-grade chondrosarcoma (sensitivity 0.83, specificity 0.84) and 7.7 to differentiate intermediate/high-grade vs. dedifferentiated chondrosarcoma (sensitivity 0.92, specificity 0.9).

**Conclusions:** Results in this large series of patients suggest a potential role of <sup>18</sup>F-FDG PET/CT for histological grading of cartilaginous bone tumors, in particular to discriminate low-grade vs. intermediate/high-grade chondrosarcoma

2307

## Tumor uptake and tumor necrosis evaluation at staging Positron Emission Tomography in osteosarcoma and Ewing sarcoma: prognostic value of Standardized Uptake Value

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**Introduction and Purposes:** 18FDG-PET parameters as SUV max (Standardized Uptake Value) and TV (Tumor Volume) of the lesion correlate with the histology and predict prognosis in patients with Osteosarcoma (OS) and Ewing's Sarcoma (ES). Aim of the study is to assess the prognostic value of different parameters at staging 18FDG-PET in OS and ES.

**Materials and Methods:** We evaluated SUV max and TV of primary lesion, SUV min and TV of necrosis in 48 patients (26 OS, 22 ES), age 4-29 years (mean  $15.06 \pm 5.8$ ), who underwent staging 18FDG-PET. We drew ROIs on the lesion and the necrotic areas and calculated the respective TV. We measured the SUV max of the lesion and the SUV min of the necrosis. We correlated these data to Huvos and Picci score, dividing the population in poor and good responders.

**Results:** Statistical analysis showed a significant difference between OS and ES groups just for lesion SUV max, with higher average in OS group than ES ( $7.06 \pm 3.82$  in OS vs.  $4.43 \pm 2.93$  in ES,  $p < 0.05$ ). There was a significant difference in lesion SUV max ( $p < 0.05$ ) and in necrosis SUV min ( $p < 0.05$ ) between good and poor responder clusters in the ES group only. ROC analysis indicated for ES group a borderline significance of the area under the curve (0.79,  $p = 0.02$ ), for both lesion SUV max and for necrosis SUV min, with a SUV max cut off value of 3.2 (78% specificity and 77% sensitivity) and a SUV min cut off value of 0.85 (78% specificity and 85% sensitivity).

**Conclusion:** Our study showed a significant statistical difference between good and poor responders as regards lesion SUV max and necrosis SUV min in the ES group only, and suggests that SUV max is helpful as prognostic factor at staging exclusively for ES patients.

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2476

## 18F-FDG PET-CT is less favorable compared to MRI for detection of skeletal metastasis in Ewing sarcoma

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**Introduction and Purposes:** To determine the level of discrepancy between MRI and 18F-FDG PET-CT in detecting osseous metastases in Ewing sarcoma.

**Materials and Methods:** 20 patients with histopathological confirmed Ewing sarcoma between 2000 and 2017 who had 18F-FDG PET-CT and MRI performed within a 4-week range were included. Each imaging modality was evaluated by an independent observer. Reference diagnosis of each lesion was based on histopathology or consensus of an expert panel using all available data. Sensitivity, specificity, and predictive values were determined. Osseous lesions were analyzed on patient- and lesion-basis. Factors possibly related to false-negative findings were evaluated using Pearson's chi-square or Fisher's exact test.

**Results:** Diagnosis of 112 osseous lesions was made in 13 patients, 107 malignant and five benign. Forty-one skeletal metastasis (39%) detected with MRI did not show increased FDG uptake on 18F-FDG PET-CT (false-negative), see Table 1. Lesion-based sensitivities and specificities were 62% (95%CI 52-71%) and 100% (48-100%) for 18F-FDG PET-CT; and 99% (97-100%) and 100% (48-100%) for MRI respectively. Bone lesions were more likely to be false-negative on 18F-FDG PET-CT if hematopoietic bone marrow extension was widespread and active ( $p=0.001$ ), during (neo)-adjuvant treatment ( $p=0.021$ ) or when the lesion was smaller than 10 mm ( $p<0.001$ ).

**Conclusion:** Although no definite conclusions can be drawn from this small retrospective study, it shows that caution is needed when using 18F-FDG PET-CT for diagnosing skeletal metastases in Ewing sarcoma. Poor contrast between metastases and active hematopoietic bone marrow or active treatment or small size significantly decrease the diagnostic yield of 18F-FDG PET-CT compared to MRI

		PET		
		+	-	Total
MRI	+	65	41	106
	-	4	2	6
	Total	69	43	112

Table 1 – Lesion-based analysis of all osseous lesions.

2554

## Improved virtual surgical planning with 3D-multimodality image for malignant giant pelvic tumors

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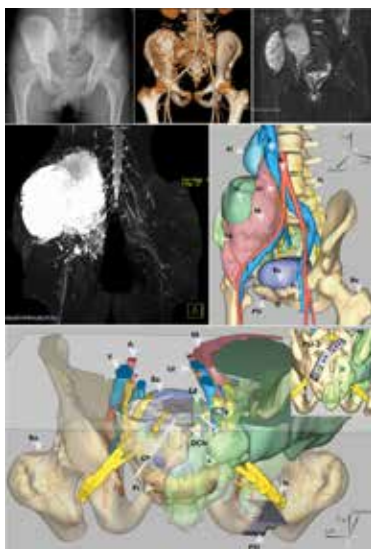
**Purpose:** We sought to assess the early clinical outcome of 3D-multimodality image (3DMMI) based virtual surgical planning for resection and reconstruction of malignant giant pelvic tumors.

**Materials and Methods:** In this retrospective case-control study, surgery was planned and performed with 3DMMI-based patient-specific instruments (PSI) in 13 patients with giant pelvic malignancy, and without 3DMMI-based PSI in the other 13 patients. In the 3DMMI group, 3DMMI taking advantages of computed tomography (CT), contrast-enhanced computed tomography angiography (CTA), contrast-enhanced magnetic resonance imaging (MRI), contrast-enhanced magnetic resonance neurography (MRN) and that revealing the whole tumor and all adjacent vital structures was utilized, based on which virtual surgical planning was conducted and the corresponding PSI was then designed. The median follow-up was 8 (3-24) months. The median age at operation was 37.5 (17-64) years. The mean tumor size in maximum diameter was 13.3 cm. Surgical margins, intraoperative and postoperative complications, duration of surgery, intra-operative blood loss were analyzed.

**Results:** In the non-3DMMI group, the margins were wide in six patients (6/13), marginal in four (4/13), wide-contaminated in two (2/13), and intralesional in one (1/13). In the 3DMMI group, the margins were wide in ten patients (10/13), marginal in three (3/13) and no wide-contaminated or intralesional margin. 3DMMI group achieved shorter duration of surgery ( $p=0.354$ ) and lower intraoperative blood loss ( $p=0.044$ ) than the non-3DMMI group.

**Conclusions:** The 3DMMI-based technique is advantageous to obtain negative surgical margin and decrease surgical complications related to critical structures injury for malignant giant pelvic tumor.

**Keywords:** surgical planning, 3D-multimodality image, pelvic tumor, patient-specific instruments, surgical margin





2635

## A convolutional neural network (CNN) for predicting fracture risk in metastatic bone disease (MBD) of the proximal femur

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**Background:** Advances in cancer therapy have prolonged patient survival even in the presence of disseminated disease and an increasing number of cancer patients are living with metastatic bone disease (MBD). Successful prophylactic surgery for an impending fracture of the proximal femur has been shown in multiple cohort studies to result in longer survival, preserved mobility, lower transfusion rates and shorter post-operative hospital stays. However, there is currently no optimal method to predict a pathologic fracture. The most well-known tool is Mirel's criteria, established in 1989 and is limited from guiding clinical practice due to poor specificity and sensitivity. The ideal clinical decision support tool will be of the highest sensitivity and specificity, non-invasive, generalizable to all patients, and not a burden on hospital resources or the patient's time. The goal of our study is to train a convolutional neural network (CNN) to predict fracture risk when metastatic bone disease is present in the proximal femur.

**Methods:** *Clinical Data.* Our fracture risk prediction tool was developed by analysis of prospectively collected data of 546 consecutive MBD patients comprising 114 pathologic fractures presenting from 2009-2016. Patients with primary bone tumors, pathologic fractures at initial presentation, and hematologic malignancies were excluded. Every patient had at least one Anterior-Posterior X-ray and clinical data including patient demographics, Mirel's criteria, tumor biology, all previous radiation and chemotherapy received, multiple pain and function scores, medications and time to fracture or time to death.

*Machine learning methods.* We have trained a convolutional neural network (CNN) with AP X-ray images of 546 patients with metastatic bone disease of the proximal femur. The digital X-ray data is converted into a matrix representing the color information at each pixel. Our CNN contains five convolutional layers, a fully connected layers of 512 units and a final output layer. As the information passes through successive levels of the network, higher level features are abstracted from the data. The model converges on two fully connected deep neural network layers that output the risk of fracture. This prediction is compared to the true outcome, and any errors are back-propagated through the network to accordingly adjust the weights between connections, until overall prediction accuracy is optimized. Methods to improve learning included using stochastic gradient descent with a learning rate of 0.01 and a momentum rate of 0.9.

*Model Evaluation.* We used average classification accuracy and the average F1 score across five test sets to measure model performance. We compute  $F1 = 2 \times (\text{precision} \times \text{recall}) / (\text{precision} + \text{recall})$ . F1 is a measure of a model's accuracy in binary classification, in our case, whether a lesion would result in pathologic fracture or not.

**Results:** Our model achieved 88.2% average classification accuracy in predicting fracture risk across five-fold cross validation testing. The F1 statistic is 0.87. Application of Mirel's criteria would have correctly classified 63.9% of patients.

**Conclusion:** Our neural network model achieved reasonable accuracy in classifying fracture risk of metastatic proximal femur lesions from analysis of X-rays and clinical information. Future work will aim to validate this algorithm on an external cohort.



# SESSION 07 AND SESSION 08 INFECTIONS AND INTERCALARY RECONSTRUCTIONS

2291

## Microbiological particularities of surgical site infections in oncologic orthopedic surgery

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**Introduction and Purposes:** In adult orthopedic oncology, surgical site infections (SSI) occur much more frequently after interventions for soft-tissue (STS) or bone sarcoma (BS) than after non-oncologic orthopedic interventions. Despite an emerging field of research focusing mainly on techniques to reduce SSI, publications regarding their microbiology are surprisingly scant. We compared surgical site infections in adult oncologic patients to adult non-oncologic patients in order to identify differences in the involved microorganisms.

**Materials and Methods:** We retrospectively compared the epidemiology of oncologic SSI and non-oncologic SSI (first episodes). We defined infection as pus, same positive results in several intraoperative microbiological samples, and as a clinically new local inflammation responding to systemic antibiotic therapy.

**Results:** Among 2752 different first episodes of infection, only 14 (0.5%) concerned infections at the site of prior oncologic surgery. Oncologic patients witnessed a particular pattern of microorganisms, characterized by more enterococci, Gram-negative pathogens, or skin commensals. The proportion of classic orthopedic pathogens such as *Staphylococcus aureus* or streptococci was not different from the control group.

**Conclusions:** The microbiology of SSI in oncologic patients is significantly different than in non-oncologic patients. The standard antibiotic prophylaxis is inadequate for the involved pathogens and the literature on this subject is lacking. More studies are clearly needed in order to tailor a specific perioperative prophylaxis in terms of choice of the agents rather than of duration of the standard prophylaxis.

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2494

### **Bacteriological description and resistances analysis in surgical site infection after resection of primary pelvic bone malignancy**

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**Introduction:** The resections of malignant pelvic bone tumors are at the origin of many complications. Surgical site infections (SSI) are common, difficult to treat, and have a significant medico-economic impact. Although the antibioprophylaxis in prosthetic orthopedic surgery is well codified, there is no clear recommendation in pelvic bone tumors resections. We find in the SSI of the pelvic bone a generally polybacterial population with a strong representation of enterobacteria. The objectives of our study were to measure the incidence of surgical site infections, describe the bacterial flora involved and identify the possible emergence of resistance related to our practices in terms of antibioprophylaxis.

**Materials and Methods:** We retrospectively included patients operated on between 2005 and 2017 from a primary pelvic bone malignancy resection surgery. This is a descriptive, monocentric study. We carried out a descriptive bacteriological analysis and we described the resistances on the germs responsible for SSI. Samples from the operative site were grinded after addition of metal balls using an automaton. The germs isolated during the recovery surgery for SSI and their antibiogram were analyzed.

**Results:** 55 patients were included, 29 in the Sepsis group and 26 in the healthy group. The incidence of ISOs was 52.7%. 75.9% of the infections were polymicrobial with a high prevalence of digestive flora germs. 68,7% were wild-type germs. There was no emergence of extended-spectrum beta-lactamase resistance. The use of imidazols didn't change the bacterial flora.

**Conclusion:** SSI is a serious postoperative complication, with a significant medico-economic impact and an issue of bacterial ecology, in the management of primary tumors of the pelvis. Most of the SSIs are due to germs of the digestive flora. Our choice of antibioprophylaxis does not favor the appearance of resistant germs including ESBL.

2666

### Is conventional antibioprophylaxis associated with increased infection rates in oncologic orthopaedics?

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**Introduction:** In oncological orthopaedics, limb salvage surgeries are associated with high risks of infection. Although crucial, the choice of antibioprophylaxis remains controversial and recommendations are scarce. In this retrospective study, we sought to identify risk factors and demonstrate that a conventional antibioprophylaxis as recommended for arthroplasty did not increase the incidence of infection.

**Material & Method:** Between 2008-2018, we identified 136 patients with a bone tumor who were reconstructed with megaprosthesis or massive bone allograft. Regardless of location or resection type, the antibioprophylaxis protocol was: 2g Cefazolin at the induction of anesthesia, every 3 hours intraoperatively and then 1g at +8h and +16h after the procedure, as recommended for arthroplasty. Risk of infection was analysed by logistic regression for age, location, superficial skin infection, deep infection, revision, cause of revision, operating time, transfusion, intensive care unit stay, use of chemotherapy and/or radiotherapy.

**Results:** Using this antibioprophylaxis regimen, 13 of the 136 patients contracted a deep infection. Soft tissue necrosis or skin infection is significantly associated with a deep infection. Revision represents a risk of infection; the cause of revision does not influence the infection rate except primary infection. However, use of chemo/radiotherapy does not influence the rate of infection.

Compared to studies using heavier antibiotic prophylaxis (e. g. vancomycin/gentamycin regimens) and according to a systematic review, we observed similar infection rate with this antibioprophylaxis protocol.

**Conclusion:** Standard antibioprophylaxis with cefazolin is cost-effective with fewer risks/ potential adverse effects that may be encountered with heavier antibioprophylaxis widely used in oncologic orthopedic procedures.

2429

## Perioperative Surgical Antibiotic Prophylaxis in Orthopaedic Oncology: Which antibiotic is adequate for resection of soft tissue sarcomas in the adductor and gluteal area

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**Introduction:** Resection of soft tissue sarcomas in the context of multimodal therapy has a higher risk of local wound infection. One of the most common locations, the adductor and gluteal region has a rate of deep wound infections up to 30% especially after neoadjuvant radiation therapy. In contrast to other regions a high proportion of gram-negative germs in infections in this regions is seen. Routine perioperative antibiotic prophylaxis in orthopedic surgery is based on cephalosporines and covers this spectrum insufficiently. Therefore in this retrospective study the germ spectrum of postoperative infections after sarcoma resections in the adductor and gluteal region was analyzed.

**Patients and Methods:** 255 patients sarcoma resections in the adductor and gluteal region between 2004 and 2017. We evaluated postoperative infection rate, involved germs, time of infection and therapy. Prognostic factors were analyzed .

**Results:** The average age of the patients was 60 years. 54% of patients were male. The mean maximal diameter of the tumor was 12 cm. The average time of surgery was 80 minutes, the mean blood loss 240 ml. Most tumors were liposarcomas (31%), followed by NOS (28%) and leiomyosarcomas (8%). Wound infections occurred in 18% of cases. The most commonly seen germs were Staph. epidermidis in 26% of cases, coagulase negative Staphylococci in 15%, E. faecalis in 13% and Staph. aureus and E. coli in 10% each.

**Discussion:** There is a clear shift to the gram-negative spectrum. Unlike other orthopedic procedures in this anatomical region (e.g implantation of a hip prosthesis), the germ spectrum is more similar to those of wound complications in visceral surgery. Therefore an adapted perioperative antibiotic prophylaxis (e.g. amoxicillin with sulbactam) is necessary.

2376

## Occlusive wound closure prevents prolonged wound discharge - A randomized controlled trial in patients undergoing tumor resection and endoprosthetic reconstruction of the proximal femur

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**Introduction/Purpose:** Prolonged wound discharge (PWD) is a common post-operative complication of orthopaedic procedures<sup>1-6</sup> and a risk factor for implant-related infection<sup>7-13</sup>. Occlusive wound closure (OWC) methods have previously been suggested to reduce or even prevent this complication<sup>14,15</sup>. However, conclusive evidence in support of this hypothesis is still lacking.

**Materials/Methods:** We performed a clinical trial on 70 patients who underwent surgical treatment for metastatic- or malignant hematologic bone disease involving the proximal femur at our center between January 2017 and August 2018. At conclusion of the tumor resection and endo-prosthetic reconstruction procedure, patients were randomized to either OWC (n=35), using the Dermabond Prineo-22 skin closure system, or routine wound closure with conventional skin staples (n=35).

**Results:** Skin closure with OWC resulted in a significantly lesser degree ( $p < 0.0001$ ) and shorter duration of post-operative wound discharge (HR 2.85 [95% CI 1.6-5.05],  $p < 0.0018$ ). Compared to staples, surgical wounds were already dry after a mean of 3.5 days (vs 6.1 days, [95%CI 3.2-3.9 vs. 4.8-7.3],  $p < 0.0003$ ). PWD for 7 days or more was observed in 23% of patients (n=8) in the Staples-group, but was entirely absent in the OWC-group ( $p < 0.003$ ). For every four patients treated with OWC, one complication of PWD of 7 days or more was prevented (NNT = 4).

**Conclusion:** This study provides strong evidence that occlusive wound closure (OWC) significantly reduces degree and duration of wound discharge in patients undergoing tumor resection and endoprosthetic reconstruction of the proximal femur and prevents PWD of 7 days or more in comparison to conventional skin staples.

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### A new non-invasive procedure to diagnose periprosthetic joint infection

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**Introduction and Purpose:** Immunohistochemical analyses revealed a variety of differentially expressed proteins in the periprosthetic membranes of patients having a septic or aseptic prosthesis loosening. Normally, proteins are degraded to peptides that may pass the blood-kidney-barrier. The aim of this study was to analyse if periprosthetic joint can be diagnosed by the urinary peptide excretion pattern.

**Materials and Methods:** Thirty patients that were admitted for prostheses exchange were evaluated in this study. Sampling of specimens was done according to the criteria of the Musculoskeletal Infection. Patients were diagnosed as having a septic or aseptic loosening of their knee or hip prosthesis. A urinary sample was analysed using capillary electrophoresis coupled to mass spectrometry. Peptides with a differential urinary excretion between the different groups were used to establish a multimarker model.

**Results:** A total of 137 peptides were excreted differentially between the septic and aseptic group. All of these demonstrated the same direction of regulation. The identified peptide markers were fragments of structural extracellular matrix proteins, which is potentially due to their origin from the periprosthetic membrane. A marker model with 83 peptides revealed the best diagnostic performance with a sensitivity of 95%, a specificity of 90% and an AUC of 0.96

**Conclusions:** The diagnostic of PJI by urinary peptide pattern seems to be a reasonable approach. This procedure is non-invasive and has therefore the potential to become a part of the diagnostic workup of PJI.

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## Short term benefits of passively eluting Agluna silver are not proven in the medium term for preventing infection in EPRs

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**Introduction and Purposes:** In 2015, Wafa et al. previously reported early outcomes of a high risk case matched cohort of endoprosthetic replacements (EPRs) with silver treated and untreated EPRs. Results in these high risk patients demonstrated lower rates of prosthetic joint infection (PJI), and improved successes following debridement and implant retention (DAIR) and two-staged revision of EPRs for PJI. The aim was to evaluate the same outcomes in the medium-term.

**Patients and Methods:** 169 patients with a mean age of 42.2 years at the time of surgery were reviewed through our prospective database after median 6.1 years (IQR 5.2 years). The procedures were undertaken between 2006 and 2011. 50 (29.5%) patients underwent primary reconstruction, 76 (45%) single-stage and 43 (25.5%) had two-stage revisions for infection.

**Results:** The mean follow-up in the silver treated group was statistically shorter than the mean follow-up in the untreated group at 4.8 years versus 7.3 years ( $p < 0.001$ , welch t-test). The overall infection rate in patients undergoing EPR with silver treated components was 18.3% compared with 20.1% in the control group ( $p = 0.511$ , chi-square). Kaplan Meier analysis failed to show a significant difference between silver and untreated groups ( $p = 0.33$ , cox ph). Sub-group analysis showed no-difference between silver and untreated in the primary and single-stage revision groups ( $p = 0.27$ ,  $p = 0.14$ , chi-square respectively). Those patients undergoing two-stage revision surgery, 15/22 silver treated (71%) had successful eradication of PJI versus 11/21 untreated patients (52%) ( $p = 0.29$ , chi-square). 19 patients underwent a DAIR procedure to treat acute PJI, of which 7/11 silver treated remain infection free vs 4/8 untreated implants ( $p = 0.552$ ). Overall failure leading to amputation was lower in the silver treated cohort (3.5%) compared to a rate of 12.9% in the control group ( $p = 0.03$ ).

**Conclusions:** In the medium term, silver treated EPR's in high risk patients are not more successful in preventing PJI nor managing PJI with two-stage revisions and DAIR. The amputation rate was lower in the silver treated group, although this may be influenced by the short length of follow-up.

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## 2403

### Two-stage revision for suspected infection in knee endoprosthetic replacement: does silver coating help?

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**Introduction:** Silver-coated (PorAg<sup>®</sup>) endoprosthesis (EPR) have shown encouraging results in reducing reinfection rate when used for the treatment of resistant PJI of the knee.<sup>1-3</sup>

The purpose of this retrospective study is to evaluate the use of PorAg<sup>®</sup> coated compared to titanium coated EPR in the setting of two-stage revision surgery for knee EPR infections (PJI).

**Materials and Methods:** 67 patients who underwent a two-stage revision for PJI were included. Median age was 30 years (range 14-83). 29 patients were re-implanted with PorAg<sup>®</sup> prosthesis (19 mobile EPR and 10 arthrodesis-KA) and 38 with titanium-coated prosthesis (33 mobile and 5 KA). PorAg<sup>®</sup> implants were mostly used in patients with higher risk bacteria such as Staphylococcus Aureus and Enterobacteriaceae (37.9% vs 23.1%, p=0.046).

**Results:** A lower number of reinfections was found in the PorAg<sup>®</sup> group (10.3% vs 25.6%, p=0.056). At 3 years follow-up, estimated reinfection rate in the silver group (13.7%) was slightly lower than in non-coated EPR (16.5%). Among re-infected patients, only one of the patients in the silver group required an amputation compared to 80% in the non-silver group (p=0.034).

**Conclusions:** Our results demonstrate the efficacy of PorAg<sup>®</sup> coating in the two-stage revision of knee EPR and may have possible advantages over this traditional strategy, in particular when applied to patients with a higher risk of re-infection. Moreover, it appears that even in the case of recurrent PJI, silver coating can result in a higher chance of limb salvage.

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2700

### **Osteoarticular reconstruction in lower limbs with MUTARS silver plated endomegaprotheses: experience of 86 cases**

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**Introduction:** In the extreme orthopedic challenges of risk to members viability, as is the case of musculoskeletal tumors with great bone destruction and other clinical situations, Medicine often responded radically and amputation appeared to be the end result.

**Materials:** The 10-year experience, from January 2008 to December 2017, of clinical cases of large osteoarticular reconstructions with preservation of lower limbs, including tumoral cases and non-tumoral cases such as infection (namely periprosthetic infection), with a casuistry of 86 Silver-coated Mutuar endomegaprosthesis. It encompasses 9 total femoral prostheses, 1 intercalary femoral dialysis prosthesis, 51 total prostheses of the knee with distal femur/ proximal tibia, or both, 3 knee arthrodesis prostheses, 2 LUMiC acetabular prostheses and 20 total hip prostheses with proximal femur

**Results:** The results obtained are encouraging, similar to the larger cases of silver-coated endomegaprotheses in Europe, with numbers of prostheses similar to those presented in this study. The functional results of the prostheses are presented based on the MSTs evaluation and the complications such as the infection and prosthetic mechanical complications.

**Discussion:** These results, in particular the low rate of complications, are due in part to the clearly demonstrated choice of the silver prosthetic coating and the good functional results to the treatment methodology and surgical technique performed, its systematic use in a protocolized way, as well as the care reconstruction and closure of soft tissues.

**Conclusion:** Mutars silver-coated endomegaprotheses are an effective surgical option in complex orthopedic clinical cases with destruction or severe damage of bone tissue and, when implanted in a solid and adequate manner, allow the functional lower limbs to be maintained in situations where the most probable solution was amputation or disarticulation.

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## Infectious complications and aseptic instability in children with megaprosthesis of bones and joints

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The aim of our study was to analyze possible acute complications after the use of megaprosthesis in children during the surgical treatment of bone sarcomas.

**Introduction:** In the practice of pediatricians in the community there are children after the end of special oncological treatment with established megaprotheses. In our work, based on the analysis, a detailed action plan was developed for possible complications after megaprosthesis in children.

**Materials:** The study included 605 children (01/2000-10/2018), who underwent 527 primary operations on implantation of megaprotheses and 78 operations related to the replacement of joints. An analysis of complications was carried out on the Henderson 2010 and 2014 scale. Patients were divided into two time intervals, which facilitated the analysis of complications. A behavioral tactic was developed for each type of complication.

**Results:** The type of complications No. 1 (associated with soft tissues) in the last 8 years occurred in 77 cases (12.7%), type No. 2 (aseptic loosening of the legs of the prosthesis) occurred in 52 cases (8.6%), type No. 3 (structural disorders of the bone and prosthesis) in 24 cases (4%). Infectious complications, type No. 4, occurred in 75 cases (12.5%) of them early infectious complications up to 2 years after surgery in 45 cases and later, more than 2 years, in 30 cases. The percentage of local recurrence in the area of operation, a complication of type 5, occurred in 5% of cases (30 patients).

**Conclusions:** On the basis of the analysis performed, infectious complications after megaprosthesis of the joints in children with bone sarcomas and aseptic loosening of the implant legs are still at a high level - 12% and 8.6%. Using the developed algorithm of behavior, it can significantly reduce the data risk, which was confirmed by the analysis of time intervals from 2000 to 2009 and from 2010 to 2018.

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## Clinical outcome of infection treatment after endoprosthetic reconstruction of the lower extremities

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**Introduction:** Deep infection is the main cause for failure of tumor prostheses of the lower extremities. However, there is little evidence supporting treatment strategies, and a lack of data on causative microorganisms. Therefore, we assessed the clinical outcome of infection treatments and epidemiology of causative microorganisms.

**Methods:** We retrospectively identified all patients who developed an infection during follow-up of an endoprosthetic reconstruction (EPR) of the lower extremity. The micro-organisms that were isolated during first debridement were recorded, as were the treatment strategy, and final outcome of infection treatment.

**Results:** From a total of 337 patients, 67 developed an infection (20%): 32 distal femoral (48%), 21 proximal femoral (31%) and 10 proximal tibial (15%) reconstructions. Median age was 52 years (9-85). Infections were diagnosed at a median of 33 days after last surgery (4 days-6 months). Thirty-three infections (50%) occurred after revision surgery for a mechanical complication. Fifty-five (82%) were primarily treated with DAIR procedures. Of these, the infection was eradicated in 34 (62%), 13 (22%) received suppressive antibiotics. Thirteen patients (24%) eventually needed a two-stage revision. Twenty-eight infections (42%) were poly-microbial, eight (12%) were caused by Gram-negatives. The number of microorganisms cultured was associated eradication rate of infection (OR1.6, 95%CI1.0-2.5, p=0.05).

**Conclusions:** Half of the infections of lower extremity EPRs occur after revision procedures for mechanical complications. The profile of causative microorganisms cultured is characterized by a high percentage of poly-microbial infections with inferior treatment outcomes. DAIR procedures provide an acceptable treatment option for acute infection with 84% of patients treated having a functional implant in situ.



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## Microsurgical reconstruction with vascularized fibula and massive bone allograft for bone tumors

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**Introduction and Purpose:** Combining massive bone allograft and vascularized fibula in intercalary reconstruction following resection of bone tumors represents a complex reconstructive procedure that requires specialists in microvascular surgery as well as orthopaedic surgery. The purpose of our study was to examine the outcomes using this surgical technique in patients with bone tumors in terms of oncologic results, complications related to surgery, Musculoskeletal Tumor Society (MSTS) scores and duration of surgery.

**Material and Methods:** We analyzed 81 patients with femoral or tibial sarcomas who underwent intercalary resection and microsurgical reconstruction with massive bone allograft and vascularized fibula. There were 56 boys and 25 girls with a mean age of 13.4 years at the time of surgery. The patients' medical records were reviewed for clinical and functional outcomes as well as post-operative complications. The study group was comprised of 33 patients who underwent reconstruction of the femur with massive bone allograft and free vascularized fibula and 48 patients who underwent reconstruction of the tibia with massive bone allograft and free or pedicle vascularized fibula. The mean length of resection was 15.9cm (8-31cm). The functional evaluation of the patients was done at the end of the follow-up using MSTS score for the lower limb. All patients had at least a 2-year follow up.

**Results:** The overall limb salvage rate was 94%, although many patients required reoperation after the procedure. Complications occurred in 24 patients, 18 of which underwent additional surgical procedures. They included fractures of the massive bone allograft-vascularized fibula construct with or without implant failure (19) and deep infection (5). After surgical or conservative treatment, all the fractures successfully healed. The overall MSTS functional score was good to excellent in 91% of patients.

**Conclusions:** The combination of massive bone allograft and vascularized fibula seems to be a reasonable option for reconstruction of diaphyseal defects following intercalary resection of bone tumors. Although there was a high rate of complications and therefore reoperations, the biology of vascularized fibula was able to save the reconstruction in most of the cases that had complications.

Table

Age (years)	13.4		
Gender			
Male	56		
Female	25		
Site			
Femur	33		
Tibia	48	23	Free Fibula
		25	Pedicle Fibula
Diagnosis			
Osteosarcoma	46		
Ewing Sarcoma	31		
Adamantinoma	4		
Type of Reconstruction			
Femur	33	23	concentric assembly

		10	parallel assembly
Tibia	48	47	concentric assembly
		1	parallel assembly
Length of resection	15.9 (8-31cm)		

Summary of data in 81 patients treated with diaphyseal resection of bone tumors and reconstruction with combination of massive bone allograft and vascularized fibula

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**Complications of reconstruction of bone defects after wide resection of malignant musculoskeletal tumours with a devitalized autograft combined with free vascularised fibular graft**

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**Objective:** The aim of this study is to report the complications of patient series with malignant bone tumors treated with wide resection and using an autograft containing tumor treated by liquid nitrogen or irradiation combined with free vascularized fibular graft.

**Study Design:** Single-center based retrospective study

**Methods:** We reviewed 11 patients who underwent curative resection for malignant musculoskeletal tumour followed by reconstruction with vascularized fibular graft in combination with the tumour bearing autograft treated by liquid nitrogen or irradiation. 6 cases were located in the tibial shaft, 4 in the femoral shaft and 1 in the distal femur. The operative technique consisted of wide en-bloc resection of the tumour, curettage of the tumour from the resected bone segment, management of the resected segment with liquid nitrogen or irradiation, harvest of vascularised bone graft from fibula, reimplantation and internal fixation of the autograft treated with liquid nitrogen or irradiation.

**Results:** 11 patients (6 female, 5 male) with a mean age of  $17.2 \pm 9$  (range, 5-32) years were evaluated. At the final follow-up all patients were alive, while 7 patients remained free from disease with a mean follow-up of  $37.2 \pm 35$  (range, 3-129) months. Bony union was seen at a mean of  $20 \pm 6.5$  (range, 11-32) months after the operation in 7 patients. 7 patients suffered from complications including 4 non-union, 3 delayed union, 2 superficial and 1 deep infection and 1 local recurrence. There was no recurrence from liquid nitrogen applied or irradiated bone segment. There was a %63 complication rate. All complications were managed successfully.

**Conclusions:** Reconstruction of bone defects after wide resection of malignant bone tumours with a devitalized autograft combined with free vascularised fibular graft has high complication rates. However this technique still remains as a biological and useful reconstruction method.

2580

## Intercalary endoprosthetic reconstruction: an analysis of complications

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**Introduction:** Endoprosthetic options for reconstruction following resection of diaphyseal tumors have historically been limited to megaprotheses involving the joint. Intercalary endoprostheses combine the benefits of early return of function and pain relief with a smaller sized implant. The primary objective of this study is to report the outcomes and complications of patients treated with intercalary endoprosthetics for diaphyseal segmental defects at a single institution.

**Methods:** Thirty-six consecutive patients (40 limbs) treated at a single institution from 2008-2018 with intercalary endoprostheses were retrospectively reviewed. Inclusion criteria were patients who had segmental bone loss from an aggressive or malignant bone tumor with preservation of the joints above and below. Patients underwent cemented reconstruction with a modular intercalary endoprosthesis (OsteoBridge™ IDS; Merete, Berlin, Germany) of the humerus, tibia, or femur.

**Results:** Mean age at the time of surgery was  $60 \pm 17$  years with a mean follow-up of 23.8 months (range 1.4-102.6 months). Of the 40 endoprostheses, 17 involved the humerus, 15 the femur, and eight the tibia, with 27 limbs treated for metastatic disease and 13 for primary tumors. Thirty-two patients underwent surgery due to primary resection, while eight had surgery as salvage after failed reconstruction. Mean defect for femur, tibia and humerus reconstruction were 9.7cm, 10.6 cm, and 6.3 cm respectively. Complications were reported in 10 (25%) patients and categorized by according to Henderson et al. (Table 1). The mean MSTS score for patients in the series was 80%.

**Conclusions:** Intercalary endoprosthetic reconstruction provides an option for limb salvage in patients with diaphyseal tumors, with a complication rate 25% and MSTS scores of 80%. The highest rate of complication is seen with femoral reconstruction. Future prospective large multi-centered studies comparing intercalary endoprostheses and other reconstructive methods are needed prior to broad application of these findings.

Table 1. Implant Complications and Outcomes

Failure Mode	Femur	Tibia	Humerus
Type 2	-	3	1
Type 3a	5	-	-
Type 3b	-	-	-
Type 4	1	-	-
Type 5	-	1	1
Total Complications	6	4	2
MSTS score	73%	73%	83%

\*Complications categorized according to Henderson et al.

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## Preliminary results of a new intercalary modular endoprosthesis for the management of diaphyseal bone tumors

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**Introduction and Purposes:** Surgical resection of diaphyseal bone tumors often results in significantly reduced bone stock and presents a reconstructive challenge for orthopaedic surgeons. Several treatment strategies have been described and endoprosthetic limb salvage procedures are gaining popularity. We present our preliminary result of a novel intercalary endoprosthesis (S-Link Estasâ, Turkey) after resection of malignant diaphyseal bone tumors.

**Materials and Methods:** In a retrospective case series, 15 consecutive patients who underwent endoprosthetic reconstruction for malignant bone tumors from 2016 to 2018 with at least 6 months of follow-up were enrolled. The mean age of patients at the time of operation was 50 (range 12-78) with an average follow-up of 13 (range 6-22) months. The diagnosis was osteosarcoma in 5 patients, adamantinoma in 1 patient, metastatic lung carcinoma in 7 patients and renal carcinoma in 2 patients. Wide excision was performed with a mean length of 130 mm (range 65-240). 6 femur, 5 humerus and 4 tibia intercalary resection were reconstructed with intercalary endoprosthesis. Post-operation functional outcomes, oncological results and complication rates were analyzed.

**Results:** The mean Musculoskeletal Tumor society functional analysis for humeral reconstruction was 86% (range 75-93) and for lower extremity reconstruction was 79 % (65-98). All the patients are free of disease and no recurrence was noted. One patient with femur reconstruction (%6,6) underwent additional plating after index operation for non-union, 2 patients with tibia reconstruction (% 13,2) needed further medial gastrocnemius flap for local wound control. No prosthetic breakdown or periprosthetic fracture was noted at the final follow-up.

**Conclusion:** Limb salvage procedure with a novel intercalary prosthesis may yield satisfactory functional results after wide resection of malignant bone tumors. Although few complications were reported in our series, long term follow-up and larger studies are needed.

Figure 1. Pre-operative and post-operative x-rays of 44 years old female who underwent wide resection of right tibia for telangiectatic osteosarcoma.



# SESSION 09

## SOFT TISSUE SARCOMAS 2



2542

## Novel treatment of Zaltoprofen for diffuse-type tenosynovial giant cell tumor arising in knee and ankle joint: A pilot study

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**Introduction and Purposes:** We have revealed that zaltoprofen, a nonsteroidal anti-inflammatory drug possessing the ability to activate peroxisome proliferator-activated receptor gamma (PPAR $\gamma$ ), can inhibit the proliferation of tenosynovial giant cell tumor (TGCT) stromal cells<sup>1)</sup>, and got the patent. PPAR $\gamma$  is a ligand-activated transcription factor that belongs to the nuclear hormone receptor superfamily. Therefore, we conducted this pilot study to evaluate whether zaltoprofen is safe and effective for patients with Diffuse TGCT (D-TGCT).

**Materials and Methods:** Patients with advanced primary and recurrent D-TGCT arising in knee and ankle joint were enrolled in this study. Zaltoprofen (240mg) was given orally, daily for 48 weeks or until progressive. The response was assessed using the Response Evaluation Criteria in Solid Tumors (RESIST), which was measured by MRI every 3 months. The functional status of the patients was assessed using Ogilvie-Harris score for knee and MSTS score for ankle D-TGCT. Adverse effects were evaluated using the Common Terminology Criteria for Adverse Events v4.0 (CTCAE).

**Results:** Twelve patients were enrolled. Mean age was 44 years (range, 16 to 67 years). Mean tumor size was 59 mm (range, 31 to 93 mm). Mean follow-up periods were 76 weeks (range, 12 to 143 weeks). Tumor locations were knee in 7 and ankle in 5 pts. Mean tumor size reduction was 2.9% (range, -9.5% to 16.4%). Eleven patients kept the stable disease and one patient showed progressive disease after 72 weeks. Surgery was performed in 3 patients due to their request. Mean pre- and post treatment Ogilvie-Harris score was 64% and 80%. Mean pre- and post treatment MSTS score 96% and 99.3%. No adverse effect (>Grade 3) was observed. Surgery was performed for 3 patients with ankle D-TGCT due to their request at 12, 24 and 48 weeks.

**Conclusions:** Zaltoprofen was well tolerated and kept stable disease without improving the limb-function. It could be a novel treatment in patients with TGCT. The results of this study contributed to the development a randomized, placebo-controlled, double-blind, multicenter investigator-initiated clinical trial which is currently on-going.

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### Low grade fibromyxoid sarcoma: demographics, prognosis and behavioural patterns

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**Introduction and Purposes:** Low-grade fibromyxoid sarcoma (LGFMS) was described by Evans in 1987. It is a rare soft tissue sarcoma (STS) subtype. Compared to other STS, it is characterized by an unusual behaviour with late local recurrence and metastasis. In the literature few clinical prognosis factors have been reported. From a genetic point of view, LGFMS presents in the majority of cases with a balanced translocation resulting in a fusion of FUS and CREB3L2 genes.

The aim of this study was to identify clinical prognostic factors from a tertiary referral sarcoma centre experience.

**Material & Method:** This retrospective mono-centric study included 44 patients, diagnosed and treated between 1979 and 2015. Median age was 37 years old (6-75). Treatment was resection for all patients and adjuvant radiotherapy was performed in 9 cases. Median follow up was 7.3 years (2-35).

**Results:** Eight patients developed a local recurrence at a median period of 48 months (9-228). 4 patients had metastasis at diagnosis and 5 patients presented with metastasis during the follow up at a median period of 52 months (25-326). Five years disease free survival (DFS) was 74% (28/38), 10 years 56% (10/18), 15 years 55% (6/11) and 20 years 20% (1/5).

Deep tumours, proximal limb tumours and trunk, and tumours presenting more than 6 cm in diameter were criterion associated to worse DFS. Local recurrences were associated with higher rate of metastasis. Only 2 patients have died as a result of their disease.

**Conclusion:** LGFMS has a variable pattern of behaviour both preoperatively and post-operatively. This study suggests that current international soft-tissue sarcoma surveillance guidelines may need to be adjusted to accommodate low-grade STS lesions in general, and this tumour in particular.

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## Outcome After Surgical Treatment of Dermatofibrosarcoma Protuberans (DFSP): Does it requires all this follow up? How much resection margin is enough?

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**Background:** Dermatofibrosarcoma protuberans (DFSP) is a rare, cutaneous tumor of intermediate monoclonal dermal neoplasm. DFSP is known to be locally aggressive and infiltrative. It seems to be associated with high local recurrence rates after surgical intervention and current resection method advocates extra-wide margins or often results in high chance of local recurrence.

**Objective:** Assess the outcomes of DFSP resection in our facility and shape a new follow-up protocol based on this evaluation.

**Methods:** All DFSP treated in the unit were included through our prospective database: consents were obtained from patients at time of referral to our sarcoma clinic and prospective follow-up data was collected. Patients with and without prior surgery, and patients with fibrosarcoma were included. Each patient was operated with 2.5cm wide-margin resection method, to ensure complete resection of the tumor. Patients were followed up after surgery to monitor complications, recurrence, transformation and/or metastasis. Minimum follow-up was of one year.

**Results:** N=196 patients (mean age=42.4, standard deviation= 13.7) were included in Mount Sinai Hospital Sarcoma unit, Toronto with minimum follow up of a year. 136 (39.4%) had prior “whoops” surgery before referral. After our surgery, 14 (7.1%) patients were found with positive margins; 8 patients underwent radiation treatment while the other 6 patients were discharged without any further treatment. During follow-up, 1 patient who had local recurrence at time of referral, developed additional local recurrence. 1 other patient developed a lesion at another site. No recurrence was observed in all other patients.

**Discussion:** The recurrence rate in our DFSP cohort is significantly lower than previous reports. This demonstrates that our minimalist approach to treating DFSP, i.e. wide margins of resection, is viable and effective. Patients treated with our method do not require frequent follow-up. This resection method can significantly improve patient outcomes and reduce visits to hospitals post-surgery. Future studies should look at if closer margins can also produce similar treatment outcome

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### Challenging factors in the treatment of synovial sarcoma

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**Introduction:** Synovial sarcoma represents a rare soft tissue sarcoma, mainly occurring in young adults. Mainstay of treatment consists of wide resection of the lesion, either with neoadjuvant or post-operative radiation and chemotherapy. Current literature provides recommendations for treatment but a gold standard was not established so far. We aimed to evaluate the oncological outcome and influencing factors after treatment of patients with synovial sarcoma.

**Methods:** A retrospective analysis of our prospectively collected database between 1965 and 2017 detected a total of 119 patients, that were diagnosed with synovial sarcoma for further evaluation.

**Results:** The mean age at diagnosis was 36.5 years ( $\pm 17.3$ ). The disease occurred in 58 female (49%) and 61 male (51%) patients. Tumor grading was described as grade 3 in 77 cases (65%) and grade 2 in 29 cases (24%). Localization of the lesions were the lower extremity in 82 patients (69%), the upper extremity in 28 patients (24%) and the torso or spine in 3 (3%) and 5 (4%) patients, respectively. Localization of the lesion close to the torso (torso, spine, hip or shoulder girdle) occurred in 26 patients (22%) and was associated with decreased survival ( $p=0.001$ ). Thirty-one patients (26%) underwent a whoops procedure before they were treated at our institution which also was associated with a decreased survival ( $p=0.041$ ). Limb sparing procedures were performed in 74% of the cases, whereas in 26% an amputation was indicated. Thirteen patients (11%) had metastases at diagnosis, which was clearly associated with inferior survival ( $p=0.025$ ). Likewise, the occurrence of metastases after treatment was a negative predictor ( $p=0.012$ ). Fifteen patients (13%) received neoadjuvant chemotherapy and 8 patients (7%) received neoadjuvant chemotherapy and radiation, which was associated with improved survival rates ( $p=0.002$ ).

**Conclusion:** Occurrence of the tumor close to the torso and inadequate surgery are significantly impacting survival, justifying treatment in specialized centers only. Neoadjuvant chemotherapy and radiation could significantly increase survival. Therefore, an interdisciplinary approach in the treatment of synovial sarcoma can be recommended especially in cases of progressed diseases and unfavorable location of tumors.

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## Does pre-operative Magnetic Resonance predict the risk of local recurrence in primary myxofibrosarcoma of the extremities?

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**Introduction:** Myxofibrosarcoma (MFS) shows an unusual infiltrative growth pattern, expressed as a characteristic 'tail-like' pattern on magnetic resonance imaging (MRI). The aim of this retrospective study is to analyse MRI features of primary MFS and their correlation with patients' prognosis.

**Methods:** 94 patients with primary MFS of the limbs were included. Mean age was 69 years (range, 18-77); 75 (80%) tumours were grade 3, 17 (18%) grade 2 and two (2%) grade 1. The presence of a "tail pattern" was recorded and myxoid matrix and Gd enhancement were graded with a semiquantitative method.

**Results:** "Tail pattern" was observed in 32% MFS; most of the tumours presented high myxoid features and high grade of Gd enhancement. Grade 3 tumours more often presented high myxoid pattern ( $p=0.003$ ); a tail-like pattern was mostly observed in MFS smaller than 5 cm ( $p=0.001$ ). Mean follow-up was 27 months (range, 2-104). Local recurrence (LR)-free survival rate was 70.3% at 3 and 58.4% at 5 years. A higher LR-rate was observed in those tumours presenting a tail pattern at MRI ( $p=0.039$ ), in those with high myxoid features ( $p=0.047$ ) and in those with high Gd enhancement ( $p=0.029$ ). Overall-survival (OS) was 67.9% at 3 years and 62.6% at 5 years. A worse OS was observed in high Gd enhancement ( $p=0.013$ ) and in deep tumours ( $p=0.031$ ).

**Conclusions:** MFS features on preoperative MRI can be useful in order to identify risk classes of LR. These data may suggest that patients with a "tail pattern", high Gd enhancement and high myxoid features should be followed up more carefully after surgery. The assessment of the "real" extent of tails is critical for optimal surgical planning minimizing the risk of local recurrence after resection and ultimately reducing the potential for metastatic disease.

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### Prognostic survival model of myxoid liposarcoma patients using machine learning

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**Introduction and Purposes:** Predicting outcomes for oncology patients is largely generalizable and individualization of outcome prediction remains limited. Machine learning applications offer a resource to individualize patient outcome predictions in a manner usable for clinicians. We sought to develop an interactive application to predict survival outcomes in myxoid liposarcoma patients.

**Materials and Methods:** A national oncology registry and an institutional database were utilized for creation and validation of a 5-year survival prediction model of myxoid liposarcoma patients. Multiple machine learning algorithms were applied to the national registry, and the most accurate algorithms for predicting patient survival were then tested and validated on an institutional database. The most predictive model was then deployed on an interactive, online application (Wojciechowski).

#### Results:

When developed and tested on a national database, 4/10 predictive models displayed area under the receiver operator characteristic curve (AUCs) of over 0.80. The best model, a support vector machine, had a positive predictive value (PPV) of 76.9% and a negative predictive value (NPV) of 85.7%. When these 4 models were validated on the institutional dataset, the best performing model was a random forest with an AUC of 0.78 (95% confidence interval [CI], 0.64-0.92), PPV of 86.4%, and NPV of 75.0%. An interactive web-application of the model is now available online.

#### Conclusions:

Using machine learning models, individual outcome prognostication can now be quantified and modeled. Our publicly available survival model can be utilized by researchers and clinicians to estimate 5-year survival probabilities in patients with myxoid liposarcoma diagnosis.

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## Are we detecting extra-pulmonary metastases early enough in Myxoid Liposarcomas?

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**Introduction and Purposes:** Myxoid Liposarcoma (MLS) accounts for 5% of soft tissue sarcomas, with a predilection for extra-pulmonary metastasis (EPM). Routine extra-pulmonary imaging is not part of national sarcoma surveillance. We aimed to assess the efficacy of current protocols at identifying MLS relapse.

**Materials and Methods:** A retrospective analysis of appendicular MLS cases from 2005-2015 at a supra-regional UK sarcoma service. Data on relapse site, relapse-free interval (RFI) and detection modality were collected from electronic databases and analysed using SPSS v22.

**Results:** N=111. Mean overall survival (OS) was 90.1% with 55 months mean follow-up. 23/111 (20.7%) patients relapsed: 2(1.8%) local recurrences (LR), 18(16.2%) metastases, 3(2.7%) had both. Tumours that locally recurred were larger with closer resection margins ( $p=0.05$ ). Mean time to LR was 39.4 months. 16/21 (76.2%) metastases were EPM, 2/21 (9.5%) pulmonary (PM) and 3/21 (14.3%) across both. Mean RFI to EPM was 30.1 months, 13.5 months to PM and 13.0 months to both. 3/23 (13%) relapses were detected by routine surveillance. All LRs and 73.3% of EPM were self-detected. 6(43%) self-detected relapses had disseminated disease on re-staging. Tumour characteristics and margins were not significant in predicting relapse on regression analyses. Cases which relapsed had significantly larger primary tumours ( $p=0.007$ ). Nine patients underwent metastatectomy, which significantly improved OS in EPM ( $p=0.049$ ). This did not reach statistical significance in PM.

**Conclusions:** We demonstrate a high relapse rate, particularly with EPMs in MLS. A majority of relapses were self-detected outside the scope of routine surveillance, particularly important in MLS where metastases often occur in odd places. Metastatectomy in EPM conferred a significant survival benefit. We suggest more stringent extra-pulmonary imaging is required in MLS surveillance for earlier identification of disseminated yet potentially resectable disease.

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### Incidence and outcome of abdominal metastases in soft tissue sarcoma. Results of a multicentre study

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**Introduction and Purposes:** The incidence of abdominal metastases (AM) in soft tissue sarcomas is low and prognosis is poor. The aim of the present study was to investigate the incidence of AM in extremity STS, risk factors for development of AM and outcome of patients with AM.

**Materials and Methods:** 769 patients with primary localised STS undergoing surgery at three tertiary tumour centres were retrospectively included in the study. Medical records and follow-up images were used to ascertain clinical, tumour- and treatment-related parameters as well as follow-up information. Uni- and multivariate Cox-regression models were calculated.

**Results:** 202 patients (26.3%) developed secondary metastases after a median of 15 months (interquartile range [IQR]: 10-29 months). 24 patients developed AM during the study period (3.1%). Ten of these patients developed first AM (FAM) after a median of 1.4 years (IQR: 0.8-4.2 years), whilst 14 patients developed late AM (LAM) at a median of 3.5 years (IQR: 1.4-4.4 years), after having being diagnosed with metastases to other sites. Irrespective of age or grading, patients with liposarcoma (no difference between myxoid/pleomorphic/dedifferentiated) had a significantly higher risk of developing primary AM (HR: 6.915; 95%CI: 1.727-27.683; p=0.006). Patients with metastases had a significantly poorer overall survival than patients without metastases (p<0.0001). Post-metastasis-survival was similar between patients with AM and those with metastases to other sites (p=0.585). Moreover, patients with FAM or LAM did not show a significant difference in post-metastasis-survival (p=0.884).

**Conclusions:** Survival in soft tissue sarcoma patients with AM appears to be poor, irrespective of the time of AM occurrence. Considering that patients with liposarcomas appear to be at a significantly higher risk of developing AM, regular abdominal surveillance with sonography or abdominal CT should be considered for this subtype.

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## Soft tissue sarcoma abutting/invading the bone, a proposed guideline for surgical management

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**Background:** The incidence, surgical treatment and effect on overall survival and recurrence of bone invading/abutting soft tissue sarcoma, still poorly described in the literature.

**Objectives:** To present an institutional experience regarding; surgical treatment and outcome of soft tissue sarcoma abuts the bone.

**Material / Methods:** From July 2006 -Dec. 2016, 212 patients with wide local/compartement resection, at KHCC. Forty three patients (20%) the tumor were attached to the bone. Patients divided into 3 groups:  
Group 1: bone abutment only (n=25)  
Group 2: cortical invasion (n=10)  
Group 3: either medullary canal invasion or total encasement of bone (n=8)  
Tumor location includes: extremity 21, one case pelvic and one case chest wall, once case sacrum.  
All patients with group 1 received subperiosteal resection of the tumor, group 2 received hemicortical resection, and group 3 received segmental bone resection of the involved bone.

### Results:

At mean follow up of 56 month (16-78mo)  
8 patients died of disease metastasis  
4 patients developed local recurrence at the soft tissue, all of them the pathology of the resection show negative margin, 2 from group 1, and 2 from group 2.  
two patients had radiation related femur fracture  
6/10 patients with bone invasion on MRI, found to have bone invasion in histopathology exam.  
5 yr. EFS = 53%  
5 yr. OS = 76%

**Conclusion:** This is a small group retrospective pilot study; the results show that STS abutting bone probably do not lead to worse outcome. Our proposed guideline for surgical management of different scenarios of soft tissue tumor with adjacent bone abutment/invasion can be the basis for objective mean to plan the management of this subtype of soft tissue sarcoma. Larger size study is needed to expand this guideline.

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### Outcomes of vascular reconstructions following sarcoma excision

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**Background:** Limb salvage surgery with vascular reconstruction is currently considered as the standard treatment for extremity soft tissue and bone sarcoma (STS/BS), with equivalent patient survivals compared with amputation. Few publications assessed this specific type of reconstruction and their vascular outcomes. In this study, surgical and functional outcomes after arterial and/or venous reconstruction in limb salvage surgery for STS were analysed.

**Methods:** We examined our prospective database and all patients who underwent vascular management as part of limb salvage surgery for extremity STS or BS from 1996 to 2016 were included in this study. Incidence of surgical complication, graft patency, and patients' vascular and functional outcome were reviewed.

**Results:** During the study period, 52 STS patients (29 men, 23 women; mean age: 56 years) were included: 33 had an artery + vein reconstruction, 11 patients had a vein ligation with arterial reconstruction, 5 had their vein alone reconstructed and 3 patients had a vein ligation only. Autologous great saphenous vein (GSV) was the most commonly used vascular conduit in both arterial and venous reconstruction (81% and 77.0%). During a mean follow up of 3 years, 25 patients died (50%), 6 patients (11.5%) needed amputation of the initially salvaged limb because of reconstruction failure (thrombosis or leakage). There were 6 post op DVT, 8 superficial infection, and 6 flap failures with deep infection. At the last follow-up, 77 % of assessable arteriovenous reconstructions had a patent graft on US, 100% of venous or arterial only reconstructions were patent. One-year and 5-year post-op mean MSTS scores were of 78 and 88, respectively. Seventy percent had oedema and 40% used compression stocking. 50% had significant symptoms (cramps, tightness or heaviness).

**Conclusion:** Limb salvage surgery of soft tissue tumour combined with vascular reconstruction showed favourable functional outcomes with good local control. Even though amputation was more frequent because of selection bias studying more severe case, limb salvage should be considered (89% limb survival rate) with low impact of vascular symptoms on functional outcomes. Oncological outcomes were comparable to classical survival rates of STS, advocating for limb salvage even when vessels are involved.

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### Patterns of care and survival in elderly patients with advanced soft-tissue sarcoma

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**Background:** Elderly population represent more than 50% of sarcoma patients and they often present many differences compared to younger patients. The aim of this study is to analyze clinical outcome and treatment related toxicity of elderly STS patients.

**Materials and Methods:** We retrospectively collected data of patients > 65 years old diagnosed with locally advanced STS in a single institution.

**Results:** The study included 111 pts. Mean Charlson Comorbidity Index (CCI) was 7.5 (range 2-12). 105(94.6%) underwent surgery, 91 (82%) received radiotherapy (RT), 23 (20.7%) received radiochemotherapy and 20(18.1%) received chemotherapy. Grade  $\geq 3$  acute skin toxicity was recorded in 38 (52.8%) patients out of 72 who received postoperative RT, age >80 years correlated with higher incidence of toxicity compared to younger (63.6% vs 33.3%,  $p=0.02$ ). Late fibrosis, late edema and joint stiffness occurred in 10.4%, 11.8% and 4% of patients. At a mean follow up of 4.1 years (0.1-17.7), 24(22%) patients recurred, 3-and 5-year local recurrence free survival were 80.3% and 75.7%, respectively. 55(52.9%) patients developed distant metastasis, 3-and 5-year distant metastasis free survival (DMFS) were 59.6% and 44.6%, respectively. Omission of adjuvant RT and lack of surgery correlated with higher recurrence ( $p=0.043$  and  $p=0.002$ ). Undifferentiated pleomorphic sarcoma histology and CCI >7 were independent factors associated with DMFS ( $p=0.026$  and  $p=0.0001$ ). Overall survival (OS) was 62% and 46.6% at 3 and 5 years. Surgery and CCI  $\leq 7$  were independent factors associated with OS ( $p=0.006$  and  $p=0.0001$ ).

**Conclusion:** Outcome in older pts may be influenced by invasive histotype and less aggressive management. In this study elderly STS pts receiving a tailored treatment encompassing surgery, RT and/or chemotherapy obtained a good efficacy and safety. Comorbidities should be considered to offer the best treatment to this frail patient population.

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### Advancing soft-tissue sarcoma aftercare using flexible parametric survival models

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**Introduction and Purposes:** Current follow-up strategies for soft tissue sarcoma (STS) follow a heuristic approach. However, risks for local recurrences (LR) and distant metastases (DM) strongly differ per grade, size, histology, margins and (neo)adjuvant radio-/chemotherapy (RTX/CTX). The aim of the present study was to predict LR- and DM-rate in STS-patients using a flexible parametric model (FPSM), aiding individualisation of STS-aftercare.

**Materials and Methods:** 1963 patients with primary non-metastatic high-grade STS managed with curative intent at 5 tertiary sarcoma centres were retrospectively included (54% males, mean age: 60 yrs; median follow-up: 4.1 yrs). The validation cohort consisted of further 1095 patients from 2 tertiary sarcoma centres. A FPSM with spline functions was constructed to estimate rates for LR and DM, accommodating for non-constant hazards.

**Results:** In the FPSM for LR, clear margins, small size, neoadj. and adjuvant RTX and female gender (all  $p < 0.001$ ) were independently associated with lower risk, irrespective of age, neoadj. CTX and grading. Furthermore, all subtypes had a higher LR-risk than myxoid liposarcoma (LS), except for dediff. LS ( $p < 0.05$ ). In the FPSM for DM, small size, female gender, low grade (all  $p < 0.001$ ), clear margins ( $p = 0.016$ ) and no neoadj. RTX ( $p = 0.011$ ) were associated with lower risk, irrespective of age, neoadj. CTX and adj. RTX. All subtypes had higher DM-risks than myxoid LS, except for dediff. LS and myxofibrosarcoma ( $p < 0.05$ ). Based on these models, rates depending on histology for LR (Fig.1) and DM (Fig.2) per 1 patient year were predicted (FPSM allows prediction for any constellation of variables). Our models showed good internal (c-index for LR: 0.701; for DM: 0.702) and external calibration (c-index for LR: 0.738; for DM: 0.710).

**Conclusions:** Our approach allows individualised prediction of rates for LR and DM at any point in time for STS-patients, aiding individual patient aftercare in practice.



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### Prognostic factors and outcomes in soft tissue sarcomas of the extremities: 10-year experience at tertiary care hospital

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**Introduction:** Soft tissue sarcoma of the extremity (STS) is rare, approximately 1% of all adult malignancies. 10-38% of patients have local recurrence, 10% present with metastasis with 20-30% 3-year survival rate. There was only one published report that presents prognostic factors, clinical results and epidemiologic study of STS in Thailand.

**Purposes:** (1) To assess overall survival (OS) and (2) To determine the factors that affect local recurrence, metastasis, and survival in patients who were diagnosed with STS and undergone surgical treatment at a tertiary care hospital in Thailand.

**Materials and Methods:** Medical records of 113 patients who were diagnosed with STS and undergone surgical treatment from June 2006 to June 2016 were retrospectively reviewed. Incomplete recording or loss of medical records was excluded. The 10-year OS was analyzed by Kaplan-Meier survival analysis. Log-rank test for univariate analysis and Cox proportional hazards model for multivariate analysis was used to assess the factors that affect local recurrence, metastasis, and survival.

**Results:** The 10-year overall survival was 37.5%. Surgical margin affected local recurrence significantly. Positive margin increased the risk of local recurrence 2.6 times compared to negative margin. Gender affected metastasis and survival significantly. Male increased the risk of metastasis 2.5 times compared to female and increased the risk of death 1.9 times compared to female. AJCC staging affected survival significantly. AJCC stage 4 increased the risk of death 6 times compared to stage 1. Histopathology affected survival significantly, malignant peripheral nerve sheath tumor was the most increased risk of death.

**Conclusions:** Positive surgical margin increased the risk of local recurrence. Male increased the risk of metastasis and death. MPNST and AJCC stage4 increased the risk of death. The 10-year overall survival was 37.5%.

2356

## Sarcopenia affects incidence of surgical wound complications in localized soft tissue sarcoma patients but not outcome

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**Introduction:** Sarcopenia, the age-associated loss of skeletal muscle mass and function, has been associated with poorer outcome in carcinoma patients. We hypothesized that sarcopenia would have decreased survival and increased wound complications.

**Methods:** We retrospectively reviewed all patients treated for localized soft tissue sarcoma with preoperative abdominal CT scans between 2011 and 2017. Sarcopenia was then assessed by measuring the total cross-sectional area of bilateral psoas muscles and then adjusted for height ( $\text{cm}^2/\text{m}^2$ ). The association between sarcopenia and local recurrence, metastasis and mortality were assessed with a logistical regression analysis and the association between sarcopenia and wound complications was assessed with a chi-squared test.

**Results:** We found 16 women and 14 men, with a mean age of 56.7 years (17-87) and a mean BMI of 26.09 (20.3-35.43). Twenty-two patients (73%) had high grade and 8 (27%) intermediate grade tumors with a mean size of 9.98 cms (3.6-25). Mean height adjusted total psoas area was  $5.6 \text{ cm}^2/\text{m}^2$  (2.86-9.53). In sarcopenic patients, with a height adjusted total psoas area  $< 5 \text{ cm}^2/\text{m}^2$ , had statistically significant more wound complications requiring surgery ( $p=0.04$ ) but similar outcomes.

**Conclusions:** Sarcopenia appears to affect postoperative wound complications requiring surgery but does not influence overall survival in patients with localized soft tissue sarcoma.

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2550

## Results of multi-visceral resection for retroperitoneal sarcoma from a UK reference centre

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**Background:** Retroperitoneal sarcoma is a rare and challenging condition to treat. Adjuvant treatments are rarely effective and largely unproven leaving surgery as the cornerstone of management. In Europe, there is a trend toward extended multivisceral resection to clear the relevant retroperitoneal compartment. This involves removal of contiguous, uninvolved organs to maximize the chance of clear margins analogous to compartmental resection in the extremities.

**Results:** We present our experience since 2006 which includes 300 resections. Over two thirds of the patients had either liposarcoma or leiomyosarcoma. The rest included a wide range of pathologies the next commonest subtype being solitary fibrous tumour. We can demonstrate clear resection margins in over 80% of patients with minimal morbidity.

**Conclusion:** Surgery for retroperitoneal sarcoma requires special expertise. This should be provided in a small number of referral centres and we recommend a minimum of 24 cases per year.



# SESSION 10 BENIGN AND PSEUDOTUMORAL LESIONS

## 3002

### Operative versus non-operative approach in aggressive fibromatosis: preliminary data from a multicentric study

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**Background:** Desmoid fibromatosis management is still debated; the current trend supports non-operative approaches but small series fail to provide evidence in favor of one treatment.

**Purpose:** to perform a multicentric study to compare different fibromatosis treatments and to investigate risk factors for recurrence.

**Methods:** Six Institutions are collecting data on 367 patients with a histologically diagnosed fibromatosis. The submitting Institution is contributing with 91 patients. At present 77/91 patients have been reviewed (44 females/33 males, age: 39 years (8-81). 69 had a virgin disease. Diagnosis was performed 14 months after symptoms onset. Site of location was: shoulder girdle (26), thigh (15), pelvic girdle (12), leg (9), arm (6), foot (4), forearm (3) and hand (2). The lesion was <5cm in 28 patients, 5-10 cm in 38 and larger than 10 in 11. The mass was extra-fascial in 11 patients while in the vast majority was deep (66). Nerve involvement was observed in 6 patients. Sixty-four patients with a symptomatic resectable lesion underwent surgical excision of the mass (Group I); fourteen patients with either an asymptomatic small lesion or an unresectable mass were referred to a medical oncologist and underwent observation (Group II - 7 patients), chemotherapy (Group III - 2 patients) or were administered systemic estrogen receptor modulators (Group IV - 4 patients). Clinical and imaging records from all patients were reviewed. At the latest followup either clinical examination or phone interview was performed.

**Results:** At mean follow-up of 88 (6-235) months, 12 patients in Group I 41 patients had remission of the disease while 23 had a local recurrence. In Group II four patients showed a stable disease and three had remission. One patient in Group III had disease progression and the other one has a stable condition. In Group IV two patients showed disease progression, and the 2 have a stable disease.

**Conclusions:** The preliminary results from one Institution of a multicentric study showed a high recurrence rate in patients who underwent surgery (36%). On the other hand, we did not observe a progression of the lesion in the conservative group in which we recorded a size regression in 42% of the cases. The small sample of this preliminary report doesn't allow anyway to define the optimal strategy to approach aggressive extra-abdominal fibromatosis. Definitive data on 367 patients will be available and presented at the time of the EMSOS conference in Florence together with an analysis of risk factors.

2449

### Prognostic factors for the disease progression of aggressive fibromatosis on the wait-and-see policy: analysis of 35 patients at a single institution

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**Background:** Aggressive fibromatosis (AF) is rare soft tissue tumor with a high frequency of local recurrence. According to published data the recurrence rate after surgical excision is ranging from 30% to 40%. On the other hand, it is known that AF can be stable for years and even spontaneously regress. So, for some patients wait-and-see policy can be used. The data about factors that predict disease progression is controversial. Objective: To search prognostic factors that associated with the disease progression for patients with AF on the wait-and-see policy.

**Methods:** 35 patients with AF were included in the study (19 patients with primary and 16 recurrent tumor; mean age  $34.2 \pm 13.5$  y.o.; 20 male, 15 females; localization on the trunk 22, on limbs 13; median sum of largest diameters  $181.5 \pm 75.6$  mm. For all patients watchful-waiting strategy was used. During follow-up period disease progression was observed in 11 patients, other 24 patients remained stable. Such factors as age, sex, tumor localization, tumor size, previous treatment was investigated as predictors of disease progression.

**Results:** In univariate analysis, older age ( $37.2 \pm 19.1$  vs.  $32.8 \pm 10.1$ ;  $p$  0.943) and smaller sum of tumor diameters ( $176.5 \pm 71.6$  mm vs.  $183.8 \pm 78.8$  mm;  $p$  0.859) is associated with disease progression. Female sex (female vs. male: OR 1.48; 95% CI 0.28-8.75;  $p$  0.599), absence of the previous treatment (primary tumor vs. recurrent tumor: OR 1.75; 95% CI 0.33-10.3;  $p$  0.452), localization on the trunk (trunk vs. limbs: OR 1.67; 95% CI 0.30-8.97;  $p$  0.491) were unfavorable prognostic factors.

**Conclusions:** Older age, female sex, absence of the previous treatment and localization on the trunk associated with poor prognosis but their impact on disease progression for patients with AF on the wait-and-see policy is insignificant.



2465

## Surgical treatment of patients with diffuse-type tenosynovial giant-cell tumours: an individual patient data meta-analysis

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**Introduction and Purposes:** Diffuse-type Tenosynovial Giant Cell Tumour (TGCT) is a rare, locally aggressive and difficult to treat disease. An international multicentre-pooled retrospective study of individual patient data was developed to describe global treatment protocols, evaluate surgical outcome, complications and functional results.

**Materials and Methods:** Patients treated in 31 sarcoma reference centres between 1990 and 2017, with histologically proven diffuse-TGCT of large joints were included. Only patients with complete data on core criteria were included for analyses. Core-criteria comprised: TGCT-type, admission status, date and type of initial treatment at a tertiary centre and first local recurrence after treatment in a tertiary centre. Primary endpoint was local recurrence free survival (RFS).

**Results:** In 1192 cases of diffuse-TGCT, 693 (58%) were female with a median age of 35 (IQR 26-48) years. 758 (64%) affected the knee and in 628 (54%) of 1163 primary treatment was one-staged open synovectomy. At a median follow-up of 54 (IQR 27-97) months, recurrent disease developed in 425 (44%) of all 966 surgically treated cases, with RFS at 3, 5, 10 years of 62%, 55% and 40%, respectively. Complications were noted in 105 (12%) of 906 patients. Pain and swelling improved after surgical treatment(s) in 255 (59%) of 434 and in 328 (72%) of 453 patients respectively.

**Conclusions:** This international individual data study of patients with diffuse-TGCT, provides a comprehensive and up to date disease overview, evaluating the clinical profile and management of the disease. Since complete resection of diffuse-TGCT could be regarded as nearly impossible and recurrence percentages remain unacceptably high after both arthroscopy and open synovectomy in the knee, even in specialized centres, a multimodality approach on individual patient basis, including adjuvant treatments, is warranted.

Table - Diffuse-TGCT recurrence free survival (RFS) of all patients (N=966) versus therapy naïve patients (N=758) treated at tertiary centre

Year	N all patients	% RFS all patients (95% CI)	N therapy naïve patients	% RFS therapy naïve patients (95% CI)
3	474	62 (59-65)	372	70 (67-74)
5	297	55 (51-58)	227	64 (60-68)
10	89	40 (35-45)	70	50 (44-56)

N is number of patients at risk for recurrent disease at 3, 5 and 10 years

2663

## The effect of imatinib mesylate in diffuse-type tenosynovial giant cell tumour on MR imaging and PET-CT

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**Introduction and Purposes:** Recurrence rates remain high after surgical treatment of diffuse-type Tenosynovial Giant Cell Tumour (TGCT). Imatinib Mesylate (IM) blocks Colony Stimulating Factor 1 Receptor (CSF1R), the driver mechanism in TGCT. The aim of this study was to determine if IM reduces the tumour metabolic activity evaluated by PET-CT and to compare this response with the response seen on MR imaging.

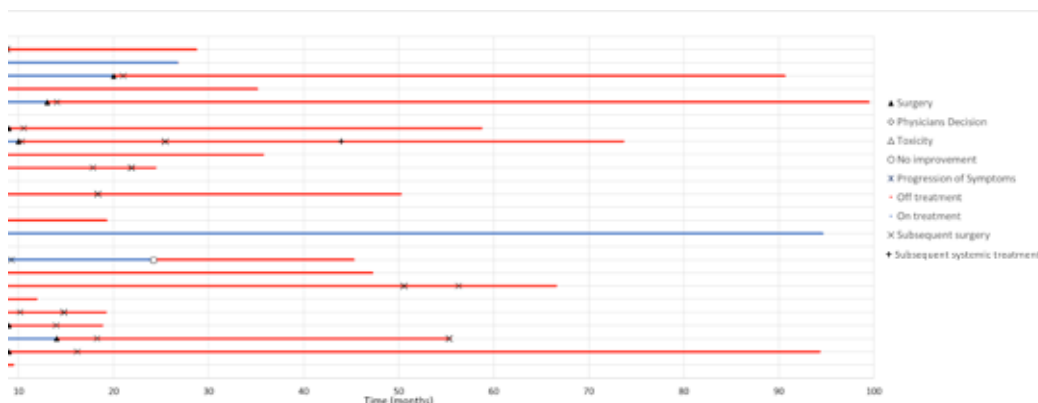
**Materials and Methods:** 25 Consecutive patients treated with IM (off label use) for locally advanced (N=12) or recurrent (N=13) diffuse-type TGCT were included, 15 male and median age at diagnosis 39 (IQR 31-47) years. The knee was most frequently affected (n=16; 64%). The effect of IM was assessed pre- and post-IM treatment by comparing PET-CT and MR scans. PET-CT scans were evaluated based on maximum standardized uptake value (SUV-max)<sup>1</sup>. MR scans were assessed by Tumour Volume Score (TVS), a calculation of the tumour volume as a percentage of the total synovium<sup>2</sup>. Partial response was defined as more than 50% tumour reduction.

**Results:** Median duration of IM treatment was 7.0 (IQR 4.2-11.5) months. 20 patients discontinued IM treatment for intended surgery or poor response followed by surgery (n=16; 64%) (figure). 20 Patients experienced an adverse event grade 1-2, 3 patients grade 3 (creatinine increment, neutropenic sepsis, liver dysfunction). PET-CT showed a significantly decreased mean difference of 5.3 SUVmax between pre- and post-IM treatment (P<0.05; CI 1.9-8.7). MR assessment showed 54% (7/13) partial response and 46% (6/13) stable disease, with a significant mean difference of 23% TVS between pre- and post-IM (P<0.05; CI 4-42). Measurements in suprapatellar recess, posterior of Hoffa's fat pad and posterior joint space (mm) presented mean differences of 11.3 (P=0.11; CI -2.9-25.5), 6.4 (P<0.05; CI 1.6, 11.2), 8.5 (P<0.05; CI 5.4, 11.6), respectively.

**Conclusions:** This study confirms the partial radiological response of IM in diffuse-type TGCT with imaging, however with high rates of surgical treatment after discontinuation of treatment and a relatively high rate of grade 3 adverse events.

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2628

### Chondroblastoma of bone in extremities-a single centre study of 177 cases

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**Introduction and Purpose:** Chondroblastoma (CB) is a rare benign bone tumour that usually occurs in children and young adults. They are cartilaginous tumours arising in the epiphysis or apophysis of a long bone. The tumour is classified as benign, although rare cases of pulmonary metastases have been reported. The purposes of this study were to describe clinical, radiographic characteristics of CB; to analyse the local recurrence (LR) rate and complications associated with surgery having special attention to proximal femur.

**Material and Methods:** This retrospective study included 177 patients, who had been diagnosed with a CB in extremity between 1990 and 2015 at the Royal Orthopaedic Hospital (ROH), Birmingham, UK.

**Results:** The most common site was proximal tibia 20%, followed by proximal humerus 19%, proximal femur 18%, distal femur 16% and foot 15%. One patient has died of the disease and one patient is alive after being operated for lung metastases. There was LR in 25/177 (14%) patients. The median time to LR was 10 months (range 3-158 months). The most common site for LR was proximal tibia (22.2%). LR developed in 17/116 (14.7%) cases after curettage, 3/22 (13.6%) after radiofrequency ablation (RFA), 4/33 (12.1%) after curettage with bone grafting and none after EPR, curettage with cementation or osteoarticular allograft. The proximal femur was the location in 32/178 (18%) of the cases. 18/32 (56%) were in the greater trochanter (GT) and 14/32 (44%) in the femoral head (FH). The mean age was lower in tumours located in FH when compared to the GT; 19.5 years and 13.9 years respectively ( $p=0.004$ ). Tumours located in GT were all curetted without further complications. The lesions in the FH were treated minimally invasive via a drill along the femoral neck in 6/14 cases, through an open trapdoor in femoral neck in 2/14 cases, directly through cartilage in two cases and by RFA in five cases. LR was seen more often in FH tumours than tumours located in GT, though without statistical significance; 3/14 (21%) and none, respectively ( $p=0.073$ ). All of the LR in cases located in FH occurred to patients treated minimally invasive via a drill along the femoral neck.

**Conclusions:** CB is a rare benign to intermediate grade bone tumour with a potential to metastasise. FH chondroblastoma is rare, presenting 4.5% of all CB cases. Around 50% of the CB in FH occur in patients with open growth plates. LR in FH patients occur frequently when treated through femoral neck. RFA is promising.

2330

### Characteristics of giant cell tumor in teenagers

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**Introduction:** Giant cell tumor(GCT) is one of the most common benign tumors in adult. Although it is regarded as a benign tumor, it has an aggressive nature and it is known to be found mainly in young people in their 20s and 30s. It is reported that the incidence of GCTs in teenager is extremely low because of immature skeletal growth and there were several studies that growth plate has not yet closed inhibited the development of GCTs. But GCTs occurred in teenagers have been reported in few studies. We investigated the clinical and radiological features of GCTs in the teenagers.

**Methods:** A total of 9 patients were retrospectively studied. We followed for an average 7.2 years. Mean age at the diagnosis was 14.9 years. We investigated the clinical symptoms of patients and the location and pattern of the tumor. Also we studied the surgical methods performed on the patient, recurrence of disease and complications during follow-up.

**Results:** Three patients had multicentric GCTs. There were 14 lesions of GCTs including 6 knee around, 2 proximal humerus, 2 metatarsal bones, 1 proximal femur, 1 distal ulna, and 1 cuneiform bone. GCT in young age has more metaphyseal involvement than adults and has concentric features rather than eccentric features. Extensive curettage was performed in all patients. Cement augmentation was additionally performed in 12 lesions and bone grafting was additionally performed in 2 lesions. A total of 3 lesions were recurred. And we performed reconstruction using tumor prosthesis, allograft prosthesis composite, and en-block excision respectively.

**Conclusion:** The incidence of GCTs in teenagers is very rare and is somewhat different from that of adults. The GCT was more concentric than the eccentric and progressed more multicentric than adults and had a higher recurrence rate. Unlike GCTs that occur in adults, GCTs in teenager may be difficult to differentiate them from other diseases. Clinicians should be cautious in diagnosis and treatment.

2652

## Clinical outcome and risk for recurrence of progressed giant cell tumors of the bone – retrospective analysis of 90 cases

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Benign but locally aggressive giant cell tumor of the bone (GCT) may be surgically treated by intra- or extralesional resection. Aim of the study was retrospective analyses of clinical outcome and recurrences. 90 advanced GCT cases of the upper and lower extremities (58% Campanacci-grade-III; 41% grade-II) were enclosed (mean follow-up 119 ( $\pm$ 90) months). Surgical details, histology, metastases, recurrences, and data on satisfaction and function including the Musculoskeletal-Tumor-Society (MSTS)-score were evaluated.

Overall tumor recurrence-rate was 33%. Kaplan-Meier cumulative recurrence-free-survival was 74% at 2-years-follow-up and 63% at 10-years-follow-up. Extralesional wide resection (n=19) did not show recurrences but worse MSTS-scores ( $20.7 \pm 6.6$  versus  $25.4 \pm 4.7$ ;  $p=0.03$ ). Intralesional resection included vigorous curettage, burring, and polymethylmethacrylate bone cement filling (n=60) or cancellous bone filling (n=11). Recurrence-rate was significantly lower after bone cement filling (2-fold,  $p=0.03$ ). More interestingly, additional cleaning of the lesion cavity with hydrogen-peroxide before bone cement filling significantly reduced recurrence-rate (3-fold,  $p=0.007$ ) and significantly increased cumulative recurrence-free-survival-rate (77% versus 36% at 10-years-follow-up;  $p=0.004$ ). In multivariate analysis, significant risk-factors for recurrence were pathological fracture (hazard-ratio 3.7;  $p=0.04$ ), high mitosis-rate (hazard-ratio 15.6;  $p=0.01$ ), and lack of hydrogen-peroxide use (hazard-ratio 6.0;  $p=0.02$ ).

In conclusion, intralesional curettage showed high risk for local recurrence but significantly better clinical results compared to extralesional resection. For the first time, the present study proved that additional cleaning of the tumor cavity with hydrogen-peroxide before defect filling significantly reduced recurrence-rate and significantly increased recurrence-free-survival in advanced but intralesionally treated GCT cases.

## 2240

### Denosumab - Why and when?

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**Background:** There have been very few studies with a minimum reasonable period of follow up that have exclusively evaluated this combination strategy of “neoadjuvant” denosumab with surgery without the use of post-operative denosumab.

**Objectives:** To analyze a single institution series of GCTB patients with minimum 24 months of follow-up post operatively. The intent was to evaluate efficacy of pre-operative denosumab in achieving prospectively decided intent of therapy in operable GCTB patients and document local recurrence free survival (LRFS).

**Methods:** During the period January 2014 and June 2016, 44 patients of GCTB were started on denosumab and underwent subsequent surgery. None of them received post-operative denosumab. The intent of starting denosumab was: 22 - to facilitate curettage, 16 - to facilitate resection, 6 - with intent of converting resection to curettage.

**Results:** Mean number of denosumab injections was 5 (range 2-7). In 42 of 44 patients (95%) denosumab helped achieve prospectively decided intent. 41 patients were available for follow up at mean follow up of 34 months (range 24-48 months). There were 12 local recurrences (29 %); in 11 of 25 (44%) patients who had curettage and 1 of 16 (6%) patients who had resection. Mean time to local recurrence was 16 months (range 8-25 months). LRFS was 76% at 2 years; 94 % for cases with resection, 64% for cases with curettage ( $p = 0.013$ ).

**Conclusions:** Though local control rates are unlikely to improve with use of preoperative denosumab, a short pre-operative course of denosumab can facilitate surgery in certain cases of operable GCTB with a high risk of local recurrence making curettage or resection technically easier. It may also help in converting a lesion needing resection to one that could possibly be treated with curettage.



2472

### **Incidence of malignancies in fibrous dysplasia: data from a national pathology cohort**

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**Introduction and Purposes:** Fibrous dysplasia (FD) is reported to be associated with increased risk for breast and thyroid cancer and for the pre-malignant intraductal papillary mucinous neoplasm (IPMN), possibly due to extra-skeletal tissue distribution of GNAS-mutations. Data on further associations of FD with malignant tumors are scarce. Since these associations may have significant clinical implications, we performed a cohort study on tumor occurrence in FD.

**Materials and Method:** Pathology reports from patients with confirmed FD were retrieved from the Dutch National pathology registry (PALGA). Incidence rates for malignant tumors were estimated and compared between FD patients and the general Dutch population by calculating standardized morbidity ratios (SMR).

**Results:** Of the 1146 PALGA FD patients, 177 (M/F; 79/98) had a malignant tumor. Mean age at FD diagnosis was 47.0 years (1-86yr) and mean age at diagnosis of malignancy was 49.7 years (2-92yr). Among known GNAS-related and bone tumors, SMR was increased for thyroid cancer (3.71[95%CI 1.13-7.76]) and for osteosarcoma (26.31[95%CI 6.58-59.20]). For the three most prevalent malignancies in The Netherlands, SMRs were increased for prostate cancer (3.08[95%CI 1.82-4.63]) and melanoma (1.99[95%CI 1.05-2.94]), but not for colorectal cancer.

**Conclusion:** Our data confirm that patients with FD have an increased risk for thyroid cancer and osteosarcoma. We also report for the first time an increased risk for a number of other malignancies in FD such as melanoma and prostate cancer, both associated with GNAS-mutations, but no increased risk for pancreatic cancer was found. Our findings raise awareness for the risk of malignancy in FD, although caution should be exerted in the interpretation of these data, as true incidence rates of malignancy might have been underestimated by the inclusion in this study of only patients with histologically-confirmed FD, and the specific role of GNAS mutations in the pathophysiology of FD-related tumors is as yet to be unraveled.

2506

## The West China Hospital femur classification: a retrospective analysis of 237 patients for fibrous dysplasia of the femur

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**Introduction and Purposes:** Fibrous dysplasia (FD) is a common and involving in skeletal disorder (monostotic or polyostotic) resulting in pathological fractures, deformity, limping and pain. It, first identified by Lichtenstein in 1938, is a benign intramedullary fibro-osseous lesion<sup>1</sup>. The incidence of fibrous dysplasia is difficult to determine because many patients are asymptomatic. But the lesions are not rare; it represents approximately 1% of primary bone tumor and 5%–7% of benign bone tumors. Although much experience in the treatment protocols approach to these patients is being reported, which varies depending on the location, symptom, age and disease activity, effective treatment is not yet available in FD. Surgical options, including curettage and bone grafting and osteotomy, and internal fixation or hip arthroplasty, might be recommended in those cases with pain, pathologic fracture and severe deformity. However, current classification systems for fibrous dysplasia of the femur do not achieve the major factors, resulting in the significantly difference in descriptions treatments and clinical outcomes (Table 1). An ideal classification systems should be reproducible, generalizable, easily applied, and clinically relevant. In our study, five types are being classified through retrospective review of X-ray film of lower extremity and axial computed tomography (CT) film. Firstly, we reviewed literature of FD to identify the important features of the classification of FD. Then, we tested the repeatability of the classification system for the kappa test by assessing our own population, and a statistically analyzed was performed among 5 observers to test the reliability (intraobserver and interobserver) of our classification system. 264 femurs were treated with different surgical options, based on corresponding classification (Fig 1).

**Materials and Methods:** We identified 237 patients with fibrous dysplasia of the femur who had preoperative and postoperative radiograph imaging and were treated at our hospital between 1995 and 2017. All affected femurs were measured according to our classification. The intraobserver and interobserver reproducibility among 4 observers who evaluated 40 femurs were assessed with use of the Cohen kappa (k) statistic.

**Results:** Clinical outcome was valued and each patients was followed for at least 12 months. The 264 femurs were categorized into five types: type I (31.8%), normal bone strength in the proximal femur without severe deformity; type II (28.0%), decreased bone strength in the proximal femur without severe deformity; type III (20.4%), associated with coxa vara and deformity of femoral shaft; type IV (11.3%), related to genu valgus; type V (8.3%), osteoarthritis of the hip in fibrous dysplasia; Intrarater and interrater reliability kappa values were good, ranging from 0.77 to 0.92. Only two cases of type III remained pain, and only one of type III cases had trendelenburg gait. In type IV, one case had slightly trendelenburg gait. Of all type V, two cases remained mild limping.

**Conclusion:** We developed a new classification for FD of the femur which is built on a review of the literature and clinical outcomes. Agreement analysis of the classification of our own population showed that our classification is an applied category to describe FD of the femur. In addition the follow-up showed pain relief and gait improvement in most. We believe our classification provides guidance for surgical plan. Therefore, we recommend this classification for the description and treatment of FD of the femur.

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**Table 1 Present Classification Systems for Fibrous Dysplasia in Femur**

Classification System	Limitations
Ernesto Ippolito et al <sup>7</sup>	(1) No description of proximal femoral strength
Type 1: normal neck-shaft angle with altered shape of the proximal femur	(2) No description of limb alignment
Type 2: isolated coxa valga with neck-shaft angle >140°	(3) No description of hip degeneration
Type 3: isolated coxa vara with neck-shaft angle <120°	(4) Classification possible only for level
Type 4: lateral bowing of the proximal half of the femur associated with normal neck-shaft angle	
Type 5: type 4+ coxa valga	
Type 6: type 4+ coxa vara	
Xuelel Zhang et al <sup>8</sup>	(1) Classification possible only for proximal femoral level
Type 1: without sever deformity	(2) No description of limb alignment
Type 2: Reduction in the proximal femoral strength	(3) No description of hip degeneration
Type 3: Coxa vara ± type 2	
Type 4: Varus deformity in the proximal femoral shaft ± type 2	
Type 5: Coxa vara+ type 4 ± type 2	

Table 2 Patient Characteristics\*

	No. of Patients (%)
Sex	
Male	108(46)
Female	129(54)
Category	
Monostotic	167(70)
Polyostotic	70(30)
Affected side	
Left femoral	114(48)
Right femoral	96(41)
Unilateral femoral	210(89)
Bilateral femoral	27(11)

\*N=237 patients (264 affected femurs)

Table 3 Radiographic Classification System of Fibrous Dysplasia in Femur

types	Radiographic features				
	Reduction in the proximal femoral strength	Coxa vara	Deformity femoral shaft	Genu valgus	Hip arthritis
Type I	-	-	-	-	-
Type II	+	-	-	-	-
Type III	+/-	+/-	+/-	-	-
Type IV	+/-	+/-	+/-	+	-
Type V	+/-	+/-	+/-	+/-	+

TABLE 6 Preoperative and postoperative clinical scores evaluated by the modified criteria of Guille

Types	Categories	Unsatisfactory		Average		Satisfactory	
		Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
Type II (n=72)	Pain	51	0	21	14	0	58
	Hip motion	29	0	33	25	10	47
	Limping	44	0	8	20	20	52
	Activities of daily living	53	0	4	21	15	51
	Social activities	58	1	9	40	5	31
Type III (n=52)	Pain	50	2	2	18	0	34
	Hip motion	39	0	13	25	0	27
	Limping	41	1	7	27	4	25
	Activities of daily living	49	1	2	18	1	33
	Social activities	51	2	1	22	0	26

Type IV (n=28)	Pain	23	0	4	7	1	21
	Hip motion	0	0	16	3	12	25
	Limping	13	1	13	11	2	16
	Activities of daily living	13	0	11	13	4	15
	Social activities	15	0	13	15	0	13
Type V (n=21)	Pain	21	0	0	1	0	20
	Hip motion	20	0	1	4	0	17
	Limping	13	2	8	9	0	10
	Activities of daily living	17	0	4	8	0	13
	Social activities	20	1	1	12	0	8

Figure 1: The classification is indicated by Roman numerals, starting with I and ending with V.



2512

**First application of three-dimensional (3D) designing total hip arthroplasty (THA) with long uncemented stem for fibrous dysplasia (FD) patients combined with hip joint osteoarthritis (OA)**

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**Introduction and Purposes:** The 3D designing techniques were firstly used for severe proximal femur FD patients combined with hip joint OA. The goals are to present and evaluate the design and mid-term outcomes on using this 3D designing THA with long uncemented stem for FD patients combined with hip joint OA.

**Method:** 12 FD patients combined with hip joint OA between July 2013 and April 2015 were analyzed. 7 patients received 3D designing osteotomy and THA, and the other 5 patients underwent 3D designing THA.

**Results:** All patients were followed up with an average duration of 47 months. There was no infection, dislocation, wound healing problems or mechanical failures. For the seven patients received 3D designing corrective osteotomy, the mean extremity lengthening was 2.8 cm. The bone union was achieved in averaged 4.2 months. The average Harris score and modified criteria of Guille were improved from 46.08 and 3.2 preoperatively to 93.72 and 8.6 at the last follow-up, respectively.

**Conclusions:** The 3D designing corrective osteotomy can restore alignment, thus improve function of limb. The 3D designing implantation of long prosthesis stem is precision for bone preservation and primary stability. Besides, perioperative management is significant.

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2426

### Can an artificial bone graft provide bone regeneration and mechanical support? A preliminary study on clinical reliability

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**Introduction and Purposes:** Several bone grafts are available for the clinical use. Each graft has its own peculiar properties from the biological and mechanical point of view. Smartbone<sup>®</sup> (IBI, S.A., Switzerland) is obtained combining mineral structures from natural bovine bones with bioreabsorbable polymers and cellular nutrients. The aim is to evaluate clinical, biological and structural properties of this bone graft and its reliability in orthopaedic oncology.

**Materials and Methods:** In the period October 2016- October 2018 21 adult patients (age range 18-85ys, mean 43) have been treated with Smartbone<sup>®</sup>. Diagnosis were: G1 chondrosarcoma (4), giant cell tumor (GCT, 2), enchondroma (4), benign fibrous histiocytoma (1), unicameral bone cysts (4), aneurismal bone cyst (1), fibrous dysplasia (3), non-ossifying fibroma (1), myxofibrosarcoma with bone involvement (1). A clinical-radiological follow up has been conducted (range 4-17mo, mean 8,85). Plain X-rays to evaluate graft integration and eventually CT/MR to confirm possible local recurrence. Local complications (infection, local recurrence, wound dehiscence, fracture, early reabsorption) have been evaluated.

**Results:** No fracture or infection occurred. One local recurrence in a patellar GCT after 1 year. Wound dehiscence occurred twice (1 requiring local flap). Follow up X-rays showed good to excellent graft integration.

**Conclusions:** Preliminary results confirmed the clinical reliability of this graft with a low complication rate, a fast integration, and no inflammatory reaction in the surrounding tissues. Smartbone<sup>®</sup> has mechanical structural function that can (in selected cases) allow early weight bearing and avoid a preventive bone fixation (only 4 patients in this series). The graft is available in different shapes and dimensions and is also customizable by the producer or by the surgeon in the operating theatre. Further studies are mandatory to confirm these promising results.

# SESSION 11 FREE PAPERS 1

2530

### **Oncological outcomes of surgically treated extremity and pelvic chondrosarcomas**

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**Objective:** To evaluate oncological outcomes of operated cases of pelvis and extremity chondrosarcoma and assess prognostic factors that influence outcomes.

**Design:** Retrospective analysis.

**Methods:** 243 operated cases of pelvis and extremity chondrosarcoma of bone were identified from prospectively maintained surgical data base from January 2006 to December 2015. Clinical, radiological, histopathological and follow up details were retrieved from electronic medical records. 91 patients had age < 40 years and 152 ≥ 40 years. Male were 167 and 76 female patients. 136 tumors were in the extremities, 83 in the pelvis and 24 in shoulder girdle. 202 patients had a high-grade (II, III) and 18 had low-grade (I) tumor. 15 were metastatic at presentation. 28 had a pathological fracture. 199 patients underwent limb salvage and 44 had ablative surgeries. 16 patients were excluded from the analysis as they did not follow up after surgery. 11 patients were lost to follow up.

**Results:** Overall survival for non-metastatic primary chondrosarcoma at 5 years was 68% compared to 98% for secondary (p value = 0.005\*). EFS for primary chondrosarcomas was 61% compared to 88% for secondary at 5 years (P value = 0.001\*). The 5yr OS for non-metastatic cases of grade II chondrosarcomas was 81 % compared to 59 % for grade III and 94 % for grade I chondrosarcomas. 2 yr OS for patients with pathological fracture (20) was 65 % as against 86% for no fracture (192) (P value < 0.006). The overall survival for chondrosarcomas at 5 yrs was 75%. 5 year OS for male and female was 72% and 87% respectively (P value= 0.009\*). OS for age less than 40 years at treatment was 94% compared to 67% for greater than 40 years (P value < 0.000\*).

**Conclusion:** Limb salvage with wide margins is oncologically safe. Age, gender and metastasis were significant factors for predicting prognosis on multivariate analysis. Grade of chondrosarcoma, primary or secondary chondrosarcoma and presence of pathological fracture impacts survival.

## 2401

### Prognostic factors and survival in clear cell chondrosarcoma patients – an European Musculoskeletal Oncology Society study

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**Introduction and Purposes:** Clear cell chondrosarcoma (CCC) is a rare tumor (1). Our aim was to evaluate the influence of possible prognostic factors on local recurrence (LR) & disease-specific survival (DSS).

**Materials and Methods:** We performed a retrospective analysis of the data of 148 patients treated at tertiary centers in Europe and North America between 1990 and 2017. Survival curves were calculated with the Kaplan-Meier method and compared with the log-rank test. Hazard ratios (HR) were estimated in multivariate Cox regression models.

**Results:** Median age at diagnosis was 41 years, median follow-up amounted to 75 months. LR and DSS amounted to 18% & 91% after 5 years and 27% & 84% after 10 years, respectively. In univariate analysis intralesional surgical margins ( $p < 0.001$ ), soft tissue extension ( $p = 0.001$ ), axial tumors ( $p = 0.002$ ) & biopsy prior to referral ( $p = 0.003$ ) were associated with a higher LR. Axial tumors ( $p < 0.001$ ), soft tissue extension ( $p < 0.001$ ), tumor size  $> 8\text{cm}$  ( $p < 0.001$ ) & patient age  $> 40$  years ( $p = 0.014$ ) were associated with a poorer DSS. Intralesional surgical margins ( $p = 0.929$ ) had no influence on DSS. In multivariate analysis intralesional margins (HR 1.07-7.96;  $p = 0.037$ ) & soft tissue extension (HR 1.01-5.70;  $p = 0.048$ ) were associated with a higher LR, while soft tissue extension (HR 1.35-96.15;  $p = 0.025$ ) & tumor size  $> 8\text{cm}$  (HR 1.19-19.06;  $p = 0.027$ ) were associated with a poorer DSS. LR was not associated with DSS in multivariate models (HR 0.43-6.50;  $p = 0.460$ ).

**Conclusions:** CCC appears to have a good long-term prognosis. Tumor size  $> 8\text{cm}$  and soft tissue extension appear to be negative prognostic factors for DSS. While intralesional excisions appear to be associated with a higher LR, they had no influence on DSS in uni- and multivariate analyses in our series, suggesting they might be appropriate for patients with small, intraosseous tumors of the extremities.

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2367

## Lung metastasectomy improves survival in high-grade chondrosarcoma

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**Introduction and Purposes:** Chondrosarcoma (CS) represents a real challenge for orthopaedic oncologists, as it is resistant to both chemotherapy (ChT) and radiotherapy (RT). [1] Therefore, surgery is the mainstay of treatment both for primary tumour and metastasis. [2] [3] The aim of this study is to evaluate the role of pulmonary metastasectomy (PM) in patients affected by lung metastasis (LM) in CS.

**Patients and Methods:** 61 patients affected by LM in grade 2 and 3 CS were included. Mean age was 51 years (range, 17 to 84); 44 (66.7%) patients had grade 2 CS, 17 (25.8%) grade 3.

**Results:** 51 patients presented multiple nodules; bilateral LM in 44 (72.1%) cases. Lung metastasis characteristics did not differ between patients. 29 (47.5%) out of 66 patients underwent PM of LM whereas 32 (52.5%) underwent ChT and stereotactic RT alone. At final follow-up (mean 83 months, range 13-298) 47 patients (77.0%) died of the disease. A better survival (OS) was observed in those patients who underwent PM (55.1% vs 13.1% at 5 years follow-up,  $p < 0.001$ ) and in patients with unilateral LM (60.4% vs 25.6% at 5 years,  $p = 0.016$ ). The number of LM also played a prognostic role, with a higher OS in patients with only one nodule than in those with 2-4 LM and in those with more than 5 nodules (66.7% vs, 50.0% vs 23.2% at 5 years, respectively,  $p = 0.016$ ).

**Conclusions:** The survival outlook for patients with lung metastases of chondrosarcoma unfortunately remains bleak, with approximately 75% of patients ultimately dying from their disease. Nonetheless, until significant improvements in chemotherapy can be made, pulmonary metastasectomy should be considered to improve post metastatic survival.

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2294

### Does surgical resection of primary lesion improve survival in osteosarcoma patients with metastasis at diagnosis?

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**Introduction and Purposes:** About 10-20% of osteosarcoma patients present with metastatic disease at initial diagnosis, who generally have poorer prognosis. Treatment for them can be challenging, and limited evidence is available for the optimal surgical strategy. The objective of this study is to evaluate if surgical resection of primary disease is beneficial for overall survival.

**Materials and Methods:** We conducted a retrospective analysis based on the Japanese Nationwide Bone and Soft Tissue Tumor registry. In total 1978 records of osteosarcoma were identified, and 382 records (19.3%) had metastatic disease at initial diagnosis. 199 records have undergone surgical resection of primary disease (group Y), while 137 records haven't (group N), and 46 records were excluded due to incomplete data. Characteristics of two groups (age/sex/size/location/with or without chemotherapy/with or without radiotherapy) was adjusted with propensity score matching technique. 60 records from each group were matched, whose overall survival rates were calculated with the Kaplan-Meier method, and compared with log-rank test.

**Results:** The patient characteristics listed above had no statistically significant difference between the two groups. The survival rate of group Y was significantly better than that of group N, with median survival of 27 months (95% confidence interval: 12.5-41.5) vs 12 months (95% confidence interval: 8.4-15.6) ( $p < 0.001$ ).

**Conclusions:** Surgical resection may be associated with better prognosis, even in osteosarcoma patients with metastatic disease at initial diagnosis. Further prospective studies to validate this hypothesis are required.

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2394

### Extremity sarcoma resections: how far is far enough?

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In recent years there has been a decrease in safety margins in sarcoma resections. The aim of this monocentric prospective study was to evaluate the influence of resection margins on the prognosis of these patients.

**Patients and Methods:** Between 2012 and 2017, 573 sarcoma resections were performed. The extent of the resection distance (mm) was prospectively and all known prognostic factors retrospectively evaluated. There were 411 (71%) soft-tissue sarcomas and 162 (28%) bone sarcomas. The most common entities were undifferentiated sarcoma (22%), liposarcoma (16%), chondrosarcoma (14%) and osteosarcoma (10%). 47% were highly malignant (G3), 31% G2 and 21% G1 differentiated. In 13 cases the entities were not graduated by definition. The average age was 55 years (2-99).

**Results:** 472 (82%) patients were R0 resected, 97 (17%) R1 and 4 (1%) R2. Without the atypical lipomas 89% R0 and 11% R1/2. Overall Survival in respect to grading is shown in Fig. 1. Only 453 G2/3 sarcomas are considered below. Resection margins were contaminated in 10%, <1 mm in 19%, 1-5 mm in 44%, > 5 mm in 14% and > 10 mm in 13%. Local recurrences (LR) was seen in 15% of cases. In contaminated margins in 29%, in <1 mm in 21%, in 1-5 mm in 14%, in > 5 mm in 6% and in > 10 mm in 7%. Local recurrence-free survival was highly dependent on this (Fig. 2). Considering only 398 patients with G2/3 tumors with no metastatic disease at the time of surgery, the difference becomes even clearer. On the other hand, the resection margin had no influence on Overall Survival. Metastatic disease after resection was seen in 22% of cases. In case of LR at 49%, without LR in 18% (p < 0.0001). The R-status was correlated with overall survival, but not the resection margin in mm. Looking at the Overall Survival in multifactorial analysis (R-status, age, metastatic disease at the time of surgery, tumor size and grading), even the R-status loses its significance, while the other 4 factors remained significant. If local recurrence is taken as a factor, this is was also significant.

**Conclusion:** The distance of the resection margins (in mm), even in R0 resections, is highly significantly linked to the risk of local recurrence. Increasing the margin over more than 10 mm does not further decrease the risk of LR. Regarding Overall Survival the resection margin (R-status and/or distance in mm) has no prognostic value, but the local recurrence itself.

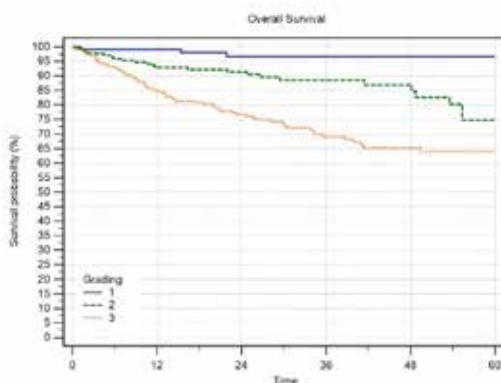


Figure 1

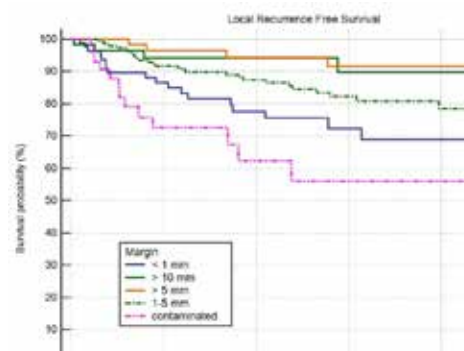


Figure 2

## 2302

### Endoprosthesis distal femur replacement after intra-articular knee resection for sarcoma and recurrent giant cell tumor

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**Introduction and Purpose:** Distal femur replacement is the reconstruction technique most commonly used today for patients with distal femur sarcoma. However, the complication rates with megaprotheses are higher in comparison with conventional knee arthroplasties. This single-center study reports results with the MUTARS distal femur replacement since its introduction in 1993.

**Materials and Methods:** A total of 191 patients (median follow-up 99 months) who underwent intra-articular distal femur resection were included in this retrospective study. The study evaluated the clinical results and complications on the basis of the Henderson classification.

**Results:** Local recurrence or infection were reasons for secondary amputation (7.9%). The cumulative incidence of prosthetic failure (Henderson 2–4) was 32.9% at 5 years, and 45.9% at 10 years postoperatively. Although the risk of loosening was reduced by using a cementless stem with a hydroxyapatite (HA) coating (loosening rate 5.3%), the main mechanical problem is currently a failure of the joint mechanism, with a lifetime risk of 24.1%. The polyethylene bushing that was previously used is associated with the highest failure rate here (23.7%), while the metal-on-metal mechanism has the lowest rate at 4.3% up to now. Periprosthetic infection was observed in 33 over the study period as a whole resulting in an overall infection rate of 17.3% (titanium 18.9%, n = 20; silver 15.3%, n = 13).

**Conclusions:** These results suggest that long-term limb salvage is not always possible with tumor prostheses after resection of the distal femur. While mechanical complications can be treated successfully with revision surgery, periprosthetic infection continues to be a major reason for secondary amputation. Whereas aseptic loosening is rare with hexagonal HA-coated stems, the weakest point in the prosthesis is the joint mechanism.

## 2311

### Giant cell tumour of the distal radius: wrist arthrodesis or osteoarticular reconstruction?

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**Introduction:** Stage 3 giant cell tumour (GCT) of the distal radius (DR) should be best treated with en-bloc resection to minimize the risks of LR.[1,2] Multiple reconstructive options have been proposed, including osteoarticular graft (OA) [3,4] and wrist arthrodesis (WA), either radio-carpal/metacarpal [2]. The aim of this multi-institutional retrospective study is to compare OA and WA in DR resections for GCT.

**Material and Methods:** Sixty-seven patients (47 OA and 20 WA) were included. Mean age was 40 years (range, 13-74). Grafts included fresh frozen allograft or non-vascularized fibular autograft. Complications requiring surgical revision were recorded. Clinical outcome was assessed with MSTs and DASH score.

**Results:** Fifteen patients developed a local recurrence (LR) after a mean of 23 months (range, 6-137), with no correlations with the reconstructive technique used (OA vs WA,  $p=0.358$ ). 16 patients required revision surgery for complications, with no differences between OA and WA groups ( $p=0.255$ ). Ten out of 16 (7 in the OA group and three in the WA group) developed complications related to the graft (3 graft reabsorptions, 6 graft fracture, 1 non-union). Among OA, two painful instabilities and four severe arthritis required conversion into WA after a mean of 26 months (range, 13-38). At a mean follow up of 108 months (range, 12-395) a similar functional outcome (MSTs and DASH score) was observed between OA and WA ( $p=0.208$  and  $p=0.234$ ).

**Conclusions:** A patient-by-patient decision should be taken regarding both the type of reconstruction (OA or WA) and the type of graft (allograft or autograft). The reconstructive choice should consider the patient's functional expectations: WA is preferable in patients requiring a solid and stable wrist for heavy activities, OA in young patients concerned with function preservation.

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2370

### **Radiologic follow-up of untreated enchondroma and atypical cartilaginous tumors in the long bones - update**

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**Introduction:** Since both enchondroma and atypical cartilaginous tumors (ACT) are not considered malignant, we need to question whether intralesional treatment with adjuvant therapy is justifiable. The aim of our study was to evaluate the natural course of conservative-treated enchondroma and ACT in the long bones and present long term results.

**Methods:** We analyzed the results of patients in whom we refrained from surgery and only regularly performed radiological follow-up of the tumor. Cases were categorized, retrospectively, for conservative follow-up time (<24 months, 24 months – 5 years, > 5 years) and tumor size (≤5 cm, >5cm).

**Results:** 233 cases were included in this study, of which 37 cases (16%) had a conservative follow-up of more than 5 years. 27 out of 233 cases (12%) received surgical treatment during follow-up of the tumor. The reasons for surgery were radiologic change of the lesion in 11 cases, invalidating pain in 5 cases, patient request in 7 cases, and total knee arthroplasty (TKA) due to osteoarthritis combined with curettage of the lesion in 4 cases. Most operations (67%) were performed in the first 24 months after diagnosis. Only 1 case (3%) was operated on 5 years after diagnosis. Tumor size was not a risk factor for surgery during follow-up (p value 0.20). Of the 80 tumors larger than 5 cm, 6 tumors (8%) were operated on during conservative follow-up. In comparison, of the smaller tumors (≤5 cm), 21 out of 153 (14%) were operated on.

**Conclusion:** In this follow-up series of conservatively treated enchondroma and ACT, only 7% of the cases had a medical indication for surgery. Based on our results, we recommend active surveillance for asymptomatic enchondroma or ACT in the long bones, irrespective of tumor size. Active surveillance for these tumors prevents unnecessary operations.

# SESSION 12 INTRAOPERATIVE CONTROL SURGERY (CUTTING GUIDES, NAVIGATION, ROBOTICS)

2380

## Evaluation of surgical margins using computer assisted surgery of primary bone sarcoma resections

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**Introduction and Purpose:** Computer assisted surgery (CAS), especially the use of intraoperative CT (iCT) guidance aids in improving accuracy and predictability of bone sarcoma resections. Thereby minimizing healthy tissue resection and preserving functional and oncological outcome. Here we describe the accuracy in terms of surgical margin achieved of navigated primary bone sarcoma resections.

**Patients and Methods:** A retrospective study of 51 patients undergoing iCT navigated primary bone sarcoma resections with curative intent between 2014 and 2018 was conducted. Surgical margins were classified by Enneking.

**Results:** 16 patients (31%) presented with osteosarcoma, 22(43%) with chondrosarcoma, 5(10%) with Ewing sarcoma, 6(12%) with chordoma and 2(4%) with other tumors. Median age at surgery was 45 years (range 3 – 89). There were 11(22%) low grade and 40(78%) high grade tumors. 27(53%) tumors were located in the sacrum/pelvic, 15(29%) in extremities, and 9(18%) in axial skeleton. Bone resection margins: in the sacrum/pelvic there were 3 low grade tumors of which 2(67%) wide and 1(33%) intralesional, and 24 high grade tumors of which 17(71%) wide, 3(13%) marginal, and 4(17%) intralesional. In the extremities there were 4 low grade tumors of which 2(50%) wide and 2(50%) intralesional, and 11 high grade tumors of which 10(91%) wide and 1(9%) marginal. In the axial skeleton there were 4 low grade tumors of which all were wide, and 5 high grade tumors of which 4(80%) wide and 1(20%) intralesional. Intralesional resections were due to neurovascular structures(3), tumor spill(1), progressive disease(1), and unclear surgical margin(1).

**Conclusion:** Using CAS more wide bone margins are achieved in all locations, especially for high grade tumors. Wide margins are associated with less local recurrence and thus improved oncologic outcome. Further studies are needed to compare navigated with non-navigated resections to provide indications for the use of CAS in orthopaedic oncology.



2492

## Computer-assisted surgery in orthopaedic oncology indications, problems and results en 164 consecutive patients

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**Introduction:** The advances in the treatment of bone tumours in the last decades mainly focus on new adjuvant therapies, improvements in the diagnosis methods and new surgical techniques. Despite the good quality of the preoperative images, the transfer of information to the surgical field is usually difficult. (1,2) The development of the 3-dimensional preoperative planning techniques and intraoperative virtual navigation system could help to achieve this objective, providing precision for resections and versatility to perform complex multiplanar osteotomies (3-7). Although the potential advantages of intraoperative navigation in surgeries, such as arthroplasties or post-trauma reconstructions have been described, the use of this technology was associated with technical problems, increased of surgical time and costs, without clear benefits in clinical outcomes. (8-11) Specially, in the area of orthopaedic oncology, computer-assisted surgery (CAS) has been shown to be effective in achieving tumour-free margins resections and improving the accuracy of bone cuts. (12-15) Image-guided surgical navigation allows the oncologic orthopaedics surgeons to perform an adequate tumour resection based on fused images (CT scan and MRI), reproducing what was planned in a virtual preoperative setting as accurate as possible. (16-18) Although the application of virtual navigation was initially focused on the axial skeleton (spine, pelvis or sacrum) and malignant bone tumours, recent publications have described the use of this technique in benign bone tumours or tumours located in the extremities. (19-22) However, despite the use of intraoperative navigation become popular, the advantages, applications and problems of this technology continue to be the subject of debate. The purpose of the study was to review a group of patients with bone tumours treated with intraoperative navigation and analyse:

1. The technical problems and causes of system failure.
2. The indications to perform a navigation.
3. Oncological results in terms of local recurrence.
4. Postoperative complications.

**Patients and Methods:** A retrospective review from our prospective oncology data base was performed, and all patients who had preoperative virtual planning for bone and a oncological resection with navigation was indicated between 2010-2015 were analysed. The indications for computer-assisted resection included malignant tumours, benign local aggressive lesions and metastasis of the extremities or appendicular skeleton. After the preoperative studies were performed, the CT and MRI were fused. Using MIMICS<sup>®</sup> software (Materialise, Leuven, Belgium), the affected bone was reconstructed with the tumour and the osteotomies for tumour resection were planned in an oncologic meeting. The virtual surgical planning was imported back into a navigation system (Stryker Navigation System II, Orthomap software Version 1.0, Freiburg, Germany). Intraoperative technical problems were classified as software and hardware crashes and reported after each surgical procedure. The use of computer-assisted surgery was classified according to the procedure performed: (1) navigated intralesional resections, (2) navigated en-block resections, and (3) navigated en-block resections + navigated allograft reconstructions.

**Results:** Demographics characteristics. 168 patients were planned to be treated with intraoperative navigation. However, in 164 the procedure could be completed. Tumour anatomical distribution was: 72 in the femur, 42 in the pelvis, 33 in the tibia, 9 in the sacrum, 6 in the humerus, 1 in the ulna and 1 in the foot. The main indication was for primary malignant bone tumors (n = 125), followed by metastases (n = 23) and benign tumors (n = 16).

**Technical problems and causes of system failure:** Four patients (4/168, 3.4%) of the series presented technical problems, and the navigation could not be completed. In two of those procedures, we experienced software failure, and we experienced hardware problems in the other two. One of the software technical crashes happened because the computer did not recognize one letter of the patient's last name (the Spanish ñ). The other software failure occurred when we tried to navigate the position of the osteosynthesis plate for the reconstruction, and the information to perform this exceeded the capacity of the computer navigation system. Both hardware failures were related to broken trackers undetected during the procedure.

**Intraoperative Navigation Indications:** Eight procedures were indicated for intralesional resections, 65

procedures were done for en-block resections and 91 procedures were en block resection + reconstruction with allografts.

*Intralesional Resections:* The 8 intralesional procedures were 5 benign tumours and 3 metastatic diseases. 5 out of the 8 patients of this group developed local recurrence.

*En block resections:* A total of 65 procedures navigated were en-block resections. 4/65 were benign lesions, 11/65 were metastases and 50/65 were primary bone tumours. The main location in this group of patients was the pelvis and sacrum (n = 50), followed by the femur (n = 9), the tibia (n = 3), the humerus (n = 2) and the foot (n = one). The main indication for an oncological surgery with wide margins guided by navigation (without navigated reconstruction) was pelvic and sacral tumours. In all cases the bone margins were defined as free of tumour. However, the local recurrence rate of this group was 9% (6/65) and all of them reported in the pelvis. A total of 12 complications were reported. Infection was the most prevalent (10/12).

*En block resection + allograft reconstruction navigation:* A total of 91 patients, were treated with en-block resection + an allograft reconstruction, both procedure assisted with navigation. In this group, all tumours were located in long bones (57 femurs, 29 tibias, 4 humerus and 1 ulna). Regarding the type of reconstruction, an intercalary allograft was used in 61 patients (23 hemicilindrical and 38 massive) while in the remaining 30 patients an osteoarticular transplant was chosen. The local recurrence rate was 4.5% (4/91 patients). In all cases, the bone margins were defined as tumour free. There were 9 postoperative complications, all of them classified as mechanical failures: 7 fractures, 1 non union and 1 joint collapses.

**Conclusions:** The main indications for Computer-Assisted Surgery were primary malignant tumours. The main use for en-block resection was in pelvic and sacrum tumours. Wide resection + allograft reconstruction assisted with navigation were only indicated in extremities tumours. The technical failures precluded navigation use in 2% of the series. Level of recommendation for surgical navigation in Orthopedic Oncology:

1. Intralesional resection: +
  2. Wide resection + Allograft reconstruction of long bones: ++
  3. Wide resection in pelvis and sacrum: +++
- Level of evidence: IV

**Key words:** computer-assisted Surgery; navigation; bone sarcomas; allograft

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2340

### Improved surgical accuracy for navigated pelvic and sacral primary bone sarcoma resections: A case-control study

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**Introduction and Purposes:** Anatomical and surgical complexity make sacro-pelvic bone sarcoma resections challenging. Positive surgical margins are more likely and increase local recurrence rate, which affects oncological outcome. Intra-operative guidance could assist in achieving higher surgical accuracy. Here we evaluate the accuracy in terms of surgical margin achieved of navigated pelvic and sacral primary bone sarcoma resections compared to non-navigated.

**Materials and Methods:** A case control study comparing 36 navigated with 34 non-navigated sacro-pelvic bone sarcoma resections with curative intent between 2000 and 2017 was conducted. Primary outcome was surgical margin achieved classified by Enneking. Wide margins were considered adequate; marginal or intralesional margins inadequate. Secondary endpoints were total blood loss, complication rate and operating time. Means were compared using Mann-Whitney U or Chi square test.

**Results:** Bone margins in the navigation group were wide in 28 (78%), wide-contaminated in 1 (3%), marginal in 3 (8%) and intralesional in 4 (11%). Margins in the non-navigation group were wide in 16 (47%), wide-contaminated in 1 (3%), marginal in 8 (24%) and intralesional in 9 (26%). Using navigation more adequate margins, 81% versus 50% for non-navigated resections ( $p=0.03$ ) were achieved. Soft tissue margins did not significantly differ between both groups. Mean overall blood loss was 2270ml (range 250-8500) for the navigation group versus 2740ml (range 500-6500) for the non-navigated group ( $p=0.308$ ). Mean operating time was not significantly prolonged using navigation,  $352 \pm 195$  versus  $333 \pm 126$  for non-navigated. Complication rate was 53% for navigated versus 47% for non-navigated resections ( $p=0.81$ ).

**Conclusions:** Intra-operative guidance techniques greatly improve surgical accuracy of bony resections in sacro-pelvic bone sarcoma. More wide margins are achieved which allows for better oncological outcome. Achieving adequate soft tissue margins still remains a challenge.

2537

### The advance in planning and modification of the procedure of hemipelvectomy with 3 D reconstrucion based on the experience of 30 cases - is navigation the best option?

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**Purpose:** Hemipelvectomy is a highly demanding procedure in treatment of advanced malignant bone tumors. The limb salvage procedures are possible in most cases of type II and III hemipelvectomy. However, larger defects require solutions with the usage of dedicated customized implants manufactured with 3D technology. The modern technical possibilities have put forward a promising treatment results. On the other hand, the necessity of precise planning and to carry out the operation fairly quickly is the clue to achieve the therapeutic success.

**Method:** Material was composed of 30 selected patients hospitalised in three European orthopaedic oncology centers at Pomeranian Medical University of Szczecin, Poland, University of Padova, Italy and The Institute of Mother and Child in Warsaw, Poland between 2013 and 2019. All of them were diagnosed with advanced forms of primary bone tumors (13 osteosarcoma, 15 chondrosarcoma and 2 Ewing sa pts). The surgical procedure in all cases was hemipelvectomy type III or IV and the reconstruction of the defect by 3D custom made implants covered with EPORE surface (Implantcast). EPORE® is a highly porous structure made of titanium alloy (Ti6AlV4). Titanium alloy is a material for use as a porous in-growth structure as it is biologically inert, ductile, corrosion resistant and has a high fatigue strength. We used specially designed new generation printed cutting guides which were designed the same way 3 D implants were. It is worth to emphasise that the guides are totally different from what was used before. They were produced in more precise way and dedicated exactly the surface they were to be placed. The new method was performed at surgery in 10 latest patients and replaced the need to use navigation.

**Results:** The method not only enabled the estimation of exact resection but also showed that the surgical procedure can be shortened to at least 1 - 2 hours. The authors have emphasised that navigation should only be concerned in the unique extraordinary cases and is no more required in standard 3D procedures.

**Conclusions:** The presented method of planning and performing the procedure can be a useful guide for surgeons who deal with pelvic tumors and would like to improve the surgical technique of the procedure of hemipelvectomy.



2703

## Computed Tomography Assisted Percutaneous Fixation of Extensive Metastatic Cancer and Pathologic Fracture of the Ilium Improves Pain and Maintains Function at One Year

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**Background:** Metastatic disease of the pelvis is common and often associated with disabling fractures and pain. Response to radiotherapy varies and pain palliation may be incomplete. While total hip replacement has been shown to effectively address periacetabular cancer, management of disabling mechanical pain of pelvic metastases outside the periacetabular region after radiotherapy remains unclear and the role and modality of surgery is not well established. In this setting, minimally invasive percutaneous fixation of fractured iliac metastases is an attractive treatment option, due to lower risk of perioperative complications and faster recovery than open surgery. We explored this technique to address mechanical pain and impaired function in a small cohort of patients with locally advanced pelvic cancer, limited residual bone stock and lack of dependable treatment options.

**Questions/purposes:** The study was designed to answer the following clinical questions.

Does CT-navigated percutaneous fixation in patients with locally advanced metastatic disease and pathologic fracture of the ilium and sacro-iliac region:

- Palliate pain as measured by Visual Analog Scale (VAS) and morphine equivalent dose narcotic consumption (NYSDH MME)?
- Improve quality of life and mobility, measured by Eastern Cooperative Oncology Group (ECOG) Performance Status and ambulation?
- Provide durable relief overtime?

**Methods:** A retrospective review of prospectively collected data on five patients treated for locally advanced metastatic disease of the pelvis involving the supra-acetabular, posterior ilium and sacro-iliac region, between September 1<sup>st</sup>, 2017 and January 31<sup>st</sup>, 2018. All patients presented with incapacitating functional pain requiring high-dose narcotics after radiotherapy, very limited or absent ambulatory capacity and evidence of pathologic fracture through a lytic iliac metastasis. The goal of surgery in all patients was palliative and aimed to improve pain and pelvic stability by internal fixation of the pathologic fracture through remaining bone. Outcome measures for pain were Visual Analog Scale (VAS) score and analgesic requirements according to the New York Department of Health and Mental Hygiene Morphine Milligram Equivalent (MME). Function was assessed using the Eastern Cooperative Oncology Group (ECOG) Performance Status and ambulatory capacity. Outcome measurements were prospectively recorded at baseline preoperatively and at one, three and twelve months from surgery. Differences between preoperative, one month and three months postoperative data were assessed with ANOVA and Chi-square.

**Results:** There were no cases of hardware misplacement and there were no intra or perioperative complications. All five patients were alive at one month, 4 patients were alive at 3 months and 3 patients were alive at 12 months follow-up. Reduction and stable fixation were maintained in all patients.

- The mean VAS score was 8 preoperatively and 1.8 one month postoperatively ( $p=0.001$ ). The mean MME was 222 preoperatively and 64.7 at one month ( $p=0.047$ ). The mean VAS score of the four patients alive at 3 months was 7.5 preoperatively and 2.7 at 3 months ( $p=0.006$ ). The mean preoperative MME was 192.5 and 143.5 at three months ( $p=0.57$ ).
- At one month follow-up, the ECOG improved in 4 out of 5 patients but was not statistically different ( $p=0.26$ ). At three months the ECOG score was improved in all 4 remaining patients from their pre operative status but was not significant ( $p=0.17$ ).
- At 12 months follow up, the 3 remaining patients were alive and functional, showing stable fixation and unchanged pain measurements, analgesic requirements and ambulatory capacity compared to three months follow-up.

**Conclusion:** CT guided percutaneous fixation was clinically successful in providing significant pain relief, reducing narcotic consumption and improving performance status in patients with metastatic pathologic fractures of the ilium and sacro-iliac region after radiotherapy. Clinical benefit was durable and persisted in all the living patients at 12 months from surgery. Evidence of mechanical pain warrants consideration for internal fixation and this minimally-invasive technique is an appealing treatment option for selected patients with



very limited treatment alternatives. Future studies may further refine surgical indication, improve technique and provide longer term follow-up.

2503

**Web access 3D model-based ICT tool for surgeon-manufacturer communication to manage rare and complex orthopaedic cases treated with patient-specific devices (implants and surgical guides)**

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**Introduction and Purposes:** Although the superiority of patient-specific devices over standard solutions is proven, they currently fail to achieve large-scale commercial success due to interdependent drawbacks. To initiate the transition to personalized medicine, it is necessary to tackle the current paradigm by promoting new approaches and developing innovative ICT tools.

Scientific literature shows the focus on the advantages of pre-surgical planning and patient-specific implants/surgical guides. But less is being analyzed regarding the efficiency of pre-surgical planning software and of the planning-to-production processes.

**Materials and Methods:** To make this transition a reality, the first open-access 3D-virtual-model-based ICT tool for surgeon-manufacturer communication and pre-surgical planning, serving as patient-specific implant configurator, has been developed for the management of complex clinical cases.

**Results:** This tool successfully grants the surgeons, via the manipulation of 3D models, the ability to describe in easier way, the individual solutions to be used in the treatment of a particular patient. Additionally, the surgeon's participation in solution co-creation and approval processes is being facilitated through the specification of requirements on virtual models and the systematization of the product design features. Along with it, the accumulated experience of the use of PSI will be used as clinical decision support and as learning tool to create added value not only to patient, but to surgeon and hospital as well.

**Conclusions:** The newly developed 3D virtual model-based technology, set as surgeon-manufacturer communication standard for serving PSI orders, ensures correct data interpretation, product safety and functionality. Those will accelerate the shift of the surgical thought paradigm to the personalized approach and undoubtedly will lead to drop the costs of the implants used for treating rare and complex clinical cases and shorten product lead times.

2396

## Surgical classification for robot-assisted sacral tumor resection

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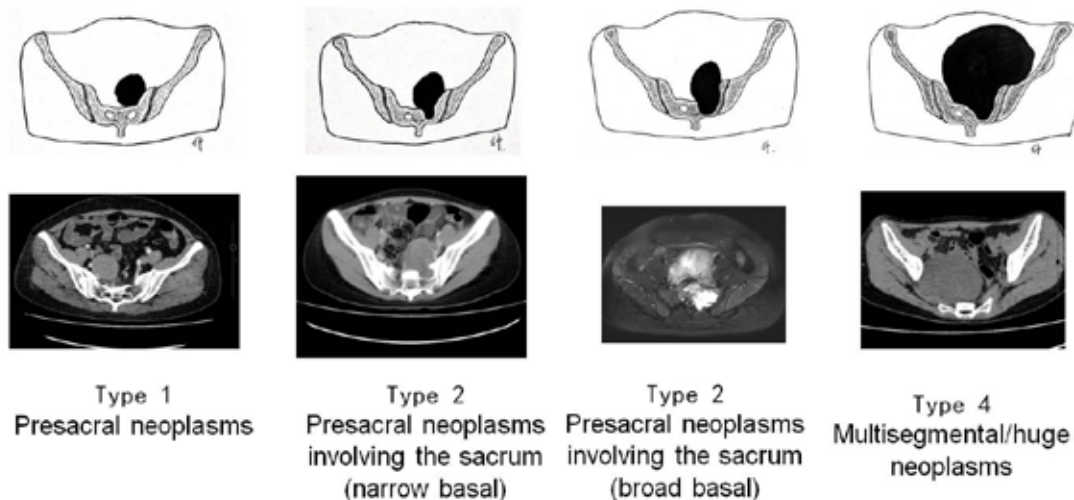
**Introduction and Purposes:** We put forward a new surgical classification system for robot-assisted sacral tumor resection, aiming to examine the relationship between the classification system and the outcomes of ten patients with benign sacral tumors treated with a robotic surgical system at a single center.

**Materials and Methods:** All patients with benign sacral tumors who underwent transperitoneal resection using the da Vinci Si HD robotic surgical system (Intuitive Surgical Inc.) between June 2015 and October 2018 were included in this retrospective study. The anatomical relationship between tumors and the sacrum can be classified into four types. Type I: Presacral neoplasms. Type II: Presacral neoplasms involving the sacrum (narrow basal). Type III: Presacral neoplasms involving the sacrum (broad basal). Type IV: Multi-segmental/huge neoplasms.

**Results:** Eight female and two male patients were included in this study. Seven type I patients underwent complete tumor resection by the da Vinci robotic surgical system. One type II patient underwent complete excision assisted by orthopedic tools. One type III and one type IV patients underwent excision of the presacral tumor via posterior approach by the da Vinci robotic surgical system. The histological diagnosis comprised schwannoma of the sacral nerve (8 cases) and chordoma of the sacrum (1 case) and solitary fibroma (1 case). No intraoperative, perioperative or postoperative complications were encountered.

**Conclusion:** This new surgical classification system based on minimally invasive system was beneficial to guiding treatment. Robot-assisted minimally invasive sacral surgery was suitable for type 1, type 2 and part of type 3 patients. Some patients of type 3 and 4 can use da Vinci Si HD robotic surgical system as adjuvant therapy.

Keywords: surgical classification system, minimally invasive system, sacral tumor



The illustration for Surgical classification about robot-assisted sacral tumor resection

2434

## Robotic surgery assisted En Bloc sacrectomy for primary bone tumours of the sacrum

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**Introduction & Purposes:** Surgery is the main stay management of primary bone tumours of the sacrum and obtaining wide surgical margins is an important predictor of survival and local recurrence. En bloc sacrectomy is associated with significant functional impairment and neurological dysfunction. We report our experience with a novel staged technique of robotic surgery assisted anterior adhesiolysis coupled with posterior En bloc resection, for primary bone tumours of sacrum.

**Materials & Methods:** 7 patients with primary tumors of the sacrum (4 chordoma, 2 osteosarcoma and 1 chondrosarcoma), with a mean age of 35 years (range: 24-53) were operated by first stage robotic surgery assisted anterior adhesiolysis followed by second stage posterior open sacrectomy, on the following day. Partial sacrectomy was performed in 5 patients (S1-S2 resection in 2 patients, S2-S3 resection in 3 patients) and total sacrectomy was performed in 2 patients.

**Results:** The mean total surgical time was 342 ( $\pm 93$ ) minutes and the mean blood loss was 880 ( $\pm 450$ ) ml. All the resected specimens had margins free of tumour. None of the patients had surgical site complications after surgery. Local recurrence free survival was 100% and overall survival was 85.7%, at a mean follow-up of 28 ( $\pm 11$ ) months. Mean MSTS score at final follow up was 24 ( $\pm 3.2$ ).

**Conclusions:** Anterior preparatory robotic surgery assisting posterior staged sacrectomy is a relatively new technique and has only been recently reported in the literature. It allows effective, safe anterior dissection with minimal blood loss and complications resulting in excellent oncological and functional outcome.

Figure 1

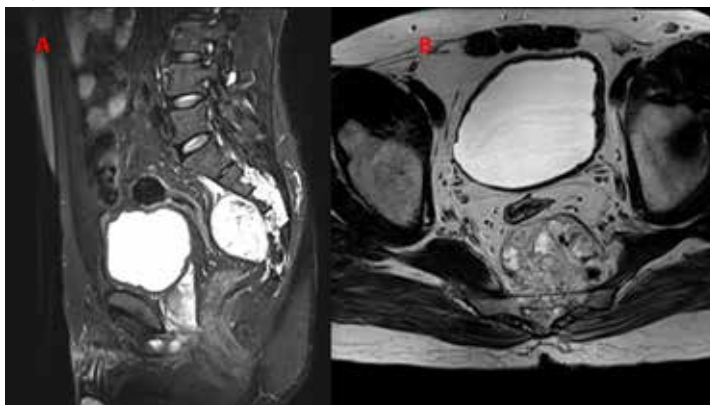


Figure 2

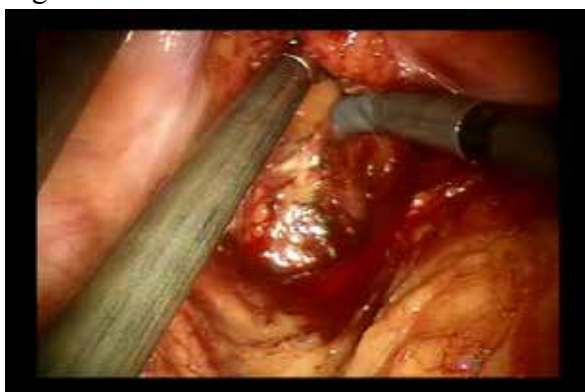
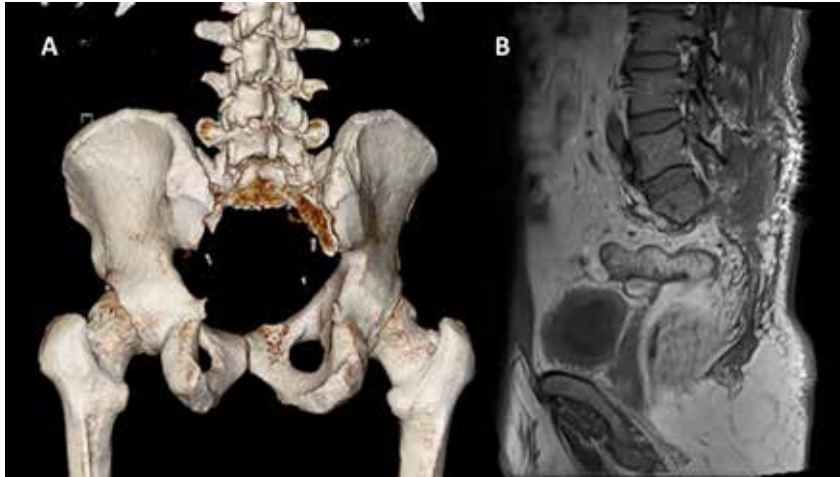


Figure 3



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2552

## Ultrasonography-guided surgery for impalpable and ill-defined malignant soft tissue tumor

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**Introduction and Purposes:** The accurate excision of impalpable or ill-defined soft tissue tumors are usually thorny. In recent years, the image quality of ultrasonography (US) has improved considerably. The US has also advantage regarding to noninvasive and easy to get the repeatable real time imaging<sup>1)</sup>. We have used the US in the surgery of impalpable or ill-defined soft tissue tumors for the guide of tumor excision. The purpose of this study is to evaluate the usefulness of US-guided soft tissue excision.

**Material and Methods:** Inclusion criteria of this study is the patient who was treated by ultrasonography-guided surgery at least 2 years follow-up or until death. Before the skin incision, all tumors were we detected the exact tumor location by US. The probe and cable were wrapped by in a sterile plastic field to use in the operative filed. Tumor was monitored via adjacent fat tissue, fascia or muscle during the tumor excision. The histological surgical margins were evaluated in all tumors.

**Results:** Twenty patients (13 men & 7 women) were enrolled. Mean age was 53 years (35-70) and mean tumor volume was 74.5 cm<sup>3</sup> (0.13–476.8). Mean follow-up term was 37 months (5-86) (Two tumors were primary and 4 were recurrent. Mean follow-up time was 35 months (24-54). Surgical margins were determined histologically as R0 in 19 patients and R1 in 1. Two local recurrences were detected, however both recurrences developed in the distant from surgical field.

**Conclusions:** This study showed that the histological tumor-free margin was obtained by intraoperative use of US for impalpable or ill-defined malignant soft tissue tumor excision. The limitation of this study is that the number of patients was rather small, so further analysis is necessary. US-guided surgery is simple, noninvasive, and useful to monitor the exact tumor location, and help to excise the tumor accurately.

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# SESSION 13

## CUSTOM MADE PROSTHESES AND DEVICES

2322

### Custom-made acrylic bone cement spacers for the reconstruction of difficult cases in orthopedic oncology

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**Introduction:** Limb salvage surgery is performed in patients with bone sarcomas of the extremities, however current options for the reconstruction including endoprosthetic replacement, allografts, and autografts are not best suited for some challenging patients. Challenges among these patients gather difficult periarticular bone locations, growing children, the need to resume chemotherapy soon after surgery and poor societies. We present a series of patients treated with cheap custom-made acrylic bone cement spacers as an alternative to accomplish limb salvage in difficult cases in orthopedic oncology.

**Materials and Methods:** We present 7 cases of reconstructions with custom - made acrylic bone cement spacers to treat Ewing's sarcoma and osteosarcoma in challenging cases. There were 5 cases of Ewing's sarcoma, 1 case of osteosarcoma, and 1 case of chondrosarcoma. The locations include the calcaneus, proximal ulna, radius, proximal femur, and tibia. The reconstructions were made with custom hand shaped spacers in 6 cases and 1 case with a 3d printed mold to make the spacer.

**Results:** Ages ranged from 6 to 42 years. Follow-up ranged from 8 months to 11 years, with a mean of 41 months. Functional outcome was assessed with the MSTs score over 80% in all cases. There were no local recurrences and none of the spacers needed revision for mechanical failure. There were 3 patients who underwent a second stage surgery during follow up.

**Conclusions:** Custom-made acrylic bone cement spacers remain as a cost-effective and durable alternative, with good functional outcomes, especially for challenging cases where autografts, allografts or endoprosthetic replacement are not a good option, are not available or where its cost limits its use. They are especially useful as an alternative in poor societies and in challenging cases including children bone sarcomas and difficult bone locations.

2518

## Uncemented three-dimensional printed prosthetic reconstruction for giant cell tumor of the distal tibia

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**Introduction and Purposes:** Although giant cell tumor (GCT) of the distal tibia is not common, its surgical treatment is highly demanding, especially for Campanacci grade III or recurrent GCTs. In this study, the reconstruction of the distal tibia using customized uncemented three-dimensional (3D)-printed prosthesis with polyethylene articular surface for GCT treatment was described. Furthermore, the clinical outcomes and radiograph were presented and evaluated.

**Materials and Methods:** Between March 2016 and January 2019, four patients with distal tibia GCTs were treated with personalized 3D-printed prosthesis with best-fit polyethylene liner. Clinical outcomes and radiographs were assessed retrospectively.

**Results:** The average follow-up was 21 months. The knee function was satisfied and mean postoperative MSTs score was obviously higher than the preoperative score (preoperative versus postoperative: 56% versus 87%). The perioperative joint space was 1.8 mm on average. No complication associated with prosthetic replacement, such as aseptic loosening, subluxation, or breakage, were observed.

**Conclusions:** The uncemented 3D-printed prosthesis with best-fit articular polyethylene liner, medial malleolus structure, and suturing pores might be a feasible and alternative to treat Campanacci grade III or recurrent GCTs of the distal tibia, and it can enhance the stability and flexibility of the ankle joint and protect the cartilage on the talus.

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2486

## The use of 3-D printed Joint Sparing Endoprosthesis in bone tumor Sugery, The future is now!

Ahmad Shehadeh<sup>1</sup>, Muthana Abdelhaleem<sup>1</sup>, Mohamad Qwasmi<sup>1</sup>, Ula Isleem<sup>2</sup>

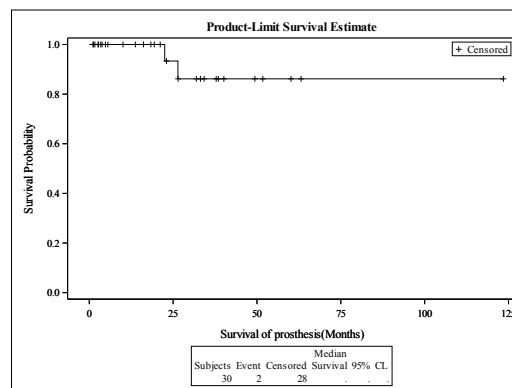
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**Introduction:** Joint sparing surgery make it possible to save not only the limb affected by malignancy, but also, the adjacent joint with or without the physis . Reconstruction options can be biological reconstruction or endoprosthesis.

**Objectives:** To investigate the outcome of using customized Joint Sparing Endoprosthesis (JSE) after juxta articular resection of bone tumors.

**Materials and Methods:** Twenty Eight patients, (age:4-55 year,Median 13), and 31 joints received JSE, 21 patients for primary reconstruction, 7 patients for revision .Femur=15, tibia=10, humerus=6. Osteosarcoma was the commonest pathological diagnosis (n=13). Flat surface HA coated JSE was used in 15 joints, and short stemmed JSE was used in 16 joints. The length of remaining bone epiphysis for JSE anchorage from the knee and ankle joints, was 25-75 mm, median=45mm, and the length of cortical bone remaining from lesser trochanter and olecranon fossa for proximal femur, distal humerus respectively, was 5-70 mm, median= 10 mm.

**Results:** Histological examination of all resected specimens show clear bone resection margins, 2 patients had positive soft tissue margins. At mean follow up period of 3 years(6 mo-7yrs), 6 patients developed local and systemic recurrences, three of them had pathological fracture at time of diagnosis and 4 poor response to chemotherapy(P=0.016), all recurrences occurred in the soft tissue. Implant survival at 5 year was 86.5%, MSTS score 90%(83-96%)



3 years survival rate: 86.15%

5 years survival rate: 86.15%

**Conclusion:** This is the biggest series in literature for joint sparing surgery in which custom JSE was used .In our series, both implants designs that we used; survived well at 5 year follow up (86.5%), no increased incidence of local recurrence in comparison to joint sacrificing techniques . No increased need for revision surgery in comparison with joint sacrificing approach. the early results of using custom made JSE is encouraging and functional outcome is outstanding.

2613

### 3D-printed custom-made prosthetic reconstructions: analyses of 41 cases in two referral Centers

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**Introduction and Purposes:** Three-dimensional (3D) printing is an emerging technology used in numerous medical fields in the last decades. We analyzed: 1) indications and designs of 3D-printed prostheses; 2) complications rate considering site (3) oncologic and functional outcomes at mid-term follow-up

**Materials and Methods:** We analyzed patients in whom a custom-made 3D printed prosthesis was used after resection for a bone tumor or in challenging revision surgery from 2014 to 2017. Forty-one patients (17 men [41%]) with a mean age of 55 years (range, 10-78 years) were included. Nine were non-oncologic patients, whereas in the remaining cases chondrosarcoma was the predominant diagnosis (n=17 [41%]). Custom-made 3D printed prostheses were used in pelvis (34), forearm (2), scapula (2), distal tibia (1), calcaneus (1) and femoral diaphysis (1). The reconstruction included articular replacement in 13 cases (32%).

**Results:** Overall complication rate was 36.5% (15/41 cases). Six patients (15%) had postoperative wound dehiscence requiring surgical debridement, whereas other four cases (10%) were successfully treated with surgery, flap and antibiotic therapy due to deep infection, maintaining their implants. One patient reported a periprosthetic fracture and four (12.5% [4/32 cases]) had local recurrence. The implant survival to major complications was 70% at 2 years f-up. In the oncologic group, 28 patients (87%) were disease-free, whereas one was alive with disease (3%) and three died with disease (9%). Mean MSTS score was 70% (range, 36%-93%).

**Conclusions:** We believe these 3D-printed prostheses are useful reconstructive options after tumor resections or failed prior implants. Infection and wound healing problems are relatively common after these complex reconstructions, especially in pelvic reconstructions.

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2520

### Three-dimensional printed customized prosthesis for periacetabular malignancies: prosthesis design and surgery techniques

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**Introduction and Purposes:** With rapid prototyping evolving, three-dimensional (3D) printed customized prostheses provide a promising option for pelvic oncologic bone defect. This study firstly describes detail of periacetabular prosthesis design.

**Materials and Methods:** 13 patients with periacetabular tumor were treated by 3D printed customized prosthesis replacement between May 2017 and December 2018. Design was developed in Mimics combined with Geomagic and basically according to dimension of sacral vestibule, narrowest zone of pubis and inclination of acetabulum.

**Results:** Mean width of first sacral vestibule was 25.84 mm in male and 22.34 mm in female, while height was 21.31 mm and 19.34 mm. Four screws dilating 6.5 mm were distributed in first sacral body as fanshaped. The average diameter of the narrowest zone of pubis was 7.32 mm in male and 6.18 mm in female. Pubic stem was extended to narrowest pubis and matched medullary cavity of pubis in prosthesis design. Mean anteversion was 14.89 in male and 17.26 in female while abduction was 47.39 in male and 45.87 in female. Inclination of artificial acetabulum was set as 20-25 in anteversion and 40-45 in abduction, it would be adjusted to soft tissue resection. Intraoperative time and blood loss was reduced than routine operations. Compact integration could be observed two months postoperatively and mean MSTS score was 22.9 (18-27) three months after operation.

**Conclusions:** rosthesis design should take not only macroscopic factors including biomechanical property and surgery procedures but also microscopic factor such as bone-implant integration into consideration.

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2610

## The use of custom made prostheses after oncological massive bone resections: remarks deriving from our experience

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<sup>1</sup>Department of Trauma and Orthopaedic Surgery, Pisa - Italy

**Introduction and Purposes:** Reconstruction in massive bone defect after surgical resection is still today an arduous issue. The recent introduction of custom-made 3D-printed prostheses has give a valid support in order to preserve anatomy and function as much as possible.

**Materials and Methods:** From January 2016 to May 2018, at our Hospital 11 patients underwent reconstruction with a 3D prosthesis after massive bone resection. 9 of them were affected by a malignant tumor, both primary of the bone (n 6) and metastases (n 3, one Sertoli cell tumor of the testis and two clear cell renal carcinoma). 4 cases involved the scapula (2 type IV and 2 type II according to Malawer classification of shoulder girdle resection), while the other the pelvic bone (3 patients underwent to type II + III resection, one patient II resection type and 1 patient I+II resection type according to Enneking resection classification). The functional results were evaluated using the Revised Musculoskeletal Tumor Society Rating Scale (MSTS) for lower and upper extremity-bottom. The complications percentage was calculated assessing Henderson et al. classifications and considering Campanacci and Capanna's system. The oncologic outcomes were also evaluated.

**Results:** Only one oncologic patient died with disease (DWD), all the others oncologic patients were alive (1 AWD, 4 NED and 3 NED II). At a mean follow-up of 12,6 months (4 – 24 range) the median MSTS score was 25 (range 17 – 30) excluding the dead patient. Assessing Henderson classification, the overall rate of complications was 27,3%: we recorded 1 wound dehiscence (Type 1), 1 tumor progression (Type 5), and 1 wound dehiscence with tumor progression (type 1 + 5). None of the patients had aseptic loosening (Type 2), structural failures (Type 3) or infections (Type 4) that needed surgical removal of implants. As regards the wound complications, they were classified according to Capanna and Campanacci system as one grade 3 (treated with surgical wound debridement, VAC and antibiotic therapy) and one grade 2 (seroma treated with drainage and antibiotic therapy).

**Discussion and Conclusions:** The introduction of custom made technology in bone reconstruction after oncologic resections has provided an innovative approach. Being recently introduced, literature appears to be poor in data therefore the use of 3D-custom-made implants continues to be debated. Despite the complications rate remains high, this preliminary study shows satisfactory and promising results with excellent and early functional recovery if compared with classical techniques of reconstructions. Further investigation with a longer follow up and more patients is mandatory in order to have significant results.

2326

# **Reconstruction with a novel combined hemipelvic endoprosthesis after resection of periacetabular tumors involving the sacroiliac joint: a report of 25 consecutive cases**

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**Introduction and Purpose:** To assess the clinical outcomes of the novel combined hemipelvic endoprosthesis for patients undergoing extensive resection of periacetabular tumors involving the sacroiliac joint.

**Materials and Methods:** 25 patients diagnosed with Enneking type I/II/I<sub>c</sub> pelvic tumors from 2010 to 2016 were retrospectively included in this study. All patients underwent limb salvage surgery and reconstruction with the prosthesis.

**Results:** The median follow-up period was 48 months. At the most recent follow-up, 11 patients were alive, with estimated 3- and 5-year survival rates of 45.6% and 38.0%, respectively. 14 patients died, with a mean survival of 20.8 months, and 8 patients had local recurrence at an average of 9.3 months after surgery. Distal metastases were detected in 11 patients at an average of 11.0 months after surgery. The total complication rate was 56.0%, and the most common complications were wound healing disturbances (28.0%) and deep infections (16.0%). The prosthesis-related complication rate was 24.0%, and periprosthetic infections and aseptic loosening were most common. The estimated 1- and 3-year prosthesis survival rates were 81.2% and 63.2%, respectively. The mean Musculoskeletal Tumor Society score was 48.0%. Function and prosthesis-related complications did not differ significantly after adding an extra screw fixation to the first sacral vertebra.

**Conclusions:** Reconstruction outcomes with a novel hemipelvic endoprosthesis are promising, with acceptable function and complication rates. Adding an extra screw fixation to the first sacral vertebra was not associated with any improvement in the clinical results after short-term follow-up. Improvement and further studies of this endoprosthesis are needed.



Figure 1. The combined hemipelvic endoprosthesis.



Figure 2. Reconstruction with the combined hemipelvic prosthesis.

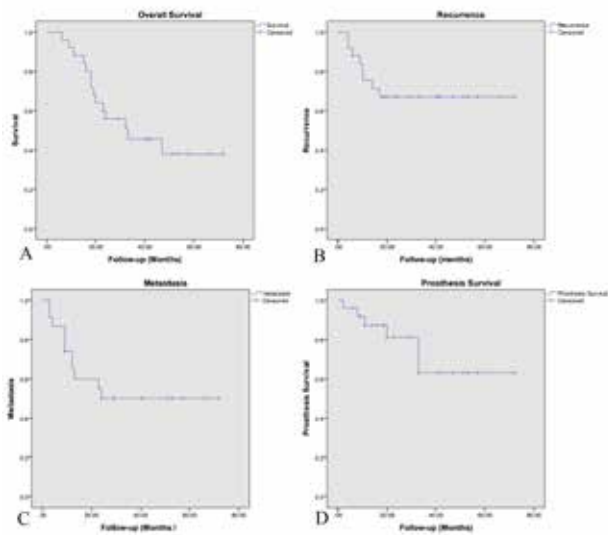


Figure 3. Kaplan-Meier survival analysis.

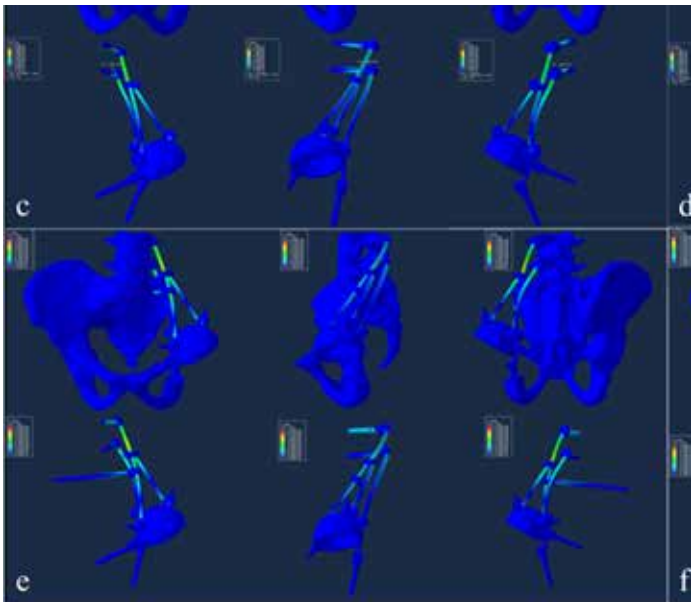


Figure 4. Stress distribution of the post-operative pelvis.

2454

## Custom made 3D printed implants in orthopedic oncology: problem solving or new problem?

**Giovanni Beltrami<sup>1</sup>, Guido Scoccianti<sup>2</sup>, Pierluigi Cuomo<sup>2</sup>, Francesco Muratori<sup>2</sup>, Maurizio Scorianz<sup>2</sup>, Francesca Totti<sup>2</sup>, Rodolfo Capanna<sup>3</sup>, Domenico Andrea Campanacci<sup>2</sup>**

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**Introduction:** Since the last forty years, after wide bone tumor resection in Orthopedic Oncology, many reconstructive techniques has been used for limb salvage. Bone massive allograft, allograft prosthesis composite, autologous bone graft, recycled autograft and conventional prosthesis has been widely employed with encouraging and documented results. Nevertheless, any reconstructive techniques showed a constant overall rate of short and long-term failure rate, especially for articular surfaces and difficult sites. For this reason, thanks' to improved industrial technology, custom made 3D printed implants has been widely tested and implanted in the last few years. The aim of our study is to critically present our casuistic of custom made implants after bone tumor resection.

**Material & Methods:** At Department of Pediatric & Adult Orthopedic Oncology of Florence we have implanted, from June 2016 to December 2018, 16 custom made 3D printed implants in primary bone tumors. Custom reconstruction was used as primary reconstruction in 14 cases, and as salvage of previous failed reconstruction in two cases. The entire patient's image data were imported into CAD system, and a 3D model of the resected bone was reconstructed. The size-matched prosthesis was designed by scaling down data of the contralateral site. Custom manufacturing of the porous titanium implant was developed and implanted. Custom prosthesis with articular joint reconstruction were used in 13 cases, while custom plates in 3 cases. Regarding sites, we used custom prosthesis in one finger phalanx, 3 scapula, 3 humerus, one distal femur, 5 pelvis, while custom plates all in proximal tibia.

**Results:** At the average follow up of 14 months (2-30), all 13 custom prosthesis are still in site and effective, while 2/3 custom plates has been removed for skin troubles. No acute infections appeared; aggressive curettage and antibiotics pearls resolved one late hematological deep infection. Two scar sloughs were revised and healed. No early mechanical complications appeared.

**Conclusion:** After bone tumor resection, custom made implants are a really interesting and theoretically efficacy new surgical solution, especially for articular reconstruction in difficult sites. Despite this, possible difficulties must be considered, both intraoperatively or long term. For this reason, we suggest utilize this sophisticated technique only in selected cases, when the "conventional solutions" appear to be unpredictable.

2632

### Complex spinal reconstruction after spinal tumor surgery: do we really need custom made 3D-printed implants?

Marco Girolami<sup>1</sup>, Riccardo Ghermandi<sup>1</sup>, Stefano Bandiera<sup>1</sup>, Giovanni Barbanti-Brodano<sup>1</sup>, Silvia Terzi<sup>1</sup>, Giuseppe Tedesco<sup>1</sup>, Gisberto Evangelisti<sup>1</sup>, Valerio Pipola<sup>1</sup>, Alessandro Gasbarrini<sup>1</sup>

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**Introduction:** Reconstruction of the segmental spinal defects after tumor surgery aims at immediate stability and secondary solid fusion. The present communication provides an update on the results of the ongoing study on use of 3D printed custom made implants for anterior column reconstruction.

**Materials and Methods:** In 21 patients surgically treated for benign aggressive (Enneking stage 3) or malignant tumors of the mobile spine or sacrum between November 2015 and January 2019 at the same institution, anterior column reconstruction was done using 3D printed custom made implants. Resection was planned according to Enneking and Weinstein-Boriani-Biagini staging systems. Implants were designed according to the preoperative planning of the resection on CT-scan.

**Results:** At an average 21 months follow-up (range 3-36), 1 major mechanical complication occurred and 1 implant was replaced due to recurrence of the disease. In 18 cases the thoracolumbar spine was reconstructed. In the remaining 3 cases, 2 involved the upper cervical spine (C2), and 1 case sacrum and lumbo-sacral junction. No breakage, nor migration of the implants occurred.

**Conclusions:** Custom made 3D printed titanium implants seems to be a viable option for restoration of the anterior column after spinal tumor surgery, especially in complex junctional reconstructions. Longer follow-up will be needed for fusion rates and long-term complication rates.

# SESSION 14

## SPINE AND PELVIC TUMORS



2674

### Carbon-fiber-reinforced PEEK fixation system in the treatment of spine tumours

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**Introduction:** Combination of surgery and radiotherapy is becoming more and more frequent in the protocols for the treatment of spine tumours. The metallic hardware interfere with postoperative radiotherapy, while the composite material carbon-fiber-reinforced polyethyl-ether-ether-ketone (CRF-PEEK) is biologically compatible and radiolucent, allowing easy planning CT scan, early detection of local recurrence and no scattering effect during radiotherapy. We retrospectively evaluated 60 consecutive tumor patients, treated in a single institution, who underwent spinal surgery including a composite CFR-PEEK fixation system with screws and rods.

**Materials and Methods:** 33 male and 27 female, mean age 58 years (range 18 – 78). 37 cases: primary tumours (24 recurrence), 23 cases: metastases (13 recurrence). Separation surgery has been performed in 41 cases, gross total excision in 11 cases and en-bloc resection in 8 cases.

**Results:** One intraoperative complication related to the implant (screw breakage). No rod breakage, neither any screw/rod disconnection were found during the follow-up. One case of loosening of sacral screws at 12 months in a patient having a local recurrence for a multi recurrent malignant tumour. One case of screw mobilization at 6 months. After the surgery, in 41 patients a postoperative radiotherapy has been performed (23 cases with particle and 18 with photons).

**Conclusions:** CFR-PEEK fixation system is comparable to standard titanium system in terms of intraoperative complications, stability at weight bearing and at functional recovery. Thanks to radiolucency CFR-PEEK stabilization devices are more suitable in patients eligible for radiotherapy: the absence of image artefacts together with significantly less dose perturbation improve the treatment accuracy. Moreover, the radiolucency is useful in the follow-up of patients allowing early detection of local recurrence.

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**2618**

### **Sacrectomy. The Royal National Orthopaedic Hospital experience**

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**Introduction:** Sacral tumours are challenging to manage surgically and have significant associated morbidity. The aim of our study was to review the experience of sacrectomy in our centre, and quantify the morbidity and mortality rate including the rate of wound complications, re-operation, length of hospital stay (LOS) and bowel/bladder/sexual function.

**Methods:** Hospital clinical coding records identified 105 patients who underwent partial or total sacrectomy between 1993 and 2018. Data collected included patient demographics, histopathological diagnosis, post-operative complications, adjuvant therapy and patient survival.

**Results:** 105 patients were identified with a mean age of 52.3 years (11y-78y). There were 67 males and 38 females. The diagnosis was Chordoma in 65 patients (62%). LOS averaged 52.2 days (11-112 days). 74% of (how many?) patients required intra/post-operative blood transfusion. 74% had wound complications. 46% required re-operation. 84% had impairment of bowel, bladder or sexual function and this correlated to the level of sacral transection. Mean follow up was 223 weeks (4-1152). Overall mortality at 1, 5 and 10 years was 11%, 42% and 48% respectively.

**Conclusion:** Sacrectomy remains a complex and morbid procedure, yet, oncological advances together with careful patient selection can offer patients the best chance of cure. Nonetheless, this often results in significant morbidity and compromised functional outcome for which patients should receive pre-operative counselling. We hope that our review offers a comprehensive report of our experiences and provides a guide both to clinicians and patients as to their expected outcome, allowing them to make fully informed decisions and access the appropriate support networks.

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## 2334

### Sacral chordoma treated with resection or carbon ion radiotherapy

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**Aim:** To compare the outcome of resection with that of carbon ion radiotherapy (CIRT) in the treatment of sacral chordoma.

**Methods:** 20 patients with sacral chordoma were diagnosed in our hospital between 1993 and 2014. Between 1993 and 2000, all 5 patients were resected surgically. 2 patients had the tumor above S3, and 3 below or at S3. Since 2000, 4 patients (all below S3) were resected and 11 patients (5 above S3, 6 at S3) were referred to undergo CIRT.

**Results:** Average follow-up is 142 months for resection and 117 months for CIRT. 5 of 9 patients who underwent sacrectomy are continuously disease-free (CDF). There were 3 local recurrences (LR; 28, 78, and 151 months postop.) and 4 distant metastases after sacrectomy. 2 of those are no evidence of the disease (NED) after CIRT or resection for the recurrent tumor, and 2 died of the disease (DOD). 4 of 11 who underwent CIRT are CDF. 7 developed local tumor progression average 72 months (19-132 months) after CIRT, 4 of those underwent additional CIRT for the tumor progression. 3 developed multiple lung metastasis. 1 NED, 3 are alive with the disease, and 3 DOD. 3 could not walk after resection, but all after CIRT could walk with or without supports. 5- and 10-year LR-free survival are 89% and 76% for sacrectomy, and 73% and 62% for CIRT, and 5- and 10-year overall survival (OS) are 88% and 88% for sacrectomy, and 91% and 82% for CIRT, indicating no statistical difference between 2 groups.

**Discussion:** CIRT institute in Chiba analyzed on 188 sacral chordomas, reporting 77% of 5-year LR-free survival and 81% of 5-year OS with median follow-up period of 62 months. There was no difference in oncological outcome between resection and CIRT for sacral chordoma, but functional outcome could be better after CIRT, especially for chordoma arising above S3. We conclude that safely-resectable chordoma below S3 can be treated surgically, and CIRT is optimal treatment for chordoma above or at S3 or hardly-resectable chordoma.

2342

### What is The Risk of Mortality following Local Chordoma Recurrence?

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**Background:** Sacrococcygeal chordomas have historically been treated surgically. Even with negative margins, there remains a high risk of local recurrence (LR). The mortality risk of patients experiencing LR remains poorly described. The purpose of this study was to determine the mortality risk following a LR of a sacral chordoma.

**Patients and Methods:** 193 undergoing resection of primary sacral chordomas from 1990 to 2015 were reviewed. Mean age was 59 (range 13-88), with 124 males at a mean follow-up of 7 years.

**Results:** Overall 10-Year survival for all 193 patients was 59% (Figure 1A). 36 patients (19%) experienced LR. Patients with LR had a 39% 10-Year survival (Figure 1B), there was no difference in mortality between patients with and without LR ( $p=0.10$ ). All patients experiencing LR, who died, died of disease (DoD). For patients with LR, age <55 years conferred similar mortality rates (10 Years: 75%) compared to patients  $\geq 55$  years (10 Years: 54%) ( $p = 0.82$ , Figure 2A). Amongst patients without LR, patients <55 had similar risk of DoD compared to patients  $\geq 55$  years (8% at 10 years,  $p = 0.24$ ). Patients  $\geq 55$  were 2.1-fold more likely to experience death due to other causes (30% at 10 years) than patients <55 (14% at 10 years,  $p = 0.01$ , Figure 2B).

**Conclusions:** Patients with LR following resection of a sacral chordoma trended towards 38% higher 10 year mortality than those without recurrence. Mortality risk over time is similar in the setting of LR, whether patients are young (< 55 years) or older ( $\geq 55$  years). For older patients without LR, death due to non-disease causes occurs over 2-fold more commonly than DoD.



Figure 1A-B: A) Overall mortality free survival (Green). B) Mortality free survival for patients experiencing LR (Red) and those without LR (Blue).

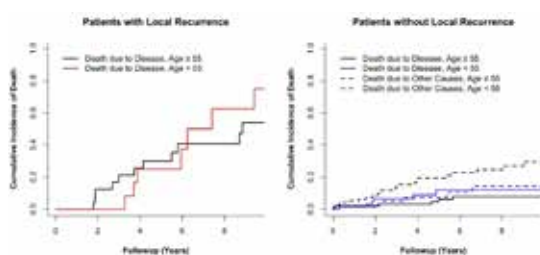


Figure 2: Cumulative incidence of DoD and death due to other causes by patient age for A) Patients with LR, and B) Patients without LR.

2704

## **Surgical management of iliosacral bone malignancies: tumor location, extent of sacral excision and sacro-iliac stabilization are significant predictors of functional outcome**

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**Background:** Surgical management of pelvic sarcomas arising from the ilium and involving the iliosacral region (Enneking zone I-IV) remains a very challenging problem, due to large tumor diameter and proximity with the lumbosacral plexus, iliac vessels and viscera, such as the bladder and rectum. Extensive soft tissue dissection and skeletal excision leading to iliosacral discontinuity is often necessary to obtain a negative margin. In this setting, limb salvage surgery has been associated with superior function and quality of life than hindquarter amputation. Partial preservation of iliosacral continuity is usually associated with residual pelvic stability and does not require formal reconstruction. However, it remains controversial whether iliosacral reconstruction to restore pelvic continuity may improve functional outcome if compared to excision without reconstruction. In addition, different reconstructive techniques have been described to address iliosacral discontinuity, all essentially associated with comparable complications and outcome.

### **Purposes / Questions:**

1. Does reconstruction after complete iliosacral resection for bone malignancies consistently improve functional outcome and incidence/severity of long-term chronic pain?
2. Do location and extension of the tumor into the sacrum and the level of sacral resection affect functional outcome?
3. Is there any surgical technique predictably associated with superior clinical results?
4. In case of partial preservation of the sacro-iliac joint, is augmentation by bone grafts associated with improved function?

**Patients and Method:** A retrospective case-control study of prospectively collected data was designed on 36 patients with iliac malignancy extending to or across the sacro-iliac joint, 1994-2014. They were divided in two groups. Group 1 consisted of 27 patients with complete iliosacral resection resulting in discontinuity of the pelvic ring; 19 of them underwent also iliosacral reconstruction while 8 did not. Group 2 included 9 patients with partial preservation of the sacro-iliac joint; 6 of them underwent augmentation with ipsilateral autogenous iliac graft while 3 did not. Mean age of patients was 38 years (range: 11-80), mean follow up was 5.5 years (minimum 2 years). Diagnosis: Ewing 9, Chondrosarcoma 12, Osteosarcoma 8, Leiomyosarcoma 4, Giant cell tumor 3. Major nerve/root resections were performed in 15 patients. Autograft reconstruction was used in 15 patients, allograft in 7 and vascularized fibular graft in 3 while cement and internal fixation were used in 2 patients. Six patients required spinopelvic fixation (SPF) in addition to bone grafts. Functional outcome was assessed using MSTS score. Pain was analyzed by New York State Department of Health and Mental Hygiene Morphine Milligram Equivalent (MME). Incidence and outcome of reoperation for any reason was also analyzed. Statistical analysis used is ANOVA for quantitative outcomes and Chi-square for proportions comparison.

### **Results:**

1. MSTS mean score was 23 in patients with iliosacral reconstruction and 21 in patients who were not reconstructed ( $p=0.24$ ); however, iliosacral stabilization was associated with less pain medications (MME) at one year from surgery ( $p=0.021$ ) and less limb discrepancy (mean 0.9 vs 2.2cm;  $p=0.03$ ).
2. Eight patients (22%) had immediate postoperative footdrop; incidence was 16% in patients who had resection lateral to the sacral foramina and 64% in patients with resection medial to the foramina ( $p=0.015$ ). Patients with tumors extending to the sacrum had higher Incidence of deep infection compared to tumors not involving the sacrum (43% vs 13%). Mean MSTS score was 25 for patients who had tumors involving the ilium only and 18 in patients whose tumor extended to the sacrum ( $p=0.007$ ).
3. Different reconstruction methods showed similar functional outcome. However, patients that underwent SPF were associated with worse function and higher narcotic consumption one year after surgery ( $p=0.07$  and  $p=0.03$ ).
4. Patients with partial preservation of the sacro-iliac joint were associated with superior outcome than patients with pelvic discontinuity, with statistical significance when compared to the non-reconstruction group (MSTS 26 vs 23 vs 21;  $p=0.02$  and  $p=0.04$  respectively); no difference was made by bone graft augmentation



( $p=0.8$ ).

**Conclusions:** The value of iliosacral stabilization following complete pelvic ring discontinuity is controversial in the literature. Findings of this study suggest benefit for function and long term pain. Sacral involvement negatively affects function and increases the risk of complications. Spino-pelvic fixation association with inferior outcome and more pain is probably caused by more extensive dissection and resection. Partial reservation of the sacro-iliac joint is predictably associated with superior outcome. Limitations of the study are the retrospective design, the relatively small number of patients and heterogeneity of surgical management, similar to essentially all the studies focusing on pelvic surgery for bone malignancies.



## 2300

### **Surgical treatment of bone tumors affecting the sacroiliac joint**

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**Introduction and Objectives:** To evaluate the oncological results of locally aggressive bone tumors that affect the sacroiliac joint and have been treated in the Orthopaedic Oncology Unit.

**Material and Methods:** From January 2014 to December 2018, 6 patients were operated on for bone tumors that affected the sacroiliac joint. Epidemiological data, image studies, surgeries undergone, adjuvant treatment, complications as well as recurrence and mortality were recorded.

**Results:** There were 2 males and 4 females with an average age of 40 years (20-57). The median follow-up period was 24 months (11-37). The largest tumoral diameter was 11cm (6,5-19). Of the six patients, two were diagnosed with a low grade condrosarcoma (I/III), one with a leiomyosarcoma of the bone, one with a telangiectatic osteosarcoma, another with giant cell tumor and one had an Ewing Sarcoma. The first symptom in all the cases was low back pain. Two of them has an associated sciatica. Surgical treatment consisted of bloc tumor resection (pelvic zones I-IV), reconstruction with massive structural graft, stabilization with reconstruction plates in the pelvis and instrumented lumbopelvic arthodesis (unilateral in the sacrum in two cases and bilateral in 4) in all the cases. Postoperatively, two cases presented with an infection of the surgical wound, 1 case with neuroapraxia of the sciatic nerve and another had a paresis of the external popliteal sciatic nerve. The oncological results were that one patient (16%) presented with lung dissemination, local recurrence (16%) and died at the end of the study.

**Conclusions:** Pelvic tumors that affect the sacroiliac joint are highly complex. Local recurrence of high-grade bone tumors implies a poor prognosis with a high probability of developing systemic dissemination. In terms of biomechanics, it is necessary to reconstruct the sacroiliac joint. Therefore, the use of bone graft and lumbopelvic fixation allows for the recuperation of lumbopelvic continuity and pelvic ring stability.

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2546

### **Clinical evaluation of lower abdominal aorta balloon occlusion in pelvic or sacral tumors resection**

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**Objective:** To evaluate the clinical efficiency of balloon occlusion of the lower abdominal aorta in blood loss control during resections and reconstruction of pelvic or sacral tumor.

**Methods:** From Jan 2005 to Jun 2011, 156 patients were diagnosed as sacrum or pelvic tumor and underwent surgery in our institution. Temporary balloon occlusion of abdominal aorta was used in 51 patients during the sacral or pelvic tumors surgical operations (balloon group). Another 105 patients received the traditional operation method (control group). The whole surgery time, the quantity of blood loss during the surgery and blood transfusions, the complication, mean days in hospital, The result in two groups were compared with each other.

**Results:** All patient got en block resection in balloon group, while 9 cases in control group was not for intraoperative bleeding can't control and operation will very indistinctly. In balloon group, average operation time was  $171.96 \pm 65.16$  minutes. The intraoperative blood loss was  $746.86 \pm 722.73$  ml. The blood transfusion was  $411.76 \pm 613.73$  ml. The postoperative lead flow was  $294.50 \pm 146.09$  ml. The postoperative tube removal was  $2.98 \pm 1.07$  days. There were statistically significantly less than those in control group ( $P < 0.05$ ). No significant difference was found in postoperative complications and 5 years recurrence and metastasis between 2 groups ( $P > 0.05$ ).

**Conclusion:** Intraoperative abdominal aorta occluding can effectively control intraoperative hemorrhage, and clearly show the operation field, reduce the operation time, effectively control the blood loss and blood transfusions. Appropriately extend balloon blocking time, can obviously improve the tumor en block removal rate and the safety of the operation.

2435

## **Pelvic chondrosarcoma – a retrospective analysis of 160 patients who underwent hemipelvectomy at a single supraregional center**

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**Introduction and Purposes:** Pelvic chondrosarcoma treatment relies on tumor resection except in high-grade and dedifferentiated tumors where chemotherapy may also be administered. Local recurrence rates exceed those of other pelvic sarcomas and reported outcomes may vary depending on local recurrence rate, tumor grading, resection margin and development of distant metastasis. Therefore, it is our purpose to analyze surgical and oncological outcomes with regard to these parameters in this collective.

**Materials and Methods:** Retrospective analysis of 160 patients treated by pelvic tumor resection for chondrosarcoma between 1977 and 2014 was performed.

**Results:** 44 grade 1 (G1), 83 G2 and 33 G3 and dedifferentiated chondrosarcomas were included. Mean patient age at operation was 49 years and tumors were larger than 10 cm in the longest diameter in 76.1% and larger than 20cm in 15.4%. Pelvic resections without involvement of the acetabulum were performed in 63, intraarticular resections in 35 and extraarticular resections in 34 cases. Hindquarter amputation was necessary in 28 patients. Hip transposition was the most common reconstruction performed in 62 patients. Resection margins were clear in 86.9%, while unplanned and planned R1 resections occurred in 8.1% and 3.0%. Pulmonal metastasis was observed in 25% of patients, 8.6% of which presented with metastases, while 13.1% developed metastases after pelvic resection. Local recurrence occurred in 22.5% (G1 25%; G2 21.7%, G3 21.2%). 58.1% of patients are alive without evidence of disease. 28.1% died of disease. 81.1% of G1 patients are alive at a mean follow-up of 84.4 months, while 13.6% died of disease after a mean time of 60.3 months. 59% of patients with G2 tumors are alive at a mean follow-up of 89 months, whereas 25.3% died of disease after a mean of 38.3 months. Only 24.4% of G3 and dedifferentiated tumor patients remain alive at a mean follow-up of 69.4 months, while 54.5% died of disease after a mean of 24.1 months.

**Conclusion:** An elevated rate of local recurrences compared to other sarcomas may be accredited to larger tumor sizes as well as lacking consolidating adjuvant treatment options. Grade-specific analyses reveal that local recurrence remains the same disregarding of tumor grade while probability of distant metastasis and death of disease increase.

2570

### **Treatment of metastatic pelvic ewing sarcoma: a retrospective monocentric analysis**

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**Introduction:** Pelvic Ewing sarcoma with metastases at time of diagnosis is a rare event with-poor prognosis. We retrospectively reviewed our experience in order to identify outcomes of this subgroup of patient.

**Material and Method:** We retrospective analyzed data of patients (pts) treated at our Institution (Istituto Ortopedico Rizzoli for surgery and chemotherapy, Policlinico S.Orsola-Malpighi for Radiotherapy treatment ) from 1<sup>st</sup> January 2005 to 31<sup>st</sup> December 2015. All pts had a diagnosis of metastatic Ewing Sarcoma of pelvis at time of diagnosis and were enrolled in experimental trial. Statistical analysis was done using Kaplan-Meier curves.

**Results:** Thirty-one pts (male/female 20/11; median age 17.5 years; range 8-38 years) were included in the analysis. Median follow up was 13 months (range 1-148). At time of diagnosis 16 pts (51.6%) had lung metastases, 10 pts (32.2%) bone metastases, 4 pts (12.9%) bone and lung metastases and 1 pt (3.2%) nodal metastases. All patients received chemotherapy based on protocol trial in which they were enrolled. Twenty-eight pts (90.3%) received local treatment on pelvis: exclusive Radiotherapy (RT) on primitive tumor was performed in 26 pts (83.9%), RT+ surgery was performed in two pts (6.4%). Median interval time from diagnosis to RT treatment was 5 months. Pts who underwent RT had better outcome than pts who didn't received RT: 1-year OS was 60% versus 20% respectively. Four years OS of the two pts who underwent surgery +RT is 100%: one of them had lung metastases at time of diagnosis while the other one had nodal metastases. Median RT dose was 54Gy. Considering all population 2-years LC was 90%. One-year, 2-year and 4-year OS were 80%; 28% and 20% respectively.

**Conclusions:** Even if a good LC on primary tumor is achieved with local treatment, outcome on this subgroup of patients is poor. How to improve outcomes and how to control systemic disease is an open challenge.

2490

## Does extracorporeal irradiation and reimplantation after acetabular resections result in adequate hip function? A preliminary report

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**Introduction and Purpose:** Pelvic resections are challenging, and reconstruction of the resected acetabulum to restore mobility and stability is even more difficult. Extracorporeal radiation therapy (ECRT or extracorporeal irradiation) of autograft bone and reimplantation allows for a perfect size match and has been used with some success in the extremities. Although the risk of wound complications in pelvic surgery has discouraged surgeons from using extracorporeal irradiation of autografts in that anatomic site, we believe it may be a reasonable option.

In a small series, we asked: (1) What was the median surgical time and blood loss for these procedures, and what early complications were observed? (2) Is there evidence of osteonecrosis or cartilage loss at a minimum of 2 years after ECRT of acetabular autografts, and what functional scores were achieved? (3) What were the oncologic outcomes after ECRT?

**Materials and Methods:** Between March 2007 and September 2016, one surgeon performed 12 ECRT acetabular autografts and reimplantations after resections of pelvic or acetabular tumors. Of those, 10 with minimum 2-year followup are reported over here with respect to oncologic, functional, and radiographic assessment; all 12 are reported on for purposes of surgical parameters and early complications. During that period, we generally performed this approach when we judged it possible to achieve a tumor-free margin, adequate bone stock, and sufficient remaining hip musculature to allow use of the bone as an autograft with restoration of hip mobility. We generally did not use this approach when we anticipated a difficult resection with uncertain margins or where remaining bone was judged of poor strength for use as a graft or if both iliopsoas and abductors were sacrificed. Since 2010, this series represents seven of the 21 pelvic resections with reconstruction that we performed (five patients in this series had the procedure performed before 2010). Follow up was at a median of 65 months (range, 33-114 months) for nine patients whose functional outcomes were evaluated. The median patient age was 30 years (range, 10-64 years). Clinical parameters were recorded from chart review; radiographic analysis for assessment of cartilage was performed by looking for any obvious loss of joint space when compared with the opposite side. Functional scoring was done using the Musculoskeletal Tumor Society score, which was obtained from chart review. Oncologic assessment was determined for local recurrence as well as metastases.

**Results:** Median surgical time was 8.6 hours and median blood loss was 2250 mL. There were no perioperative wound-related complications. Two patients underwent a second surgical procedure during the postoperative period, one for a femoral artery thrombus and another for a complete sciatic nerve deficit. No patients developed avascular necrosis of the femoral head. None of the patients who underwent osteoarticular grafting showed radiographic evidence of joint space narrowing. The median Musculoskeletal Tumor Society score was 28 (range, 17-30). No fractures in the radiated segment of reimplanted bone were seen in this small series.

**Conclusions:** Results from this small series suggest that ECRT is a potential option in selected patients who have good bone stock and adequate soft tissue coverage. Although technically challenging, ECRT is a low-cost alternative to prostheses in providing a mobile and stable hip. Although we did not observe cartilage wear on plain radiographs, followup here was short term; it may appear as we continue to follow these patients. Future studies from retrieval specimens may shed light on the actual status of cartilage on the acetabulum.

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## Hemi-pelvic joint reconstruction with remaining of femoral head in peri-acetabular malignancies: a technical note of limb-salvaging surgery

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**Purposes:** To introduce a surgical technique which to simplify the traditional total hip joint replacement among patients of peri-acetabular malignancy by preservation of femoral head since it was not destroyed or involved by tumors. Furthermore, to discuss the indications and show the clinical and functional outcomes of the surgical technique.

**Methods:** From July 2015 to August 2018, 12 patients (6 males, 6 females; mean age, 34 years old; range: 10-59 years old) with malignancies of peri-acetabular region who underwent one-stage total en bloc resection of tumor and an individualized hemi-pelvic joint endoprosthesis replacement with remaining of right femoral head.

**Results:** Oncological results: Pathological diagnosis: osteosarcoma (2), giant cell tumor (1), Ewing's sarcoma (2), chondrosarcoma (6) and malignant peripheral nerve sheath tumor (1). Involved region of pelvis: region II only (4), region I+II (5), region II+III (3). The mean maximum diameter of the tumors in transverse section is 68mm (range: 44-95 mm). The mean duration of surgery was 8.1 hours (range: 4.8 to 12.3 hours) and mean blood loss was 2871ml (range: 1000 to 6000ml). All patients are alive and followed-up for 4 to 42 months (median: 6 months). Pulmonary metastasis was detected in 1 patient with Ewing's sarcoma of right ilium at 26 months after surgery while no cases of local recurrence among those patients. Besides, 1 patient experienced deep vein thrombosis (DVT) at 3 weeks after surgery. No patient experienced subluxation, dislocation or inflammation of hip joint. Functional results: Mean MSTS score of the patients was 23 points (76.7%) (range: 18-28 points; 60.0-93.3%).

**Conclusions:** Hemi-pelvic joint reconstruction with remaining of femoral head is a simplified procedure and especially suitable for developing children, adolescents and elderly patients with metastasis or poor general condition. It keeps the integrity of femoral osteofascial compartment to minimize the possibility of contamination of tumor cell and functional outcomes of patient were good during our follow up. However, long-term follow-up assessment was needed.

**Keywords:** Hemi-pelvic joint, preservation of femoral head, reconstruction, malignancy, endoprosthesis

2673

### LUMiC: updates from an international study on periacetabular reconstructions

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**Introduction and Purposes:** The LUMiC, a stemmed implant for periacetabular reconstruction, was introduced in 2008. We previously published the early results of this implant in 47 patients<sup>1</sup>. We noted a limited risk of mechanical complications, although dislocations and infections were rather common. We now aimed to assess the mid-term results in a larger cohort.

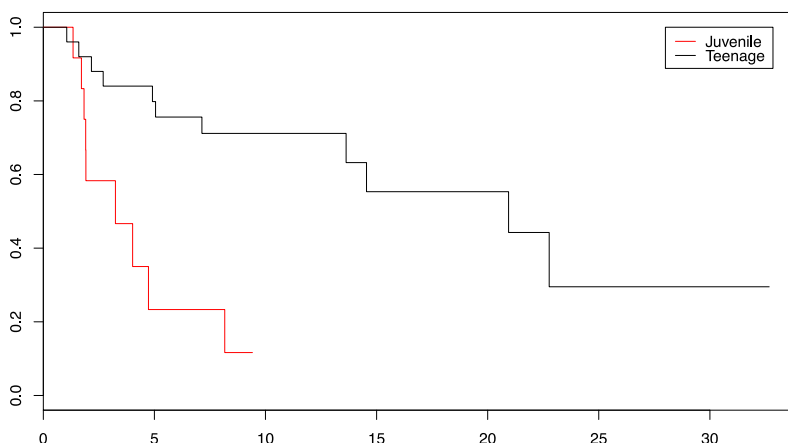
**Materials and Methods:** 83 patients (39 male, 47%) with a P2 or P2/3 resection were included; 65 (78%) were treated for a primary tumor, 18 (22%) had metastatic disease. Median age was 55 years (9-78). The majority of pelvic stems (n=76, 92%) were uncemented HA-coated. Median follow-up was 4.1 years (95% CI, 2.3-5.8).

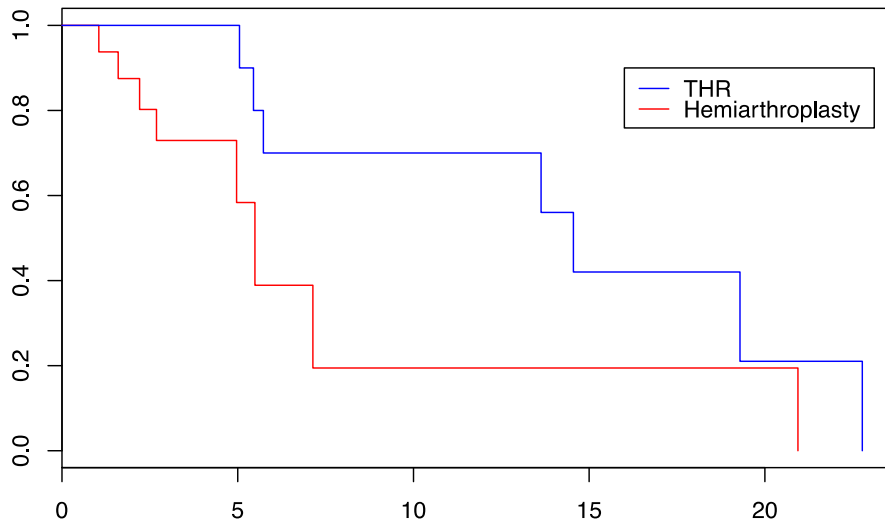
**Results:** Henderson type 1: 14 patients (17%) had one dislocation, 4 (5%) had recurrent dislocations. Dislocations occurred in 6/51 patients (12%) with a dual-mobility cup and in 12/30 (40%) with a standard cup (p=0.003). Type 2: 3 (4%) had loosening. Of these, 1 had an earlier structural allograft reconstruction, 1 had an intraoperative fracture, and 1 had a cemented stem. Type 3: no structural complications occurred. Type 4: deep infections occurred in 21 patients (25%). Fourteen infected implants (14/21, 67%) could be retained after one or more DAIR procedures. The reconstruction failed in 11 patients (13%): 7 (8%) due to infection, 3 (3%) due to loosening and 1 (1%) due to tumor recurrence. 5 failures occurred within 3 months (all due to infection). At review, 71 patients (86%) had the original implant in situ, 4 (5%) had a second LUMiC. Others either had a hindquarter amputation (n=3, 4%), girdle stone (n=2, 2%), rotationplasty, revision to a custom-made implant, or cup revision (each: n=1, 1%).

**Conclusions:** At mid-term follow-up, the LUMiC demonstrated a relatively low risk of mechanical failure. Dual-mobility cups are associated with an acceptable dislocation risk. The HA-coated stem appears to provide for long-term stable fixation in the iliac wing if adequate primary fixation is obtained. Infection is the predominant mode of failure, and these mainly occur in the first few months. Most infections do not necessitate implant removal. At review, over 90% of patients either had the original or a second LUMiC in situ.

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## The results of LUMIC endoprosthesis in patients with tumor lesion of the acetabulum

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**Introduction and Purposes:** Surgical treatment of patients with tumor lesions of para-acetabular region is one most challenging procedures in orthopaedic oncology. There are many different endoprotheses are using for reconstruction of the acetabulum. In our days there isn't a universal technique suitable for all of them. Currently, one of the most modern techniques for the reconstruction of pelvic bones is the use of modular pedestal cup endoprotheses (LUMIC). The advantage of this method is the possibility of intraoperatively during surgery to model the endoprosthesis with the specified parameters necessary for a particular patient. [1-3]

**Material and Methods:** From 2011 by 2018, surgical treatment with reconstruction by a «LUMIC» was performed in 30 patients (M: 3, F:17). The average age was 45 years (23 to 63). Chondrosarcoma was in 19 (30%), giant cell tumor in 5 (17%). The most frequently diagnosed location of the tumor in the zone P (I-II-III) - in 19 cases.

**Results:** The average duration of the operation was 310 minutes. (145-520), blood loss was 5520 ml (range 600-20000 ml.). The average follow-up was 36 months. Disease progression from 6 to 40 months was detected in 10 (33%). During observation from the progression of the disease skillfully in 6 (20%). Complications of various types were diagnosed in 50% of patients. Of these, 32% were most often characterized by deep wound infection and marginal necrosis. Mechanical complications (dislocation) in 5 (18%). One patient was diagnosed with pulmonary embolism (3.5%). Neurological deficit on the topic of the sciatic nerve was in 4 (14%). Revision operations were performed in 4 patients. The functional result by MSTS scale was 59% (15-82%).

**Conclusion:** «LUMIC» is the most new technique which using in clinics specializing in the tumor in the last 10 years. Its main advantage is the possibility of intraoperatively assembling an individual endoprosthesis, which is most suitable in any way for any patient.

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**2634**

**Acetabular reconstruction using Pedestal acetabular endoprosthesis for pelvic malignancies; the Royal Orthopaedic Hospital Experience**

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Reconstruction following pelvic resection for primary and metastatic malignancy has a significantly high morbidity and mortality. We report on 52 cases of pelvic reconstruction using an ice cream cone acetabular endoprosthesis between 2003 and 2016. The overall complication rate was 27%, with a 12% dislocation rate and an 8% deep infection rate. There was a 40% overall mortality rate. The implant had a greater than 90% survival rate at 5 years. The development of navigation techniques has help lower the complication rate compared with our earlier published series. This series shows that reconstruction using an acetabular endoprosthesis is now an established technique in the setting of primary and metastatic malignancy.

2329

## Soft tissue reconstruction after major lower limb amputation: The efficacy and reliability of free fillet flap reconstruction

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**Introduction:** The majority of major lower limb amputations (hip disarticulation or hindquarter amputation) can be reconstructed using conventional local flaps. Less than 5% require free flap reconstruction following amputation for tumour resection. The lower extremity fillet flap has been described for reconstructing defects where local flaps will be insufficient or whose use will result in poor oncological outcomes. However, literature describing such flaps are case reports or short single institutional series. There is a lack of evidence reporting the oncological outcomes of this highly selected patient group.

**Material and Methods:** Data were collected from three tertiary sarcoma units and comprised twelve patients undergoing major lower limb amputation for tumour resection with free fillet flap reconstruction.

**Results:** The median age of patients was 60 years (range 12-76). Bone resection was carried out through SI-joint in six patients, extended through the sacrum in five patients, and by hip disarticulation in one patient. Nine patients had clear resection margin and three had R1 resection, all in the extended hindquarter group. Median surgical time and flap ischemia time was 420 (249-650) and 89 (64-210) minutes, respectively. Median hospital and ICU stay was 18 (10-42) and 3 (1-8) days, respectively. Median bleeding was 2400 (950-10000) ml. Three patients required a return to theatre due to vascular compromise, with one (8.3%) total flap loss due to arterial thrombosis. Overall survival was 59.4% (95%CI 28-91%) both at 1-year and at 3-years.

**Conclusions:** The free lower limb fillet flap is a reliable method for soft tissue reconstruction in carefully selected patients undergoing major lower limb amputation. This method of reconstruction, whilst technically challenging, should be considered in patients undergoing major lower limb amputation where the margins of resection and therefore the oncological outcomes would be compromised by utilising conventional flaps.





# SESSION 15

## SURGICAL TECHNIQUES IN UPPER AND LOWER LIMB RECONSTRUCTIONS

2521

### Modular reverse total shoulder prosthesis after tumor resection

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**Introduction and Purposes:** After proximal humerus resection for bone tumor, restoring anatomy and shoulder function remains demanding. Aims of our study was to evaluate if Modular Reverse Total Shoulder Prosthesis (MRTSA) represents an available option to reconstruct proximal humerus, analyzing (1) oncologic results, (2) complications and (3) functional results.

**Materials and Methods:** We reviewed 28 oncologic patients treated with MRTSA: 11 males and 17 females, with a mean age of 51 years (range, 17-71 years). Reconstruction were performed as primary implant (25) or as revision implant (3). Diagnoses were: chondrosarcoma (11), metastasis (7), multiple myeloma (5), giant cell tumors (3) and osteosarcoma (2). Complications were evaluated according to Henderson et al. Functional results were assessed with MSTS score, Constant-Murley score and ASES score.

**Results:** At a mean follow-up of 2.8 years (range, 1 – 7.2 years), patients were with no evidence of disease in 17 cases, alive with disease in 5 cases and dead with disease in 6 cases. Complications occurred in 25% of patients: there was dislocation (Type I) in 6 cases and aseptic loosening (Type II) in 1 case. Functional results were excellent with mean MSTS score of 28.59, mean Constant score of 59.56, and mean ASES score of 80.19.

**Conclusions:** MRTSA represent the best reconstructive options with an acceptable complications rate and excellent functional results, if axillary nerve and deltoid muscle could be preserved.

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2586

### Complications and survivorship of distal humeral allograft reconstruction following tumor resection

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**Introduction:** Primary bone sarcomas of the humerus represent the majority of bone sarcomas in the upper extremity. Since 1971, allograft reconstruction (AOR) has been performed at our institution as a limb-sparing procedure following resection of humeral bone tumors. AOR can provide an enduring functional solution to reconstruction problems, and can be advantageous in comparison to prosthetic reconstruction. Due to the rarity of this technique, there is limited literature on outcomes of distal humeral osteoarticular allograft (DOA). The primary aims of this study are to determine the complications associated with DOA reconstruction and their rate of survival and to compare our case series with the existing literature.

**Methods:** We performed a retrospective review of all patients who underwent distal humerus tumor resection and AOR at an academic tertiary care center over a 23-year period. Patients younger than 18 years old were excluded. Baseline characteristics of patients as well as allograft complications, revision causes, allograft size, adjuvant therapy before or after reconstruction, tumor recurrence, and patient survival were recorded.

**Results:** Of the 7 DOAs screened, 6 met inclusion criteria. The mean patient age was 37 (range 18-69) years old. Tumors included 2 chondrosarcomas, 2 Ewing's sarcomas, 1 metastatic lesion, and 1 lymphoma. The rate of allograft survival was 83%, with one patient who died due to systemic progression of disease. The most common complication in DOA was ulnohumeral subluxation (33%), and allograft fracture (33%) the most common reason for revision surgery.

**Conclusion:** Complications associated with DOA reconstruction after distal humerus tumor resection include allograft fracture and ulnohumeral subluxation, however their rate of survival is high. Larger sample studies are required to identify potential correctable predictors of these complications. Additionally, complications should be correlated with long-term functional outcome data.

2531

### Outcomes of short segment (less than 6cm) distal radius resections and wrist fusion with iliac crest bone grafting

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**Background:** Reconstructions using auto-fibula after distal radial resections for benign giant cell tumors are fraught with complications. Ulnar instability with wrist pain and donor site morbidity are not uncommon

**Aims & Objective:** We examined donor- site morbidity, functional and disease outcomes in short segment (< 6cm, as it is not feasible to harvest more than 6cm linear bone graft from iliac crest) resections of distal radial giant cell tumors with grafting. A tri-cortical iliac crest bone wedge stabilized with a plate was used to achieve wrist arthrodesis

**Methods & Material:** Retrospective analysis was performed from a prospectively maintained database. Between Jan 2011 and Dec 2017, 13 patients (7 male and 6 female; 10 primary and 3 recurrent; 10 Campanacci grade III and 3 Campanacci grade II) were included. Mean age was 28 years (15 to 41 years) with mean resection length of 5cm (4 to 6cm). The dominant hand was involved in 7 of 13 patients. Time to union, donor site morbidity and oncology outcomes were evaluated. Function was measured using MSTs score

**Results:** One patient was lost to follow up at 24 months. No symptomatic donor site morbidity was observed. Mean time to union was 6 months (4 to 11 months). One patient has persistent non-union at both osteotomy sites at 31 months and has refused intervention. At a median follow up of 43 months (12 to 78 months) one patient had a soft tissue recurrence (excised), 1 had a stable pulmonary metastasis (treated with angio-embolization and Denosumab). Mean MSTs score is 25 (21 to 28). All patients have returned to their prior occupation

**Conclusion:** Iliac crest bone grafting with wrist arthrodesis retains pronosupination while maintaining wrist girth (cosmesis). The oncologic and functional outcomes make it an acceptable modality in selected cases of distal radius tumors with resection length less than 6cm

2278

### Acetabular erosion after bipolar hemiarthroplasty in proximal femoral replacement for malignant bone tumours

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**Introduction and Purpose:** Hemiarthroplasty megaprosthesis reconstruction of the proximal femur after tumour resection is a commonly used procedure in orthopaedic oncology. One potential complication is acetabular wear requiring secondary acetabular revision, especially in young patients. The aim of this study is to investigate prevalence of acetabular erosion, secondary acetabular resurfacing and identify potential risk factors.

**Materials and Methods:** We retrospectively identified 112 patients who underwent proximal femur replacement using a single modular implant after resection of a primary and metastatic malignant bone tumour at single institution between 1996 and 2016 and had radiological follow-up longer than 12 months. Patient details as well as surgical and oncologic factors were recorded, acetabular wear was measured using the classification proposed by Baker, and prosthetic failure was classified using the ISOLS classification. Functional assessment was performed using the MSTS and Harris hip score.

**Results:** Prevalence of acetabular wear was 28.6%. Higher grade cartilage wear occurred in 4.6% of patients. Secondary conversion to total hip arthroplasty was required in 5 patients (4.6%), all treated for primary bone tumours. No patient treated for metastatic tumour had higher grade acetabular wear or required revision. Significant risk factors for the development of acetabular wear were age under 40 ( $p=0.035$ ) and longer follow-up (63 vs. 43 months,  $p=0.004$ ). There were no significant risk factors for acetabular revision. BMI, adjuvant treatment or surgical factors did not show significant correlation with acetabular wear or consecutive surgery. The dislocation rate in the patient cohort was 0.9%.

**Conclusion:** Bipolar hemiarthroplasty proximal femoral replacement represents a very good option for reconstruction after tumour resection. Hip instability is rare. Acetabular erosion occurs in few cases can successfully be treated with conversion to total hip arthroplasty. Young patients with long-term survival over 10 years are at risk. In reconstruction for metastases, instability and acetabular wear are rare.

2391

### Preventing local recurrence of desmoid tumors involving adjacent neurovascular bundles by “separation surgery”: Mid-and-long-term follow-up of 9 patients

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**Introduction and Purposes:** Desmoid tumors are highly recurrent especially when involving nerves and blood vessels and locally infiltrative without capsules or pseudocapsules. Negative margins are difficult to obtain and residual tumors exist around neurovascular bundles. We performed “separation surgery” by constructing artificial barrier against residual tumor and investigated whether local recurrence can be prevented.

**Materials and Methods:** We performed a retrospective review of nine cases of desmoid tumor involving adjacent nerves and blood vessels. Neurovascular bundles were partly involved in six of them, and surrounded by tumors in the rest three. After marginal or intralesional excision of desmoid tumors, residual tumor existed around neurovascular bundles and we used polyester cardiovascular patch to separate involved neurovascular bundles from normal tissue. These patients were followed up for 12.4-54.2 months (median: 25.1 months).

**Results:** Among the nine patients, six had recurrent tumors and received at least once resection surgery (twice for one patient) before separation surgery. The tumors for nine patients were located at upper extremities (4 cases) and lower extremities (5 cases). After the separation surgery, no local recurrence was observed in eight of them. As for the rest one with local recurrence one year after the excision, magnetic resonance images demonstrated that recurrent tumor was located only in the region where neurovascular bundles were not separated. No particular adverse event was noticed in all patients.

**Conclusions:** Separation surgery is a novel method to prevent the local recurrence of desmoid tumors, even if residual tumors remain around neurovascular bundles, which avoids functional impairment caused by repeated operations. Prospective study will be conducted to further examine the method in the future.

Keywords: desmoid tumor, local recurrence, separation surgery



2364

### Clinical course of grafted cartilage in osteoarticular frozen autografts for reconstruction after resection of malignant bone tumour involving an epiphysis

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**Introduction and Purpose:** Osteoarticular graft is one of the options of epiphysal reconstruction but the collapse of grafted bone is common problem. Frozen autograft with liquid nitrogen has been used as recycled autologous bone graft and the purpose of the present study was to assess the outcome of grafted cartilage in osteoarticular frozen autografts used in the treatment of patients with bone and soft-tissue tumour.

**Materials and Methods:** We have treated 27 patients with cases of bone tumour resection involving an epiphysis where frozen autografts were used for reconstruction. If the tumour was located in a limited part of the epiphysis, partial resection of the epiphysis was performed to preserve the healthy part of the cartilage in 4 cases. Survival of cartilage was recorded using the Kaplan–Meier method. In case of removal of grafted bone after the surgery, pathological findings were assessed by hematoxylin and eosin staining of sections of resected cartilage in available cases to observe the fate of grafted cartilage over time.

**Results:** The mean follow-up period for grafted cartilage was 19.5 months. Collapse of the cartilage occurred in 12 patients and all patients in the partial epiphyseal freezing group survived compared with only 1 patient in the total epiphyseal freezing group who had survived to the final follow up ( $p < 0.01$ ). Resected specimens with grafted cartilage were examined histologically. A sample excised after 14 months had dead cartilage with empty lacunae and the surface of the cartilage had reactive fibrous tissue.

**Conclusions:** Grafted cartilage of frozen osteoarticular autografts collapses over time. Hemicondylar resection or intraepiphyseal resection preserving partial healthy cartilage resulted in excellent survival. This technique is somewhat demanding and requires careful planning of the surgery but might be a reliable alternative to megaprosthesis.

2655

## Asymmetrical high acetabular placement and femoral extension for endoprosthetic reconstruction of periacetabular defects following internal hemipelvectomy

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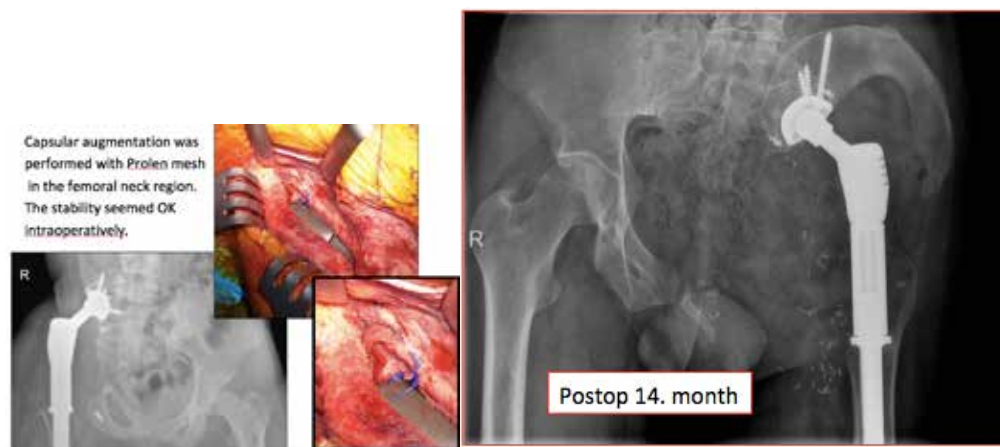
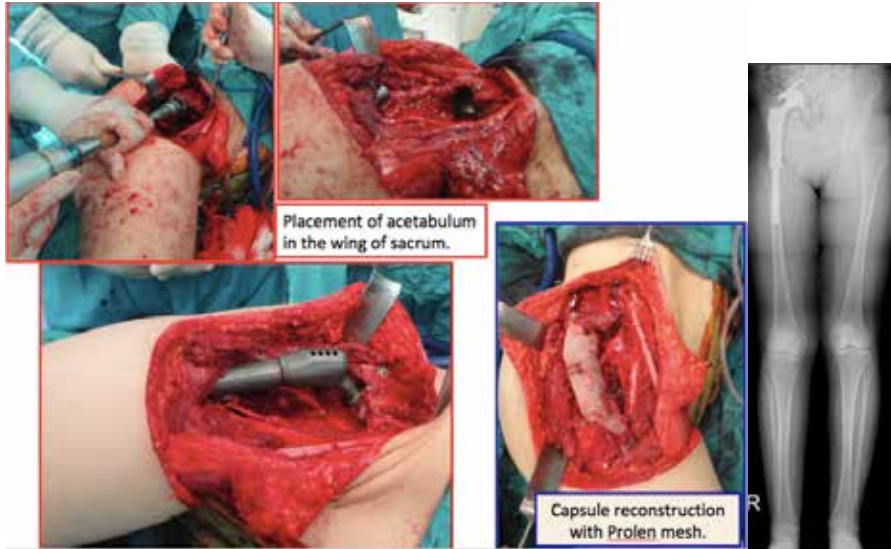
**Introduction:** Reconstruction of periacetabular defects is possible with non-anatomical total hip arthroplasty approach, which places the acetabulum in a variably high position and extends the femur with tumor prosthesis to match the acetabular position.

**Patients & Methods:** The procedure was performed in 10 patients (M/F: 5/5), who underwent internal hemipelvectomy with extraarticular resection of hip joint between 2008-2018. Resection type was I+II+III in 7 patients, I+II in 2, II+III in one. Mean age was 33 (16-54) years and follow-up was 35,5 (8-111) months. Multihole acetabular cups ranging between 38-44 mm in diameter were implanted cementless with screws and non-constrained polyethylene liners were used in all patients. Cups were implanted in iliac wing in one, S1 vertebral body in one, ala sacrum in 3 and sacroiliac joint in 5 patients. Mean proximal displacement of femoral head rotation center was 84 mm. Capsular reconstruction was done with polypropylene mesh. Abductor arm was substantially spared in 2 and partially preserved in 2 other patients.

**Results:** Deep infection was observed in 4 and dislocation in 2 patients. All infections were managed successfully with debridement and negative pressure wound therapy while retaining the implants. Dislocation was treated successfully with 2 major surgical interventions in one patient; disease progression prevented treatment of dislocation in the other. At the time of last follow-up, all acetabular components were intact with only one case of asymptomatic loosening in the patient with S1 body placement. Mean MSTS score was 20 (7-26).

**Conclusion:** Asymmetrical high placement of a standard acetabular component provides frugal use of limited bone stock and minimizes soft tissue problems due to bulky implants after internal hemipelvectomy. Modularity of the femoral prosthesis and mesh capsule reconstruction are crucial for stability. Remaining abductor function is the main determinant of quality of life.

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2389

**Free fibula reconstruction of distal tibial osteoarticular defects after sarcoma surgery**  
**bulent Erol<sup>1</sup>, Evrim Sirin<sup>1</sup>, Ozgur Baysal<sup>1</sup>, Fevzi Saglam<sup>1</sup>, Said Erkam Baykan<sup>1</sup>, Servet Igrek<sup>1</sup>**

<sup>1</sup>Department of Orthopaedics and Traumatology, Marmara University, Istanbul - Turkey

**Introduction and Purposes:** Distal tibia tumor ablation results in combined bone and soft tissue defects that involves the ankle joint. We present our experience with a limb sparing surgery using vascularized fibular graft (VFG) following resection of distal tibial bone sarcomas.

**Materials and Methods:** Between 2007-2016, 12 patients [average age 14(9-21) years] with osteosarcoma and Ewing's sarcoma of the distal tibia underwent osteoarticular resection and biological reconstruction with VFG. All received preoperative and postoperative chemotherapy. In addition, postoperative radiotherapy was applied to 2 patients with Ewing's sarcoma. The fibular graft was placed in an intercalary fashion between the remaining tibia and talus to achieve arthrodesis of ankle joint. In 2 patients with small defect size, double-barreled VFG was used. Osteocutaneous flap was required in 3 patients. Low-profile locking plates were used for fixation to provide stability. The average follow-up was 62(28-124) months.

**Results:** Graft union on bone ends/arthrodesis was achieved in 91.6% and 100% of the patients at 12 and 24 month follow-ups respectively. Graft hypertrophy was observed and progressively increased in 11(91.6%) patients between 12-24 months. In 1 patient with delayed union, fibular graft was hypertrophied between 24-36 months. The average final follow-up Musculoskeletal Tumor Society (MSTS) score was 76%(64-92%). Eleven patients regained almost normal ambulation within 24 months. The overall complication and re-operation rates were 41.6% and 33.3% respectively. Four patients underwent re-operation for delayed union(1), implant failure(1), skin necrosis(1) and wound problem(1). The disease relapsed in 3(25%) patients in terms of distant metastasis, and 11(91.6%) patients were still alive at the time of study.

**Conclusions:** Biological reconstruction of osteoarticular distal tibial defects with VFG can achieve ankle arthrodesis to provide permanent stability with good functional results.

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# SESSION 16 BONE METASTASES 1



2269

## Why bisphosphonates, denosumab, and radiation do not always work in osteolytic metastatic cancers to bone?: Fundamental scientific reasons and new therapeutic opportunities

Francis Lee<sup>1</sup>

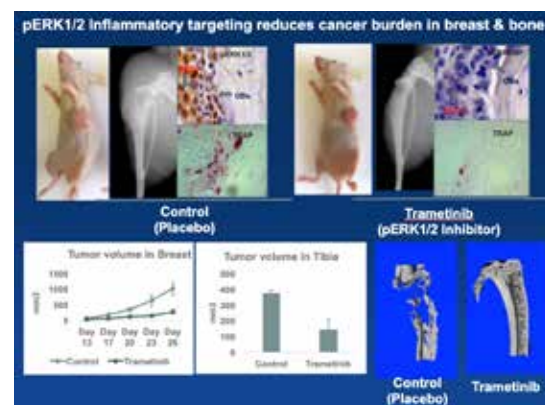
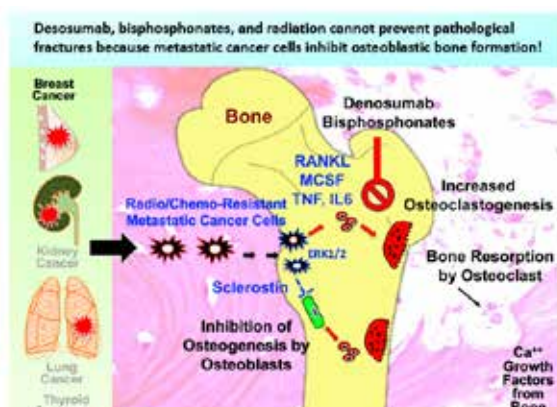
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**Introduction & Purpose:** Breast cancer metastases to bone are commonly osteolytic. Bisphosphonates, Denosumab, and radiation do not consistently prevent fractures. Why? We need to understand the molecular mechanism by which metastatic cancer cells destroy bone for better treatments.

**Materials & Methods:** In order to define a key pathway leading to aggressive bone destruction, we implanted different types of well-established human breast cancer cells into the nude mouse tibiae and breast regions. At 4 weeks, we measured the tumor size and bone destruction using radiographs and microCT. We then compared expression of inflammatory genes between the least and most osteolytic breast cancer cells (MCF7 vs MDA-MB-231). We next defined downstream pro-osteoclastogenic, anti-osteogenic proteins, kinases, and therapeutic effects using RT-PCR array, immunoblotting, and microCT. We also examined human pathology specimens (N=12) from the pathological fracture sites. We then conducted in vivo and in vitro experiments.

**Results:** Examination of pathologic specimens revealed that breast cancer cells which were metastasized into bone express sclerostin. Co-culture experiments showed that breast cancer cells inhibit mineralization of osteoblasts. Furthermore breast cancer cells stimulated osteoblasts to produce pro-osteoclastogenic chemokines. These pro-osteoclastogenic and anti-osteogenic proteins are under the regulation of pERK1/2-CREB. Inhibition of osteoblastic bone formation in vitro and in vivo by breast cancer cells were suppressed by pERK1/2 inhibition.

**Discussion and Conclusions:** Aggressive breast cancer cells directly inhibit osteoblastic bone formation in addition to by increasing osteoclastogenesis. Targeting osteoclast activity alone with bisphosphonates or denosumab is not sufficient to prevent pathological fractures secondary to osteolytic metastases. There is a need for supplemental pharmacologic treatment using targeted pathway inhibitors.





2273

## Minimally invasive percutaneous ablation-osteoplasty-reinforcement-internal fixation for osteolytic metastatic cancers to bone: a new paradigm for pelvic and periarticular impending pathological fractures

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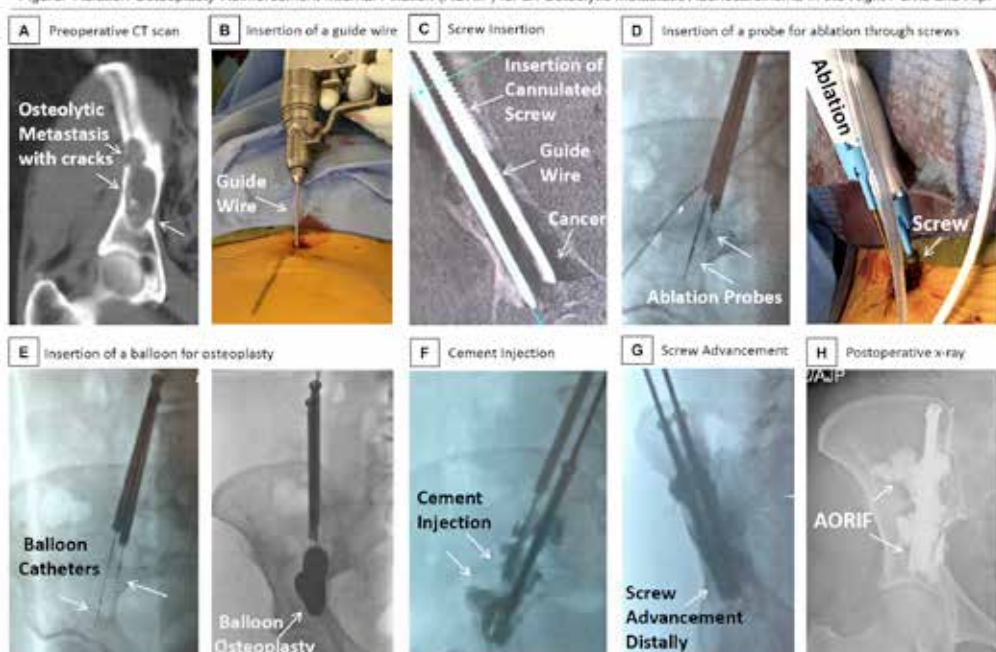
**Introduction & Purposes:** Presence of metastatic cancer cells in bone initiate bone destruction by promoting osteoclastic bone resorption and inhibiting osteoblastic bone repair. Radiation therapy and anti-resorptive drugs such as bisphosphonates often are insufficient to overcome metastatic cancer-induced bone loss unless metastatic cancer cells are gone. Therefore, local control of cancer cells is very important to prevent progressive bone loss after surgical stabilization. Surgical reconstruction of pelvic bone defects and periarticular lesions requires long skin incisions and deep surgical dissections, which are associated with high incidences of muscle weakness, infection, prolonged morbidity, transfusion, and delayed pharmacologic cancer therapies. It is most ideal if an open surgery can be avoided. We are describing minimally invasive Ablation-Osteoplasty-Reinforcement-Internal Fixation(AORIF).

**Materials & Methods:** We have developed a minimally invasive AORIF as a novel surgical strategy for management of radiation-resistant osteolytic metastatic cancers in the pelvis. 20 patients with osteolytic metastatic lesions to pelvis (N=15), tibial plateau (N=2), femur (N=4) and calcaneus (N=1) underwent AORIF. Primary cancers were from lung(lung cancers), breast(breast cancers), kidney(clear cell carcinoma), skin (melanoma), oral cavity, and bladder (endocrine cancer).

**Results:** AORIF is illustrated in Figure. None of patients required transfusion or hospital admissions. Infection, delay in chemotherapy, and prolonged morbidity from surgical dissections were avoided while functional improvement and decreased pain were observed in all patients.

**Discussion & Conclusion:** Skeletal defects secondary to metastatic cancers in deep anatomic locations can be effectively managed while avoiding extensive open surgeries. AORIF is indicated for large osteolytic defects around or near the acetabulum, sacroiliac joints, pelvic ring, proximal tibia, and calcaneus.

Figure. Ablation-Osteoplasty-Reinforcement-Internal Fixation (AORIF) for an Osteolytic Metastatic Adenocarcinoma in the Right Pelvis and Hip.



2587

### Bone metastases in sarcoma: is there any place for curative surgery?

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<sup>1</sup>Mount Sinai, Toronto - Canada

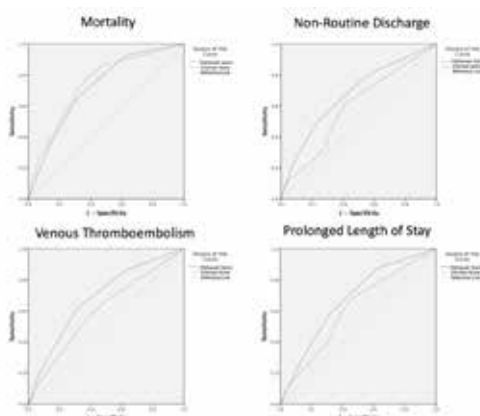
**Purpose:** Resection of sarcoma lung oligo-metastases is mostly codified but there is no literature supporting curative surgical management of sarcomas bone metastases, which are rare. Most are treated on a case-by-case basis following multidisciplinary tumour boards. One study reported some success in controlling bone metastases using radiofrequency ablation. Our goal was to assess the impact of curative resection of bone metastases from sarcomas on oncologic outcomes.

**Material and Methods:** We examined our prospective database for all cases of bone metastases from sarcoma treated with surgical resection between 1990 and 2016. Epidemiology, pathology, metastatic status upon diagnosis, type of secondary relapses, and their treatments and Overall Survival (OS), Disease-Free survival (DFS) were assessed and compared to literature.

**Results:** Eighteen men and 17 women were included (mean age: 46 years). Fifteen were soft tissue (STS) and 20 were bone (BS) sarcomas. Eight (23%) were metastatic upon diagnosis (6 lungs, 3 bone). Treatment of the primary tumour included wide excision and (neo)-adjuvant therapies as required. Margins were R0 in 32 cases and micro-positive in 3 cases. Primary lung and bone metastases were treated by wide excision. First relapse occurred in bone in 19 cases (54%), lungs and bone in 7 cases, 5 in lungs and 4 in soft-tissues. Lung metastases were treated by thoracotomy and chemotherapy or chemotherapy alone. Bone metastases were treated by chemotherapy and wide resection in 24 cases, extensive curettage in 4. Soft tissue relapses were re-excised in 4 patients. Two amputations were required. All margins were negative except for the 4 treated by curettage. Fourteen second relapses occurred in bone, 7 were radically-excised and 2 curetted. At last follow-up, 6 patients were alive (OS 17%). Mean survival was 57 months, median OS 42.5 months and median DFS 17 months.

**Conclusion:** OS was 17%, compared to 10 % usually reported in metastatic sarcomas for 10-year survival. Median DFS was better (17 vs 10 months in literature), so as median OS (42.5 months vs 15). Three patients were alive with no evidence of disease. DFS, OS and median survival seemed to be improved by bone metastases wide excision and even if several recurrences occur, curative surgery with adjuvant therapies should be considered.

Figure 1: Receiver operating characteristic curves for total population



## 2303

### When do patients with bone metastases actually break their femur? A CT-based finite element analysis of patients who fractured

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**Introduction:** Mirels' score is known for its low sensitivity in identifying impending fracture risk in patients with metastatic tumors in the femur. CT-based finite element analysis (CTFEA) is an emerging alternative as a patient specific quantitative decision support tool. Patient's femurs are automatically segmented from the CT scan, material properties are assigned and a stance position load is applied according to patient's weight. The CTFEA was validated in a retrospective study on the largest cohort of patients to date (50). Using a quantitative measure, strain fold ratio, it distinguishes between high and low risk of fracture.

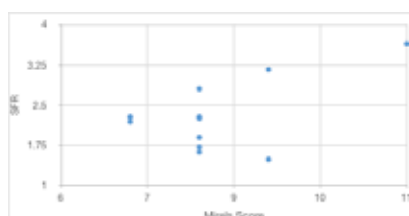
**Purpose:** This multicenter study retrospectively identified 12 patients who presented with a pathologic fracture and had a CT scan of the femur within 6 months prior to the fracture. It is the largest such cohort to be analyzed using CTFEA to further substantiate the value of CTFEA.

**Materials and Methods:** Twelve patients with metastatic tumors in their femurs and a CT scan within a period of 6 months prior to pathologic fracture were included: 6 males and 6 females. Metastatic disease diagnoses were: 4 multiple myeloma, 3 lung, 2 breast, 1 prostate, 1 TCC, 1 sarcoma. Pathologic fractures were located: 5 femoral head and neck, 5 mid and distal diaphysis, 2 subtrochanteric region. CTFEA was performed for each patient to determine the risk of fracture and the anticipated location of fracture. A strain fold ratio (SFR), defined as the ratio between the strain at the highest location (obtained in the vicinity of the tumor) and the typical strain in that area in a healthy femur, was computed for all patients. A SFR > 1.48 defined a high risk of fracture based on published data. Mirels' score was determined for all patients by experienced orthopaedic oncologists.

**Results:** All patients who experienced a pathologic fracture had a SFR > 1.48. Figure 1 presents the SFR vs Mirels score for 11 patients (one patient had Mirels score 12 and SFR 9.6 and was excluded). Most of the patients (9 out of 11) had 1.48 < SFR < 2.5, two additional patients had SFR 3.2 and 3.6. The location of the fracture was accurately determined by CTFEA in all cases.

**Conclusions:** CTFEA accurately predicts the risk of fracture in patients with metastatic tumors to their femurs. A quantitative measure of SFR > 1.48 can be classified with much higher confidence, as a cut-off, for high risk of fracture suggesting prophylactic nailing. CTFEA not only predicts the risk of a pathological fracture, but in cases of multiple metastases in both femurs, it can also identify the ones at the highest risk of fracture and the location of the fracture.

Figure 1 - Mirels score vs SFR.



2657

### Should fraction risk be assessed on plain radiographs or CT scans when using an axial cortical destruction of 3 cm, in metastatic femoral bone lesions

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<sup>1</sup>Leiden University Medical Center, Leiden - Netherlands, <sup>2</sup>Radboud University Medical Center, Nijmegen - Netherlands,

<sup>3</sup>University of Sumatera Utara, Medan - Indonesia

**Introduction and Purposes:** Adequate fracture risk assessment is of key importance in patients with symptomatic painful bone metastases. Numerous risk factors have been developed on plain radiographs. However, the predictive power of these risk factors has not been studied on CT scan images. This study aims to compare the clinical reliability of the axial cortical involvement measured on plain radiographs and CT scans with a cut-off of 30 mm to assess femoral fracture risk.

**Materials and Methods:** All patients included in two multicentre prospective studies designed to analyse fracture risk. Multidirectional plain radiographs and CT scans obtained a maximum of two months since radiotherapy were requested. An orthopaedic surgeon, radiation oncologist and skeletal radiologist independently measured femoral lesions.

**Results:** In total, 83 patients (59% male) with 93 lesions were included. Median overall survival was 11.8 months (95%CI: 7.9-15.9), with a median follow-up of 27.1 months (95%CI: 17.8-36.4). Fifty-six lesions (60%) were treated with an 8Gy single dose. Ten fractures occurred within a mean time of 4.9 months. On plain radiographs: one fracture occurred in 47 lesions (2%) with axial cortical involvement <30mm, in 46 lesions >30mm 9 fractures (20%) occurred. On CT scan: one fracture occurred in 31 lesions (3%) with axial cortical involvement <30mm, in 61 lesions >30mm 9 fractures (16%) occurred. Resulting in a Sensitivity, specificity, positive - and negative predictive value of axial cortical involvement for predicting fractures for plain radiographs compared to CT scans of 90% vs 90%, 55% vs 37%, 20% vs 15% and 98% vs 97%, respectively.

**Conclusion:** Our study suggests when assessing fracture risk using an axial cortical involvement with a 30mm cut-off in patients with femoral bone metastases, the usage of CT scan images does not result in higher predictive power in comparison with solely using plain radiographs.

2656

**An axial cortical destruction of more than 30mm measured on plain radiographs can still be used as an easy and effective risk factor in metastatic femoral bone lesions**

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**Introduction and Purposes:** An increasing number of patients diagnosed with cancer develop symptomatic painful bone metastases, possibly resulting in pathological fractures. In order to prevent the need for emergency operations, adequate fracture risk assessment is of key importance. This study aims to validate the clinical reliability of the previously reported axial cortical involvement on plain radiographs with a cut-off of 30 mm to assess femoral fracture risk.

**Materials and Methods:** All patients included in two multicentre prospective studies, who received palliative radiotherapy in femoral lesions for pain, were selected. Multidirectional plain radiographs obtained a maximum of two months previous to radiotherapy were requested. Three experts independently measured lesions and scored radiographic characteristics.

**Results:** In total, 100 patients (60% male) were included. Prostate cancer was the primary tumour in 32 patients (32%), followed by lung cancer in 25 (25%) and breast cancer in 18 patients (18%). Median overall survival was 12.8 months (95%CI: 8.6-17), median follow-up was 23.0 months (95%CI: 11-36). Fifty-five patients (55%) received 8Gy single dose. Fifteen fractures occurred within a median time of 3.5 months. Two fractures occurred in 50 lesions (4%) with cortical involvement smaller than 30mm, in 60 lesions greater than 30mm 13 fractures (22%) occurred. Sensitivity, specificity, positive - and negative predictive value for predicting fractures was 87%, 51%, 22% and 96%, respectively. Lesions >30mm had a risk of fracture 5.8 times (95%CI: 1.3-25.8) higher than smaller lesions. Competing risk analyses showed a significant ( $p < 0.01$ ) difference in cumulative incidence of fracture between lesions <30mm and >30mm.

**Conclusion:** Our validation study underlined that an axial cortical destruction of 30mm can still be used as an easy and quick way to assess fracture risk in patients with femoral bone metastases, with adequate predictive power.



2623

### Treatment of metastatic disease at the femur: do outcomes differ by diagnosis?

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<sup>1</sup>Rutgers New Jersey Medical School, Newark - USA

**Background:** Surgical decision-making in patients with metastatic disease is multifactorial and made on an individual basis. The objective of this study was to report on outcomes, as well as rates and types of failure by oncologic diagnosis in patients with metastatic disease to the appendicular skeleton

**Patients and Methods:** Patients treated surgically for metastatic disease to the femur from 2001-2017 were retrospectively reviewed. Patient information including age, gender, diagnosis, tumor volume, method of surgical treatment, and complication type was collected for analysis.

**Results:** Ninety-two patients (44 male, 46 female) treated for disease at the femur (51 endoprostheses, 41 plate/nail fixation) were included for analysis. Mean age was  $61.8 \pm 13.9$  years old. Mean follow-up was  $21.5 \pm 27.1$  months, with 52 patients dead of disease. Most common primary diagnoses were breast (27), renal cell [RCC] (15), lung (14), prostate (8), and gastrointestinal [GI] (8) cancers. Forty-two (46%) patients presented with displaced pathologic fractures. Variability existed among most common diagnoses with regards to mean tumor volume [ $p=0.008$ ]: Prostate ( $271 \text{ cm}^3$ ), GI ( $250 \text{ cm}^3$ ), Lung ( $81 \text{ cm}^3$ ), Breast ( $63 \text{ cm}^3$ ), RCC ( $55 \text{ cm}^3$ ). Presence of segmental destruction also varied by common diagnoses [ $p=0.041$ ]: Prostate (38%), RCC (20%), Breast (7%), Lung (0%), GI (0%). Complication rates varied by region of disease: Head/neck (4%), Peritrochanteric (15%), Shaft (40%), Distal (21%). Overall complication rate was 16% and comparable following endoprosthesis or plate/nail fixation ( $p=0.455$ ) and by diagnosis ( $p=0.977$ ). Complications were higher in patients with RCC [6/15 (40%) vs. 9/77 (11.7%); OR 5.0;  $p=0.006$ ], despite comparable follow-up [ $22.7 \pm 6.4$  vs.  $22.7 \pm 3.2$  months;  $p=0.999$ ]. Survival was highest in patients with prostate cancer but comparable across common diagnoses ( $p=0.400$ ).

**Conclusions:** Treatment of metastatic disease is dependent on patient factors and disease prognosis, with osteosynthesis and endoprosthesis being viable options. Patients with metastatic prostate and GI lesions presented with larger tumor volumes than patients with RCC, breast, and lung cancers. While post-treatment survival was highest among patients with prostate cancer, it was comparable across diagnoses.



2612

### Treatment of pathologic fractures of the proximal femur

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**Introduction and Purposes:** Proximal femur metastases require special consideration due to the high risk of pathologic fractures. Aim of this study was to evaluate oncological and functional results of treatment in patients with pathologic or impending fracture of the proximal femur. We analyzed 1) patient survival, 2) complications and 3) functional results.

**Materials and Methods:** Forty patients with pathologic fracture (29 cases) or impending fracture (11 cases) of the proximal femur due to bone metastases or hematologic malignancies were treated between 2016 and 2017. There were 29 females and 11 males, with a mean age of 63.6 years (range 35 to 92 years). Seventeen patients had less than three bone metastases. Surgical procedures included intramedullary nailing (IMN 7 patients), conventional endoprosthesis (EPR 4 patients) and modular endoprosthetic replacement PFR (29 patients).

**Results:** The mean follow-up was 10.2 months (range 6–26.3 years). At the latest evaluation, 23 patients were alive with disease, 3 patients were alive without evidence of disease and 14 patients were dead with disease. There was a significant better survival in patients treated with PFR compared to IMN and EPR groups ( $p = 0.0080$ ). No differences in term of survival were found comparing impending vs actual pathological fracture and oligo vs multiple metastases. After surgery, all patients experienced improvement in quality of life resulting from reduction in pain. Mean MSTS score was 22.4. The overall complications rate was 22.5% (mainly dislocation followed by wound dehiscence and infections).

**Conclusions:** Modular tumor prosthesis for proximal femur replacement provides good functional outcome, relative low incidence of complications and higher life quality in the medium term. Oncologic results were influenced by type of surgery, biased by the correct indications for resection and nailing.

#### References

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2347

### What is the best choice of stabilization in patients with actual or impending pathological fractures of the humerus? Results of a multicenter study

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<sup>1</sup>Department of General Orthopedics and Tumororthopedics, Münster University Hospital, Münster - Germany, <sup>2</sup>Department for Tumororthopedics, Helios Clinic Berlin-Buch, Berlin - Germany, <sup>3</sup>Department of Orthopedics, Tübingen University Hospital, Tübingen - Germany, <sup>4</sup>Department of Orthopedics and Traumatology, Graz LKH-University Hospital, Graz - Austria

**Introduction:** The humerus is the second most common localization of metastases in the long bones. We sought to evaluate the results of various stabilization options.

**Methods:** We performed a retrospective analysis of the files of 345 patients with actual (n=232) or impending (n=113) pathological humerus fractures due to bone metastases who underwent surgical treatment between 1997 and 2018. Non-parametric analyses were performed with the Mann Whitney-U test. Survival curves were calculated with the Kaplan-Meier method and compared with the log-rank test.

**Results:** Mean follow-up was 20 months (range, 0-134 months). 33% of the patients received an intramedullary nail (IMN), 25% an osteosynthesis with a plate (POS) & 41% underwent endoprosthetic replacement (TEP). IMN was predominantly performed in patients with multiple metastases, while 26% of the patients in the POS- & 39% in the TEP-group had solitary metastases (p<0.001). POS was associated with higher revision rates (p=0.039). TEP displayed a trend for a lower probability of local recurrence compared to IMN (9% vs. 30% after 5 years, p=0.077). Overall survival (OS) amounted to 40% after 2 years. Pathological fractures were associated with a worse OS than impending fractures (p=0.003). Patients undergoing IMN had a significantly worse OS than patients undergoing POS (p=0.002) & TEP (p<0.001), probably reflecting the differences in disease stage. Patients with multiple metastases had a worse OS compared to those with solitary metastases (p<0.001). 26% of the patients with solitary metastases & 18% of the patients with multiple metastases in our cohort were alive 5 years after surgical treatment.

**Conclusion:** Patients with humeral metastases can have a long survival after treatment of impending or actual pathological humerus fractures, which should be taken into consideration in surgical treatment planning. TEP are associated with a high local control and a low revision rate in patients with long expected survival.

2422

### Photodynamic bone stabilization system IlluminOss to treat bone metastatic lesions: the experience of a reference centre

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**Introduction and Purposes:** Bone metastases are getting nowadays more frequent and affect mostly elderly people. Often a minimally invasive system is desired especially in the upper limb. The aim of the study is to evaluate the reliability of IlluminOss System for the treatment of pathologic and impending fractures in the upper limb.

**Materials and Methods:** We evaluated 19 patients treated with IlluminOss Photodynamic Bone Stabilization System (IlluminOss Medical GmbH, Germany) for 22 pathologic bone lesions in the upper limb. Mean age was 65 years (range 35 - 84). The primary tumour was: multiple myeloma (11), lung adenocarcinoma (2), invasive ductal breast carcinoma (4), clear cells kidney carcinoma (1), prostate carcinoma (1). 21 humerus and 1 radius were treated. The mean expected survival was lower than 1 year. The ASA grade risk was 4. Complication rate (fracture stability, symptomatic non-union/instability) and pain control were evaluated. A radiologic follow up with MR after 6 months has been performed.

**Results:** One intraoperative displaced fracture occurred in a humeral lesion and it required an internal fixation with plate and screws. Pain control was achieved within one week postoperative (VAS < 3). No other complications were observed and particularly no symptomatic instability at fracture site (follow up range 4-48 months). Radiologic follow up showed no complications and less pathologic signal comparing preop and postoperative Imaging.

**Conclusions:** IlluminOss is a reliable system to stabilize pathological fractures and lytic lesions in the upper limb. No intramedullary devices are to date available for the radial and ulnar shaft. Even if it is a good solution for diaphyseal bone, meta-epiphyseal lesions are at high fracture risk with this technique and often require an additional stabilization with plate and screws. Preliminary radiologic evaluation showed a potential adjuvant mechanical effect of the implant that should be confirmed by future studies.

2504

**Preoperative venous thromboembolism as prognostic predictor for survival in operatively treated patients with bone metastases secondary to non-small cell lung cancer**

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**Introduction and Purposes:** Cancer patients with venous thrombosis have an increased mortality compared with cancer patients without. An event of preoperative thrombosis has, however, never been studied as a predictive factor for survival. Hypothesizing this factor might influence postoperative survival, our study goal is to assess the prognostic value of preoperative VTE for survival in patients with bone metastases secondary to non-small cell lung cancer (NSCLC).

**Materials and Methods:** Data of 310 operatively treated patients with bone metastases secondary to NSCLC was analyzed in a retrospective (2002-2015) multicenter cohort study. Twenty-four (8%) patients suffered preoperative VTE and 286 patients had no signs of preoperative VTE (92%). Patient and clinical characteristics, as well as the presence of a VTE until 6 months preoperative were recorded. Analyses were performed using the Kaplan-Meier method for plotting survival curves and the Cox proportional hazard regression for assessing association between VTE and survival.

**Results:** The patient group with preoperative VTEs showed worse survival in comparison with the preoperative non-VTE group (HR 2.0, 95%CI: 1.3-3.1; p=0.001). Median overall survival for the VTE group was 1.9 months (interquartile range: 1.1-2.9 months), in comparison to 3.6 months (IQR 1.5-9.2 months) for the non-VTE group.

**Conclusion:** A preoperative VTE event appears to be a prognostic factor for overall survival in patients with NSCLC and bone metastasis. Implementing this factor in future prognostic survival models should be considered.

# SESSION 17

## SALVAGE OF LIMB SALVAGE

2516

## Is salvage of limb salvage justified for locally recurrent osteosarcoma? A report by the Cooperative Osteosarcoma Study Group COSS

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**Introduction and Purposes:** Approx. 10% of patients treated by limb-salvage (LS) surgery for extremity osteosarcoma develop a local recurrence. Little is known about the best surgical strategy following local recurrence (LR), especially regarding outcome after a 2<sup>nd</sup> LS surgery.

**Material and Methods:** The COSS database of 3,657 high-grade central extremity osteosarcomas was searched for patients who suffered a LR (isolated or combined with metastases) after LS and then went on to achieve a 2<sup>nd</sup> complete surgical remission (CSR2). Results obtained by 2<sup>nd</sup> LS were compared to those achieved by ablative revision surgery.

**Results:** 107 patients with 1<sup>st</sup> local relapse after limb-salvage surgery were identified (55 isolated, 52 combined), of whom 63 achieved a CSR2: 22/63 by 2<sup>nd</sup> LS and 41/63 by ablation. 2<sup>nd</sup> LS was more likely to be chosen for females (12/24) than for males (10/39) ( $p < 0.05$ ; chi-square), there was no correlation with age, upper vs lower extremity tumors, presence of primary metastases, early vs late first relapses or combined vs isolated LR. After a median follow-up after 2<sup>nd</sup> local surgical remission (LSR2) of 3.4 years (0.4–18.8) for all 63 patients and 7.9 (0.7–18.8) for survivors, 31 were alive (20 CSR2, 8 later CSR, 3 with disease) and 32 had died. 5-year overall survival was 50% (2<sup>nd</sup> LS 45%; ablation 52%,  $p = 0.98$  (log-rank)), 5-year event-free survival 30% (2<sup>nd</sup> LS 37%, ablation 26%,  $p = 0.3$ ). 10/63 patients developed a 2<sup>nd</sup> LR (7 isolated, 3 combined; 2<sup>nd</sup> LS 6/22, ablation 4/41;  $p = 0.08$  (Fisher's exact test)). The 5-year cumulative incidence to suffer LR2 was 17% (2<sup>nd</sup> LS 29%, ablation 11%,  $p = 0.07$ ; Gray's test).

**Conclusions:** Patients whose LR is treated by a 2<sup>nd</sup> LS may have a somewhat higher risk to suffer a 2<sup>nd</sup> LR than those who are amputated, but overall outcomes do not seem to be inferior. The decision to perform a 2<sup>nd</sup> LS can be taken with appropriate caution.



2431

## Treatment and complications of sarcomas of the foot and ankle region. Is early amputation justified?

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**Introduction and Purposes:** For many surgeons most sarcomas of the ankle region (e.g. distal tibia, calcaneus, distal fibula) are clear indications for below knee amputations, based on reported high complications rates for reconstructions and a well-known good quality of life with exoprostheses. Therefore, the aim of the present study was to investigate the complication rates of sarcoma surgery at this location in two tertiary centers.

**Materials and Methods:** Altogether, 86 patients (24 Graz 1998-2018)/62 Vienna 1977-2018) of the foot and ankle region were retrospectively included in the study. 33 had bone sarcomas and 53 soft tissue sarcomas. 55.8% of patients were male (n=48) and the mean patient age was 45.6 years (range: 8- 94 years). The foot itself was affected in 26 cases, whilst in 60 cases, the distal tibia or fibula were involved. Median follow-up was 4.6 years (IQR: 2.3 – 8.9 years). Chi-squared, t-tests and Cox-regression models were used for statistical analysis.

**Results:** Altogether, 26 patients underwent primary amputation (27.9%). Upon surgery, wide margins were achieved in 29 patients, marginal margins in 14 and intralesional margins in 4 and unclear in 13. Thirty-four patients developed postoperative complications after a median of 2 months (39.5%). Twenty-nine of these patients underwent revision surgery, of whom 6 required a secondary amputation. Patients with primary amputation had significantly less complications than patients treated with complex reconstructions (19.2% vs. 46.8%; X2-test; p=0.019) In the multivariate Cox-regression analysis, amputation turned out as a positive prognostic factor regarding development of complications (HR: 0.07; 95%CI: 0.01 – 0.023; p-value=0.044), irrespective of preoperative radiotherapy (p=0.773) tumour size > 7 cm (p=0.055), plastic reconstructions (p=0.335), gender (p=0.207), location in the foot vs. ankle region (p=0.647) and age > 45 years (p=0.506).

**Conclusion:** Limb salvage surgery at the ankle region should be carefully considered and discussed with sarcoma patients, taking into account the high complication rate of nearly 50%. To provide a better guide for decision making, factors like quality of life should be evaluated in future studies.

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2282

## Outcomes of free vascularized fibular grafts for the treatment of radiation-associated femoral nonunions

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**Background:** Nonunion is a common complication following a fracture in the setting of previous radiotherapy, however currently there is a paucity of data describing the optimal treatment for these nonunions. Free vascularized fibular grafts (FVFG) have been used successfully in the treatment of large segmental bone defects; however, their efficacy with respect to treatment of radiated nonunions is limited. The purpose of the study was to assess the 1) union rate, 2) clinical outcomes, and 3) complications following FVFG for radiation-associated femoral nonunions.

**Methods:** We identified 23 patients who underwent FVFG for radiation-associated femoral nonunion between 1991- 2018. There were 11 males and 12 females, with a mean age and follow-up of 60 and 5 years. The most common oncologic diagnoses included soft tissue sarcomas (n=16), Ewing's sarcoma (n=2), and lymphoma (n=2). Mean radiation dose was 51.4 Gy at a mean of 11 years prior to FVFG. The FVFG, mean length 17 cm, was fixed in an onlay fashion using lag screws in all cases. Accompanying fixation was most commonly obtained with an intramedullary nail (n=18). In addition to FVFG, 22 patients underwent simultaneous autogenous bone grafting.

**Results:** Eighteen (78%) fractures united at a mean of 13 months. MSTs scores improved from 30% preoperatively to 73% at latest follow-up ( $p<0.0001$ ). Five fractures failed to unite; 3 were converted to proximal femoral replacements (PFRs), 1 required revision ORIF, and 1 remained a stable pseudarthrosis. Six patients (26%) required a second operative grafting. The four additional complications included 3 deep infections, and one screw fracture. No patient required amputation. Patients who failed had a significantly shorter time interval between their radiotherapy and FVFG (3 vs 12 years,  $P=0.008$ )

**Conclusions:** FVFGs are a reliable treatment option for radiation-associated femoral nonunions, providing a union rate of 78% and an improvement in functional outcome.

2627

### Vascularized fibula graft in orthopaedics oncology: management of complications

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**Introduction and Purposes:** Vascularized free fibula grafts have incited changes in the field of skeletal oncologic reconstruction. It has been used for primary bone reconstruction and long-bone allograft complication salvage. The purpose of the study is to critically evaluate the early and late complications of the technique.

**Material and Methods:** From 1998 to 2017, 49 patients (30 male, 19 women) underwent vascularized fibula graft (VFG) reconstruction for bone tumors (23 osteosarcomas, 18 Ewing Sarcomas, 8 other malignant histotypes). Mean age at diagnosis was 17 (2- 49) and mean follow-up (FU) was 5 years (2-15). 32 cases were treated with Capanna technique, 17 VFG alone. 24 tibia, 14 femur, 9 upper limb (6 humerus, 2 radius, 1 ulna) reconstruction performed. The mean graft length was 18 cm (8-29).

**Results:** We experienced 13 complications (26%): 10 developed in the tibia (5 fracture, 4 wound suffering and 1 recurrence), 2 in the femur (non-union) and 1 radius fracture. Three patients underwent removal of graft and prosthesis' implant (tibia), 2 amputations (1 for recurrence and one for infection), 2 bone bridging and 2 implant of a second contralateral plating to stiffen the construct.

**Conclusions:** Most of mechanical complications, fracture and/or non-union, developed in the tibia (80%) in adult population (85%) and for bigger resections (mean 18 cm). These data suggest that for long resection of tibia and femur it could be useful to consider a rigid synthesis construct (double plate) and allowing weight-bearing for patients with high body weight carefully, only when there is a full graft fusion.

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2579

## Surgical management of complications of expandable endoprostheses for skeletally immature patients with high grade sarcoma

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**Introduction:** Limb salvage procedures after resection of an active physis presents a unique challenge for musculoskeletal oncologists. Expandable prostheses allow for reconstruction of defects and non-invasive lengthening. This study investigates outcomes at a single institution after reconstruction with an expandable endoprosthesis.

**Methods:** We retrospectively reviewed the records of 23 patients (26 Limbs) who underwent limb salvage surgery with the Repiphysis<sup>®</sup> system from 2003-present. There were 11 males and 12 females who underwent reconstruction with at a mean age of 10.08 years. Reconstruction included the femur in 18 cases, the tibia in 5 cases, and the humerus in 5 cases. Complications were reviewed and functional scores were assessed using the MSTS functional scoring system.

**Results:** Patients were followed for a mean of 62.2 months. At latest follow-up, 9 prostheses had been converted to an adult prosthesis, 8 patients had died of disease, 7 patients had retained their Repiphysis, and one had undergone tibial turn-up plasty due to infection. Patients who were converted to an adult prosthesis had a mean of 7.0 cm of lengthening. There were a total 22 complications in 16 patients including one wound dehiscence, four aseptic loosening, four structural failures, five infections, 9 progression of disease (Table 1). The mean MSTS score for the humerus, femur, and tibia were 90%, 76%, and 83% respectively, with an overall limb retention rate of 92.3%.

**Conclusions:** Reconstruction of skeletally immature patients after resection involving the physis remains a challenge. Expandable endoprostheses are a viable option available to the Orthopaedic Oncologist for limb salvage. The most common complication encountered is failure due to disease progression, followed by deep infection. Still, limb retention rates remain high.

Table 1. Implant Complications and Outcomes

Failure Mode	Humerus	Tibia	Femur
Type 1	-	1	3
Type 2	-	1	5
Type 3a	1	1	1
Type 3b	-	-	-
Type 4	-	1	4
Type 5	-	2	2
Total Complications	1	6	15
MSTS score	90%	76%	83%

\*Complications categorized according to Henderson et al.

2275

## Second and subsequent complications after successful treatment of first megaprosthetic failure in patients with sarcoma - what should we expect and when?

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**Background:** The reconstruction of massive bone defects following resection of primary malignant bone tumors is most usually performed with megaprotheses. Many studies have analysed risk factors for the first failure of reconstruction, however subsequent failures are becoming an increasing problem given improved patient survival. The aim of this study is to assess prevalence and types of subsequent failures as well as potential risk factors.

**Methods:** We retrospectively analyzed the files of 599 patients with primary malignant bone tumors who received a MUTARS<sup>TM</sup> megaprosthesis between 1993 and 2015. 264 patients (44%) suffered first prosthetic failure during follow-up. Subsequent failures were classified according to Henderson et al. Implant survival curves were calculated with the Kaplan-Meier method and compared with the log-rank test. Non-parametric data was compared using the Mann-Whitney U-test.

**Results:** Subsequent failure occurred in 115 patients (43.6%) after a median of 17 months after first failure. The probability of a subsequent failure amounted to 29% 2 years after first failure and 51% after 5 years. Most common mode of failure was infection (39%), followed by structural failure (35%). There was no significant correlation between the type of first failure ( $p = 0.138$ ), reconstruction length ( $p = 0.531$ ), age over 40 ( $p = 0.898$ ), or the presence of pathological fracture at diagnosis ( $p = 0.931$ ) and the probability of subsequent failures. On the other hand, significantly shorter subsequent revision-free survival probability was associated with total bone replacements (51% vs. 25% at 5 years,  $p = 0.042$ ). Longer operative time ( $p = 0.007$ ) during primary reconstruction and shorter operative time during first revision surgery ( $p = 0.002$ ) were also associated with a worse subsequent revision-free survival probability.

**Conclusion:** The probability of subsequent failures is high following first failure of megaprosthetic reconstruction in patients with primary malignant bone tumors. While the site of reconstruction and length of surgery were associated with the risk of subsequent complications, reconstruction length, patient age and type of first failure had no impact on subsequent failures in our patient cohort.

2279

## Five-year experience of using modern technologies in replacing the cemented stem of the endoprosthesis to cementless after the previous cemented fixation. (The East-European Sarcoma Group)

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**Introduction/Purpose:** Cardinal positive changes in oncological results occurred in the treatment of bone tumor lesions actualized the need to improve the term of megaprosthesis use. The sensitizing capacity of acrylates, as the additives used for the polymerization of the bone cement and optional antibiotic supplements, is another problem which among others leads to stem aseptic loosening. The use of a cementless stem endoprosthesis reduces the risk of aseptic instability in the medium and long term. The purpose of this study was to analyze the possibility, orthopedic outcomes, complication risks and incidence of using cementless stem after the previous cemented arthroplasty based on the introduction of modern technological developments.

**Material/Methods:** Since 2014 to 2019, 10 revision endoprosthetics were performed with the application of technology cemented to cementless stem replacement. There were 4 males and 6 females with a mean age of 31,7 years (range, 22-39). In the morbidity structure, 50% were diagnosed with a primary malignant tumor (chondrosarcoma, osteosarcoma) and 50% had a GCT diagnosis. All patients at the time of surgery had no signs of disease. Nine replacement was performed after primary distal femur resection and one after previous revision replacement. Complete replacement of cemented to cementless endoprosthesis was performed in 7 patients and partial replacement (one stem) was performed in 3 patients with hybrid endoprosthesis, the model and design was preserved. Five patients had acrylate allergy.

**Results:** The mean follow-up time after prosthesis exchange surgery was 24,6 months (min 9 months, max 56 months). During this period in group of 10 patients there were no orthopedic and oncological complications and signs of allergy. The radiological evaluation during the observation period showed satisfactory osseointegration of the cementless tibial and femoral stems, which remained firmly attached, with no evidence of loosening or vertical migration. Bone cement mantle was completely purged by ultrasonic cement removal under endoscopic control which allowed obtaining satisfactory fixation. Osteolytic destruction defects of the bone marrow channel in 3 patients which pre-dates aseptic loosening were filled with tricalcium phosphate+hydroxyapatite allograft. In all patients this technology showed satisfactory osseointegration and extra stability of cementless stem. Functional result estimated by MSTS scale before surgery was 67,4%, six month after 95,3%, 12 month after 96,1%.

**Conclusion:** Technology of replacing the cemented stem of the endoprosthesis to cementless have a significant potential, the development of which had possible by the emergence of high-tech equipment. The use of this technology allows minimizing the risk of aseptic loosening and especially in patients with an allergic reaction to acrylates. Careful adherence to patient selection criteria avoids the complications of its use.



2365

### Implant survival and mode of failure of tumour endoprosthesis after lower limb tumour resection

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**Objective:** Prosthetic failure of tumor endoprosthesis reconstruction (EPR) often results in the failure of limb salvage. There are several modes of failure of EPR, however, the relationship between the mode of failure and amputation is not fully understood. The aim of this study is to clarify the implant survival and mode of failure of EPR after the lower limb tumor resection, and which failure associated with the amputation.

**Methods:** 141 patients who had the EPR for femur or tibia in our hospital from 1990 to 2015 and had a follow-up of more than 1 year were subjected to this study. Median age was 22 years old (8 – 86 years old) and 81 patients (57%) were male. Distal femur (40%) and osteosarcoma (69%) were the most common location and histology, respectively. We defined the event of implant failure as revision, periprosthetic fracture fixation, soft tissue reconstruction to restore joint stability, endoprosthesis removal, and amputation. The mode of failure was classified based on Henderson criteria. Failure-free survival and amputation-free survival were calculated by the Kaplan-Meier method. Univariate and multivariate analysis were performed to analyze the prognostic factors.

**Results:** Median follow-up after reconstruction surgery was 62 months (12 – 275 months) and 34 patients (24%) experienced an implant failure. Failure-free survival at 5 and 10 years were 77 and 62%, respectively. Most common failure was an infection (12 patients, 8%) occurring during the period from 3 to 134 months (median 52 months). Aseptic loosening was found in 4 patients (3%), most of the case occurred within 2 years and all of them resulted in the removal of the implant. Prognostic factor analysis demonstrated that chemotherapy was a significant poor prognostic factor (HR 3.18). Amputation was performed in 17 patients (12%), and amputation-free survival at 5 and 10 years were 89 and 85%, respectively. All patients who had an infection (12 patients) or tumour progression (5 patients) received amputation. In contrast, no patient with soft tissue failure, aseptic loosening, or structural failure had an amputation.

**Conclusion:** Chemotherapy is a significant prognostic factor for implant failure after lower leg EPR. Infection and tumour progression are the main cause of amputation.

2695

## Tumor prosthesis revisions around the knee: too-precious-to-lose-now extremities

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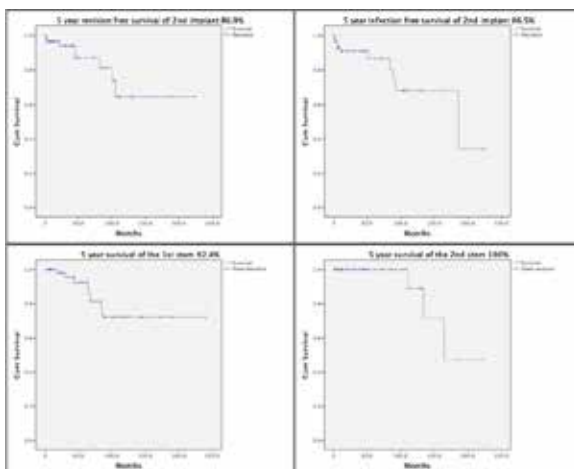
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**Introduction:** Knee tumor prostheses in long-term survivors of musculoskeletal malignancies are destined to fail at one point via one or multiple modes as described by Henderson. Each revision poses a risk for continued survival of the extremity. We sought to evaluate the modes of failure, functional outcomes after revision and survival of revision prostheses in our tumor registry.

**Patients & Methods:** Clinical data of 59 patients (M/F: 35/24), who underwent knee tumor prosthesis revision(s) between 1990-2014, were retrospectively analyzed. Mean age was 24,8 (12-72) years and resection ratio was 42% (27-100) at index surgery. Distal femur was the most common location (59,3%) and osteosarcoma was the most common pathology (46,8%). Two local designs and three implant systems from international manufacturers were used for primary reconstruction in different periods. Mean overall follow-up was 113 (12-269) months.

**Results:** Structural failure was observed in 34 patients, aseptic loosening in 25, infection in 15 and local recurrence in 6 with multiple modes of failure encountered simultaneously in some patients. Mean time to first revision was 63 (2-240) months while mean survival of 2<sup>nd</sup> implant was 49 months (1-224). Eight patients required 2<sup>nd</sup> revision and 3 required 4<sup>th</sup> revisions. At the last follow-up, 83,1% patients showed no evidence of disease, mean knee ROM was 0-11-99° and mean MSTS score was 79.9% (47-100). Better MSTS scores correlated significantly with younger age at revision ( $p=0.007$ ) and stem-retaining revisions ( $p=0.002$ ) while lower MSTS scores were associated with infection after revision ( $p=0.029$ ). Six patients had secondary amputations.

**Conclusion:** Younger age, stem-retaining interventions and successful extensor mechanism reconstruction are good prognostic factors for the functional outcome of revisions while remaining infection-free in the post-revision period is essential for the continued survival of "too-precious-to-lose-now" extremities.



2577

### Extensor mechanism reconstruction of the knee using a gastrocnemius flap

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**Introduction:** Resection and reconstruction of the proximal tibia in malignancy poses many challenges. Preserving the extensor mechanism function whilst providing an adequate resection is one of these issues. Various methods have been discussed in the literature regarding extensor mechanism reconstruction including synthetic ligaments<sup>1</sup>, local repair<sup>2</sup>, and the use of a gastrocnemius flap. The use of a gastrocnemius flap has several advantages which including tissue coverage of the prosthesis along with potential restoration of quadriceps function. The described technique involves harvesting of a medial or lateral gastrocnemius flap with a portion of the tendoachilles. This is then mobilised proximally and inlayed over the implant along with being weaved into the extensor mechanism. At this point if further coverage is required then the contralateral gastrocnemius can be used. Primary closure can often be performed, but if not a skin graft is used. Post operatively patients are in a protective extension splint for 12 weeks with a graduated recovery plan to rehabilitate quadriceps function whilst trying to avoid an extensor lag.

**Materials and Methods:** Retrospective collection of cases using theatre logbooks was performed. Patient notes and imaging were then reviewed to collect information on diagnosis, procedures, complications, re-operation rates and mortality. All living patients were then sent TESS and EQ5D scores for functional outcome assessment via post.

**Results:** A total of 41 patients underwent an extensor mechanism reconstruction over a 20 year period. The mean length of follow up was 7.6 years (range 1-20 years). The mean age of the patient at their surgery was 48. Indications were sarcoma (n=31), complex revision from previous knee arthroplasty (n=7) benign lesion (n=2) and other malignancy (n=1). Eleven patients were re-operated on (amputation=3, manipulation under anaesthetic =3, wound washout/debridement=3, excision of recurrence=2). Local recurrence rates within the sarcoma cases were 13%(4/31) and rates of metastatic disease either at presentation or after surgical treatment were 23%(7/31). During the follow up patients 8/41 died. The outcome data is currently being collected and will be ready for the date of the conference.

**Conclusion:** We present one of the largest series of patients with extensor mechanism reconstruction using any method. Complications and re-operation rates are comparable to previous series. This method appears to be a safe and reproducible approach to extensor mechanism reconstruction of the knee in cancer but is also appropriate for complex revision knee arthroplasty in the context of a failed extensor mechanism.

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# SESSION 18

## FUNCTIONAL RESULTS AND QUALITY OF LIFE

2699

### **Trevira® tube use in periarticular reconstruction with endomegaprostheses - 10 year experience**

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**Introduction:** Trevira® tube having a structure suitable for the proliferation of fibroblasts, leads to the formation of resistant fibrotic structures, allowing reconstruction of myotendinosis/tendinous insertions and ligament and capsular reconstructions. It becomes indispensable in tumor surgery, in the osteoarticular reconstruction of the shoulder, hip, knee and ankle.

**Materials and Methods:** A 10-year (2008-2017) experience with Trevira® tube cases, imaged and videotaped, of myotendinous, tendinous, and capsuloligamentous reconstruction of the shoulder joint, hip joint, ankle joint, and joint of the knee, where it is of particular importance the reconstruction of the extensor apparatus, with complete reconstruction of the patellar tendon with Trevira® tube. Macroscopic and histological evidence of the fibroblast "transformation" of the Trevira® tube into a fibrotic structure is presented after Trevira® tube revision surgeries.

**Results:** The results of stable and functional joint reconstructions are presented in tumoral surgery of large bony / osteoarticular resections, with massive myotendinous deinsertions and subsequent arthroplastic reconstruction, in particular with endomegaprostheses. The results showed good tolerability to polyethylene terephthalate, low infection rates, excellent "neoformation of fibrotic structures", good final functional result.

**Discussion:** The use of polyethylene terephthalate tubes is frankly encouraging from a functional point of view, since joint function and stability can be obtained in large arthroplastic reconstructions after osteoarticular tumor excisions, with low complication rates.

**Conclusion:** In complex tumor surgery where massive myotendinous deinsertions are performed, its subsequent reinsertion, with good healing, associated with stable capsuloligamentary reconstructions, allows arthroplasties, to have favorable functional results. Trevira® tube has proven to be a very important "tool" for achieving these goals.

2541

### Post radiation pathologic femur fractures in soft tissue sarcomas: is endoprosthetic reconstruction is a good option?

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**Background:** Soft tissue sarcomas are often managed with a combination of radiation therapy and surgical excision. However, due to the high dose of radiation causing weakening of the bone, pathologic fracture is a well-documented complication after sarcoma resection. Those fractures are known to have a very low healing rate, especially in weight-bearing bones such as the femoral shaft. Very few studies in the literature have analyzed the outcome of this specific crippling complication.

**Objective:** To assess the outcomes and complications of patients who underwent tumor prosthesis procedure after post radiation femur fracture.

**Methods:** A retrospective study with a prospective database. We included 18 patients who had a tumor prosthesis as a management of their post radiation femur fracture using either proximal femur, distal femur or intercalary prosthesis. The TESS and MSTs scores measured pre-op and the latest measure during follow-up are used to assess their functional outcome and complications such as infection, and reoperation.

**Results:** N=7 Patients had at least one of the metrics recorded both pre-op and at least one follow-up. No significant difference is found using paired t-test between pre-op and latest measures with TESS (N=5, p=0.96), MSTs87 (N=7, p=0.41), and MSTs93 (N=6, p=0.85).

**Conclusion:** Using endoprosthesis for the treatment of post-radiation sarcoma was shown to be effective. We suggest that it should be used more frequently, as it showed improved MSTs and TESS scores. It also demonstrated fewer complication rate. However, Further studies should be done with a larger sample and longer follow up.



2555

### Functional results in patients with osteosarcoma around the knee joint treated with limb salvaging procedures

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**Introduction:** Osteosarcoma is the most common malignant neoplasm of bone. It occurs most often in the bones of the lower limb. The standard treatment employs perioperative chemotherapy and radical surgical treatment. In the case when osteosarcoma is located around the knee joint, the gold standard is limb-sparing surgery with the use of various modular or custom made implants. The main objective of the study was to assess functionality of the patients treated with limb sparing procedure.

**Methods:** Patients with osteosarcoma around the knee joint who underwent perioperative chemotherapy and limb salvaging procedure with modular implants had their functionality assessed with the MSTS scale

**Results:** We have analysed 106 adult patients with osteosarcoma around the knee joint treated in our department between 2000 and 2017. The minimum follow-up period for the patients included in the analysis was 12 months. Total of 56 patients underwent limb-salvaging procedure. 46 patients underwent resection of the distal femur and its reconstruction with the distal femoral replacement, in 10 patients reconstruction with the proximal tibial replacement was performed after resection of the tumour. The overall survival (OS) in the study group was on average 75 months (10-221 months), progression free survival (PFS) 52 months (1-217 months). Functional assessment was evaluated on living patients using the MSTS scale. The mean score was 84% (100-53).

**Conclusions:** Combined treatment carried out in the tertiary centres allows to achieve good functional outcome in osteosarcoma patients who underwent limb sparing procedures with a use of modular implants.

2514

## Functional outcomes, quality of life and complications of pasteurized autograft-prosthetic composite (PAPC) compared to endoprosthesis for reconstruction around the knee

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**Objectives:** To compare functional outcomes, quality of life and complications between the use of pasteurized autograft prosthetic composite (PAPC) and endoprosthesis (EP) following resection of the distal femur or proximal tibia for bone and soft-tissue tumors around the knee.

**Methods:** Sixty-two patients underwent PAPC and 73 patients underwent EP reconstruction around the knee between 2005 and 2018 with the mean age of  $20.9 \pm 12.8$  and  $29.1 \pm 17.2$  years ( $p = 0.03$ ) and the mean follow-up time of  $37.1 \pm 22.1$  and  $49.1 \pm 41.8$  months ( $p = 0.49$ ), respectively. The mean bone resection length was  $16.0 \pm 4.9$  and  $16.7 \pm 5.1$  cm. ( $p = 0.49$ ) for PAPC and EP. Functional outcomes and quality of life were assessed by using the Musculoskeletal Tumor Society (MSTS) score, the University of California, Los Angeles (UCLA) activity scale, the Oxford Knee Score (OKS) and short form 36 (SF-36). Reconstructive failure was defined as removal of the construct.

**Results:** Regarding PAPC and EP reconstruction, failure was found in 17 of 62 (27.4%) and 17 of 73 (23.3%), respectively ( $p = 0.69$ ). Infection needed construct removal was found in 3 (4.8%) and 4 (5.5%), ( $p = 1$ ) and recurrence found in 3 (4.8%) and 4 (5.5%) for PAPC and EP reconstruction, respectively ( $p = 1$ ). For PAPC, 5 graft fractures (8%) were found. For EP, 2 loosening and 1 polyethylene failure were found. The 5-year construct survival was 63.9% (95% CI, 45.5 - 77.6) and 75.0% (95% CI, 59.7 - 85.2) for the PAPC and EP, respectively ( $p = 0.38$ ). The MSTS score was  $26.6 \pm 2.6$  and  $26.8 \pm 2.7$  ( $p = 0.83$ ), the UCLA scale was  $6.7 \pm 1.2$  and  $6.6 \pm 1.4$  ( $p = 0.67$ ), the OKS was  $40.0 \pm 5.9$  and  $42.1 \pm 8.3$  ( $p = 0.18$ ) and the SF-36 score was  $78.2 \pm 14.2$  and  $80.6 \pm 8.3$  ( $p = 0.46$ ) for the PAPC and EP reconstruction, respectively. The operative time was  $423 \pm 81.3$  minutes for PAPC and  $292 \pm 102.7$  minutes for EP ( $p < 0.01$ ).

**Conclusions:** Reconstruction around the knee with either PAPC or EP appears to offer similar rate for reconstruction failure, construct survival, functional outcomes and quality of life. The primary causes of failure were similar in both groups which were infection and tumor progression. Considering that biologic reconstruction are better for soft-tissue attachment and preserving bone stock for further revision, PAPC should be considered as a viable alternative for limb sparing surgery around the knee although it requires longer operative time.

2481

### **Muscle strength of knee flexors and extensors after endoprosthetic reconstruction**

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**Introduction:** Functional results after endoprosthetic knee reconstruction show good or excellent results (68% to 83%) when the Musculoskeletal Tumor Society Rating Scale (MSTS) is used. The MSTS score considers patient perception and satisfaction which may underestimate knee function. Only a few studies have evaluated the results of muscle strength. We aimed to determine the magnitude of muscular strength reduction after knee bone tumour resection and endoprosthetic reconstruction and the correlation between extension muscular strength and MSTS score.

**Patients and Methods:** Isometric muscle strength of 17 patients (eight distal femur and nine proximal tibia resections) was assessed by dynamometry. The peak isometric torque, during voluntary contraction, was considered for analysis and was obtained at 40° of knee flexion for knee flexion and 60° of flexion for extension. The MSTS questionnaire was administered and the factor "function" was analysed separately.

**Results:** Endoprosthetic reconstruction resulted in a mean 77.5% ( $p=0.01$ ) reduction of extension strength and 29.1% ( $p=0.01$ ) reduction of flexion strength compared to the contralateral side. The mean MSTS score was 81.6% (range 50 to 96) which was considered very good. However, when the factor "function" was independently analysed, lower scores were observed, and a significant negative correlation was identified between the extension strength deficit and the factor "function" (Spearman's coefficient, -0.52;  $p=0.03$ ), indicating that patients with major extension deficits perceive they their functional impairment.

**Conclusion:** This study shows that there is a significant reduction of extensor and flexor muscle strength in patients after reconstruction with knee endoprosthesis. Despite the good results in the MSTS questionnaire, the factor "function" showed a strong correlation with extension strength. Strength reduction is perceived by patients, harms daily activities and may be underestimated by health professionals.

2489

### **Pain sensations are key limitations in long-term survivors after major amputation for primary malignant bone tumors**

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**Objective:** Before limb salvage became the mainstay in the treatment of malignant bone tumors, ablative surgery has been the method of choice and it still is after failing megaprotheses. Phantom limb pain (PLP) can occur episodically after an amputation and can deeply bother patients. Do PLP and stump pain still matter after 20 years? Do amputees adapt in the long-term and does pain influence SF-36 QoL?

**Study Design:** 21 patients (14 male, 7 female) who underwent an amputation in the lower extremity (14 transfemoral, 4 knee disarticulations, 3 transtibial) between 1961 and 1993 (average follow-up 40 ±10 years) have been interviewed in a questionnaire study.

**Methods:** The patients were asked about the occurrence, localization and intensity of these different forms of pain. The quality of life was assessed using the SF-36.

**Results:** PLP during the postoperative period of at least 20 years was reported by 16 patients (76.2%), with a median VAS-intensity of 7.5 (range 3-10; 10-digit scale). The occurrence within the year prior to the interview was described: (1) rarely in 7 patients, (2) sometimes in 7 patients, (3) quite often in 1 patient, (4) constantly in 1 patient. Stump pain was reported by 10 patients (47.6%), the occurrence of pressure marks at least once within the postoperative period was reported by 19 patients (90.5%). In the SF-36 subscale bodily pain the patients scored significantly ( $p=0.03$ ) lower than a German random sample (mean. diff. -15.4). However, in the subscales mental health, general health perceptions, social and emotional role functioning slightly higher scores were reached.

**Conclusion:** This long-term follow-up study reveals that two thirds of amputees suffer from PLP. The reason why these forms of pain don't seem to interfere with the SF-36's mental component summary may be adaption mechanisms and coping strategies. Considering the high amount of affected amputees in this study, novel techniques (e.g. targeted muscle reinnervation) should be offered.

2499

### Physiotherapist led bone tumour surveillance clinics

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**Introduction and Purposes:** A physiotherapist led clinic for bone tumour patients has been developed to combine cancer surveillance with individualised treatment, support and advice to enable self-management of physical and emotional issues enhancing quality of life. This new clinic has been developed in a bone sarcoma service where there has been increased need for new patient and surveillance clinic appointments without consultant expansion leading to regular overbooking and subsequently patients received short appointments with little holistic care.

An innovative solution was required to manage this workload. A soft tissue sarcoma surveillance clinic had been commenced by the clinical nurse specialists which had proven to be safe and effective with high levels of patient satisfaction. Following the success of this the new bone tumour clinic was developed

**Materials and Methods:** A selected group of patients with bone tumours are seen for follow up by a Macmillan Sarcoma Physiotherapist rather than a consultant. All patients are known to the physiotherapist having been under their care as an inpatient giving continuity of care and longer appointment times 30 minutes rather than 10 minutes. Consultant review remains available if required / requested. Chest and limb imaging is performed at each appointment as per standard protocol. All imaging is reported by Musculoskeletal Radiologists within 24 hours and results communicated back to the patient by the physiotherapist. Comprehensive physical and emotional assessment at each appointment.

### Results:

- 111 patients were seen in the first 8 months of the service, increasing month on month
- Reduction in hospital visits for patients by combining surveillance, rehabilitation and advice in one appointment
- Excellent feedback – 28 patients completed a feedback questionnaire - all 28 patients felt all their needs were met and were very satisfied with the information they received. 27 patients felt very satisfied with seeing a physiotherapist over a doctor, 1 satisfied.
- The service implementation has also proved a cost saving to the NHS of £13000.

**Conclusions:** Physiotherapist Led Bone Tumour Surveillance Clinics are a safe and efficient model which frees up consultant time, benefits the patients and saves money.

2332

### A populational update on epithelioid sarcoma

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**Introduction & Purposes:** Epithelioid sarcoma (ES) is an aggressive malignancy scarcely reported on due to its rarity. This study is a database review of its demographic and clinicopathologic traits as well as prognosis and survival features.

**Materials & Methods:** Data was acquired from the Survival Epidemiology, and End Results (SEER) database with cases ranging from 1973-2015. For all analyses, statistical significance was established at  $\alpha < 0.05$ . 998 cases of ES were identified from the database. 1, 5, and 10-year Disease Specific Survival (DSS) rates were determined through Kaplan-Meier analysis and 5-year DSS hazard ratios (HR) through Cox regression.

**Results:** Average age of diagnosis of ES was 45.8( $\pm 21.5$ ) years. Patients were predominantly white(80.5%), male(55.3%) and in the mid-adult age category(36-55-31.6%). The most commonly affected primary site was the upper-limb/shoulder (27.8%). Metastasis and nodal involvement were seen in 24% & 36.9% of patients, respectively, while tumor grade was often high (III-IV-84.5%). Surgery alone(S+R-) and surgery with radiation(S+R+) were the most frequently used treatments(75.4%). Overall 1, 5 and 10 year DSS were 74%, 55.7% and 49.3%, respectively. Age, anatomical site, grade, TNM staging, treatment modality and year of diagnosis were demonstrated to be independent predictors of survival. Best outcome among age groups was observed in the pediatrics cohort(HR:0.13). The poorest outcomes for site were seen in the abdomen(HR:4.87) and thorax(HR:3.85). S+R+ (HR:0.18) and S+R-(HR:0.14) were the best for treatment. Using cases diagnosed in 1973-84 as reference, those diagnosed in 1996-2005(HR:1.79) and 2006-2015(HR:2.11) had worse prognoses. 2006-15 cases had worse outcomes(HR:1.29) than 1973-2005.

**Conclusion:** We report using the largest cohort of ES to date. Despite ES's often dismal prognosis, there are factors associated with better outcomes. A worsening survival over the years warrants further investigation into this sarcoma.



2276

### Clinical-radiographic results and quality of life in Gorham-Stout disease

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**Objective:** The Gorham-Stout disease (GSD) is a rare mono- or polyostotic condition characterised by an idiopathic intraosseous proliferation of angiomatous structures resulting in the progressive destruction and resorption of bone. The aim of this study is the analysis of clinical-radiographic results and – for the first time – of Quality of Life (QoL) data in affected patients.

**Methods:** We performed a retrospective analysis of seven consecutive patients who were diagnosed with GSD in our department between 1995 and 2018. Data regarding diagnosis, clinical- and radiographic features, treatment as well as sequelae and their subsequent therapy were obtained. QoL was determined using standardised scoring systems: Musculoskeletal Tumor Society Score (MSTS), the Toronto Extremity Salvage Score (TESS) and the Reintegration to Normal Living Index (RNL).

**Results:** The average patient age at diagnosis was 19 years (range: 5 - 42 years); the mean follow-up amounted to 8 years (range: 1 - 22 years). The average time from first symptoms until final diagnosis was 27 months (range: 3 - 60 months). Four patients had a polyostotic and three patients a monoostotic disease. Using an off-label therapy with bisphosphonates, a stable disease was achieved in five of seven cases after an average of 20 months (range: 8 - 42 months). Four of the seven patients required a total of eight surgeries in four different Departments. The average MSTS score at last follow-up was 76% (23% - 97%), the average TESS 83% (43% - 97%) and the average RNL-index 75% (39% - 88%).

**Conclusion:** Diagnosis and therapy of GSD remain a multidisciplinary challenge. Off-label treatment with bisphosphonates appears to lead to a stable disease in the majority of patients. QoL varies depending on the individual manifestations but even in polyostotic cases good to excellent results are possible

2522

### **PROMIS Physical Function item bank for outcomes measurement during therapy of a rare, heterogeneous, musculoskeletal disease population: tenosynovial giant cell tumor (TGCT)**

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**Objective:** The objective is to demonstrate the use of custom Patient-Reported Outcome Measurement Information System- Physical Function (PROMIS-PF) forms in tenosynovial giant cell tumor (TGCT) population, in which tumors affect different joints and result in heterogeneous impacts on physical function.

**Methods:** Custom PROMIS-PF forms were developed for ENLIVEN, a randomized, double-blind, placebo-controlled Phase 3 study of pexidartinib in TGCT. Items from the PROMIS-PF item bank were selected to measure physical function in patients with upper extremity (UE) tumors and separately for lower extremity (LE) tumors based on clinical expert input, a literature review, and patient interviews. These custom UE and LE PROMIS-PF short forms were administered in ENLIVEN, and a mixed model for repeated measures was used to analyze changes of PROMIS PF score from Baseline to Week 25. The ability of the PROMIS-PF to differentiate patients based on their self-rating of physical function limitation was assessed with a general linear model. The relationship of changes from Baseline to Week 25 in PROMIS-PF with changes in tumor size as measured by RECIST and tumor volume score (TVS) was examined using Pearson's correlation (r).

**Results:** A total of 120 patients were randomized (61 pexidartinib, 59 placebo), of which 51 placebo and 49 pexidartinib subjects had baseline and at least one post-baseline PROMIS-PF scores, respectively. Patients treated with pexidartinib showed clinically meaningful and statistically significant improvements in least squares mean PROMIS-PF scores (+4.06 vs -0.89 at week 25, p=0.0019). The change of PROMIS-PF scores from Baseline to Week 25 differed significantly (p<0.001) among patients categorized by the change of their self-rated physical function limitation status, indicating the ability of PROMIS-PF to differentiate patients with different level of physical function. Improvement of PROMIS-PF score was correlated with the reduction of tumor size measured by RECIST and TVS (r=-0.49 and -0.34, respectively, all p<0.05).

**Conclusions:** The custom PROMIS-PF short forms demonstrated treatment benefit of pexidartinib. The PROMIS-PF item bank could be a useful tool to assess physical function in other orthopedic disease affecting different joints in different patients.



# SESSION 19 AND SESSION 20 BONE METASTASES 2 AND MININVASIVE THERAPIES

2420

### C-reactive protein predicts survival in patients with long bone metastases

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**Introduction and Purpose:** The objective of the present study was to draw practical guidelines for the treatment of long bone metastases based on patient-reported outcomes for patients with metastatic bone disease.

**Material and Methods:** We performed a prospective cohort study of patients who had undergone surgical treatment of long bone metastases from January 2015 to June 2017. Primary tumors were categorized into 3 clinical profiles (favorable, moderate, or unfavorable) according to an existing classification system. Associations between prognostic variables and overall survival were investigated using the Kaplan-Meier method and multivariate Cox regression models.

**Results:** A total of 131 patients were included. On the basis of the independent prognostic factors, namely the clinical profile, Karnofsky Performance Score, and presence of visceral metastases and laboratory data, C-reactive protein predicts survival in patients with long bone metastases ( $P < 0.001$ ). Most of the intramedullary complications occur after 1 year as opposed to prosthetic complications, which occur early.

**Conclusions:** Prospectively collected data have demonstrated C-reactive protein predicts survival in patients with long bone metastases. A survival estimation for patients with symptomatic long bone metastases is crucial to prevent overtreatment and undertreatment. Intramedullary fixation or prosthetic reconstruction should be chosen on the basis of survival estimation for patients with metastatic bone disease, using C-reactive protein as a prognostic factor.

2567

### Prognostic factors of survival after pathological fractures in multiple myeloma

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**Introduction and Purposes:** Fractures in multiple myeloma (MM) increase the risk of death by 20% (1-2). The objective of this study is to identify factors that affect morbidity and mortality when undergoing surgery for fractures.

**Materials and Methods:** Retrospective observational cohort study. Patients diagnosed with MM that underwent surgery for pathological fractures between 2007 and 2016 were included. A univariate and bivariate analysis of the factors associated with the treatment was performed, including the use of neoadjuvant or adjuvant chemotherapy.

**Results:** We identified 35 patients (12 men - 24 women) with a mean age of 36 years (43 - 79) and a mean follow-up of 7.2 months (0.26 - 106). Of the total patients: 50% received neoadjuvant chemotherapy, 8.3% required postoperative management in the intensive care unit (ICU), and 36% of the cases required postoperative blood transfusion. There were no differences in morbidity or mortality between patients with neoadjuvant or adjuvant chemotherapy ( $p = 0.08$ ). All the patients with multiple fractures received neoadjuvant chemotherapy ( $p = 0.007$ ); 66% of the multiple fractures occurred in the postoperative period ( $p = 0.015$ ). Elevated pre- and postoperative values of calcium and creatinine were associated with longer stay in the ICU ( $p = 0.040$ ). Blood transfusion requirement was not associated with a higher ICU requirement ( $p = 0.016$ ).

**Conclusions:** Neoadjuvant chemotherapy in MM is not associated with increased morbidity or mortality but may be related to the presence of multiple fractures. Factors such as elevated calcium and creatinine may predict increases in ICU stay. The need for transfusion does not modify the requirement for intensive care.

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## 2239

### Surgical treatment of humeral pathological fracture

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**Purpose/Background:** For most patients with skeletal metastasis, the aim of treatment is not to cure disease but to improve morbidity and the quality of life during their remaining survival times. There are a variety of surgical options of pathological humeral fracture, these options can be classified into two procedures, that is, internal fixation without resection and tumor resection followed by reconstruction with a prosthesis. When deciding treatment, we take into consideration life expectancy using a Katagiri's prognostic scoring system, radiation sensitivity, and general condition. Excisional surgeries followed by reconstruction were preferred for patients with a long expectancy, and simple internal fixations followed by radiotherapy were indicated in patients with short life expectancy. The purpose of this study is to clarify the clinical results of the surgery based on our treatment strategy.

**Method:** Between 2002 and 2018, 74 in 65 consecutive patients with humerus pathological fractures were treated surgically. There were 46 men and 19 women, with a mean age of 63 years. Simple internal fixations followed by radiotherapy were performed in 55 cases, and excisional surgeries were in 19. We retrospectively analyzed survival times, restoring function, recovery from pain, complications, and local failures.

**Results:** At the mean follow up of 17.9 months (0.5 ~104), 5 patients are still alive and 60 patients have died. The mean post-operative survival was 6.4 months in patients performed simple internal fixation, 33.2 months in those of excisional surgery. Recovery from pain was improved in 68 (95%), 69 out of 72 (96%) could performed most activities of daily living. Complications were found in 13 patients (18%). Local failure was observed in 11 (15%). In simple internal fixation, local failure rate is eleven percent by 6 months, but the results deteriorated with time. After 26 months, local failure free rate is as lowering as 0. On the contrary, in excisional surgery, local control rate lasts 86 % after 2 years.

**Conclusions:** Our results indicate that our treatment taking consideration life expectancy is a reliable method. Patient's with a short life expectancy should be treated less invasively, and patients with a long expectancy require aggressive surgery to achieve long lasting local control.

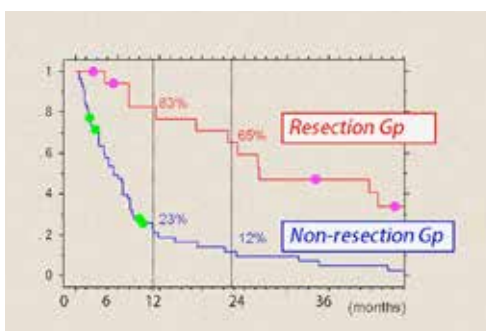


Figure 1. Overall Survival

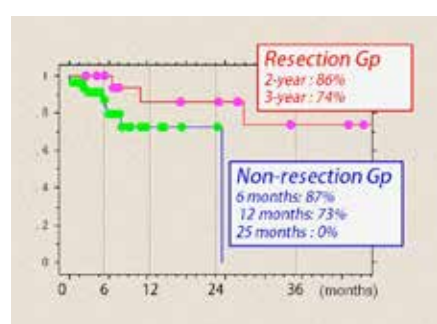


Figure 2. Local control rate

Group	Details of failure	n	Interval from OP (mths)	Main cause
Resection Gp 3/19 (16%)	Local recurrence	2	7.4 (7.3-7.5)	Insufficient surgical margin
	Deep infection	1	12.2	
Non-resection GP 8/53 (15%)	Local recurrence	3	7.7 (6.3-8.7)	Underestimation of survival
	Implant failure	2	16.2 (6.1-26.2)	
	Loss of fixation	1	0.3	
	Deep infection	1	3.0	



Figure 3. Complication

2584

### Minimal invasive intramedullary stabilization of metastatic humerus lesions

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Surgical treatment of metastatic bone disease affecting the humerus can be a challenging problem and a tradeoff between preserving limb function without posing a risk for residual survival. A pathologic lesion in the bone significantly decreases quality of life for cancer patients. In this prospective study a minimal invasive bone stabilization device (IllumiOss) was used to achieve bonestabilization reduction of pain and functional improvement.

**Methods:** 23 patients with 24 impending or actual pathological fractures of the humerus secondary to metastatic lesions were included in this open label prospective trial. Clinical and radiographic follow-up evaluations were scheduled at 14, and 45 days and every four-month from surgery. Radiological results and clinical performance and function (MSTS) and pain were evaluated.

**Results:** Average procedure time was around one hour (0:51 –1:18). No post-op infections occurred and no revisions of the device were necessary in the first 4 month. 21 patients received radiation therapy in the first 14 days after the operation. The VAS score for pain decreased between baseline and 14 resp. 45 days after surgery, from 85 to 37,2 resp. 19,2 and MSTS function scores increased from 7.8 to 17.3. Quality of life improved significant between surgery and the first two appointments.

**Conclusions:** The presenting system is able to achieve sufficient stabilization in patients with impending and imminent pathologic fractures even when the bone stock is very limited. It is a true minimal invasive technique. The device is able to fill and adapt to the shape of the intramedullary canal and seems sufficiently tamponade the tumor, so prolonged bleeding is diminished. Local control was excellent in 20 patients.

2642

### The IlluminOss Fluid nail for stabilization of proximal humerus fractures and impending fractures

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**Introduction and Purposes:** Metastases of the humerus are very commune lesions. They are usually treated conservatively: immobilization and radiotherapy are often sufficient because of the humerus does not have to support weight bearing. Nevertheless, when the osteolysis is important surgery could be advisable to decrease the risk of fracture. Intramedullary nailing is considered the mainstay treatment for radiosensitive metastasis but unfortunately the presence of an electron dense material interferes with successive radiotherapy and with its effectiveness. The IlluminOss system consists in an intramedullary stabilization with a fluid monomer that exposed to UV polymerizes becoming harder, so that it can be drilled and locked with screws. We present the preliminary experience in treating fractures and impending fractures with this system.

**Materials and Methods:** From October 2014 to January 2018, ten patients underwent intramedullary stabilization with IlluminOss system for metastatic osteolysis of the humerus. The average age was 69,9 years (62-77); six were affected by multiple myeloma, two by metastases of breast cancer and two by metastases of lung cancer. Lesions were located at the proximal metaphysis in 6 cases, at the central diaphysis in 3 cases and at the distal diaphyseal third in one case.

**Results:** All surgeries were performed without problems and complications; a screw was used to lock the nail in metaphyseal lesions. Nine out ten patients completed adjuvant radiotherapy with a good consolidation/ossification with an easy identification of the target by the radiotherapists; in the last performed case radiotherapy is still ongoing.

**Conclusion:** The IlluminOss intramedullary stabilization system could be considered a good method for treating osteolysis of the humerus. More studies with more numerous series are necessary to verify the effective advantages for the patients and possible problems in case of removal.

2418

### Minimal Invasive direct anterior approach versus standard lateral approach in the management of tumor located in the femoral neck

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**Background:** To compare the clinical outcome of patients with benign or aggressive tumor of the femoral neck who underwent surgical curettage by the minimal invasive direct anterior approach and the standard lateral approach.

**Methods:** 58 patients diagnosed with benign or aggressive tumor of the femoral neck who underwent surgical curettage at our musculoskeletal oncology center from 2010 to 2017 were retrospectively enrolled. The patients were divided into two groups: group A, 46 patients who had surgery with the standard lateral approach; group B, 12 patients who had the same procedure via the minimally invasive direct anterior approach. Oncological outcomes as well as perioperative parameters were compared between two groups.

**Results:** The median follow-up period was 43 months (15-97 months). The two groups showed no significant difference when compared in 3-year and 5-year event free survival rate ( $p=0.37$ ). Patients of group B had comparable operation time ( $92 \pm 21$  min vs.  $114 \pm 17$  min), shorter surgical incision ( $9 \pm 2.5$  cm vs.  $6 \pm 1.7$  cm), less blood loss ( $275 \pm 43$  ml vs.  $137 \pm 35$  ml), less pain ( $4.7 \pm 1.3$  NRS score vs.  $2.9 \pm 1.8$  NRS score), shorter hospital stay ( $9 \pm 3$  days vs.  $7 \pm 2$  days). Also, patients of group B had a higher Harris Hip Score at one month postoperatively ( $89 \pm 11$  vs.  $92 \pm 6$ ). One patient of group B experienced intraoperative incomplete fracture of the femoral neck which was treated conservatively.

**Conclusions:** Surgical curettage for patients with benign or aggressive tumor of the femoral neck by the minimal invasive direct anterior approach had a comparable oncological outcome and a better perioperative and function outcome than by the lateral approach. Certain strength of the femoral neck may be needed to avoid pathological fracture, which would be difficult to treat by internal fixation in this approach.

2523

### Prevention of impending pathological hip fracture with Y-STRUT® medical device: technique and clinical experience

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**Introduction and Purposes:** Bone metastasis located at the proximal femur may cause severe pathological fractures and reduce life expectancy for this fragile population<sup>1</sup>. Y-STRUT® medical device (Hyprevention, France) has been designed to provide prophylactic reinforcement of the proximal femur for these patients<sup>2,3</sup>.

**Materials and Methods:** An observational post-market study HIPON100 was initiated in March 2016 to include 100 patients with a 2-year follow-up. We included the first 15 patients implanted (mean 63 years old, 67% male) and followed up from 3 to 24 months. They all presented lytic lesions located in proximal femur with an average Mirels score of 8.7 (6-11). The minimally invasive implant, made of PEEK polymer and combined with PMMA bone cement, was implanted in 88±23min, under general or spinal anaesthesia, with 7 to 22ml of cement injected.

**Results:** Hospitalization duration was 3.2 days (1-9), and all patients could walk before discharge. One patient deceased from his metastatic disease and one sustained a fracture after 9 months due to severe tumour progression. The implant was replaced by plate and screws. VAS score stays low (≤3) for all patients, and post-operatively up to a year. Besides, chemotherapy/radiotherapy were not stopped before and could be resumed after implantation.

**Conclusion:** Prophylactic surgical stabilization with the studied device appears to be a feasible solution to improve the quality of life of oncologic patients, with low risk of operative complications. Further inclusions should confirm efficacy and clinical benefits.

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2447

## The heat transfer modelling for minimization of bone tumor lesion using the cement polymerization effect

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**Introduction and Purposes:** Bone metastases, which are frequently diagnosed late, translate an advanced tumor stage and have a high impact in patients' quality of life and survival. After the diagnosis and tumor staging, it is important to characterize the bone tumor lesions with specific attention to identify the size, type (osteolytic, osteoblastic, mix), location, etc. in the involved bone [1]. Tumors can destroy the spongy and cortical bone and extend to soft tissues. The bone cancer treatment is complex, and can include surgery, chemotherapy and radiotherapy, or other local or systemic treatments combinations, with the aim to cure or control the affected anatomic area. Bone cement (polymethylmethacrylate, PMMA) is widely used in orthopaedic surgeries due to their structural and physical properties, excellent biocompatibility and easy manipulation. This material has an exothermic reaction where volumetric dimension changes during the polymerization process with heat generation [2]. The high heat generated can lead to thermal necrosis of bone cells and also residual stresses formation that can affect the endomedular systems fixation and loosening. Different authors studied the exothermic reaction of cement polymerization and reported in different publications predictive results regarding the temperature rise and residual stresses using time-dependent polymerization function [2], [3]. Others proposed empirical models for the prediction of heat generated using experimental and numerical tests [4], [5]. In this work, the bone cement PMMA was introduced to fill in a metastatic lytic lesion area, which the main objective is playing a promising role for bone tumor necrosis due to thermal effects and biomechanical stabilization for function. All results were presented to promote a discussion for better clinical benefit and if the introduced PMMA is an alternative methodology.

**Materials and Methods:** Different numerical models were produced representing a two dimensional bone geometry with an external diameter equal to 31,2mm and with cortical thickness of 7.35mm. In the middle of the model was introduced a cement bone with the dimensions equal to H=20mm in depth and variable width L=10, 15, 20, 25 mm. Numerical models were building accordingly to average dimensions obtained from digital medical images from patients and approved from a biomechanical data control group [6]. All thermal material properties (cortical, spongy bone, cement, and endomedular titanium nail) are in accordance with the literature [2], [7]. The time-temperature depend effect in PMMA was introduced in the numerical model according experimental results from literature [5].

**Results:** The results show that the temperature in PMMA zone reaches the maximum value of 83°C and that the heat is spread through cortical and spongy bone. Increasing the amount of cement, the affected area in bone tissue also increases. The bone cement interface has a temperature equal to 83 °C at high temperature PMMA polymerization. The affected thermal necrosis occurs in the same bone area in a region width of 10 mm. For an increase amount of 5mm in the metastatic lytic lesion filled with PMMA cement, the thermal effect produces always more 10mm of surrounding spongy bone necrosis area. When the intramedullary nailing system was reproduced, the bone cement was spread in the same quantities through spongy bone. With the increase of the lytic lesion (and with the consequent increase of PMMA), the heat affects all bone tissue diameter due the good conductivity properties of the titanium endomedular nail. All cement filling the metastatic lytic lesion area affect the spongy bone and the cortical bone, and small cement quantities produce high surrounding temperature distribution.

**Conclusions:** The results obtained from the numerical analysis using the finite element method permit to conclude about the high temperature spread in bone material. In conclusion, values greater than 47°C were obtained in models without internal endomedular nail. With high width dimensions for introduced cement material filling a metastatic lytic area, the thermal effect in bone is equal through the horizontal side spread, but increase the bone area in lateral corners of the cement zone. High quantities of cement material produce thermal necrosis in bone more pronounced in depth. When the endomedular nail material is introduced, the quantities effect of cement material induces heat transfer in all model's domain due to the titanium endomedular nail as a good material conductor.



Bone cement filling and the structural stabilization with an endomedullary nail appear to have a synergic effect that can be applied to long bones metastatic lytic lesions treatment.

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2363

### Radiofrequency Ablation as a treatment for atypical cartilaginous tumors - Results of 10 years experience and 133 patients

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**Background:** Atypical cartilaginous tumors (ACT), formerly known as grade 1 chondrosarcoma, can show aggressive local growth without tendency to metastasize. Since they are resistant to both radiotherapy as well as chemotherapy, first choice of treatment has so far been surgical, either by curettage or wide resection. Radiofrequency ablation (RFA) is a minimal invasive alternative that has shown promising results in treatment of small benign tumors. However, its efficacy has not yet been studied in the treatment of larger tumors. In our hospital we developed the use of this technique for treatment of ACT for the last 10 years.

**Method:** Data of all RFA procedures for ACT in our center was collected from the patient files and the prospectively kept local bone tumor database. Data consisted of procedure variables like temperature, number of needle positions and ablation time. Procedures were both CT-guided as well as intra-operative. Tumor volume in cm<sup>3</sup> was pre-operatively measured on MRI and ablation zone was assessed 3 months post-op. Primary endpoints were treatment result and occurrence of complications.

**Results:** Out of 133 procedures we achieved a R0 ablation (complete ablation with clear margin) in 91 procedures (=68.4%). In 17 procedures (=13.7%) the result was R1 (complete ablation, without clear margin) and 16 procedures (=12.9%) were R2 (incomplete ablation). In 9 procedures the result could not be described due to lack of follow-up MRI. Result is best for relatively small tumors up to 20cm<sup>3</sup>. Higher temperatures and longer ablation time per needle tend to have a positive effect on treatment result without significantly more complications. In 21 procedures (=15.8%) a complication occurred.

**Conclusion:** Results for RFA as a form of treatment for ACT are promising with complete ablation in over 80% of procedures. Complication rates are similar to curettage. Considering the minimal invasive character we recommend the use of RFA in the treatment of ACT under 20cm<sup>3</sup>.

2575

### Endoscopic curettage of benign bone tumours

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**Purpose of the Study:** Assessment of the functional and oncological outcome of patients following endoscopic curettage of benign bone tumours.

**Material and Methods:** During the period from 2012 and 2016, 26 patients suffering from symptomatic intraosseous benign bone tumours were included in this study. There were 14 females and 12 males. Their average age was 20 years ranging from 3 to 49 years. Diagnosis included aneurysmal bone cyst in 8, unicameral bone cyst in 6, intraosseous lipoma in 4, giant cell tumour in 3, chondroblastoma in 2 and one case of benign fibrous histiocytoma, fibrous dysplasia and non-ossifying fibroma. The lesions were located in the proximal tibia in 6, distal femur in 6, calcaneus in 4, distal tibia 3, proximal humerus 3, talus 2, proximal femur 1, and fibula 1. Following curettage, the cavity was filled with bone graft in 5 patients and PMMA in 7 patients whereas no filler was used in the remaining 14 patients. The procedure used a 4mm 30 degree scope for endoscopy and high speed burr 3.5 – 5mm for extended curettage. The functional outcome was assessed using the revised musculoskeletal tumour society score.

**Results:** The average follow up period was 41 months (range from 26 to 58 months). After exclusion of one case that was lost to follow up, the remaining 25 patients showed full functional recovery at a period of 8-12 weeks and improved mean functional score from 20.2 to 28.6 postoperatively (p value <0.001). One patient developed local recurrence. One patient developed an intraoperative fracture.

**Conclusion:** Endoscopic curettage of benign bone tumours is a new effective treatment modality that has oncological and functional outcomes similar to standard techniques but with faster recovery and rehabilitation.

## 2609

### Spinal osteoid osteoma in children and CT-guided radiofrequency ablation : technical problems, results and follow up

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**Objective:** osteoid osteoma is a benign bone tumors very painful and the spinal involvement is about 15 % of all cases. Our purpose is evaluate the efficacy of CT-guided radiofrequency ablation in Pediatrics and report our experience.

**Methods:** In the last 10 years 14 patient suffering from spinal Osteoid Osteoma were treated in Our Pediatric Institute. The patient were from 8 year old to 15 year old. All of them were studied by Xray, CT scan, MRI and Bone scintigraphy, and were treated using CT -guided percutaneous RF ablation,: the probe burns the core of the lesion at 90° degree for 6 min average. All the patients were retrospectively valuated.

**Results:** 11 patients of the 14 patients had complete pain relief after the procedure in the next month after the procedure. 3 of the 14 patients had recurrence between 1 month to 12 months late the procedure: for all of them was decide the open- surgery to treat the recurrence.

**Conclusion:** The data of this study support the efficacy of the technique ; we discuss the technical problem and the development of this kind of surgery.

# SESSION 21 FREE PAPERS 2

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### **Cement spacers after first stage revision of lower limb endoprosthetic replacements: how to avoid complications**

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**Introduction and Purposes:** There is a paucity of data to describe the complication rates and the optimal type of temporary segmental reconstruction between stages revision surgeries. We describe the use of K (Kirschner) nail reinforced antibiotic loaded cement (ABLC) spacers and aimed to identify 1) the clinical outcomes following this temporary reconstruction and 2) describe the optimal method of reinforcement to minimise mechanical complications.

**Materials and Methods:** We identified all patients who underwent first stage revision of a lower limb endoprosthetic replacement (EPR) following bone tumour resection for prosthetic joint infection from a prospectively collected database at our hospital. A total of 45 patients underwent the procedure between 2007 and 2017. There were 14 proximal/total femurs, 13 distal femoral replacements and 17 proximal tibial replacements.

**Results:** We retrospectively analysed x-rays to calculate the percentage of the segmental loss and reinforced spacer relative the total lower limb length. Mechanical failures were defined as fracture, perforation, dislocation or subluxation of the spacer. 18 (47%) suffered failure of their spacers, of which 11 had mechanical failures (29%) and 7 had reinfections (18%). 9/11 mechanical complications occurred within two weeks of implantation. Two patients had re-operations for a failed spacer as a result; six had amputations with ten making a successful recovery. Four of 11 mechanical complications showing a 'windscreen effect' on their radiograph were attributed to insufficient (<5% bone defect) spacer into the residual bone, causing dislocation and/or fracture. 53% of all patients with a spacer <200% of the size of the defect had mechanical complications. The failure rate for two-stage revision EPR spacers in this cohort of patients is 47%. 73% of the patients with mechanical complications fully recovered, but only 57% made full recovery with infective complications.

**Conclusions:** Although the numbers of this review are quite small, this study provides surgeons with intra-operative guidance to avoid such complications.



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## Chondrosarcoma of the shoulder girdle behave differently depending on the location of the tumour

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**Introduction and Purpose:** Chondrosarcoma (CS) is a malignant neoplasm with cartilage differentiation. The most important factor for guiding management and prognosis is determining the histological grade of the tumour.

**Material and Methods:** Between 2000 and 2017, three oncological centers treated 138 patients with shoulder girdle chondrosarcoma. 101 were located in proximal humerus (PH) and 37 in scapula (S). 82 (59%) patients were female and the mean age was 53 years in PH and 50 years in S patients. Grade distributed equally between PH and S patients. Mean size was of the tumour was 10.4 cm in PH and 7.8 cm in S patients.

**Results:** Limb salvage was successful in 92 (92%) and 36 (97%) in PH and S patients respectively. Excision without reconstruction was done in 2 (12%) and 32 (87%) in PH and S patients respectively. Margin was intralesional in 24 (4%) and 3 (9%), marginal in 39 (39%) and 20 (57%) and wide in 36 (36%) and 2 (34%) in PH and S patients respectively. Local recurrence (LR) was seen in 12 (12%) in PH and 10 (27%) in S patients ( $p=0.039$ ). 12 (12%) of the PH patients developed disseminated disease in comparison to 6 (16%) among S patients, ( $p=0.503$ ). Disease specific survival (DSS) was at 1- and 5-years; 98% and 90% in PH and 88% and 80% ( $p=0.092$ ) in S patients. The DSS was similar in grade 1, 3 and dedifferentiated CS patients but significantly better in grade 2 PH patients. The 1- and 5 years DDS in grade 2 CS was 100% and 97% among PH patients and 100% and 76% ( $p=0.012$ ) among S patients (Figure).

**Conclusions:** It is well known that grade is the most important factor for patient survival and our results are in concordance with the literature. However, our results show that grade 2 CS in PH seems to behave in a less aggressive manner when compared to grade 2 CS in S or other locations known from the survival rates in the literature. LR rate was lower and DSS was better than expected, even though tumours were larger in size and were operated with more narrow margins than in scapula tumours.

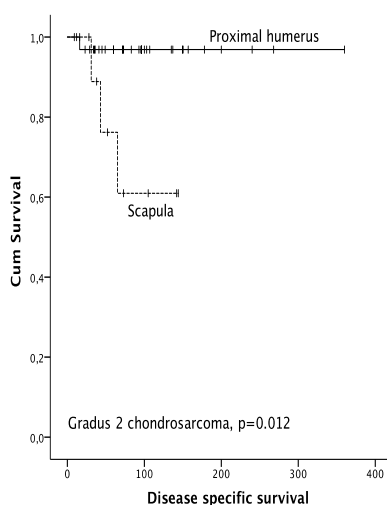


Figure Disease specific survival in grade 2 chondrosarcoma, stratified by location.

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### A case comparison study of upper and lower limb sarcoma cases – is there a difference in presentation and prognosis?

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**Introduction:** There are many prognostic factors for patients with bone sarcoma such as histological subtype, age at presentation and staging<sup>1</sup>. However there is no good evidence regarding outcomes of sarcoma relative to the extremity localisation<sup>2</sup>. We hypothesised that upper limb bone sarcoma cases appear to present in a younger age group and in a more aggressive fashion.

**Methods:** Logbooks were reviewed between 1997 and 2018 for patients with aggressive bone sarcomas of the humerus. A second cohort of lower limb bone sarcomas was collected during the same period as a comparative group. Data collected including basic demographic information, age at presentation, initial staging (prior to any neoadjuvant treatment), local recurrence, metastatic disease, amputation rate and mortality.

**Results:** A total of 30 cases presented to our institution with upper limb bone sarcomas during this time. This is compared to a series of 30 patients with lower limb sarcoma during the same time period. Mean age of presentation in both groups was 33 years of age in the humerus group versus 44 in the lower limb group ( $p=0.047$ ). Mean follow up in both groups was 6 years. Four patients presented with metastatic disease at initial staging in the upper limb group versus six in the lower limb group. Rates of recurrence were similar in both groups with five in the upper limb group, compared to four in the lower limb group. Five patients in the upper limb group had new metastatic disease diagnosed post initial resection versus four in the lower limb group. Four patients in the upper limb group were treated with primary amputation due to the staging of the cancer versus zero in the lower limb group. Within the follow up period there were 8 deaths in the upper limb group versus 5 in the lower limb group which gives a survival of 73% and 83% respectively.

**Conclusions:** Within our comparative consecutive case series of upper and lower limb sarcoma there do appear to be differences in the presentation of the patients with upper limb sarcomas presenting at a younger age and more often requiring amputation in their management. Rates of recurrence and metastatic disease were similar, however mortality was higher in the upper limb group. This paper adds to the current literature regarding prognostic indicators for bone sarcoma.

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## Identifying risk factors for increased venous thromboembolism in patients with benign and malignant bone tumors

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**Background:** Patients with malignancies of the bone are at increased risk for venous thromboembolism (VTE), and many surgeons consequently advocate for prophylaxis in these patients. Due to the relatively low incidence of this complication, however, we aimed to determine what differences in the type of malignancy, location of malignancy, and pre-operative risk factors can be identified.

**Methods:** The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) 2005-2016 database was queried to identify patients undergoing surgery with a primary diagnosis of a bone tumor. Benign and malignant cases were identified using International Classification of Diseases, 9<sup>th</sup> Revision (ICD-9) codes. Univariable analysis with independent-samples t-tests and Fisher's exact tests as well as multivariable analysis with binary logistic regression were used to determine risk factors for VTE. Significance was defined as  $p \leq 0.001$  after applying the Sidak correction.

**Results:** A total of 2,557 procedures performed on patients with bone cancer were included in our final analysis. The majority of cases were benign (56.6%) and rate of VTE was 1.8% (n=48). There was a significant difference in risk of VTE between patients with malignant (3.8%) and benign (0.3%) tumors ( $p < 0.001$ ). Univariable analysis also showed a relationship between pre-operative hematocrit, total operative time, presence of disseminated cancer, pre-operative blood transfusion, and location of malignant tumor of the pelvis, sacrum, or coccyx and the spine ( $p < 0.001$ ). Age, gender, race, pre-operative platelet count, white blood cell count, PTT, PT, INR, and BMI were not associated with VTE risk. On multivariable analysis, malignant tumors were associated with an increased odd of VTE compared to benign tumors (OR=6.12), while other tested variables failed to achieve significance. Location of tumor did not have a significant effect on rate of VTE on multivariable analysis.

**Conclusion:** Perioperative prophylaxis for VTE may be beneficial in patients with malignant cancers of bone but may not be as useful in those with benign tumors. Surgeons should have a higher index of suspicion for thromboembolic events in patients with these identified risk factors.

Table 1: Significant Predictive Variables of VTEa on Univariable Analysis and Association of Comorbidities in Patients with Benign versus Malignant Bone Cancer

Variable	No VTEa	VTEa	P Value
Pre-Operative Hematocrit (mean $\pm$ SDb)	39.3 $\pm$ 5.6	36.1 $\pm$ 7.8	<0.001*
Total Operation Time (mean $\pm$ SDb)	186.7 $\pm$ 178.1	362.3 $\pm$ 258.9	<0.001*
	Frequency (%)	Frequency (%)	
Disseminated Cancer	259 (95.2%)	13 (4.8%)	<0.001*
Pre-Operative Blood Transfusion	40 (88.9%)	5 (11.1%)	<0.001*
Malignancy of Tumor			<0.001
- Malignant	1,066 (96.1%)	43 (3.9%)	
- Benign	1,443 (99.7%)	5 (0.3%)	
Location			
- Malignant Tumor of Pelvis, Sacrum, or Coccyx	172 (93.5%)	12 (6.5%)	<0.001*
- Malignant Tumor of Spine	244 (93.8%)	16 (6.2%)	<0.001*

a Venous Thromboembolism - b Standard Deviation

Table 2: Odds ratios (OR) for Significant Predictor Variables of VTEa in Patients with Malignant Bone Cancer, Based on Multivariable Analysis

	Value	ORb (95% CIc)
Pre-Operative Hematocrit	0.183	0.97 (0.92-1.02)
Total Operative Time	0.005	1.00 (1.00-1.00)
Disseminated Cancer	0.185	1.62 (0.80-3.28)
Pre-Operative Blood Transfusion	0.085	2.61 (0.88-7.77)
Malignant Tumor (vs. Benign)	0.001*	6.12 (2.1-17.87)

a Venous Thromboembolism - b Odds Ratio - c Confidence Interval - \* Statistically Significant, Defined as p < 0.001.

2298

### Treatment results of bone sarcoma patients in the Republic of Slovenia 2009-2019: a nation-wide cohort study

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**Introduction Aand Purposes:** The Cancer Registry of Slovenia was established in 1957, but bone sarcomas have so far not been followed-up with a longitudinal cohort analysis. Our aim was to perform a nation-wide cohort study on treatment of bone sarcoma patients in the Republic of Slovenia 2009-2019 with oncological survival and endoprosthetic outcomes.

**Materials and Methods:** The study included all patients with bone sarcoma of long bones, pelvis or sacrum in the Republic of Slovenia between 2009 and 2019. Patients were treated at a single oncological centre in accordance with the national guidelines. All complications were recorded in the course of follow-up, including surgical revisions, local disease progression or death.

**Results:** The cohort included 110 bone sarcoma patients, therefrom 57 cases with megaendoprosthesis reconstruction. The mean age at diagnosis was  $41 \pm 22$  years and the mean follow-up period  $46 \pm 35$  months. By the end of observation, 27 patients died of oncological disease and 4 were lost for follow-up. Out of 29 (26 %) patients requiring at least one surgical revision after sarcoma resection, there were 6 (5 %) local tumor recurrences, 12 (11 %) deep infections, and 11 (10 %) endoprosthetic mechanical complications. In the subcohort with at least 5 years of follow-up, the bone sarcoma patient survival rate 5 years after the diagnosis was 64 %.

**Conclusions:** With the 5-year oncological survival of 64 % and overall deep infection rate 11 %, the treatment results in Slovenia are comparable to other European cancer registries where bone sarcoma survival has not improved significantly in the last 25 years. Nevertheless, silver-coated implants and better microbiological diagnostics in the last decade may have contributed to better prevention/treatment of endoprosthetic infections.

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2583

### Does insurance status affect outcomes in patients with malignant bone tumors?

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**Objective:** Research over the past decade has reported differences in outcomes of a variety of orthopaedic conditions based on insurance status and may highlight unmet needs in a vulnerable population. We identify associations between insurance status outcomes after inpatient treatment of malignant bone cancer.

**Methods:** The Nationwide Inpatient Sample database 2001-2013 was queried for patients with malignant bone cancer using ICD-9 diagnostic codes. Chi square analysis was performed to determine significant predictors of complications. Binary logistic regression was then used to account for demographic and significant predictors.

**Results:** A total of 23,149 inpatients were included in the final analysis. Complication rates included 3.3% mortality (n=761), 8.4% prolonged lengths of stay (n=1,940), 28.4% nonroutine discharges (n=6,568), and 8.3% postoperative complications (n=1,932). Regression showed that, compared to privately insured patients, uninsured patients and those with Medicaid and Medicare had higher rates of mortality (OR=1.63, 1.39, and 1.44, respectively). Patients with Medicare were more likely to have a postoperative complication (OR=1.27) and have a nonroutine discharge (OR=1.62). Uninsured patients and those with Medicaid and Medicare had higher rates of prolonged length of stay (OR=1.32, 1.46, and 1.37, respectively). Interestingly, uninsured patients had a significantly lower rate of nonroutine discharge (OR=0.69).

**Conclusions:** Having non-private insurance is independently associated with higher rates of mortality, postoperative complications, prolonged length of stay, and nonroutine discharge. Uninsured patients were associated with a lower rate of nonroutine discharge. This may result from a selection bias, as those without insurance are more likely to be homeless or leave against medical advice. Further investigations into the root cause of this difference is warranted to ensure equal access to care.



2596

## **Surgical strategy for benign lesions in proximal femur: internal fixation or endoprosthetic replacement**

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**Purpose:** The purpose of this study was to explore the indications for the two most frequently applied surgical procedures for benign lesions in the proximal femur.

**Methods:** We retrospectively reviewed 142 patients with benign lesions in the proximal femur from January 2010 to January 2015. Internal fixation (IF) was adopted in 110 patients, while endoprosthetic replacement (EPR) was applied in 32 patients. Clinical data, including operation time, blood loss, hospitalization time, and hospitalization expenses, were compared between the groups. Limb mobilization was evaluated by the Musculoskeletal Tumor Society Score-93 (MSTS-93) and Harris Hip Score (HHS). Local recurrences and complications were statistically compared.

**Results:** The average follow-up was 66 months (range 32–84 months). In the EPR group, operation time and hospitalization time were significantly shorter ( $p < 0.05$  and  $p < 0.05$ , respectively), while blood loss and hospitalization expenses were significantly higher ( $p < 0.05$  and  $p < 0.05$ , respectively). Functional outcomes of the MSTS-93 and HHS were higher at the three-week follow-up in the EPR group ( $p < 0.001$  and  $p < 0.001$ , respectively) but lower at 6 months ( $p = 0.031$  and  $p = 0.042$ , respectively). No differences were observed in the two scores at three months ( $p = 0.261$  and  $p = 0.134$ , respectively). Local recurrence and complication rates were similar in the two groups ( $p = 0.895$  and  $p = 0.942$ , respectively).

**Conclusion:** The strategy for benign proximal femur lesions should depend on the site, size, initial diagnosis, and thinning degree of cortical bone. IF and EPR both result in satisfactory local control and functional and radiological results, while EPR is more suitable for aggressive and recurrent lesions and serves as an effective measure after IF failure.

**Keywords** Benign lesions. Curettage. Internal fixation. Endoprosthetic replacement. Surgical strategy

# E-POSTERS

2238

## Genomic characterization of radiation-induced sarcoma using whole genome sequencing

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**Purpose:** Radiation-induced sarcoma (RIS) is a rare but serious complication after radiotherapy. To identify predisposing variants and mutational landscape, we analyzed the genomes of RIS samples. Herein, we report the interim results of our analysis.

**Materials and Methods:** Sarcoma specimens developed in the previously irradiated area were reviewed by experienced pathologist. DNA was extracted from freshly frozen tumor tissues or isolated tumor region through microdissection, along with isolated normal tissue or blood derived from the same individuals. In all cases, whole genome sequencing (WGS) was performed with the average coverage of tumor DNA 90bp and of normal DNA 60bp, and targeted panel sequencing of cancer-related genes was also performed in selected two cases for validation.

**Results:** Of total 25 samples, WGS sequencing of five patients were completed. RIS from different primary tumors included 2 undifferentiated pleomorphic sarcoma, 1 undifferentiated spindle cell sarcoma, 1 osteosarcoma and 1 angiosarcoma. The median latency of RIS was 8 years (range, 5-12). RIS harbored median 4,218 substitutions (range, 962-45,597) per genome and median 987 indels (range, 590-44,957) per genome. Excess of deletions relative to insertion was observed in all five samples. However, there was no significant somatic mutation in cancer-related genes for all cases. Each of the five cases showed different patterns in the copy number analyses, and inter-chromosomal translocation did not appear constantly through all samples.

**Conclusion:** We identified excessive deletions and low number of mutations without cancer driver mutation in RIS patients. The further analysis with additional patients is ongoing, and we suggest that this genetic study may reveal the underlying mechanism of the development of RIS and help patients to be treated with a novel treatment strategy.

**Keywords:** Radiation-induced neoplasm, sarcoma, whole genome sequencing

2244

**A histological positive margin after surgery is correlated with high local re-recurrence rate in patients with recurrent myxofibrosarcoma**

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**Background:** Myxofibrosarcoma has high frequency of local recurrence after surgery. To determine an optimal treatment for recurrent tumors, clinical features of recurrent cases should be characterized.

**Methods:** We performed a retrospective analysis of 30 patients with recurrent myxofibrosarcoma who underwent surgery.

**Results:** A negative margin after surgery was achieved in only 12 patients. The 5-year re-recurrence free survival rate was 31.7%. The 5-year re-recurrence free survivals for those with positive histological margin and those with negative margin were 9.8% and 62.3%, respectively, which indicated that a positive margin was the significant predictor of poor prognosis ( $P=0.006$ ). In 21 patients with recurrent myxofibrosarcoma in the extremities, 10 patients ultimately underwent amputation in the follow-up period and the 5-year amputation-free survival rate was 62.5%.

**Conclusions:** The majority of recurrent cases could not achieve negative margin and a positive margin is a significant poor prognostic indicator for local re-recurrence in patients with recurrent myxofibrosarcoma. To control local recurrence of myxofibrosarcoma was extremely difficult and amputation is often needed in the extremity cases.

2248

## Langerhans cell histiocytosis of the spine in a child: a rare case and a diagnostic dilemma

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**Introduction and Purposes:** Langerhans cell histiocytosis (LCH) comprises a rare spectrum of disorders from abnormal histiocyte proliferation. In children, incidence is from 2.2-8.9 per 10<sup>6</sup>, with spine lesions in 25%. Radiologic features are non-specific, often misdiagnosed as malignancy or infection. In endemic countries, Pott's disease caused by M.tuberculosis is a more common cause of vertebral body osteolysis. Left untreated, both conditions may cause severe sequelae. Tissue biopsy is the gold standard in differentiating LCH from spinal TB.

**Materials and Methods:** We present a rare case of Langerhans Cell Histiocytosis of the spine in a child, and the diagnostic dilemma encountered.

**Results:** An 8-year-old female presented with 1-month history of back pain, sans other symptoms. Pediatric consult yielded normal labs. Persistence despite pain relievers prompted Orthopedic referral, where whole spine x-rays showed anterior wedging of T11. Thoracic spine CT showed osteolysis of the T11 vertebral body suggestive of TB spondylitis, prompting CT-guided biopsy. Initial microscopy was negative for AFB and bacteria. The patient was started on TB medication while awaiting final results. Six weeks post-biopsy, cultures, Gene Xpert and TB-PCR studies were all negative. Histopathology was consistent with Langerhans Cell Histiocytosis.

**Conclusions:** While treatment is well-established for spinal TB, the clinical course and best intervention for spinal LCH remain uncertain. Up to 30% develop multisystem disease with higher likelihood of mortality, emphasizing accurate diagnosis and appropriate management.

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## 2251

### **Impact of adjuvant therapy using acridine orange in patients with soft tissue sarcoma treated with marginal resection: A comparative study**

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**Introduction and Purposes:** Although radical resection is important in the treatment of soft tissue sarcoma (STS), it is difficult to excise a tumor in contact with important tissue while maintaining a sufficient margin. There are few studies which have evaluated the effectiveness of adjuvant therapy with acridine orange (AO) for STS patients. Additionally, there is no study which investigated this among cases with marginal resection. We evaluated the effectiveness of AO therapy directly by comparing it to marginal resection cases that did not receive AO therapy.

**Materials and Methods:** This retrospective study included 19 and 33 patients with STS who received AO therapy (AO group) and marginal resection without AO therapy (non-AO group). The patients' information, including age, tumor location, size, metastasis, chemotherapy, the staging system of the American Joint Committee on Cancer (AJCC), local recurrence, and outcomes, was collected. We compared the clinical courses between the two groups.

**Results:** Among all patients and those with high grade sarcoma, the AJCC stage in the AO group was significantly worse than that in the non-AO group. Additionally, the local recurrence rate in the AO group was significantly lower than that in the non-AO group ( $P < 0.05$ ). The local recurrence-free survival (LRS) curves significantly differed between the two groups ( $P < 0.05$ ). High grade malignancy and no treatment with AO were identified as risk factors for local recurrence ( $P < 0.05$ ). Only high grade malignancy affected patient prognosis ( $P < 0.05$ ).

**Conclusions:** AO therapy strongly suppresses local recurrence after marginal resection of STS.



## 2252

### **A daily diagnostic multidisciplinary meeting to reduce time to definitive diagnosis in the context of primary bone and soft tissue sarcomas**

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**Introduction:** Cancer services in the United Kingdom are under increasing pressure to deliver waiting time targets. Our service at the Royal Orthopaedic Hospital in Birmingham has seen referral numbers increase to over 3000 per annum, with more than 80% coming from secondary care. In order to deliver a responsive service, the department has introduced a daily diagnostic multidisciplinary meeting (DMDT). The aim of which is stratification of resources by directing rapid access to clinics and diagnostics to those felt to be at greatest risk of malignancy at the start of the pathway. It also aimed to improve communication with patients and referrers, consistency in decision making and deliver improved diagnostic turn-around times in a sustainable manner.

**Aims:** An evaluation was undertaken to assess whether the introduction of a daily DMDT has improved the pathway, the primary endpoint being a reduction in time to definitive diagnosis (TTDD). Secondary endpoints included measurements of efficiency and whether there has been a reduction in variation in practice.

**Methods:** Retrospective access to patient notes via the Onkos spinal database and IMPAX imaging database over a 1-month period before (2015) and after (2018) the intervention.

**Results:** The introduction of the DMDT has led to an improvement in service efficiency and a reduction in both TTDD (9 days) and time to first management decision (8 days). The service also has an added benefit in reducing average total patient miles travelled over the course of diagnosis by 24.41 miles.

**Conclusion:** The introduction of a diagnostic MDT at the start of the pathway does lead to an improvement in service efficiency and a reduction in TTDD.

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## 2257

### **Metastatic pleomorphic liposarcoma with pathological fracture of the proximal femur: A case report and review of the literature**

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**Introduction:** Soft tissue sarcoma of the extremities are exceedingly rare. Pleomorphic liposarcoma (PLPS) is the less common histopathological subtype of liposarcoma. Lung is the most common site of distant metastasis from PLPS, but extrapulmonary metastasis especially bone is very rare. There are few reports about bone metastasis from PLPS and the treatment strategies are still unclear.

**Purposes:** (1) To report the new case of bone metastasis from PLPS, (2) To present the treatment strategies of bone metastasis from PLPS.

**Case presentation:** In June 2014, a 56-year-old man was diagnosed with pleomorphic liposarcoma at posterior aspect of left thigh. He was treated with wide resection, postoperative chemotherapy, and radiotherapy. In December 2017, he had pathological fracture at intertrochanteric region of the right femur. The MRI revealed the tumor at right proximal femur with soft tissue extension. Incisional biopsy was performed, and pathological diagnosis was metastatic pleomorphic liposarcoma. En bloc proximal femur resection was performed and reconstructed with cemented long stem bipolar hemiarthroplasty. Polymethylmethacrylate (PMMA) was used to build up for replacing the proximal femur. Dacron vascular graft was placed cover PMMA to be the base for soft tissue reconstruction. The final pathological report was metastatic pleomorphic liposarcoma, free margin but vascular invasion was presented. He was treated postoperatively with radiotherapy and chemotherapy.

**Results:** The results at 6 months after surgery, he was still alive with the disease, but no local recurrence occurred. He could walk without gait aid. He had good functional outcomes with the Thai version of Toronto Extremity Salvage Score (TESS) for lower extremity was 74.2%.

**Conclusion:** Bone metastasis from PLPS is very rare but can be found. Wide resection is recommended. Radiotherapy and chemotherapy are still controversial and should be considered to the patient individually.

2259

### Organisation of bone sarcoma care: a cross-sectional European study

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**Aim:** High-grade bone sarcomas are aggressive tumours with a high potential of metastasis. Diagnosis and treatment of these neoplasms is challenging due to low incidences. Therefore, centralisation of sarcoma is important in order to realize a multidisciplinary approach by an experienced team. This study aims to assess organisation of care in several bone tumour centres in Europe affiliated to EMSOS for comparison and identification of potential improvements in organisation of care.

**Methods:** Data was obtained through a digital questionnaire filled in by EMSOS members of several bone tumour centres across Europe. The questions were focused towards diagnosis, multidisciplinary decision making and data storage.

**Results:** We received data from 25 representative of bone tumour centres across Europe. Authorisation to perform oncological care in a bone tumour centre was government issued in 36.0% and based on expertise without governmental influence in 64.0%. All of the centres used a multidisciplinary approach towards bone sarcoma care. During this multidisciplinary meeting a median of 15 cases were discussed. In terms of storage of oncological data, a local registry is used in 11 bone tumour centres (44.0%). A national registry is used in 11 bone tumour centres (44.0%).

**Conclusions:** A national bone tumour board for extensive case evaluation including classification and advice for treatment gives tumour centres with little adherence the opportunity to gain knowledge from an experienced team. Centralisation of care towards a bone tumour centre should be mandatory. A national registry is essential for adequate storage and reproduction of oncological data.

## 2263

### Tibial turn-up plasty for a failed limb salvage surgery with complex problems

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**Purpose:** The purpose is to present a solution for a failed distal femoral limb salvage surgery with complex problems.

**Patients:** The patient is a 22-year old female. She was diagnosed with osteosarcoma in the distal femur when she was 7-year old. The tumor located at the metaphysis and extended into epiphysis. Expandable prosthesis was too large for this young patient. We resected the tumor and reconstructed with pasteurized osteochondral autograft. Since then, she has been disease free. The pasteurized bone united but late complications developed. Because of the knee instability from ligamentous insufficiency, she could hardly bear her weight on the leg and needed double crutches. The lower limb showed insufficient growth resulting 11cm of limb discrepancy. Bone atrophy caused tibial fracture twice. Pasteurized graft underwent resorption with retrograde nail eroding on the tibia. However, rotation plasty was not appealing for this lady and impossible because of vascular abnormality with skin veins working as drainage veins.

**Method:** We performed tibial turn-up plasty to make her lower extremity similar to knee disarticulation. First, distal femur was taken out. Second, lateral skin and fibula was resected followed by amputation proximal to ankle joint. Finally, the tibia with medial skin was rotated clockwise as a vascularized pedicle graft and distal tibial osteotomy surface was osteosynthesized to proximal femoral cutting line so as the tibial plateau work as weight bearing area (Fig 1).

**Result and Conclusion:** She can walk with a cane and knee prosthesis with no pain. There was marked improvement of her Musculoskeletal Tumor Society score from 37% to 70% and Toronto Extremity Salvage Score also showed improvement from 78% to 82%. Tibial turn-up plasty can be an excellent option for failed limb salvage surgery.

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2265

## Effect of fascial manipulation on orthopedic disease

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**Introduction:** In recent years, I have experienced many examples of remaining pain in orthopedic disease after surgery. Various effective intervention methods are being studied for patients complaining of other parts of pain. There are approaches to the fascia among various intervention methods. We are said to be able to improve if pain due to muscle, fascia, joint capsule abnormality. A fascial manipulation was carried out this time and improvement was observed in the range of motion and muscle strength with the reduction of pain, so we report it.

**Purposes:** We decided purpose that to evaluate effect of fascial manipulation.

**Materials and Method:** The subjects were 15 (4 males, 11 females) who had orthopedic disease and underwent surgery. The survey was conducted from October 2016 to June 2017. The average age is  $70.9 \pm 9.7$  years. NRS · NRS improvement value · NRS improvement rate · ROM improvement value · ROM improvement rate · MMT improvement value · MMT improvement rate · NRS after 5 days as the items to be considered. The method used fascial manipulation of Luigi Stecco. Implementation was completed when tender tender at the time of implementation became NRS 2 or less.

**Result:** NRS: 9.1 before treatment 1.4 after treatment, NRS improvement value 7.6, NRS improvement rate 100%, ROM improvement value 23.3, ROM improvement rate 100%, MMT improvement value 1, MMT improvement rate 80%, after 5 days NRS 0.8 and significant We made improvements.

**Conclusions:** As a result of this study, improvements were obtained for all items by fascial manipulation. According to Carla Stecco et al, fascia are spread around the whole body, that densified is a leading organization of tissue from the sol causes dehydration of fascia tissue to gel. Agglutination of hyaluronic acid also occurs, which is said to cause friction failure of the fascia and cause pain. I considered that gain the normalization of the muscle length and the improvement of the fascial gliding performance. So, this approach was suggested to be effective immediately after treatment for orthopedic diseases.

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2266

## A case of malignant melanoma of unknown primary origin in the sacrum

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**INTRODUCTION:** It is rare for malignant melanoma of unknown primary origin to be diagnosed from bone metastasis. We report one such case with treatment challenges due to rapid progression.

**Materials** (case): A 47-year-old woman with abnormalities in the sacrum detected on computed tomography scanning for gynecological screening was referred to our department. Needle biopsy showed cells such as melanocytes but no atypical cells. The patient was thus followed up by imaging studies, which revealed no changes. Five years later, the patient returned to the department complaining of pain in the left lower limb. Advanced sacral destruction was observed on imaging. Biopsy results led to a diagnosis of malignant melanoma. No tumor was found outside the sacrum, thereby establishing a diagnosis of metastatic malignant melanoma in the sacrum of unknown primary origin. Carbon ion beam was administered to the sacrum; however, it was ineffective. Chemotherapy with nivolumab was initiated but had to be discontinued because of worsening of the pre-existing rheumatoid arthritis and concurrent development of autoimmune cholangitis. Dacarbazine therapy was administered instead, but this led to an increase in tumor size and bladder invasion. Currently, the patient is under observation, with palliative treatment.

**Discussion:** Most cases of malignant melanoma of unknown primary origin are diagnosed from lymph node metastasis. Yet, lymph node-only metastasis from malignant melanoma of unknown primary origin accounts for only about 5% of all malignant melanoma cases. Furthermore, there have been only a few reports on bone metastasis from malignant melanoma of unknown primary origin. Here, no changes were observed within the bone for several years, during which no malignancy was found on multiple biopsies. Once the tumor started to enlarge, it progressed rapidly. Malignancy was confirmed by biopsy.

**Conclusion:** The primary site could not be identified through examinations during the observation period. As with bone metastasis from melanoma with an identifiable primary site, the prognosis was poor. We discuss at what point surgical resection should have been considered.



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### The PARP inhibitor olaparib potentiates the effect of the DNA damaging agent doxorubicin in osteosarcoma

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**Introduction and Purposes:** PARP1 facilitates the recovery of DNA-damaged cells by recruiting DNA damage response molecules such as  $\gamma$ H2AX and BRCA1/2, and plays a role in resistance to antitumor therapies. Therefore, this study evaluates the expression and prognostic significance of the individual and combined expression patterns of PARP1 and PARP1-related DNA damage response (DDR) molecules such as  $\gamma$ H2AX, BRCA1, and BRCA2 in osteosarcomas. Thereafter, the possibility of therapeutic efficacy of co-treatment of the PARP inhibitor olaparib and doxorubicin was evaluated in osteosarcoma cells.

**Materials and Methods:** We evaluated the expression of DNA damage response molecules in 35 human osteosarcomas and investigated the effects of co-treatment of the PARP inhibitor, olaparib, and doxorubicin in osteosarcoma cells.

**Results:** The expression patterns of PARP1,  $\gamma$ H2AX, BRCA1, and BRCA2 were significantly associated with shorter survival of osteosarcoma patients. In osteosarcoma cells, knock-down of PARP1 and treatment of olaparib significantly inhibited proliferation of cells and induced apoptosis. Moreover, the anti-tumor effect was more significant with co-treatment of olaparib and doxorubicin in vitro and in vivo.

**Conclusions:** This study suggests that combined use of a PARP inhibitor with doxorubicin, a DNA damaging agent, might be effective in the treatment of osteosarcoma patients, especially in the poor-prognostic subgroups of osteosarcoma expressing PARP1,  $\gamma$ H2AX, or BRCA1/2.

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## Effect of NSAID combination with lidocaine on pain control for soft tissue biopsy patients: A randomized controlled trial study (Preliminary reports)

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**Introduction and Purposes:** The objective of this study was to compare the pain control efficacy of local nonsteroidal anti-inflammatory drug (NSAID) combination with lidocaine compared to local conventional lidocaine injection in core needle biopsy of musculoskeletal tumor.

**Materials and Methods:** Forty patients who suspected with musculoskeletal tumor were included in this randomized controlled clinical trial. Each patient was randomized into either NSAID combination with lidocaine group (20 patients) or lidocaine group (20 patients). The NSAID combination with lidocaine syringe contained 30 mg of ketorolac and 2% lidocaine with adrenaline; and lidocaine syringe contained 2% lidocaine with adrenaline. The pain level after core needle biopsy at 1, 6, 12, and 24 hours of each patient was evaluated using Visual Analog Scale (VAS) indicator.

**Results:** The patients in NSAID combination with lidocaine group had significantly decreased pain at 12 hours, while both groups were effective to pain relieve at 1, 6, and 24 hours after core needle biopsy.

**Conclusion:** In this study, the injection of NSAID combination with lidocaine resulted in greater improvement in pain control up to 12 hours after core needle biopsy of soft tissue in extremities based on VAS indicator.

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## Combined use of vascularized fibular graft and frozen autograft treated with liquid nitrogen for the reconstruction after excision of malignant bone tumors

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**Introduction:** The reconstruction of large bone defects following tumor resection remains a surgical challenge. The use of intercalary devitalized bone graft such as frozen bone, irradiated bone and pasteurized bone, has enabled the repair of massive bone defects while reconstituting bone stock and maintaining the adjacent joints, resulting in a durable reconstruction. However, it has been reported high incidences of nonunion, fracture, and infection when using intercalary devitalized autograft. Frozen autograft combined with a vascularized fibular graft (VFG) were performed at our institution for the reconstruction of metadiaphyseal large bone defects of the lower limb.

**Purposes:** The purpose of the present study was to discuss the operative results, function outcome and problems of our approach.

**Methods:** From 2000 to 2015, we performed on 10 cases to reconstruct the metadiaphyseal bone defect after resection of a musculoskeletal tumor. There were 7 males and 3 females with a mean age of 26.7 (11-64) years at the time of surgery. Reconstructed bone defects were located in the femur in 6 cases and the tibia in 4 cases. The pathological diagnosis was osteosarcoma (n=6), Soft tissue sarcoma (n=2), adamantinoma (n=1) and chondrosarcoma (n=1). A plate was used for fixation in 9 cases, screws only in one case. Seven patients were given chemotherapy preoperatively and/or postoperatively. The mean follow-up period after surgery was 45.9 months (9 to 132). Free vascularized fibula flap was used in all patients. The average length of the resected segment was 17.5cm(10-22). An intramedullary technique was used in nine cases and onlay technique in one case. We evaluated the success of primary bone union, the period required to achieve bone union, complications, clinical outcome, and the International Society of Limb Salvage (ISOLS) score.

**Results:** Clinical outcome status was continuous disease free in 4 patients, no evidence of disease in 1, alive with disease in 2, and died of disease in 3. All but one patient had successful bone union. The average period required to achieve bone union was 8.1 months. Six patients had local complications. Complications included nonunion in 2, fracture in 2, infection in 1 and necrosis of monitoring flap due to venous thrombus in 1. Graft removal was required in one case with infection. This patient eventually achieved bone union using an autogenous cancellous bone graft. The mean ISOLS score at final follow-up was 88% (60-100).

**Conclusions:** To prevent complications such as nonunion, infection and graft fracture, we have used VFG in combination with frozen autografts for the primary reconstruction of segmental bone defects. This method is more complex regarding its surgical technique, but has the advantage of combining the mechanical strength of the frozen autograft with the biological activity of the VFG to enhance bone healing, minimize failures, and facilitate the functional use of the limb. Our results suggest a frozen autograft combined with VFG can be useful reconstruction method in patients with large bone defects after wide excision of malignant bone tumors.

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### Sentinel lymph node biopsy is an important staging tool for digital papillary adenocarcinoma

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**Introduction & Purposes:** Digital papillary adenocarcinoma (DPA) is a rare sweat gland neoplasm commonly found in the hands and feet. Regional lymph node (LN) spread has been reported in DPA. We reviewed our institution's experience with DPA to explore its common presenting features and natural history, as well as the utility of sentinel lymph node biopsy (SNLB) given the propensity for metastasis to the lymph nodes.

**Materials & Methods:** We reviewed all cases of DPA treated by a single surgeon at our institution. Cases were reviewed for clinical and pathological data, as well as for the use and results of SNLB.

**Results:** 23 cases were identified. Patients commonly presented after incomplete excision elsewhere. 26% of the time the prior surgery resulted in a suboptimal incision that required a change to the operative plan. Tumor location was digit in 12 cases, hand in 7, wrist in 2, and leg/foot in 2 cases. Surgery performed was limb-sparing wide resection in 18 cases, amputation in 5. SNLB was performed in 16 cases, 13 percent were positive for LN involvement. At a mean follow up of 47 months, 88% of patients were alive without evidence of disease, and 4% each were alive with disease, dead of other causes, or dead of disease.

**Conclusions:** DPA most commonly presents in the fingers and hand, often after prior unplanned excision. In many cases, this resulted in a suboptimal incision leading to a change in the operative plan. Although rare, DPA is an important diagnosis for surgeons to consider prior to surgical intervention. We demonstrate a LN involvement in 13 percent of cases. We feel this finding warrants the use of SNLB in all patients with this diagnosis for staging purposes given the low morbidity of the procedure. Further investigation is warranted to study whether treatment of positive LN leads to improved survival.

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## Lipoma as a compressive origin of the posterior interosseous nerve syndrome: a clinical case

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**Introduction and Purposes:** The extrinsic compression caused by a lipoma is one of the less frequent causes of the posterior interosseous nerve (NIP) syndrome. It is necessary to perform electromyography and imaging techniques as ultrasonography and magnetic resonance to prove the compressive tumoral origin of the case. If the etiological suspicion is a tumor, then surgical treatment is indicated with excisional biopsy to decompress the nerve and to perform the anatomical pathology study. Our aim is to report an uncommon case about an illness which does not have long case series published.

**Material and Methods:** Clinical case description.

**Results:** We present a case of a NIP syndrome caused by a lipoma and treated surgically with excisional biopsy and complete resolution of the symptoms during the follow-up period.

### Conclusions:

1. The NIP syndrome due to a compression caused by a lipoma is a rare illness.
2. To achieve the diagnosis the clinical examination, the electromyography and the magnetic resonance are necessary keeping a high index of suspicion.
3. Its treatment is surgical showing good functional outcomes in early compressive stages.

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## 2285

### Hamstring autograft to augment extensor mechanism reconstruction after proximal tibia resection

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**Introduction and Purpose:** Extension lag following proximal tibia resection and endoprosthetic reconstruction is due to patella alta. This results in reduced functional scores [1]. Various techniques to reconstruct the ex-tensor mechanism have all had a high rate of patella alta and extensor lag [1-4]. This report describes, using an illustrative case series, a novel surgical technique to re-construct the patellar tendon using ipsilateral medial hamstring autograft, polypropylene mesh, and a medial gastrocnemius rotational flap.

**Materials and Methods:** The hamstrings were harvested using a hamstring stripper. A polypropylene mesh was folded in four layers, reinforced with non-absorbable sutures and attached to the patellar tendon. The hamstrings were attached to the patellar tendon and mesh, which were sutured to the prosthesis (Fig1A). The medial gastrocnemius was then rotated around the prosthesis and sutured onto itself (Fig1B). A hinged knee brace locked in extension was applied for six weeks. Then, 10 degrees of flexion was added each week until 90 degrees of flexion was achieved.

**Results:** Four patients were followed for a mean of 12 months (range, 8 - 15 months) (Table 1). Fig2 shows a case in which our technique was utilized. At 15 months the Blackburn-Peel ratio was 1 (Fig3). Active knee motion was 0 - 100 degrees and his Musculoskeletal Tumor Society (MSTS) score was 28.

**Discussion:** This study is limited by the small sample size and lack of a comparison group, however our small cohort showed that patients who underwent reconstruction with this technique had stable radiologic findings with good functional outcomes.

Case	Age (years)	Follow up (months)	Extension lag	MSTS score	Blackburne-peel
1	17	15	0	28	1
2	15	12	10	26	1.1
3	27	8	5	18	0.85
4	16	14	10	18	0.85

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Figure 1. Intraoperative images.



Figure 2. (A, B) AP & Lateral views of the knee in a patient with proximal tibia osteosarcoma. (C) MR image showing the extent of the tumor. (D,E) 6 months after surgery using the current technique, adequate patellar height is seen on the lateral view.



Figure 3. Lateral view of left knee 15 months postoperatively. Blackburne-peel ratio = 1.

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**Metastatic extraskeletal myxoid chondrosarcoma: Long-term survival with close observation**

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**Introduction and Purpose:** Extraskelatal myxoid chondrosarcoma (EMC) is a sarcoma of uncertain differentiation (1). It typically has an indolent course and is known to recur or metastasize over 10 years following the initial diagnosis, however some aggressive forms exist, which carry a poor prognosis (2). Treatment is surgical resection as systemic therapies do not appear to be effective. Despite this, many patients who present with metastasis are treated with a combination of surgery, chemotherapy, and radiation therapy (3, 4). We present three cases of EMC with pulmonary metastasis at presentation, who have not received systemic therapy, managed with long-term close observation.

**Materials and Methods:** Data from three patients who presented with metastatic EMC and managed with close observation were collected. This included imaging, age at diagnosis, sex, site, duration of follow-up, and outcome.

**Results:** One patient died from colon cancer, unrelated to his EMC diagnosis, at 10 years follow-up. He initially had a below knee amputation for his mass. He did not receive systemic treatment. The other two patients have been followed for three and five years. Their primary masses and metastatic nodules have slowly progressed, however neither patients complain of pain or respiratory symptoms (Figure 1 and 2). These results are summarized in Table 1.

**Discussion:** This report is limited in that it is a small cohort and lacks a comparison group, however it showed that these patients can have long-term survival without systemic treatment. EMC is a unique sarcoma in that patients who present with metastatic disease may in some cases be safely monitored without intervention.

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Table 1. Patient characteristics and outcomes

Case	Age	Sex	Site	Follow-up (years)	Outcome
1	48	Male	Gluteal fold	3	AWD
2	65	Male	Thigh	5	AWD
3	69	Male	Ankle	10	Deceased of other causes

AWD: Alive with disease

Figure

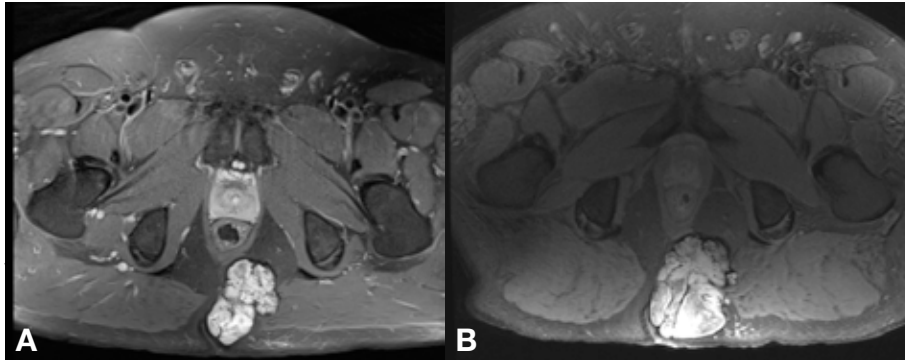
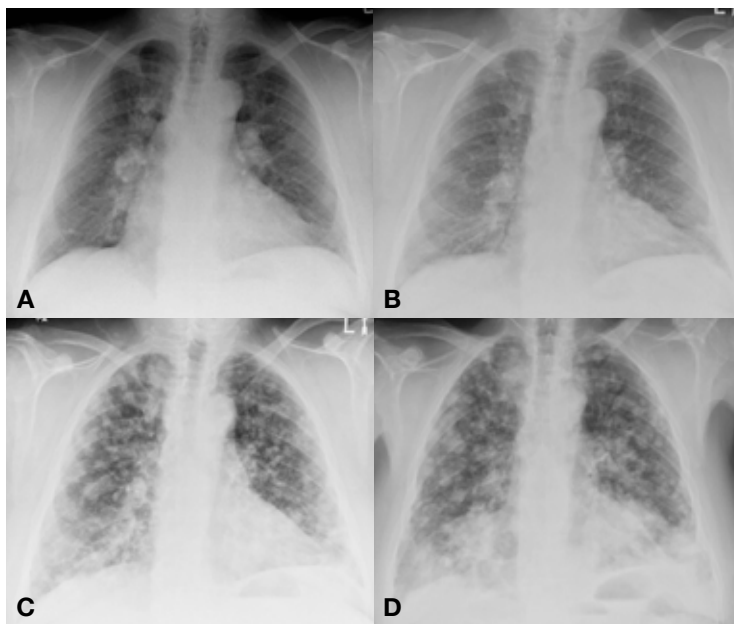


Figure 2. CXRs of pt 3 showing slow progression of metastatic nodules at two (A), five (B), seven (C), and 10 year (D) follow-up.



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### Survival outcomes after adjuvant radiotherapy for aggressive fibromatosis depend on time frame and nuclear $\beta$ -catenin

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**Purpose:** To identify prognostic factors influencing progression free survival (PFS) of aggressive fibromatosis (AF) after postoperative radiotherapy (PORT) and assess correlations between immunohistochemistry (IHC) features of  $\beta$ -catenin/smooth muscle actin (SMA) and PFS.

**Materials and Methods:** Records of 37 patients with AF treated by PORT from 1984 to 2015 were retrospectively reviewed. Fifteen patients underwent wide excision for AF and 22 patients received debulking operation. The median total dose of PORT was 59.4Gy. IHC staining results of  $\beta$ -catenin and SMA were available for 11 and 12 patients, respectively.

**Results:** The median follow-up duration was 105.9 months. Five-year PFS rate was 70.9%. Tumor size or margin status was not related to PFS in univariate analysis ( $p=0.197$  and  $p=0.716$ , respectively). Multivariate analysis showed that increased interval from surgery to PORT ( $>5.7$  weeks) was a marginal risk factor for PFS ( $p=0.054$ ). Administration of PORT at the initial diagnosis resulted in significantly improved PFS compared to deferring PORT after recurrence ( $p=0.045$ ). Patient with both risk factors of deferring PORT after recurrence and interval from surgery to PORT  $>5.7$  weeks had significantly lower 5-year PFS than patients without risk factor (34.1% vs. 100.0%,  $p=0.012$ ). Nuclear  $\beta$ -catenin intensity tended to inversely correlate with 5-year PFS, although it did not reach statistical significance (low, 62.5% vs. high, 100.0%,  $p=0.260$ ). SMA intensity was not related to PFS ( $p=0.700$ ).

**Conclusions:** PORT should be performed immediately after surgery irrespective of margin status or tumor size especially in recurrent case. Nuclear  $\beta$ -catenin staining intensity of IHC might correlate with local recurrence.

**Keywords :** Aggressive fibromatosis, adjuvant radiotherapy, immunohistochemistry, beta catenin, progression free survival.

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### Treatment results of localized dedifferentiated liposarcoma in the extremities

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**Background:** Dedifferentiated liposarcoma (DDLPS) is a rare malignancy. It is biphasic showing transition from an atypical lipomatous tumor (ALT) to a sarcoma of variable morphologic appearance. There are very few reports assessing the clinical outcome of primary localized DDLPS in the extremity. We therefore investigated the imaging and clinicopathological analysis of primary localized DDLPS in the extremity.

**Methods:** The participants included 13 patients with localized DDLPS of the extremity who received surgery in our institution between 2003 and 2018. We analyzed local recurrence-free survival (LRFS), metastasis-free survival (MFS), and overall survival (OS). Survival rate was estimated using the Kaplan–Meier method.

**Results:** PET/CT showed the biphasic pattern which had a close relationship to the MRI findings. The dedifferentiated component presented high FDG uptake (median SUVmax; 2.3), while the ALT component presented almost no FDG uptake. In immunohistochemical studies, the positive staining of both p16 and CDK4, and CDK4 and MDM2 were 100% and 100%, respectively. Local recurrence and distant metastasis developed in 23% and 23% of the patients, respectively. 3-year LRFS, MFS, and OS were 84%, 85%, 69%, and 92% respectively. On univariate analysis, tumor size ( $\geq 15$ cm) was found to be the only significant factor influencing LRFS ( $p=0.04$ ).

**Conclusions:** The clinical behavior of DDLPS is relatively aggressive, and local recurrence or metastasis developed in 46% of the patients. Careful attention during the follow-up period is important in patients of extremity DDLPS with tumor size of  $\geq 15$ cm.

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## Metastatic bone disease from lung cancer. Do we need to reconsider our surgical management?

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**Introduction and Purposes:** Historically bone-involved metastatic lung cancer meant a poor prognosis. Surgical intervention, guided by the metastatic bone disease (MBD) guidelines<sup>1</sup>, has been primarily indicated for palliation of pain, with functional improvement a secondary factor. The implant choice should out-live the patient. Survival of these patient is usually measured in weeks or months.

**Methods:** Our Unit is a tertiary referral centre for patients with MBD and its complications. It is common to newly diagnose patients with a primary lung cancer from skeletal-related events as a result of metastases. In the UK, targeted therapy for non-small cell lung cancer (NSCLC) has been available for some years. Yet it is only relatively recently that it has become more common practice for cytogenetic testing at diagnosis, mainly for the EGFR and ALK genetic mutations (20-25% of NSCLC)<sup>2</sup>.

**Results:** From 2012, 65 patients with NSCLC; adenocarcinoma (23), squamous cell carcinoma (15), large cell (9), unspecified (18) were reviewed in our multidisciplinary team meeting. Genetic test reporting was present in 12 patients, and positive for mutation in 5. The first test was noted in 2013, with the majority from 2016 onwards.

**Conclusion:** We present 2 case studies to illustrate the changing presentation of mutation positive lung cancer MBD. Careful consideration must be given to the choice of implant and its longevity, given that patients can now live with their disease, and with good function, potentially for years. It is a priority to consider cytogenetic testing in patients who may benefit from surgical intervention.

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## **Intraosseous papillary intralymphatic angioendothelioma (Dabska tumor). Intralesional radioablation is not sufficient**

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**Introduction:** Papillary intralymphatic angioendothelioma (PILA) is a rare neoplasm. First reported by Dabska and included in the latest WHO edition tumor classification. It affects children as skin and soft tissues. Only few cases have been referred in bone (two in distal femur). Although PILA was described as malignant low-grade neoplasm, recent series demonstrated no local recurrence or metastases. Due to its odd location, PILA management remains a challenge.

**Material and Methods:** A 50-year-old woman referring atraumatic knee pain (worse at night and no improvement with NSAIDs). Studies revealed 2x2cm epifysary radiolucent lesion type Ib in the medial femoral condyle (MFC), without periosteal reaction. MRI T1 hypointense and T2 hyperintense, with intense tracer uptake in MFC. A CT-guided needle-biopsy and intralesional-radioablation was performed and showed PILA. Due to the vague tumor progress and pain remission, followed by edema reabsorption and lesion decrease in MRI, close follow-up was carried out. Symptoms reappeared 4-months later, so a multidisciplinary committee decided tumoral MFC wide-resection with CT-guided navigation. Reconstruction by osteocondral allograft and osteosynthesis with 2 headless-screws was accomplished.

**Results:** Histological examination evidenced PILA. The patient is pain-free and practices unlimited sports, with 28 points in MSTs score. After 1 year follow up, no local recurrence was evidenced.

**Conclusions:** It is necessary to reconsider additional tests when clinical and pathological correlation is lost. These can benefit from management at expert sarcoma centers. The resemblance remains unclear between soft tissue and intraosseous PILA. A reasonable option consists in wide tumoral resection without adjuvant therapies.

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## 2301

### Risk factor analysis of surgical site infection after resection of primary pelvic bone malignancy

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**Introduction:** The resections of malignant pelvic bone tumors are at the origin of many complications. Surgical site infections (SSI) are common, difficult to treat, and have a significant medico-economic impact. The objectives of our study were to identify the risk factors and to deduce a predictive score of SSI.

**Materials and Methods:** We retrospectively included patients operated on between 2005 and 2017 from a primary pelvic bone malignancy resection surgery. This is a descriptive, monocentric study. We analyzed the risk factors including patients' comorbidities, tumor characteristics and treatment, per- and postoperative data. We performed a univariate analysis and then a multivariate model to identify independent risk factors of SSI. We deduced a predictive score, tested on a validation population sample comparable to our cohort.

**Results:** 55 patients were included, 29 in the Sepsis group and 26 in the healthy group. The incidence of SSI was 52.7%. The parametric analysis revealed that the volume of the resection part was significantly higher in SSI group:  $1715.37 \pm 566.87$  vs  $606.67 \pm 606.83$  cm<sup>3</sup>,  $p = 0.007$ . Univariate analysis followed by the multivariate model showed that BMI  $> 30$  kg/m<sup>2</sup> ( $p = 0.027$ ) and intraoperative bleeding  $> 1200$  ml ( $p = 0.039$ ) were associated with increased risk of SSI. We have developed a predictive score of SSI, the BLB-21 (Blood Loss BMI  $> 21$ ). A BLB-21 = 2 was predictive of SSI with a Statistics C at 0.836 and a positive likelihood ratio at 5.16 [2.05; 13].

**Conclusion:** Significant bleeding volume synonymous with massive RBC transfusions and a high BMI are SSIs high risk factors. A high volume of resection is associated with increased SSI. The predictive score BLB-21 is promising and has been successfully tested on our validation sample but requires external validation.

## 2304

### **New technical know how in reconstruction of bone defects in children and youth with primary malignant bone tumors - own experiences**

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**Purposes:** to improve the results of reconstruction after pelvic malignant bone tumours surgery.

**Methods:** To resolve the problem of reconstruction after resection the primary bone tumors in inconvenience localization or the big mass of the tumor we can to take advantage of new concept of using existing solutions or Innovation technology for replacement of massive bone defects after excision of primary bone tumor. Originally Lumic endoprosthesis was dedicated for hemipelvectomy type II and II+III by Enneking's classification. In specific situation we can using lumic for reconstruction i.e. after hemipelvectomy type I, II and III by Enneking classification. In another situation we need Innovation technology for replacement of massive bone defects after excision of primary bone tumor, for example Stratos system to reconstruction in the cases with thorax bone tumor localization. Complete new technology is 3D printer. We can produce the implants of any localization, any shape. We need only a good CT scan and computer software to produce the needed replacement for young patients.

**Results and Conclusions** (by the clinical experience): Chance for reconstruction of bone defects in children and youth with primary malignant bone tumors depends on: localization and extent of the tumor, tumor reaction on neo-adjuvant chemotherapy, patients determination, surgeon determination in using of new concept of existing technology or in using of new technology. Custom made endoprosthesis is very useful in the case of atypical tumor localization and it is possible to implant it after good response for neo-adjuvant chemotherapy. Personal experience of operating surgeon and being faithful to success is of more importance for successful results.

2305

### Left humerus reconstruction in an 8-month-old girl with Ewing sarcoma using the growing megaendoprosthesis

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**Introduction And Purposes:** The paper presents a case of a 6-month-old girl with a large left arm tumor detected after birth.

**Materials And Methods:** The paper shows a case report of the smallest megaendoprosthesis of the humerus in the world in such small children. After the biopsy, Ewing's sarcoma was diagnosed. The performed imaging examinations showed a large tumor comprising 2/3 of the left humerus with a large tumor in soft and exalted tissues. In addition, a metastatic lesion was visible in the proximal left humerus. There were no metastatic lesions in the remaining bones and in the lungs. Chemotherapy treatment was introduced. After applying 6 neoadjuvant chemotherapy treatments according to The Euroewing 2008 program has been significantly reduced. The tumor volume decreased 3 times. This allowed to plan the removal of the tumor along with the entire humerus and soft tissue tumor. In order to reconstruct the resulting cavity, the humeral endoprosthesis was made using the 3D printing technique. The procedure was performed on 5/12/2017. No complications were observed after the procedure. Currently, the patient finished adjuvant chemotherapy.

**Results:** The treatment was radical surgically. Intensive rehabilitation was applied. A full range of movements was achieved both in the shoulder and elbow joints. There were no movement and sensory deficits in the left arm. We consider the treatment effect as very good.

**Conclusion:** The 3D technique allows the preparation of even whole bone implants for a particular patient. This allows you to restore full operative efficiency of the operated limb. It was the first such treatment in the world.

2309

## How to decide hemicortical resection in parosteal osteosarcoma? A therapeutic algorithm

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**Background:** The aim of this study is to evaluate significance of Magnetic Resonance Imaging (MRI) findings, surgical margins, previous interventions and their effects on prognosis with oncological and functional outcome differences by the retrospective single center experience of parosteal osteosarcoma.

**Methods:** Twenty-seven randomized patients (8 male/19 female) with the diagnosis of primary parosteal osteosarcoma were retrospectively reviewed. The epidemiological data and biopsy method were noted. The lesions maximum circumferential extension, maximum longitudinal extension, intramedullary involvement and neurovascular extensions in MRI sections were evaluated. The resection type (segmental intraarticular/segmental intercalary/hemicortical), reconstruction type (biologic/non-biologic) and surgical margins were noted. Functional and oncological results were assessed.

**Results:** The mean age was 31.6 (12-73) years; median follow-up was 63 (15-270) months. Closed biopsies in elsewhere centers were related with increased number of re-biopsies and misdiagnosis/improper interventions. ( $p < 0.001, p = 0.044$ ) Intramedullary involvement percentage was related with maximum circumferential extension percentage and maximum longitudinal extension. ( $p = 0.006, p = 0.005$ ) The intramedullary involvement ratio of  $\leq 10\%$  suggested no recurrence or metastasis. The mean MSTS score was 81.1% (60-100%). Hemicortical resections with biological reconstructions had the best MSTS scores. ( $p = 0.002$ ) The maximum circumferential extension percentage, the maximum longitudinal extension of the lesion, intramedullary involvement percentage and neurovascular encasement had lower MSTS scores. ( $p = 0.003, p = 0.028, p = 0.038, p = 0.022$ ) The 5-year overall survival was 95.5%, and local recurrence-free survival was 77.2%.

**Conclusion:** The lesions extent of intramedullary involvement, neurovascular bundle proximity and maximum periosteal circumferential extension on MRI should be considered when planning the surgery. The evaluation of maximum circumferential extension on MRI is crucial for the resection margins. Biological reconstructions should be considered whenever possible.

Criteria	Value	p value
Maximum Circumferential Extension	< 50%	$p = 0.001$ (95% CI, 0.000-0.119)
Maximum Longitudinal Extension (mm)	< 120	$p = 0.002$ (95% CI, 0.000-0.215)
Intramedullary Involvement	< 10%	$p = 0.003$ (95% CI, 0.000-0.193)

## 2313

### Pazopanib treatment for alveolar soft part sarcomas

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**Objectives:** Alveolar soft part sarcoma (ASPS) is a very rare soft tissue sarcoma that predominantly affects adolescents and young adults. ASPS is also known resistance to conventional chemotherapy with less than 10% remission rate. Recent reports have showed the response to pazopanib in ASPS. The purpose of this study is to evaluate the activity of pazopanib in patients with metastatic ASPS.

**Patients and Methods:** Between 2012 and 2018, total fourteen patients (9 female, 5 male) with metastatic ASPS received pazopanib treatment.

**Results:** Mean age was 31 years old (range: 23-39). Primary tumor was extremity in nine, trunk/head and neck in five. 13 patients had metastases before starting treatment (13 in lung, 3 in brain). No patient received prior doxorubicin based chemotherapy. 11 patients were treated with pazopanib as first line chemotherapy and the others three with sunitinib followed by pazopanib. The mean treatment duration was 684 days (164-2142) in pazopanib treatment and seven patients received for more than one year. In evaluable 13 patients best RECIST response was PR in three, SD in seven and PD in three (DCR was 77%). The severe adverse events (G3 or >G3) were observed in four. Ten patients discontinued pazopanib treatment due to progressive disease. At a 16-month median follow-up, median of PFS after pazopanib administration was 410 days (13.7 months), and the OS was 100% for 2 years, 33% for 5 years.

**Conclusions:** Pazopanib showed the clinical efficacy with tolerable adverse events in patients with metastatic ASPS despite its poor doxorubicin-based chemo sensitivity. Long term disease control was possible as recently reported. Although pazopanib may be one of the promising options for ASPS like other anti-angiogenic treatment, clinical trial is warranted to establish an evidence to determine the most optimal multi-targeted kinase inhibitors.



2314

### Long term functional outcomes of surgery and radiation for sacral chordomas

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**Introduction and Purposes:** After surgery and radiotherapy, rates of local recurrence of sacral chordomas are high. The morbidity associated with surgery and radiation is considerable due to sacral nerve root involvement. The following questions were investigated: 1) What is the association between local recurrence, functional outcome, modality of treatment and development of a complication? 2) Does the use of radiation in sacral chordoma influence postoperative neurologic function?

**Materials and Methods:** We performed a retrospective review of 85 patients who underwent treatment for sacral chordoma at our institution. Data collection included demographics, oncologic characteristics, treatment details and postoperative functional outcome. Musculoskeletal Tumor Society scores for lower extremity score was assessed at two time points.

**Results:** All patients presented with a primary tumor. Median tumor size was 6.8 cm (1.4-40). A negative margin was obtained in 59 (85.5%) patients. Radiation therapy was administered in 29 (42%) cases. Patients undergoing sacrectomy at the L5, S1, or S2 level reported a median total score of 23.5 while those who underwent lower sacrectomies reported a median score of 30 ( $p=0.012$ ). Local recurrence is a significant predictor of functional outcome ( $p=0.003$ ). There was no association between local recurrence and radiation status ( $p=0.272$ ). Level of resection is not a predictor of local recurrence ( $p=0.79$ ); however, it has a significant association with bladder and bowel function ( $p<0.001$  and  $0.033$ ). The addition of radiation therapy in a multivariate model did not alter these results.

**Discussion:** Acceptance scores are significantly associated with the preservation of bladder function. Local recurrence and resection level is associated with overall functional outcome. There is no evidence to suggest that radiation status affects bladder and bowel function, regardless of the resection status.

2316

## Serum adhesion molecule levels in childhood bone sarcomas and its effect on prognosis

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**Objective:** Adhesion molecules (AMs) are cell surface proteins which are responsible for physiological and pathological processes including carcinogenesis and metastases. The aim of this study is to analyses serum levels of AMs and their prognostic significance in bone sarcomas.

**Methods:** Thirty-six patients and 31 healthy control were included the study. Serum CD44, ICAM-1, VCAM-1, E-selectin and N-cadherin levels were analyzed with ELISA method at diagnoses and at the end of treatment. Mean AM levels of patients were compared with the control group. The relationship of AM levels and presence of metastasis, percentage of necrosis and course of disease were also evaluated.

**Results:** There were 16 males and 20 females with a median age of 13.5 years. The diagnoses were osteosarcoma in 21, Ewing sarcoma in 15. Tumor location was long bones in 78% of cases. Eighteen patients (50%) had metastatic disease. The mean CD44 ( $1711.32 \pm 157.96$  pg/ml), E-selectin ( $2303.35 \pm 132.13$  ng/ml), N-cadherin ( $330.02 \pm 19.50$  ng/ml) and VCAM-1 ( $1880.03 \pm 192.61$  ng/ml) levels of patients at diagnosis were significantly ( $p < 0.05$ ) higher than controls' levels. The AM level of patients decreased after the end of treatment and the reductions in CD44, ICAM-1 and cadherin levels were significant. The CD44, V-CAM-1 and N-cadherin levels of patients with lung metastasis was significantly higher than non-metastatic patients. There was no relationship between AM levels and ratio of necrosis after treatment. The VCAM-1 levels were significantly higher in patients who had relapsed disease ( $p:0.002$ ) and who died ( $p:0.03$ ).

**Conclusion:** We found that serum CD44, VCAM-1, E-selektin and N-cadherin levels in bone sarcomas increased at diagnosis and decreased after treatment. The CD44 and VCAM-1, N-cadherin levels were associated with metastatic disease. VCAM-1 was related with outcome. Our findings suggest that, these molecules may be used as markers in diagnosis, follow-up and prognosis.

**2317**

## **Precision surgery- is there a role in musculoskeletal tumor resection?**

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**Introduction:** Computer assisted surgery is gaining popularity in the surgical field. Its advantages are in accurate resections and/or minimally invasive navigated procedures. We present several cases of innovative computer assisted navigated cases [1-3].

**Methods:** A case series of four patients with bone tumors. All patients had robotic surgery using the ZEEGO system. Results: First patient had a Ewing sarcoma of the distal tibia and underwent Geographic resection of the tumor using intra op CT navigation and reconstruction (picture 1). Second patient had an Epithelioid Hemangioendothelioma of the tibia bone and underwent resection using a patient specific costumed jig and intra op CT navigation (picture 2). Both patients margin were clean. Third patient had a supraacetabular lung metastasis which was treated with Radio-Frequency (RF) ablation using intra op CT navigation with 3D imaging. Fourth patient had an Osteoblastoma which was treated with RF ablation using Brainlab system navigation based on intra op CT. All procedures were accurate to less then 0.5mm of the pre-operative plan. All patients are cured and are ambulatory. Median MSTS score 29. Conclusion: In the modern era, precision surgery is the next step. We present several innovative options with highly accurate results. In our case series we were able to improve patient's functional outcome with accurate and less extensive resections.



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2320

### **Bizarre parosteal osteochondromatous proliferation in the upper extremity - Discussion of a rare bony lesion**

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**Introduction:** Bizarre parosteal osteochondromatous proliferation (BPOP) is a benign osteocartilaginous lesion of bone composed of a disorganized mixture of cartilage, bone, and fibrous tissue. It is frequently found in the small bones of the hands and feet. Due to unspecific radiological and histological features, it remains a diagnostic challenge.

**Materials and Methods:** We reviewed records of all patients who underwent treatment for biopsy-proven BPOP between 2008 and 2018. Cases were reviewed for demographic and clinical data, diagnostic features, treatment details, and outcome.

**Results:** 7 cases were identified. Patients were diagnosed with BPOP at a mean age of 37 years (17-68y). 4 patients had recurrent disease at the time of presentation. Mean tumor size was 1.8cm (1.3-2.2cm). 6 cases involved lesions in the middle of proximal phalanx, 1 case involved the elbow. 5 patients presented after open biopsy or surgery elsewhere. In 4 cases, diagnosis was made following history of pain, in 2 cases due to persistent swelling, and in 1 case after trauma. Delayed diagnosis occurred in 4 cases, mainly due to misinterpretation of the initial symptoms. In all cases, imaging showed no cortical destruction. The surgical treatment was marginal excision in 1 case, and wide excision in 6 cases. All margins were free of tumor. Local recurrence occurred in two patients, with a mean time of recurrence of 19 months (17 - 20). At a mean follow up of 3.9 years (0.3m-10y), all patients showed no evidence of disease. At the last follow-up visit the mean MSTs score for upper extremity was 29.5.

**Conclusion:** BPOP should be considered in the differential diagnosis of any osseous or cartilaginous lesion of the hand. It rarely exhibits radiological evidence of cortical destruction. Due to unspecific symptoms, diagnosis is often made in a delayed fashion. To limit lesion progression and to restore function, wide excision is the therapy of choice.

## 2321

### **Adamantinoma: long-term follow-up study of 20 patients treated at a single institution**

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**Introduction:** Adamantinomas belong to the tumors with low malignancy, however, they can spread to the lungs, lymph nodes and other regions. The rarity of this disease and the nonspecific initial symptoms complicate the diagnosis.

**Materials and Methods:** We reviewed records of 20 patients who underwent treatment for biopsy-proven adamantinoma between 1975 and 2018. Cases were reviewed for demographic, clinical and pathological data, treatment details, and outcome.

**Results:** Patients presented at a median age of 22 years (1-79y). 14 patients had a primary tumor, 3 recurrent and another 3 metastatic disease at the time of presentation. Median tumor size was 5.7cm (0.5-15.5cm). In 19 cases, the tumor was located in the tibia and in 1 case in the fibula. 3 patients presented after biopsy and 8 patients after surgery elsewhere. In 14 cases, diagnosis was made following history of pain, in 2 and 4 cases due to trauma and pathologic fracture, respectively. Due to misinterpretation of the initial symptoms or biopsy results, delayed diagnosis occurred in 11 cases. Wide resection was performed in 11 cases, the remaining 9 patients underwent curettage, intralesional resection or amputation; systemic treatment was administered in 2 cases with metastatic disease. Resection margins were negative in 16 cases. At a median follow up of 6.7 years, 14 patients had no evidence of disease, 2 patients were alive with disease, and 4 patients died from disease; two of them presented with metastatic disease initially. All distant metastases were located in the lungs. Local recurrence occurred at a median of 11.4 years (6m-19y), and distant metastasis at a median of 15.7 years (4m-23y) years after diagnosis.

**Conclusion:** In our review, distant metastases occurred up to 23 years after initial diagnosis; a long-term follow-up with imaging of the chest is required. Adequate histopathological diagnosis is crucial to avoid delayed diagnosis.

2331

## Local control with limb sparing surgery and cryo-ablation in Ewing's Sarcoma of the appendicular skeleton

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**Introduction:** Localized Ewing's Sarcoma of bone is treated with systemic chemotherapy and local control is usually achieved by wide resection. Tumor volume, necrosis rate and resection margins play a role in the decision to add radiation in the adjuvant setting. We have been utilizing localized cryoablation in the setting of benign and malignant bone tumors for limb sparing surgery with good functional and oncological results over the last 25 years. Our protocol in the setting of localized Ewing's Sarcoma of the appendicular skeleton that are small in volume and are staged (Enneking staging) as IIa or minimal IIb, i.e. minimal extra skeletal tumor expansion, is intralesional curettage and cryoablation.

**Aim:** The aim of this study is to summarize our experience with local cryoablation and curettage in the setting of Ewing's Sarcoma of the appendicular skeleton.

**Materials and Methods:** Our departmental database includes 188 patients under the age of 18 that were treated for Ewing's Sarcoma between the years 1993 and 2018 and includes eight patients that were treated by curettage and cryoablation with or without adjuvant radiotherapy and those were included in the study. Their charts were reviewed for demographic, clinical and functional outcomes.

**Results:** The average age of the patients was 12.6 yrs (range 2-17 yrs) at time of surgery, all were staged as IIa or minimal IIb, six underwent intralesional curettage and two underwent a geographical resection with negative bur close margins. All underwent adjuvant cryo- ablation during surgery. Tumor necrosis rate was reported as 100% in all patients. At an average follow-up of 97 months (range 10-222 mos), all patients, but one, are alive. One patient developed a local recurrence and lung metastasis and died of his disease. Two patients received post-operative radiation. Overall functional outcome as measured by the MSTs 97 test averaged 27 (range 24-30).

**Conclusion:** We believe that low volume Ewing's Sarcoma of the appendicular skeleton with minimal extra skeletal involvement can be safely treated by systemic chemotherapy and intralesional curettage or a geographical resection with adjuvant cryoablation without adjuvant radiation This approach allows for a good oncological and functional outcome.



2333

### The use of bone marrow aspirate concentrate (BMAC) and demineralized bone marrow (DBM) in the treatment of unicameral bone cysts of the proximal humerus

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**Introduction:** Unicameral bone Cysts (UBC) are benign bone lesions of unknown etiology, found in the metaphyseal areas of long bones in children and adolescents. Treatment is usually based upon clinical symptoms, the typical radiographic findings of an UBC and the occurrence of a pathological fracture. Treatment options include watchful waiting, cyst aspiration and injection of steroids/bone marrow aspirate, limited or extended curettage and subperiosteal resection with allograft reconstruction with or without instrumentation amongst others. Bone Marrow Aspirate Concentrate (BMAC) has become popular in recent years as a treatment option in tendon and muscle tears, rotator cuff pathology and meniscal and articular cartilage lesions. The rationale for using BMAC lies in the concept that due to centrifugation of the bone marrow aspirate, one obtains a stem-cell and growth factor rich solution – as compared to “regular” bone marrow – which should enhance healing.

**Aim:** To summarize the results of curettage, intra-lesional injection of BMAC with Demineralized Bone Marrow (DBM) in the setting of UBC of the proximal humerus. A method that has not been previously described for this diagnosis.

**Material and Methods:** Our departmental database includes 118 patients treated for an UBC between the years 2003-2018, of whom 30 patients were treated with minimal curettage, BMAC/DBM injection for an UBC of the proximal humerus. Their charts were reviewed for demographic, clinical, radiographical and functional outcomes.

**Results** -The average age of the patients was 11 years (range 9-17), with a follow-up of 2.8 years (range 1.3-3). 14 patients required a second intervention due to recurrence of their lesion, of these, 8 required a third procedure. 4 patients underwent bone-grafting after additional curettage due to recurrence of their lesion. A fracture was observed in 4 patients at an average of two years (range 1.9-3) from their first intervention.

**Conclusion:** The use of BMAC/DBM after minimal curettage in UBC of the proximal humerus is effective in 55% of the patients treated and an alternative to other minimal invasive methods in use today. A prospective study comparing it to formal bone-grafting of these lesions would be beneficial to our understanding of the real role the presented method in this setting.

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### Significance of tumor resection and reconstruction with endoprosthesis for metastatic bone tumor of the proximal femur

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**Introduction:** The proximal femur is one of the frequent sites of metastatic bone tumors. When skeletal related event events occur at the site, quality of life disorder such as gait disturbance is serious. In this study, we aimed to examine the significance of tumor resection and reconstruction with endoprosthesis for metastatic bone tumor of the proximal femur.

**Materials & Methods:** Twenty patients who underwent tumor resection and reconstruction with endoprosthesis for metastatic bone tumors at the proximal femur were enrolled from 2012 to 2017 in our hospital. Cases consisted of 9 men and 11 women with an average age of 65.2 (range, 54-86 years) at the time of operation. The average follow-up period after surgery was 6.8 months (range; 4-26 months). The primary sites were breast in 6, kidney in 4, lung in 4, prostate in 3 and others in 3. Inclusion criteria for the surgery were as follows: conditions of impending or pathological fracture, general anesthesia is possible and prognoses of 3 months or more can be expected. Operative records were reviewed for operative time, intraoperative blood loss and complications during the operation and perioperative period. In clinical courses, surgical-related complications, pain assessment by the NRS and mobility at 3, 6 months and final follow up.

**Results:** 1) Surgical results: Blood loss averaged 264 (range; 80-450) ml during the operation. Operative times were 146 (range, 125-214) min. Complications during the surgeries included the revision of femoral stem due to mal-alignment in 1. There were no surgical site infection cases. Dislocation in 1 and soft tissue necrosis by chemotherapy in 1 were observed. 2) Clinical results: In all cases, the subjective symptoms improved within 1 month. There were no recurrent cases during the follow up period. Trendelenburg's sign was recognized in 2 cases. At 3 months, 6 months, and 1 year after surgery, all cases were possible to walk with a cane at 3 months and 5 of 14 cases were possible to walk without cane at 6 months.

**Discussion:** Performance status can be maintained by reacquiring the function of femur as a load bone by surgery and adjuvant therapy such as chemotherapy and radiotherapy can be continued. This surgery, when adapting to the procedure, is not great invasive, can obtain satisfactory surgical results, and can be one of effective therapeutic tools.

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### Comparison of health-related quality of life due to antitumor agents in chemotherapy for advanced soft tissue sarcoma

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**Introduction:** In cancer treatment, maintenance and improvement of quality of life (QOL) are important issues as well as prolongation of overall survival. For advanced soft tissue sarcoma (Ad-STS), the combination regimen of adriamycin and ifosfamide (AI) are introduced as the first-line treatment. When disease progresses, pazopanib (PZP), trabectedin (TRB) or eribulin (ERI) are introduced as second or subsequent treatment. However, few have been evaluated for longitudinally QOL for Ad-STS patients using each antitumor agents. The purpose of this study is to compare health-related QOL (HRQOL) during first-line and second or subsequent treatment for Ad-STS.

**Materials & Methods:** A total of 12 patients (mean age; 52.3 years) diagnosed with Ad-STS and started chemotherapy between 2010 and 2017 at our hospital were enrolled in this study. HRQOL was assessed using EORTC QLQ-C30 after 3 cycles of each chemotherapy before assessing the effect of treatment. We compared 1) global health status, 2) functional scale and 3) symptomatic scale with AI regimen and second or subsequent treatments.

**Results:** Mean score of global health status among patients treated with AI regimen and secondary and subsequent treatments was 37.9 and 56.8, respectively. Global health status during secondary and subsequent treatments showed significantly higher than the AI regimen. No statistically differences were found in the 5 functional scores during each treatment. Nausea and vomiting score showed statistically difference between AI regimen and ERI. Constipation for AI regimen was statistically higher than those of PZP and ERI. Diarrhea during PZP treatment was 61.1, which was significantly higher than the AI regimen and ERI.

**Conclusions:** Compared to the AI regimen, secondary and subsequent antitumor agents can continue treatment while maintaining high QOL even in patients with progressive disease. While taking treatment with the AI regimen, nausea and vomiting and constipation are factors.

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## Outcome of Modular Cemented Endoprosthetic Reconstruction in Bone Tumors in the Lower Limbs, Review of 118 Patients

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**Background:** The use of endoprosthesis in developing countries is still not as common as developed ones, due mainly to its high cost and lack of availability.

**Objectives:** To study the outcome of the use of modular cemented endoprosthesis reconstruction in the lower extremity in a single institute in Jordan.

**Materials and Methods:** One hundred and eighteen patients, ages ranging from 16-65 yr, received modular cemented endoprosthesis for reconstruction after resection of aggressive bone tumors in the lower extremities. Of the patients, 67 received endoprosthesis in the distal femur (DF), 31 in the proximal tibia (PT), and 20 in the proximal femur (PF). In all proximal femoral endoprosthesis, bipolar femoral heads were used. All expandable and custom-made implants were excluded from analysis.

**Results:** The follow up was 1-12 years (median 7 yr). Out of the 118 patients, deep infection was found in 10 (8% - 7 PT, 2 PF, and 1 DF). Soft tissue complications were encountered in 6 patients (5% - 3 PT and 3 DF). The MSTS score for DF, PT, and PF endoprosthesis was 93%, 83% and 86%, respectively. Secondary amputation was required in 6 patients (5%) (5 PT and 1 DF), two for local recurrence and four for deep infection. Mechanical complications were found in 5 patients, all DF, due to one broken stem, two cases of endoprosthesis loosening, and 2 periprosthetic fractures. All of the 5 patients required revision. One patient with PF endoprosthesis developed acetabular erosion and required revision.

**Conclusions:** The outcome of using modular endoprosthesis for reconstruction in bone tumors in our center, in terms of complication rate and function, is comparable to that achieved in developed countries. The proximal tibia remains the anatomical location associated with the highest risk of infection and secondary amputation (22% and 16% respectively). Use of bipolar heads in our study was not associated with a higher incidence of acetabular erosion.

## 2341

### Easy-to-use clinical tool for survival estimation in Ewing sarcoma at diagnosis and after surgery

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**Introduction and Purposes:** Accurate survival estimations in Ewing sarcoma are necessary to develop risk- and response adaptive treatment strategies allowing for early decision-making. We aim to develop an easy-to-use survival estimation tool from diagnosis and surgery.

**Materials and Methods:** A retrospective study of 1314 patients from the EURO.E.W.I.N.G 99 database was performed. Associations between prognostic variables at diagnosis/surgery and overall survival (OS), were investigated using Kaplan-Meier's estimates and multivariate Cox models. Predictive accuracy was evaluated by cross-validation and Harrell C-statistics.

**Results:** Median follow-up was 7.9 years (95%CI 7.6-8.3). Independent prognostic factors at diagnosis were age, volume, primary tumor localization and disease extent. Based on these factors 5 risk categories (A-E) were identified with 5-year OS (95%CI) of 88% (86-94), 69% (64-74), 57% (50-64), 51% (42-60) and 28% (22-34) respectively (Figure 1). Harrell C-statistic was 0.70. Independent prognostic factors from surgery were age, volume, disease extent and histological response. A proportional hazard Cox model from surgery including histological response and risk category was estimated, see Figure 2. In categories A-B, 5y OS increased to 92% (87-97) and 79% (71-87) respectively for 100% necrosis and decreased to 76% (67-85) and 62% (55-69) respectively for <100% necrosis. In categories C-E, 5y OS increased to 65% (55-75), 65% (52-78) and 52% (38-66) respectively for ≥90% necrosis and decreased to 38% (22-54), 11% (0-26) and 7% (0-19) respectively for <90% necrosis.

**Conclusion:** We present an easy-to-use survival estimation tool from diagnosis in Ewing sarcoma based on age, volume, primary tumor localization and disease extent. Histological response is a strong additional prognostic factor for OS.

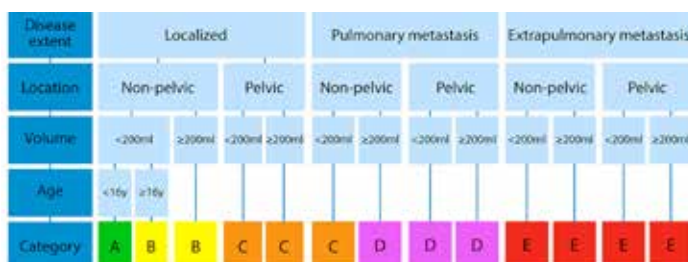


Figure 1 – Flowchart for stratification of Ewing sarcoma patients at diagnosis.

Category	A		B		C		D		E	
5 year OS (95%CI)	85% (80-90)		71% (66-76)		59% (50-68)		52% (40-64)		44% (28-56)	
Histological response (%)	100	<100	100	<100	≥90	<90	≥90	<90	≥90	<90
5 year OS (95%CI)	92% (87-97)	76% (67-85)	79% (71-87)	62% (55-69)	65% (55-75)	38% (22-54)	65% (52-78)	11% (0-26)	52% (38-66)	7% (0-19)

Figure 2 – Flowchart for stratification of Ewing sarcoma patients at surgery.



2345

### **Rapid, pronounced and sustained tumor responses to the tropomyosin receptor kinase inhibitor larotrectinib in two infants with advanced infantile fibrosarcomas carrying the characteristic ETV6-NTRK3 rearrangement**

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**Introduction and Purposes:** The ETV6-NTRK3 fusion, a potent oncogenic driver, is present in most infantile fibrosarcomas (IFS). We report very rapid and sustained responses of two advanced IFS with proven ETV6-NTRK3 fusions to targeted treatment with the oral tropomyosin kinase receptor (TRK) inhibitor larotrectinib on the SCOUT study (NCT02637687).

**Materials and Methods:** Patient A: This boy suffered from recurrence of congenital IFS of the tongue which had progressed during 2 cycles of vincristine-doxorubicin-cyclophosphamide chemotherapy. At screening, a large right cervical mass was clinically visible. Magnetic resonance imaging (MRI) revealed bilateral cervical and axillary lymph node involvement as well as infiltration of the floor of the mouth, the largest lesion measuring 5.5 x 4.5 x 4.4 cm (ca. 55 cm<sup>3</sup>). He started larotrectinib 100mg/m<sup>2</sup> BID at age 3½ months. Patient B: This previously treatment-naïve boy suffered from a large IFS (6.0 x 5.4 x 4.9 cm, ca. 63 cm<sup>3</sup>) of the right buttock penetrating the ilium. He started larotrectinib 100mg/m<sup>2</sup> BID at age 7½ months.

**Results:** Patient A: By day 4, the parents noted that the tumor was softer, the visible swelling receded rapidly. The 1<sup>st</sup> scheduled control MRI at week 9 demonstrated a complete response according to RECIST1.1. Patient B: By day 8, there was clinical improvement. The week 9 MRI demonstrated a residual tumor mass of 2.9 x 2.2 x 0.8 cm (ca. 2.5 cm<sup>3</sup>), corresponding to a partial remission. At last follow-up, both patients maintained their best responses after 41 (patient A) and 25 weeks (patient B) on larotrectinib, respectively, and remain on therapy. Surgery of the residue is being planned for patient B.

**Conclusions:** Selective TRK-inhibition by larotrectinib offers a novel, highly specific and highly effective therapeutic option for infantile fibrosarcomas carrying the characteristic ETV6-NTRK3 fusion. Its use should be considered when surgery is not feasible or might be mutilating.

2346

### Study of a genetic variant in Ewing sarcoma and its possible association with vincristine-induced peripheral neuropathy

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**Introduction:** Vincristine (VCR) is the most effective and frequently used chemotherapeutic agent for the treatment of leukemia, lymphoma and is one of drugs frequently used in chemotherapy protocols for Ewing Sarcoma, both in children and adults. The limiting factor of VCR dose is the occurrence of neuropathy associated with VCR (VIPN), causing discontinuation of therapy in 25% of patients, with an increased morbidity. A genetic variant with functional impact was recently identified in the promoter region of the CEP72 gene (SNP rs924607C/T) associated with increased incidence and severity of VIPN

**Purpose:** We aim to determine the frequency and association of rs924607C /T (being "T" the risk allele) in a cohort of patients with Ewing Sarcoma receiving VCR at single institutions and its association with peripheral neuropathy.

**Methods:** Prospective study. All patients with Ewing Sarcoma treated at our institutions with the VIDE chemotherapy protocol since January 2015 were enrolled in the study. A total of 11 patients were included and DNA was extracted from all of them. The median age was 15 years (range 5-28). Seven were male and four were females. Non of the patients involved in the study presented with metastasis at diagnosis and all of them were treat with chemotherapy and surgery. The presence of the wild-type C or risk T allele were determined by qPCR genotyping using Real-Time PCR System (TaqMan®) probes in a StepOnePlus™ thermal cycler. Neurological evaluations were performed by a specialized neurologist and neuropathies classified according to the total neuropathy score- pediatric Vincristine. Clinical and genetics results were analyzed by an independent observer (PGH).

**Results:** 2 patients presented the TT genotype, 6 the CT genotype and 3 the CC genotype. The mean dose of total vincristine was 16.5 mg (range 5.4 – 28).

The 2 patients with TT genotype developed neuropathy. For a total of six CT genotype patients, 4 developed VIPN. In the case of CC genotype for a total of 3 patients only 1 developed VIPN

**Conclusion:** With the data collected there would not be relationship between owning the allele C or T and the development of the Vincristine induced peripheral neuropathy. A major number of patients should be enrolled in the study in order to get higher information in our population.

Key words: Ewing Sarcoma, CEP72, Peripheral Neuropathy, Vincristine.

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## Accuracy of magnetic resonance imaging for detection of intraarticular involvement in juxta-articular located malignant mesenchymal tumors

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**Introduction and Purposes:** Assessment of joint involvement in juxtaarticular located malignant soft tissue and bone tumors determines the need for extra-articular resection. The purpose of this study was to determine the diagnostic accuracy of magnetic resonance imaging (MRI) in relation to the histopathological findings.

**Material and Methods:** All patients with sarcomas diagnosed from 2015 until 2018 with adequate clinical data and MRI were included in the study. MRI sections were compared to histological findings of the surgical specimen.

**Results:** Seven patients with 8 malignant juxtaarticular bone tumors (5 osteosarcomas - two of them developing in the same patient, 1 chondrosarcoma, 1 leiomyosarcoma and 1 clear cell sarcoma) were included. There were 2 female and 5 male patients; the mean age was 32.8 years (age range, 9-63 years). Four neoplasms were located in the knee, two in the shoulder, one in the hip and one in the elbow, respectively. Three patients with osteosarcoma received preoperative chemotherapy. In all patients, intraarticular involvement was observed at MRI, leading to extra-articular resection. These findings were confirmed by histology in 7/8 (88%) surgical specimens. In the last case tumor regressed under chemotherapy.

**Conclusions:** Detection of joint involvement in juxtaarticular located malignant sarcomas is important for choosing the right treatment option. Comparison between MRI and pathological examination in our study indicate that MRI is accurate for determining macroscopic intraarticular tumour extent. Negative histological findings related to joint involvement can be a consequence of prior chemotherapy, thus insight into patient's history and multidisciplinary approach are emphasized.

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### Detection of intraarticular involvement in periarticular located malignant mesenchymal tumors - a literature review

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**Introduction and Purposes:** Periarticular located sarcomas can spread and involve the joint. Currently, multiplanar MRI is the technique of choice for the staging of local tumor extension. The presence of peritumorous inflammatory changes may lead to false-positive diagnosis of joint involvement, which may be followed by unnecessarily radical en block resection of the joint. We performed a literature review to determine the overall diagnostic accuracy, sensitivity and specificity of magnetic resonance imaging (MRI) for assesment of joint involvement in comparison to histopathology.

**Material and Methods:** Electronic literature search of human studies in English language on PubMed from 01/01/1990 to 18/01/2019 was conducted using following terms: "magnetic resonance imaging" or "MRI" together with "joint involvement", and different types of soft tissue and bone sarcoma. No restrictions were applied on the study design and population age.

**Results:** Among 33 articles retrieved, five were included for final analysis with a total of 610 patients. For detection of intraarticular involvement in juxtaarticular located sarcomas MRI shows diagnostic accuracy 97.3%, sensitivity 94.8% and specificity 91%.

**Conclusions:** The recognition of joint involvement in periarticular located sarcomas is very important for further therapeutic decisions, as this finding leads to extra-articular resection. Comparative studies between MRI and surgical or pathohistological findings suggest that MRI is reliable in detection of intraarticular tumour extent. Considering the given results, MRI should be used as a standard method for accurate diagnosis of intraarticular involvement.

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## 2350

### Soft tissue sarcoma Clinical features and prognosis of extraosseous Ewing sarcoma in the pediatric population

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**Introduction and Purpose:** Extraosseous Ewing sarcoma (EES) accounts for 20% to 30% of all cases of ES (1). It is most frequently found in those older than 35 years and less than 5 years of age (1). Few reports in the literature discuss EES in children (2). We herein present the clinical features and outcomes of EES in the pediatric population.

**Materials and Methods:** We performed a retrospective chart review of pediatric patients diagnosed with EES. All patients were treated according to the AEWS0031, Regimen B protocol (3). Data collected included demographics, site of disease, subcutaneous location, baseline hemoglobin (Hb) and lactate dehydrogenase (LDH), duration of follow-up, size, metastasis at presentation, and disease recurrence.

**Results:** Fourteen patients were included. The mean age was 11.5 years. Three were subcutaneous. Two patients (14.3%) had lung metastasis at presentation. Eleven patients (78.5%) were alive at last follow-up (mean = 5.4 years). Two of the three patients who died of disease presented with a low Hb (10.5 and 10.6 g/dL) and elevated LDH (867 and 556 IU/L). None of those who died had subcutaneous masses, and all had local and/or systemic recurrence. Summary in Table 1.

**Conclusions:** The outcomes of pediatric patients with EES at a mean five-year follow-up appear to be favorable and are comparable to their osseous counterpart (2). Low Hb and elevated LDH may be negative prognostic factors, as previously reported (4).

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Table 1. Patient characteristics

Patient	Age	Sex	Follow-up (years)	Site	Metastasis at presentation	Local or systemic recurrence	Outcome
1	1.7	F	5.3	Thigh	No	-	Alive
2	16	F	3	Shoulder	No	-	Alive
3	14	M	6	Paranasal sinuses	No	-	Alive
4	13	M	2	Thigh	Yes (lung)	LR	Died
5	12	M	5	Arm	Yes (lung)	-	Alive
6	17	M	4	Maxillary sinus	No	LR / SR	Died
7	9	M	9	Shoulder	No	-	Alive
8	7	F	11	Thorax	No	-	Alive
9	8	M	1	Pelvis	No	LR / SR	Died
10	14	F	8	Maxillary sinus	No	-	Alive
11	9	F	6	Back	No	-	Alive
12	11	M	6	Back	No	-	Alive
13	16	M	3	Shoulder	No	-	Alive
14	13	F	6	Nasal	No	-	Alive

LR = local recurrence; SR = systemic recurrence



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### **Silver coated megaprotheses: better outcome following primary implantation vs. revision surgery**

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**Introduction:** Silver-coatings have been introduced to reduce infection rates at megaprosthesis reconstructions. The aim of the current series was to report the clinical outcome and complication rates.

**Materials & Methods:** Between 2004 and 2014, 46 patients underwent limb salvage surgery using silver-coated megaprotheses. Seventeen patients received the prosthesis in a primary setting following resection of a malignancy and 26 implants were used for revision surgery as prophylaxis against re-infection or in case of poor soft tissue coverage. In three further cases a proximal femoral replacement was necessary for revision THA due to massive bone loss.

**Results:** During the follow-up six patients died in the primary group and six in the revision group, respectively. Two patients were lost to follow-up in each group, additionally. The mean follow-up was 28 months (range, 3-106) in the primary group and 59 months (range, 1-155) in the revision group. According to the classification system of Henderson et al. there were four Type 1 (soft tissue failure, 20%), one Type 2 (aseptic loosening, 5%), two Type 3 (structural failure, 10%), no Type 4 (infection, 0%) and one Type 5 (tumour progression, 5%) failure in the primary group. In the revision group, there were five Type 1 (19%), three Type 2 (12%), three Type 3 (12%), nine Type 4 (35%) and no Type 5 failures. Overall, there was a revision rate of 40% in the primary group and 77% in the revision group.

**Discussion:** The current series showed high re-infection rates in revision setting but there were no infections following primary implantation of silver coated prostheses. For sure, silver coatings are not the definitive solution for periprosthetic joint infections in megaprosthesis reconstructions, but as shown in the literature, it can be an additional weapon for patients who are at higher risk because of previous septic complications or local or systemic compromising conditions.



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**Clear cell sarcoma in the lower extremity: an institutional case series**

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**Introduction:** Clear cell sarcoma (CCS) of soft tissue is a very rare melanocytic soft tissue sarcoma affecting young adults between the age of 20 and 40 years. CCS are associated with typical translocations like EWSR1/ATF1 or EWSR1/CREB1. Normally they are located deep in the fascia and are usually of small dimensions.

**Patients and Methods:** Between 2009 and 2019, 4 patients with a mean age of 29 years (range, 18-46), were treated due a CCS of the soft tissues. There were two male and two female patients. Two sarcomas were located at the knee (intraarticular & with an extraarticular part) and two in the soft tissues next to the hip.

**Results:** The mean postoperative follow-up was 23 months (range, 2-74). A wide resection was done in three cases and a diagnostic biopsy in one case because of metastatic disease. Overall, two patients died within 2 and 10 months following biopsy or resection, in one case due to pneumonia and due to progressive metastatic disease in the other case. In both cases metastases at the lymph nodes were evident at time of diagnosis. The other two patients were alive without disease.

**Discussion:** Bianchi et al. reported five and ten-year disease-specific survival of 56% and 41%, respectively. Two-year disease-specific survival rates for lymph node and pulmonary metastasis groups were 40% and 0%. Like in the current series, patients with metastatic disease at time of first diagnosis or during follow-up showed a poor prognosis. Overall, prognosis for patients with CSS did not change within the last decades. Surgical resection with clear margins seems to be still the treatment of choice, although adjuvant radiation therapy seems to increase the rates of local control. Further studies are needed to understand this rare entity and to try to develop further treatment guidelines, maybe with new therapeutic agents.

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### Infection of megaprotheses following bone tumor resection: a retrospective study

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**Introduction and Purposes:** The risk of infection in megaprotheses following bone tumor resection, is 10 times higher than in standard joint replacement. This is a retrospective study to assess the incidence of infection, type of treatment and the clinical and radiological outcome.

**Materials and Methods:** We evaluated 111 patients undergoing to a megaprotheses implant during the period 2000 to 2017 with a minimum 2-year follow-up. 12 patients developed infection (10,8%). Silver coated and DAC (Defensive Antibacterial Coating) implants were adopted. The mean age at the time of the first implant was 48.8 years (range:15-80).

**Results:** We found 5 "early infections", 1 "delayed infection", 6 "late infections". In 5 patients the pathogen was not identified; in 5 patients gram positive bacteria were isolated; gram negative bacteria were isolated in 2 patients. 5 patients underwent to a debridement procedure; in 2 cases an attempt was made for one stage revision, but once proved unsuccessful, the implant was removed and a two-stage revision was performed; 2 patients underwent directly to a two-stage revision. A hip disarticulation was necessary in an early infection. In 1 case a two-stage revision was planned but poor medical conditions of the patient led to perform an amputation. In conclusion, there were 5 amputations, 3 chronic infections, 1 flail shoulder for removal of the head of a humeral megaprosthesis; the remaining 3 infection healed with salvage procedures. The percentage of infection in our study was 10.8% in line with the literature. The amputations were 5 (41.5%). Only 3 patients had a complete recovery. The poor outcome in these cases shows how challenging is the treatment when an infection occurs, and the high complication rate that often leads to an amputation.

**Conclusions:** Considering the high rate of revision surgery failure and the lack of univocal international guidelines, the need emerges to develop standardized revision surgery procedure protocols for these patients, even in light of the fact that improved chemo and radiotherapy have increased the survival of cancer patients.

2357

## **Cement spacer formed in a patient-specific mould based on a three-dimensional bone model. A case report**

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**Introduction:** Patient-specific cutting devices based upon three-dimensional (3D) triangular surface models are frequently used for complex corrective osteotomies, tumor resections and endoprosthetic reconstructions. We have applied these principles to prepare a cement spacer for the treatment of an infection associated with a tumor and simultaneous reconstruction of the distal radius.

**Methods:** N.S.\*1973. In 2012 a clear cell sarcom of the distal forearm was accidentally resected. In 2014 she had resection for recurrence and received percutaneous radiotherapy with. In 2018 she presented to our institution with soft tissue metastases on the forearm and ulceration over the distal radius invaded by the tumor.

To achieve at least marginal margins extensive soft tissue and part of the distal radius needed resection. Due to the ulceration and infection it appeared neither justified to replace the distal radius with an allograft or endoprosthesis.

The patient-specific spacer should also serve to guide the needed resection of the radius. Soft tissue was reconstructed with a microvascular M. gracilis flap and split skin.

**Results:** The patient regained the preoperative function and a surprisingly stable articulation of her wrist was observed at 8 months postoperative.

**Discussion:** The application of a cement spacer was important to locally control infection and to use it as a spacer. Instead of intraoperatively forming a cement spacer it was chosen to design molds to form a spacer identically shaped as the part of the radius to be resected.

**Conclusion:** The mould must be designed specifically in a way that the cast can be removed after hardening. We needed 4 parts composed together to allow removal of the hardened cement. In our patient the cement spacer was planned to be implanted only temporarily to aid in infection control. At present it is, however, kept in place as the patient is pleased with the function. In selected cases such a patient-specific formed spacer maybe a useful option.

2358

### Osteosarcoma as secondary malignancy in patients following retinoblastoma

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**Introduction:** The incidence of secondary malignant neoplasm (SMN) in familial retinoblastoma is increasing as the number of long term survivors in retinoblastoma increases with the advance of multidisciplinary treatment. The most common SMNs is osteosarcoma. Our study reports the outcomes and the characteristics of osteosarcoma as SMN.

**Methods:** Ten cases of osteosarcoma following retinoblastoma were identified. Medical records and images were reviewed retrospectively.

**Results:** Median age at diagnosis of retinoblastoma was 6.0 months (range 2.0–18.0 months). Median age at the time of diagnosis of osteosarcoma was 9.2 years (range, 5.3-15.2) and the medial interval of two malignancies was 8.0 years (range, 4.9-14.8). All patients underwent neoadjuvant chemotherapy, wide excision, and adjuvant chemotherapy, in the same way as the primary osteosarcoma. 5-year survival rate was estimated 78.8%. Main imaging modality for surveillance of bone lesion after treatment of retinoblastoma was bone scan. Asymptomatic abnormality on bone scan were found in two patients and eight patients of osteosarcoma were detected by symptoms. The characteristics of SMN was heterogeneous. In location, 70% (n=7/10) of the tumor had a tendency to exist in proximal than diaphysis-metaphase junction. The definite contour of the lesion was invisible in 3 cases even though active lesion was detected in bone scan. Median size of the tumor lesion was 8.8cm (range, 5.2~13cm). Sclerotic-dominant matrix was observed in 72.7% (n=8/11) of the entire cohort. Soft tissue extension was found in 27.2% (n=3/11). In 3 cases bony abnormality was found on bone scan without symptom.

**Conclusion:** Osteosarcoma in retinoblastoma survivors tends to be in a little more diaphyseal location than metaphysis, and the matrix of the lesion looks often sclerotic-dominant even though it did not have statistical significance. Bone scan is an effective modality for surveillance. The clinical outcomes of osteosarcoma as secondary malignancy following retinoblastoma are not inferior to those of conventional osteosarcoma.

2360

### Chronic nonbacterial osteomyelitis - clinical presentation and outcome in children and adults - a case series of 32 patients

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**Introduction and Purposes:** Chronic nonbacterial osteomyelitis (CNO) is a rare inflammatory bone disease, diagnosed in childhood and adulthood. Important differential diagnoses are bone sarcoma and bacterial osteomyelitis. The most commonly used term with children and adolescents is chronic recurrent multifocal osteomyelitis (CRMO) and with adults synovitis acne pustulosis hyperostosis osteitis (SAPHO) syndrome. The aim of this study was to compare clinical, laboratory and radiological data of both age groups.

**Materials and Methods:** Retrospective single-centre study of patients at the Medical University of Graz with a diagnosis of CNO, CRMO or SAPHO syndrome between 1993 and 2017. The manifestation of the disease before the age of 18 years meant attribution to the paediatric group.

**Results:** We included 32 patients, 23 paediatric and 9 adult. Mean age at time of diagnosis was 12 years in the paediatric group, 30 years in the adult group. The mean time to diagnosis was 1 year in the paediatric group, 3 years in the adult group. Whereas 48 % of the paediatric cohort had a multifocal manifestation with predominant involvement of the long bones, 56% of the adults had a multifocal manifestation and predominantly an involvement of the sternum. The use of imaging techniques showed clear differences in the application of whole-body MRIs (paed. 0.2, adult 0), plain X-ray (paed. 3.7, adult 0.8) and computer tomography (paed. 0.4, adult 1.6). Therapeutic differences were found in the prescription of bisphosphonates (paed. 52%, adult 11%) and biologicals (paed. 13%, adult 0%). At last follow-up 52% of children and 11% of adults were in clinical remission.

**Conclusions:** Due to the vast similarities in clinical appearance, radiological and laboratory findings it can be assumed that CRMO and SAPHO are different forms of the same entity. Different strategies of diagnosis and therapy indicate the absence of validated diagnostic and treatment guidelines and low awareness of this disease.

2361

### Total femoral replacement (TFR)

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**Objectives:** We performed 10 TFR in adult patients for primary or metastatic musculoskeletal oncologic pathology in our Institution. Our purpose was to review functional and oncologic results and describe surgical complications.

**Materials and Methods:** 10 TFR were performed between 2008-2018. Patients' mean age was 24.7 years and the mean FU was 57 months (4-121). Diagnosis was as follows: 6 osteosarcomas, 1 Ewing sarcoma, 1 soft tissue sarcoma with extensive bone invasion and 2 breast metastatic cancer. In every case the implant was a modular tumoral megaprosthesis with a bipolar cup in the hip and a rotatory hinge in the knee.

**Results:** ONCOLOGIC: In 7 of the 8 sarcomas the resection was considered R0. Two patients developed local recurrence. 3 of 10 of our patients were alive at the evaluation and the mean survival was 19.5 months. FUNCTIONAL: MSTS/ISOLS score was mean 18.5 (61.8% of mean normal function). COMPLICATIONS: No deep infections or mechanical failures were observed. 2 cases were amputated for local recurrence.

**Conclusions:** TFR is the last option before a hip disarticulation for patients with locally advanced tumor disease with gross invasion of bone and surrounding soft tissue in the thigh. Adverse outcomes in our series were for local recurrence in sarcoma cases. We did not register deep infections, instability or failure for mechanical reasons .

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## 2366

### Is arthrodesis a reliable salvage option following two-stage revision for suspected infection in proximal tibial replacements?

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**Introduction:** An attractive alternative to maintain limb salvage in the multiply revised infected proximal tibia (PT) replacement is knee arthrodesis (KA).<sup>1</sup> The aim of this multicentric retrospective study was to verify whether KA is a viable reconstructive option after two-stage revision for infection of PT endoprosthetic replacement (EPR).

**Materials and Methods:** 60 patients who underwent a two-stage revision were included. Median age was 25 years (range 12-76). KA was mostly indicated in case of bad soft tissue coverage, weak extensor mechanism and bad pre-infection knee function, presence of high infection risk comorbidities such as diabetes and high virulence bacteria isolated (Staphylococcus aureus-SA, Streptococcus spp and Enterococcus spp.). Patients were evaluated with Musculoskeletal Tumour Society Score and Oxford Knee score.

**Results:** Five patients did not receive any reconstruction after the first stage. In 14 cases a KA was performed, in 41 an EPR was implanted. At 5 years follow-up, reinfection rate in the KA group (10%) was lower than in EPR group (17.5%). In re-infected patients, the KA group had a reduced rate of amputation when compared to those with EPR (50% vs 88%). Silver-coated prosthesis, either an EPR or KA had a lower rate of recurrent infection when compared to non-silver coated implants ( $p=0.048$ ). Functional evaluation did not show any significant differences between the 2 groups.

**Conclusions:** Although the surgeon and the patient may consider an arthrodesis of the knee as an inferior alternative to a hinged prosthesis, KA can eradicate infection and allow preservation of the limb with good function and good pain relief when used in the setting of a two stage revision for an infected PT EPR.

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2373

### The outcome of sarcoma treatment in a developing country, review of 238 patients treated in a single institute

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**Background:** Limb salvage surgery (LSS) became the standard surgical treatment for bone sarcomas since the late 1970s; however, LSS has high cost and numerous complications that make it less applicable in developing countries.

**Objectives:** To Show that LSS in developing countries, can be compared to developed countries, when; team work, expert surgeon and enough resources are available.

**Methods:** Since July 2006, a multidisciplinary team of sarcoma was established. This team consisted of pediatric and medical oncologists, radiation oncologists, radiologist, nurse coordinator and a full-time orthopedic oncology surgeon. The team was supported by a service for physical therapy. Clinical practice guidelines were established and a special protocol for rehabilitation following surgery was applied. Two hundreds and thirty eight patients with malignant or benign aggressive bone tumors presented at the study period, 44 patients received primary amputation, 194 patients received LSS (82 % of all patients) included in our analysis, with mean follow up of 70 months (range, 6-120 months). Tumors were located in the extremities (n=172), in the scapula (n=7) and the pelvis (n=15).

**Results:** At 6 yr. median follow up, local control was achieved in 88% of patients, 82% of patients has no complications, 8% developed infection, 4% developed mechanical complications, 95% of limbs survived, MSTS functional score=87%.

**Conclusions:** Our results in term of local control, prosthesis related complications, limb survival and function are compared favorably to most of the literature in developed countries. Patients with sarcoma are managed better within a multidisciplinary team that is familiar with highly specialized procedures including LSS. Inappropriate initial intervention in outside facility was the most common cause of amputation.

## 2375

### How accurate a free hand core needle biopsy for bone and soft tissue sarcoma can be?

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**Background:** Classic teaching has advocated the use of open biopsy to diagnose and grade extremity sarcoma. Reported advantages of core needle (Tru-cut) biopsy include the minimal morbidity, cost, and time. The perceived disadvantage has been diagnostic inaccuracy, and sample insufficiency.

**Objectives:** To present an institutional experience in core needle biopsy without image guidance; for diagnosis and grading of bone sarcoma with palpable soft tissue component and soft tissue sarcoma.

**Materials and Methods:** Eighty four patients received core needle biopsy on outpatient bases at orthopedic oncology clinic. Fifteen patients with Bone sarcoma (Osteosarcoma n=12, Ewing's sarcoma n=12, Chondrosarcoma, Giant Cell Tumor and metastatic leiomyosarcoma to bone 2 each), and 54 patients with Soft tissue sarcoma (STS). Forty located in the thigh and femur, 10 in the buttock and iliac bone, 12 in the upper limb and 8 in other places, all biopsies were performed by the lead author using a 12 gauge Tru-cut needle, under local anaesthesia, 6 to 8 cores were obtained by redirection of the needle through the same entry with correlation to the MRI extent and location of the lesion. Radiological size of the tumors ranged from 5-30 cm. All samples were sent to our pathology lab for study.

**Results:** All specimens obtained were adequate to make the diagnosis. All histological diagnoses were concordant with the resection diagnosis (100% accuracy); two biopsies graded low were found to be intermediate to high on the resection specimen (grade accuracy 97%). Two patients developed hematoma, and treated with local compressive dressing.

**Conclusion:** The radiologically un-aided (Hand-free) core needle biopsy for Soft tissue sarcoma and bone sarcoma with extra osseous component, provide accurate diagnostic information for malignancy and grade, adequate core needle biopsy enables to avoid open biopsy which decreases tissue planes contamination and facilitate subsequent resection of the biopsy tract.

2377

## Neoadjuvant Concurrent Chemoradiation for High-Risk Adult Soft Tissue Sarcoma - 16 Years of a Single Institution Experience

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**Introduction and Purposes:** Neoadjuvant chemoradiation (NCRT) shows promising results regarding locoregional disease-free survival (LRDFS), disease-free survival (DFS) and overall survival (OS) in high-risk soft tissue sarcomas (HRSTS). However, it is not accepted as standard of care yet. This study aims to evaluate pathologic response, feasibility of conservative surgery, R0 resections, local control and survival after NCRT.

**Materials and Methods:** We retrospectively analyzed 28 patients treated with neoadjuvant intent for HRSTS stage III between 2002-2018, of which only 15 received NCRT (Adriamycin 90mg/m<sup>2</sup>+Dacarbazine 900mg/m<sup>2</sup>±Vincristin 2mg bolus+Ifosfamide 10mg/m<sup>2</sup>;50-54Gy/25-30fr) followed by surgery. Necrosis grade and surgical margin status were accessed by pathologic reports. Acute toxicity graded by CTCAEv5.0 and survival estimated by Kaplan-Meier method.  $\alpha=0.05$ .

**Results:** 15 patients with a median age of 50years (18-78), mainly male (66.7%), with extremities HRSTS in 73.2% and median length of 16cm. Pleomorphic sarcoma was found in 33.3% and G3 in 73.3%. All patients completed NCRT, with acute toxicities in 79.9%, mainly due to anemia G2-3 (53.3%), leucopenia G3-4 (33.3%), thrombocytopenia G3-4 (20%) and radiation dermatitis G3-4 (53.4%). Conservative surgery was possible in 93.3%, with R0 in 78.6%. Necrosis  $\geq 90\%$  was obtained in 41.7% patients, one of which had complete response. Postoperative complications occurred in 33.3%, mostly related to poor wound healing; one patient had osteitis. With a median follow-up of 60 months (8-177) 5-year LRDFS was 91.7%, DFS 57.3%, OS 62.6% and cancer specific survival 69.5%. 5 patients had metastasis, none with local recurrence. R1 resections led to significantly poorer LRDFS (50% vs. 100%,  $p=0.025$ ). Although not statistically significant, patients with  $\geq 90\%$  necrosis tend to show better outcomes.

**Conclusions:** NCRT for HRSTS is feasible, with high local control rates and manageable acute toxicity. R0 rates were high and led to better LRDFS.

2378

### **Oncological results of cryosurgical therapy for chondroid tumors of the hand**

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**Introduction:** Chondroid tumors are the most common tumors of the hand and are traditionally treated with curettage without adjuvant. To the best of our knowledge this is the largest study describing oncological results of curettage and cryotherapy of chondroid tumors located in the hand.

**Methods:** We analyzed the oncological results of 84 enchondroma tumors and 4 atypical cartilaginous tumors (ACT) of the hand treated with curettage and cryotherapy, between 2008 - 2017, at our institution. Mean post operative follow-up was 16 months (range: 1 - 61 months).

**Results:** 34% of the cases were diagnosed due to pathologic fractures, 28% were incidental radiographic lesions. The other cases were diagnosed due to pain and/or palpable lesions. All cases were treated with curettage and cryosurgery, in 71 cases (81%) the defect was filled with a bone graft (78% auto graft, 23% allograft). In none of the cases cement was used. During follow-up residual tumor was seen in 2% (1 enchondroma, 1 ACT). All cases with residual tumor remained stable during follow-up and were not operated on. Recurrence occurred in 3% (2 enchondroma, 1 ACT), in 2 cases recurrence in combination with pain complaints was reason for re operation.

No progression of tumor grade or metastases were observed in this study. There were in total 5 complications (6%): fracture (3 cases) and infection (2 cases). Infection was reason for re operation in both cases.

**Conclusion:** In this large study, curettage and cryosurgery showed excellent oncological results for enchondroma and ACT in the hands. Reported recurrence and complication rates varies greatly in current literature. Using cryosurgery as an adjuvant did not result in a higher complication rate and recurrence rate was either comparative or lower compared with current literature.

2379

## Differentiation of atypical cartilaginous tumors and high-grade chondrosarcoma by magnetic resonance imaging: a systematic review

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**Introduction:** Adequate pre operative staging and grading of chondrosarcoma is of paramount importance as it determines both treatment and outcome. The aim of the present systematic review is to provide an overview of magnetic resonance imaging (MRI) criteria used to differentiate between atypical cartilaginous tumours (ACT) and high-grade chondrosarcoma (HGCS).

**Methods:** For this systematic review PubMed and Embase were searched, from inception of the databases to 12<sup>th</sup> July 2018. All original articles describing MRI characteristics of pathologically proven primary central chondrosarcoma were included. Subsequently a quality appraisal of the included papers was performed. Associations of MRI criteria and histological grade of chondrosarcoma were tested using the Fisher exact test.

**Results:** Our search identified 2132 unique records, of which 14 studies were included. In total 239 ACT and 140 HGCS were identified. Entrapped fat ( $p < 0.001$ ), internal lobular architecture ( $p = 0.011$ ) and ring and arc enhancement ( $p < 0.001$ ) were significantly more present in ACT. The following MRI characteristics were significantly more present in HGCS: bone marrow edema ( $p < 0.001$ ), bone expansion ( $p < 0.001$ ), cortical thickening ( $p < 0.001$ ), scalloping ( $p = 0.040$ ), cortical breakthrough ( $p < 0.001$ ), periosteal edema ( $p < 0.001$ ), soft tissue edema ( $p < 0.001$ ), soft tissue expansion ( $p < 0.001$ ), high signal on T1 ( $p = 0.002$ ) and central non enhancing region ( $p < 0.001$ ). Our quality assessment shows great variability in consensus criteria used for both pathologic and radiologic diagnosis.

**Conclusion:** This systematic review provides an overview of MRI characteristics used to differentiate between ACT and HGCS. Several MRI characteristics have been identified to be helpful in differentiating these tumors.



2382

## Reconstruction of the pelvic ring by the metal-polymer composition after internal hemipelvectomy

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**Introduction:** Hemipelvectomy internal I and II types according to Enneking in patients with pelvic tumors require reconstructive procedure. The use of a metal-polymer composition (polyaxial screws, titanium rods, wire and polymethylmethacrylate) for this purpose is relevant from an economic point of view and can be considered as an individual intraoperative endoprosthesis of pelvic defects after such resections.

**Aim:** Analysis of the behaviour of the metal-polymer composition after pelvic ring reconstruction in patients with hemipelvectomy internal I and II types.

**Material and Methods:** Based on previous biomechanical studies (computer simulated 3D models and behavior of structure "bone-fixator-endoprosthesis" by finite element analysis), the hemipelvectomy internal was performed in 25 patients. 16 of them, followed-up from 15 to 36 months (type I - 13, type II - 3) were analysed. The average observation time is  $22,1 \pm 7,6$  months. The septic and aseptic instability, limb function by MSTS scale were evaluated.

**Results:** Late deep infection were detected in 3 (18,7%) patients: type I - 2 pts (12,5%) and type II - 1 pt (6,2%). The mean MSTS score at last available follow-up was: type I -  $66,9 \pm 15,7\%$  and type II -  $51,7 \pm 11,8\%$ . The mean MSTS score in 13 patients without complications was  $69,4 \pm 15,2\%$  and  $59,3 \pm 5,7\%$ , respectively. Aseptic loosening was not observed in any case within the specified observation period.

**Conclusions:** The clinical application of the metal-polymer composition of pelvic ring defects based on biomechanical studies demonstrates the stability of the system for more than 2 years and its applicability.

Keywords: pelvic bone, hemipelvectomy, functional outcome, complications.

2383

### Result of application of denosumab in preoperative treatment of giant cell tumor

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**Background:** Recent studies showed that target agent denosumab (monoclonal antibody to RANK ligand) is effective agent for treatment of giant cell tumor (GCT) but whether it is possible to say that it is always the method of choice in the treatment of this pathology.

**Aim:** To present the results of treatment of patients with GCT using denosumab at different localizations.

**Materials and Methods:** Study included 49 patients with GCT who were treated from 2011 to 2017, localized in pelvic bones in 7 cases, distal femur – 17 cases, proximal tibia – 10 (1 distal tibia), humerus – 8, distal radius – 3 and ulna – 2 cases, lumbar vertebra -1. Median follow-up was 53.7 months. All patients received 6 injection of denosumab (120 mg) as neoadjuvant therapy. In Some patients treatment by denosumab was continued in the postoperative period. In the subsequent patients underwent curettage with liquid nitrogen cryotherapy and plastic of defect by bone cement. The treatment efficiency was assessed by radiological techniques (CT) and postoperative morphological study.

**Results:** In all 49 (100%) patients were achieved positive effect of therapy (decrease in pain intensity after 2 week of treatment). In 42 (85,7%) cases was revealed tumor regression by 30%, were detected calcification of tumor area and consolidation of cortical area. In all patients, excluding one, observed complete tumor necrosis by morphological study. 9 (18,4%) patients had local recurrence, 3 of them in distal radius cases (100%) after surgery (from 6 to 12 months). All of these patients underwent radical resection of the radius with autoplasty. For patients with other localizations and recurrence - repeated courses denosumab followed by curettage. 6 (12,2%) patients refused of any surgical treatment – they are continuing treatment to 12 injections and observed from 12 to 26 months without any signs of disease progression. In two of them was detected disease progression in 21 and 18 months after therapy. 38 patients (77,52%) currently in remission (median follow-up – 47,2 months).

**Conclusions:** Conservative treatment of GCT with denosumab, certainly, reduces the number of bone resections. However, the recurrence rate is still quite high in this mode of use and such terms of observation. The localization of the tumor in the distal radius is a contraindication for conservative treatment in our opinion.

Fig. 1

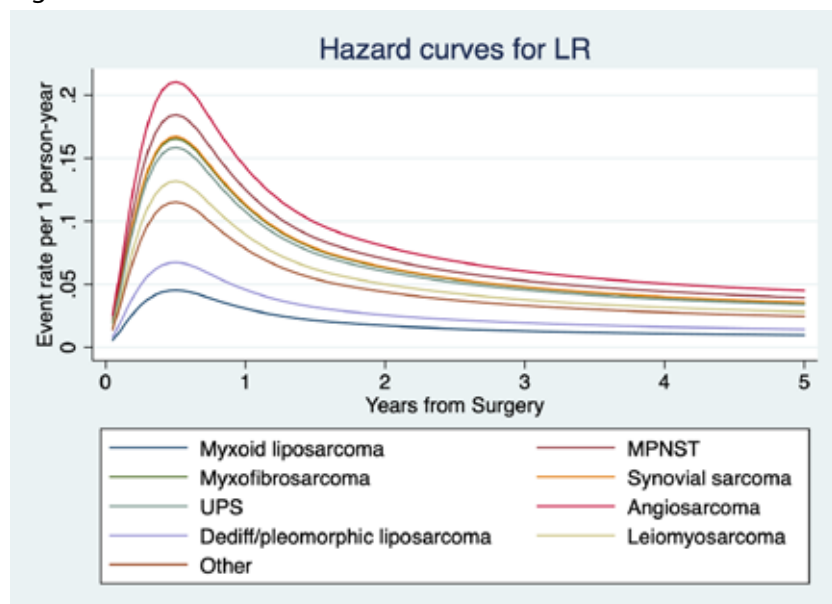
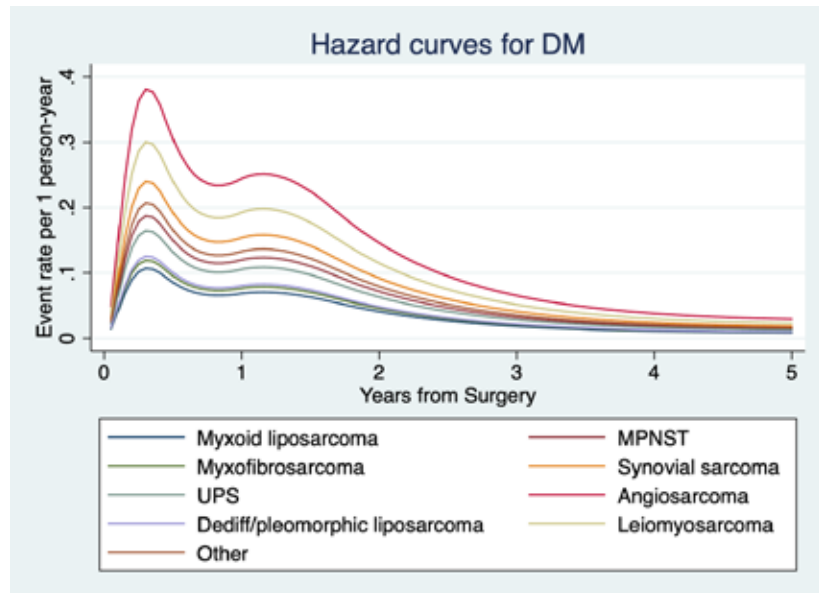


Fig 2.



## 2385

### Preliminary results of surgical treatment of tumors of a sacrum

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**Introduction and Purposes:** Preliminary experience of verification and surgical treatment of 17 patients with tumor of sacrum.

**Materials and Methods:** Morphological verification of a tumor in 3 cases (17.6%) was made by open approach and trepanation biopsy in 14 patients (82.3%). When carrying out trepan biopsy we used the new device for doing biopsy of a tumor of bones.

**Results:** On morphological type of a tumor patients were distributed: 7 (41%) - a giant-cell tumor, 3 (17%) - a chondrosarcoma, 2 (11%) - neurogenic sarcoma, 1 (5%) - a chordoma, 3 (17%) - an osteosarcoma, 1 (5.8%) - a neurinoma. In order to reduce the intraoperative blood loss, at the first stage, we carried out embolization of the "feeding" vessels of a tumor. The sacrum hemiresection was done in 2 patients at the level of VS3-VS5, in 3 cases resections was carried out at the level of VS1-VS3 vertebrae with stabilization systems of TPF by a lumbo-pelvic fixation approach, in 10 patients subtotal - removal of a sacrum at the level of VS2 and in 2 patients at the level of VS3 was made. The average duration of operation was - 150 min. The volume of intraoperative blood loss was - 400 ml. Postoperative complications accounted of 34.6% with subsequent full recovery of organ functions. The continued growth and relapses of tumor were noted in 3 patients (16.8%) and in 4 patients (23.4%) respectively.

**Conclusion:** The resection of sacrum with decompression of nervous structures allows to stop a pain syndrome, to recover functions of pelvis, to thereby improve quality of life of the patient. Performance of the selection angiography with acute embolization of the feeding vessels of a tumor, in 24-48 hours prior to operation, prevents intraoperative bleeding, thereby reduces blood loss volume by 3.7 times, operation duration by 2.8 times, allowing to complete remove of tumor.

**2386**

**Preliminary results of surgical treatment of tumors of a sacrum and pelvis**

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**Introduction and Purposes:** Preliminary experience of verification and surgical treatment of 35 patients with tumor of sacrum and bones of pelvis.

**Materials and Methods:** Morphological verification of a tumor was made by open approach in 24 (68.6%) and in 11 cases trepan biopsy (31.4%). In order to perform trepan biopsy we used the new device for a biopsy of a tumor of bones.

**Results:** On the basis of morphological type of a tumor patients were distributed: 5 (14%) - a malignant giant-cell tumor, 13 (37%) - a chondrosarcoma, 15 (43%) - an osteosarcoma, 2 (5%) Ewing's sarcoma. Out of 35 in 7 patients (20%) were treated by surgical methods (5 (71%) had the Malignant giant-cell tumor and 2 (29%) patients had Chondrosarcoma) and 9 (25%) patients received chemotherapy. The rest of patients 19 (54%) received the combined treatment. The resection of an ileum (P1) was made in 8 (30%) (morphologically in 4 (15.3%) chondrosarcoma, in 3 (11.5%) osteosarcoma, in 1 (3.8%) Ewing's sarcoma). The amount of patients with tumor of sacrum were (P4) - 4 (15.4%). For the purpose of reduction of intraoperative blood loss, the first stage, carried out embolization of the "feeding" vessels of a tumor. In 2 (7%) the patient made a resection of sacrum at the level of VS3-VS5, subtotal - removal of a sacrum et the level of VS2 - in 1 (3.5) patient, in 1 (3.5) resection at the level of VS3. The average duration of operation made up - 150 min. The volume of intraoperative blood loss was - 400 ml. Postoperative complications accounted of 34.6% with subsequent full recovery of functions.

**Conclusion:** Different types of surgical methods are considered as useful methods in treatment of benign and malignant tumors of a sacrum and pelvis as well as the integral stage in treatment of malignant tumors.

2387

### The choice of surgical treatment of tumor of distal part of radial bone involved

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**Introduction and Purposes:** Preliminary experience of surgical treatment of tumor of distal part of radial bone involved.

**Materials and Methods:** We provided experience of surgical treatment of 40 patients with tumor involving of distal part of radial bone. Out of them 18 (45%) men, 22 (55%) women. Average age made up 32 years old. Morphologically, in 31 (77,5%) cases giant-cell tumor, 1 (2,5%) chondromyxoma, 3 (7,5%) fibrous dysplasia, 3 (7,5%) osteosarcoma, 1 (2,5%) malignant giant-cell tumor, 1 (2,5%) mesenchymal chondrosarcoma. 17 (42,5%) the patient made a segmented resection of distal department of a beam bone with defect substitution by an autotransplantant from a fibular bone. In 7 (17,5%) patients underwent a segmented resection of distal department of a radial bone with substitution of defect with use of an endoprosthesis worked out by our department. In 15 (37,5%) patients medical cement was used. In one (2,5%) case the distal segmented resection of a radial bone was made.

**Results:** The period of following up made from 12 months to 10 years. Recurrence at a segmented resection of distal department of a radial bone with defect substitution by an autotransplant of a fibular bone was observed in 11.7% patients. Rejection of an autotransplantant in 17.6%, in 5.8% was observed metastasis of a tumor. At defect substitution by an endoprosthesis recurrence was revealed in 14.2%, metastasis was not observed. In 20% cases relapses were revealed after a tumor excochleation with defect substitution by medical cement.

**Conclusion:** The tumor involving of distal part of a radial bone with existence of a soft tissue component and both thinning of a cortical layer of a bone, transition of a tumor to a joint surface of a bone, and morphological structure of a tumor the choice of surgical treatment is the segmented resection with defect substitution with an endoprosthesis.



2390

## Results of limb-sparing reconstructive surgery using autovenoplasty for soft tissue tumors of limbs

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**Introduction and Purposes:** To study of the results of limb-sparing reconstructive surgery with the application of autovenoplasty for soft tissue tumors of limbs.

**Materials and Methods:** A total of 8 patients were enrolled in our study. Patients' eligibility criterion was soft tissue tumors with vascular invasion to main blood vessels. Sex ratio: 6(75%) males and 2(25%) females. Age interval was 19–57. The tumors histological investigation showed following (no.(per cent)): 2(25%) desmoid, 1(12.5%) fibrosarcoma, 1(12.5%) neurofibromatosis, 1(12.5%) fibroxanthoma, 1(12.5%) pleomorphic sarcoma, 1(12.5%) liposarcoma and 1(12.5%) adenocarcinoma of sweat glands. Only patient (12.5%) underwent surgery for synthetic prosthesis of iliac-femoral artery. The autovenoplasty (autovenous transplant) using large saphenous vein has been performed to rest of patients – 7(87.5%), which includes autovenoplastic interventions to brachial (n=2), subclavian-axillary (n=1), axillary (n=2) and femoral (n=2) arteries. In one case it was carried out synchronously skin-muscle transplant and autovenoplasty.

**Results:** There was no evidence of surgical complications after performing one. As well, circulatory failure in limbs, atrophy of extremity muscles, purulent-necrotic processes and functional disorders of limbs were not occurred in postoperative period. Surveillance period was 1-3 years. One case of recurrence was registered. Even though duration of limb-sparing surgery procedure is longer than non-sparing surgical method such as amputation of a limb, the first one provides to avoid disability, improve patients' quality of life and follow radical principle of treatment.

**Conclusion:** The results of the treatment demonstrate that performing of limb-sparing reconstructive surgery using autovenoplasty for soft tissue tumors of extremities ensures to excision of tumor radically, improve patients' quality of life and avoid disability of patients.

2392

### Amputation for Extremity Sarcoma: Indications and Outcomes

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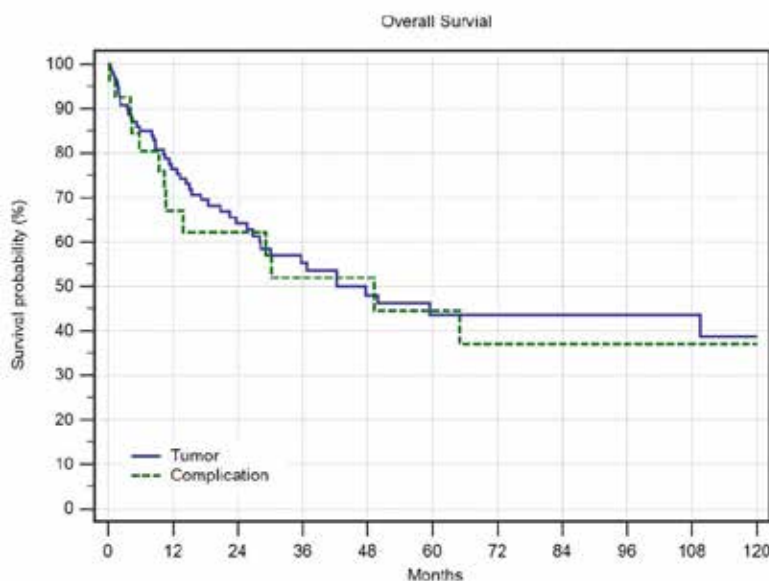
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Amputation for localized extremity sarcoma (ES) is still a relevant surgical procedure. We reviewed our experience, identified indications and evaluated outcomes.

**Patient and Methods:** Between 1980 and 2018 149 sarcoma patients had been amputated. The indications had been in 80% the tumour, in 20% complications of limb salvage (LS). Osteosarcoma was the most seen entity (35 cases), chondrosarcoma (18), UPS (17), synovial sarcoma (11) and further entities with each less than 10 cases were noted. In 109 cases the lower extremity including the pelvis, in 40 the upper extremity was involved. The mean age of 92 male and 47 female patients was 54 years (13-89). The patients with complication induced amputations were 3 years younger (n.s.).

**Results:** 29% of patients already had metastatic disease. 61% already had a first resection before amputation. 54% a local recurrence as indication of amputation. In 95% a R0 resection was possible. In 1 of 29 patients amputated for complications of LS and in 16 of 117 (14%) of cases amputated for local tumour recurrence, local recurrence developed. 13 of 16 patients with LR showed metastatic disease. Overall survival was 45% after 5 and 40% after 10 years. Only 2 patients had a G1 sarcoma. G2 patients showed a better survival than G3 patients. In cases of a LR Overall Survival dropped to 50%. In those patients with LR as indication for amputation Overall Survival was worse but not significantly (Fig. 1).

**Conclusion:** Amputation is still a valid option in treating sarcoma patients. Unexpectedly patients who had been amputated for complications of limb salvage had the same prognosis as patients amputated for the tumour itself. The Overall Survival of 40-45% after 10 years underlines the bias in regard to patients with worse prognosis being amputated. LR was still seen in 16% of patients after amputation for the tumour.



2397

### **Telangiectatic osteosarcoma: Differential diagnosis from aneurysmal bone cyst via a discriminant function and outcome analysis**

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**Introduction and Purposes:** Telangiectatic osteosarcoma (TOS), a rare variant of osteosarcoma, may be easily misdiagnosed as aneurysmal bone cyst (ABC). The aims of this study were to investigate the diagnostic and prognostic factors of TOS by reviewing our experience with TOS and to develop a diagnostic model that may distinguish TOS from ABC.

**Materials and Methods:** We identified 51 cases of TOS treated from March 2001 to January 2016 and reviewed their records, imaging information and pathological studies. A diagnostic model was developed to differentiate TOS and ABC by Bayes discriminant analysis and was evaluated.

**Results:** The multi-disciplinary diagnostic method employed that combined clinical, imaging, and pathological studies enhanced the diagnostic accuracy. Age 18 years or younger and pathologic fracture were more common among the TOS patients than among the ABC patients ( $P=0.004$  and  $0.005$ , respectively). The average white blood cell (WBC), platelet, lactate dehydrogenase (LDH), and alkaline phosphatase (ALP) values of the TOS patients were higher than those of the ABC patients ( $P=0.002$ ,  $0.003$ ,  $0.007$ , and  $0.007$ , respectively). Our diagnostic model, including the aforementioned factors, accurately predicted 62% and 78% of the TOS patients in the training and validation sets, respectively. Tumor volume and the LDH level were predictive prognostic factors ( $P=0.040$  and  $0.044$ ) but not the presence of pathologic fracture or misdiagnosis ( $P=0.424$  and  $0.632$ , all respectively).

**Conclusions:** The multi-disciplinary diagnostic method and diagnostic model based on predictive factors, i.e., age, the presence of pathologic fracture, and platelet, LDH, ALP and WBC levels, aided the differentiation of TOS and ABC. Smaller tumors and normal LDH levels were associated with better outcomes.

**Keywords:** telangiectatic osteosarcoma; aneurysmal bone cyst; discriminant analysis; diagnostic model; prognostic factor

2399

### **Synchronous tumors: where do i start?**

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**Introduction:** The presence of multiple malignant primary tumors on the same subject is a rare finding. We report the case of a 72 year old male with three synchronous primary tumors with different histological diagnosis. The goal of this report is to expose the diagnostic and therapeutic peculiarities of sarcomas when they are diagnosed synchronously with one or more primary tumors.

**Material and Methods:** We report a case of a 72 year old male with clinical history of chronic hepatitis C virus that, during the routine screening, shows four liver lesions that suggest a stage A hepatocellular carcinoma. During the extension study, another lesion compatible with primary pulmonary neoplasia was identified in the left upper lung lobe. The study was completed with PET-CT, confirming the existence of a primary bronchogenic carcinoma as well as a hypermetabolic area in the left iliopsoas muscle.

**Results:** Given the results of the imaging tests, the differential diagnosis of the iliopsoas hypermetabolic area was between metastatic affection and another primary tumor. The FNA of psoas was done, and we obtain an histological result of primary epithelioid sclerosing fibrosarcoma FNCLCC grade 2. The presence of three synchronous primary tumors requires a multidisciplinary approach, so this case was presented in the Tumor Committee where the global therapeutic strategy was established. The four hepatocellular lesions were treated with radiofrequency ablation while surgery was required for lung and psoas neoplasms. Psoas fibrosarcoma was treated through surgical removal in association with intraoperative radiotherapy. The lung epidermoid carcinoma was treated with upper lobe segmentectomy.

**Conclusion:** Every malignant lesion diagnosis must be followed by an extension study. The current report proves that in spite of the identification of a primary tumor with well-known histology we must not forget the possibility of finding other lesions. Furthermore, incidental findings during the extension study are common and force to complete the study with new image or histological tests. The therapeutic approach of synchronous tumors should be the treatment of each separately, but the treatment of one of them should not interfere with the treatment of others. Therefore, the treatment of every tumor needs a multidisciplinary approach suitable to the staging of each one.

2402

## Elevated mean glucose level predicts decreased disease free survival in soft tissue sarcoma patients

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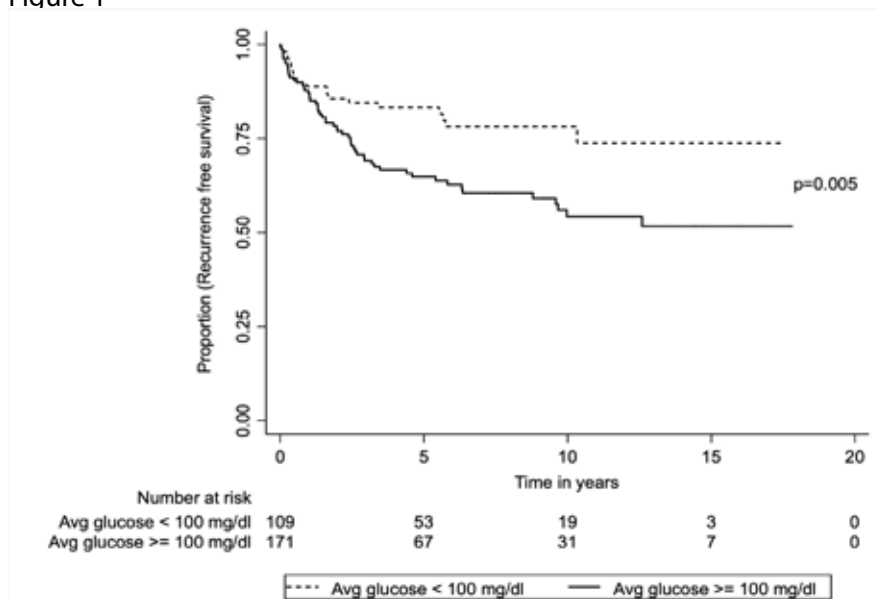
**Background:** Hyperglycemia has been shown to be an adverse prognostic marker in cancer patients. In the present study, we investigated the prognostic impact of the mean glucose level on disease free survival (DFS) and overall survival (OS) in soft tissue sarcoma (STS) patients after curative resection.

**Methods:** A retrospective analysis of 280 patients with STS and without established diabetes mellitus was performed. The mean of all measured glucose levels from date of surgery till date of recurrence was calculated for each patient. We used a blood glucose threshold of 100mg/dl to define normo- and hyperglycemia, respectively. Survival analysis was performed by using Kaplan-Meier estimators and uni- and multivariate Cox regression models.

**Results:** During a median follow up of 46 months 5- and 10-year DFS were 82% and 75% in patients with normal glucose levels and 65% and 55% in patients with elevated glucose levels, respectively. In univariate analysis, the elevated glucose levels were significantly associated with decreased DFS (HR: 2.05, 95% CI: 1.23 – 3.41, p= 0.006) and remained significant in multivariate analysis (HR: 1.83, 95 % CI: 1.02 – 3.28, p= 0.042). In OS analysis, the elevated serum glucose level showed no significant association with OS in univariate (HR: 1.41, 95% CI: 0.93 – 2.14, p= 0.100) and multivariate (HR: 1.15, 95% CI: 0.71 – 1.86, p= 0.579) analysis.

**Conclusion:** This study identified an elevated glucose level as an independent negative prognostic factor for DFS in STS patients.

Figure 1



2404

## Tips and tricks about 3D Printing and surgery plan in musculoskeletal tumours

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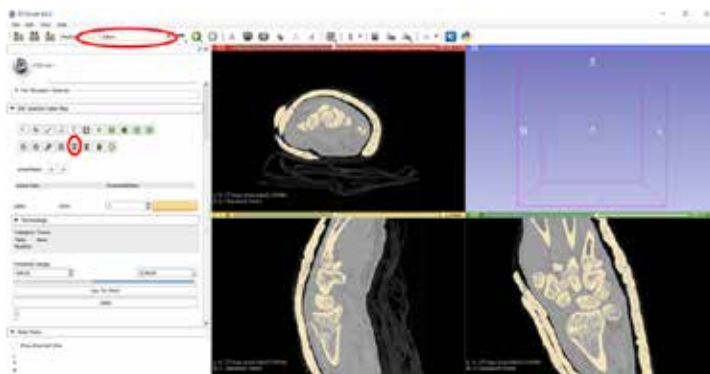
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**Introduction and Purposes:** The future is today. 3D printers lend to produce objects worldwide in a very simple, fast and cheap way... if you know how. The development of new 3D printers and new materials have reached the technology to our daily lives and to our surgical plan too. Our purpose is to teach to the people what programs and tools are needed to handle this new technology in the musculoskeletal surgery plan.

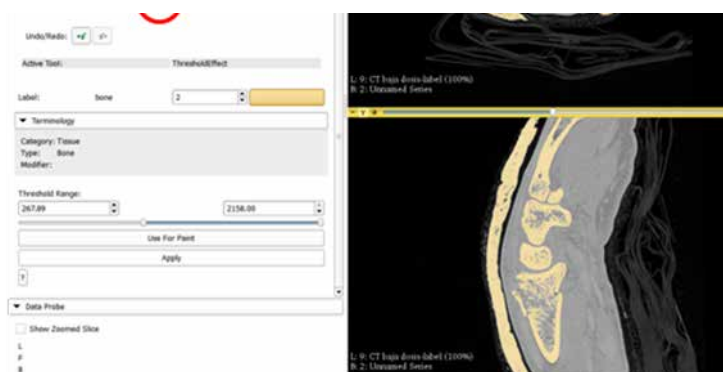
**Materials and Methods:** The two programs that we are gonna use are Microsoft 3D builder and Meshmixer, two completely free programs. To take the model from the CT or MRI, we will use 3D Slicer, a completely free program available in Microsoft. We will use the wide dynamic range to extract the bone profile and we will save the model as STL file. Then we will open it with Meshmixer, and we will remove all the parts of the model that are not useful. Finally, we will use Cura to prepare the model to the 3D printer.

**Results:** In less than 5 minutes and using completely free programs we can create 3D models ready to be printed in every 3D printer. We don't need to pay for subscription to any software neither other devices, what makes possible to use it in our daily lives.

**Conclusions:** The 3D printing programs have evolved in their quality and in the price of the software needed. Nowadays, we don't need special software neither special devices to produce our own 3D models, what has made possible to use it in our daily lives just following, step by step, the instructions given in this poster.

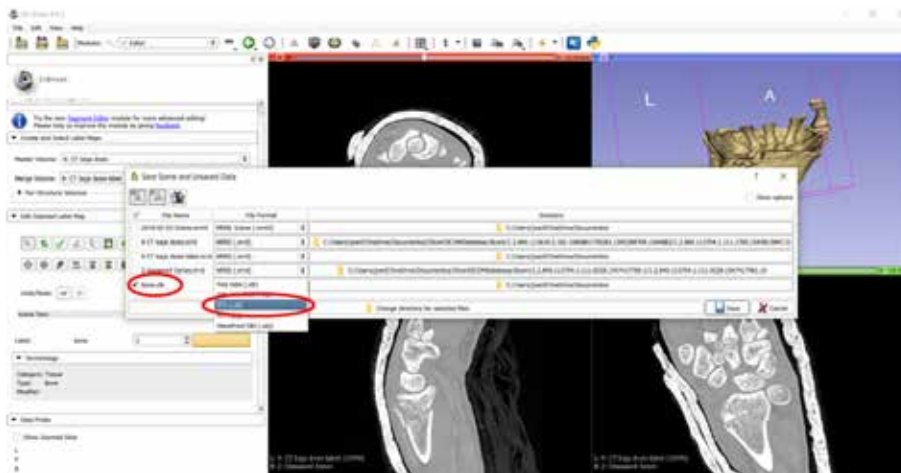
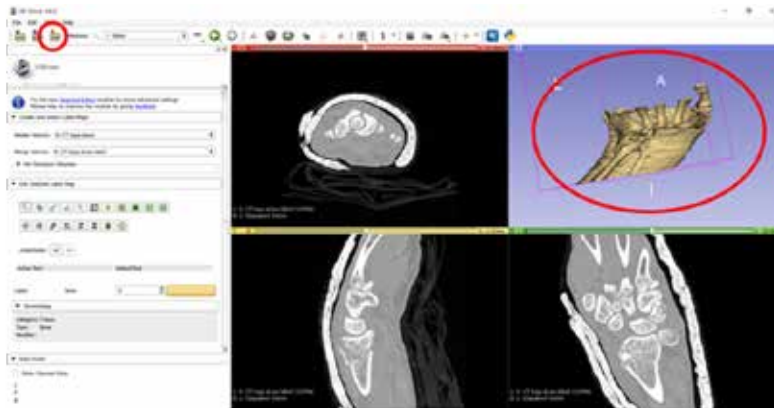


Step 1: how to select the model you want to print

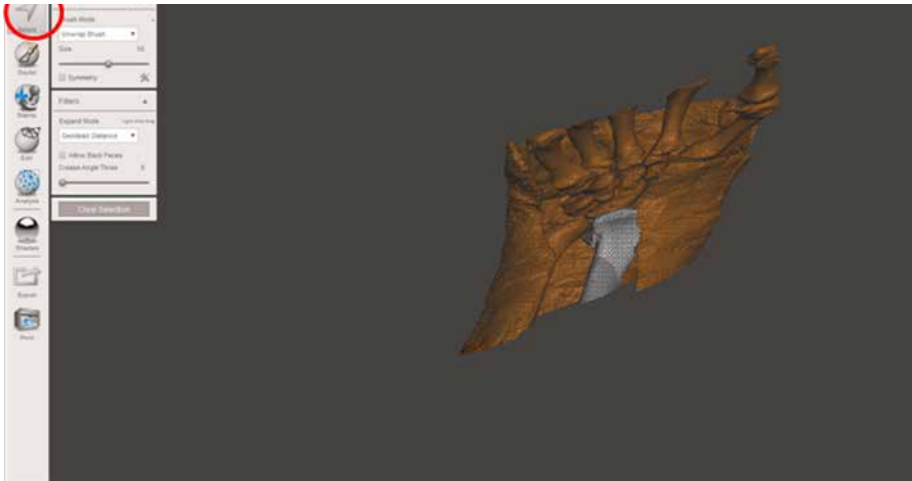


Step 2: How to create the model

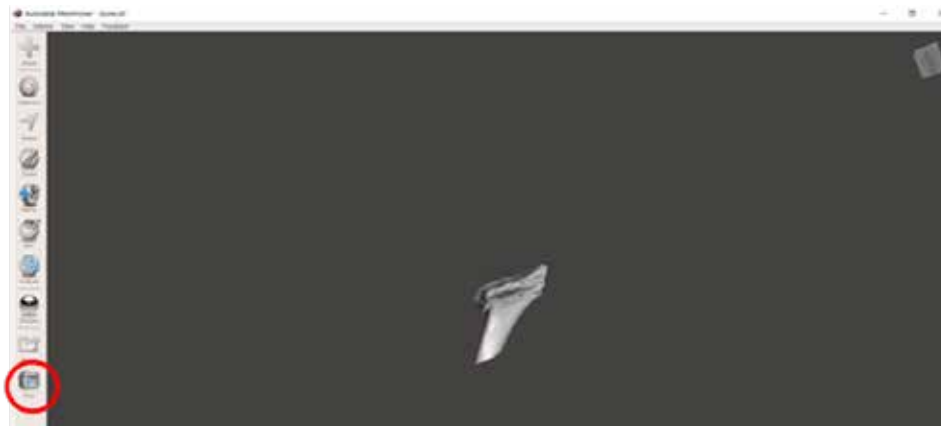




Step 3: How to save it



Step 4: How to “clean” it



Step 5: How to print it

2407

### Clinical outcomes and influential factors for complications and limb function in patients with malignant soft tissue tumors of the thigh

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**Introduction and Purposes:** Malignant soft tissue tumors can occur in any compartment of the thigh, but little is known about the correlation of postoperative results on each compartment<sup>1)</sup>. This study aimed to analyze the relationship of various factors particularly tumor location with clinical outcome in the patient with malignant soft tissue tumors of the thigh.

**Materials and Methods:** Patients who underwent wide excision for malignant soft tissue tumors of the thigh without metastasis at the time of initial visit from January 2006 to December 2017 were identified. The relationships between sex, age, body mass index, stage of UICC/AJCC, tumor localization, operation time, amount of muscle removed and complications, MSTS score, and prognosis were analyzed.

**Results:** Forty-six patients were included. The rate of complications was significantly higher after surgical time of more than 120 min and excision of more than two muscles. Seroma tended to be higher in the medial compartment. MSTS score was significantly lower in the combined resection of more than two muscles, surgical time over 120 minutes, and stage III. Stage III was significantly associated with lower 5-year metastasis survival rate and the 5-year disease specific survival rate.

**Conclusions:** The tumors located in the medial compartment might correlate with postoperative seroma, however the location of tumor showed weak impact for other clinical results. The number of resected quadriceps was associated with MSTS score. The intermuscular or infiltrative tumor as well as stage III tumor needed the more extensive muscle resection, which might result in the high incidence of postoperative complications and a decrease in the average MSTS score.

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2408

**Interim- as well as posttreatment response to neoadjuvant chemotherapy assessed by F-18-FDG PET/CT can predict the outcome in osteosarcoma of the extremities**

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**Introduction and Purpose:** We assessed whether sequential F-18-FDG PET/CT (PET/CT) could predict the outcome of patients with osteosarcoma of the extremities after one cycle and two cycles of neoadjuvant chemotherapy.

**Materials and Methods:** A total of 73 patients with with American Joint Committee on Cancer (AJCC) stage II extremity osteosarcoma treated with two cycles of neoadjuvant chemotherapy, surgery and adjuvant chemotherapy were prospectively enrolled in this study. All patients underwent PET/CT before (PET0), after one cycle (PET1), and after the completion of neoadjuvant chemotherapy (PET2), respectively. PET parameters [maximum standardized uptake value (SUVmax), metabolic tumor volume (MTV), and total lesion glycolysis (TLG)] and their % changes were calculated, and histological responses were evaluated after surgery. ROC curve analyses and the Cox proportional hazards model were used to analyze whether imaging and clinicopathologic parameters could predict event (metastasis or local recurrence)-free survival.

**Results:** A total of 36 patients (49%) exhibited a poor histologic response and 17 patients (23%) had experienced events (metastasis in 16 and local recurrence in 1). Both on PET1 and PET2, the % change of SUVmax most accurately predicted events by ROC curve analysis (area under the curve = 0.667 for PET1 and 0.685 for PET2, respectively). By multivariate analysis including the % changes of SUVmax on PET1, PET2, histologic response, age, sex and AJCC stage (A or B), only the % change of SUVmax on PET2 > -54% independently shortened event-free survival (relative risk, 6.39; 95% confidence interval, 1.45-28.10). Patients with the % change of SUVmax on PET2 > -54% had worse 2-y (74% vs. 93%) and 5-y (67% vs. 93%) metastasis-free survival rates than the others (P = 0.005).

**Conclusions:** The %changes of SUVmax both on PET1 and PET2 could predict the outcome of patients with osteosarcoma of the extremities. The %changes of SUVmax on PET2 better predicted the outcome than histologic response.

2410

### Anti-tumor effect of cyclolinopeptide for giant cell tumor of bone

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**Introduction and Purposes:** In recent years, the effectiveness of anti-receptor activator of NF-κB ligand (RANKL) therapy on giant cell tumours of the bone (GCTB) has been reported. Flax (botanical name: *Linum usitatissimum*) is a member of the family of Linaceae and raw material for linseed oil. Cyclolinopeptide (CL), derived from flax, suppresses the RANKL signal and osteoclast differentiation from myeloid progenitor cells<sup>1</sup>. However, the anti-tumour effects of CL remain poorly understood. This study aimed to evaluate the anti-tumour effects of CL on GCTB in vitro.

**Materials and Methods:** Three cases of GCTB tissue were collected from a surgical specimen. The GCTB tissues were treated with collagenase and sub-cultured several times in D-MEM medium supplemented with 10% FBS. Three kinds of GCTB cell lines were established. Immunofluorescence of the GCTB cells were evaluated for RANKL expression and transmutation of histone H3F3A, a driver gene mutation in GCTB. GCTB cell growth inhibition by CL was evaluated using water-soluble tetrazolium salt (WST)-8 cell proliferation assay and 5-ethynyl-2'-deoxyuridine (EdU) cell proliferation assay. The mRNA expression levels of RANKL and RUNX 2 were evaluated using real-time polymerase chain reaction (PCR) before and after administration of CL.

**Results:** During immunofluorescence, RANKL expression and transmutation of histone H3F3A were observed in all cell lines. In WST-8 cell proliferation assay, dose-dependent inhibition of GCTB cells was observed in the CL-administered group, compared to non CL-administered group ( $P < 0.05$ ). During EdU cell proliferation assay, the ratio of EdU positive cells decreased in the CL-administered group ( $P < 0.05$ ). During real-time PCR testing, expressions of RANKL and RUNX2 mRNA were decreased within the CL-administered group ( $P < 0.05$ ).

**Conclusion:** Our study suggests that CL has anti-tumour effects on GCTB in vitro.

#### References

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2412

### Survival of malignant soft tissue sarcomas of the extremities

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**Introduction and Purposes:** Soft tissue sarcomas (STS) are heterogenous group of tumor that originates from mesenchymal tissue. The aim of this study is to describe the prognostic factors on survival rates of STS of extremities.

**Materials and Methods:** This retrospective study includes 102 malignant STS that were diagnosed according to 4th edition of WHO soft tissue tumors classification system, between January 2002 and December 2015.

**Results:** Among 102 patients, women and men were 51% and 49%, respectively. The mean age was 53.2 years old. The mean follow-up time was 82.7±9.1 months. The tumors were liposarcoma (n:16/15.7%), fibrosarcoma (n:15/14.7%), leiomyosarcoma (n:10/9.8%), rhabdomyosarcoma (n:7/6.9%), angiosarcoma (n:1/1%), chondroosseous tumor (n:1/1%), malignant peripheral nerve sheath tumor (n:13/12.7%), malignant soft tissue tumors of uncertain type (n:13/12.7%), undifferentiated/unclassified tumors (n:26/25.5%). According to Enneking staging system, 30 patients (29.4%) had stage 3 disease, 10 patients (9.8%) had stage 5 disease and survival rates were 64%, 0%, respectively. According to 8th American Joint Committee on Cancer (AJCC) staging system, 18 patients (17.6%) were at stage 3, 10 patients (9.8%) were at stage 6 and 5 year survival rates were 81.2%, 0%. With reference of the tumor size of ≤5 cm, between 5-10 cm and >10 cm, the patients displayed 68.2%, 44.0%, 26.1% of 5-year disease specific survival rates. Disease free survival rates without local recurrences and metastases were 61.8 % in the first year and 32.1% for 5 years.

**Conclusions:** We found that pain as presenting symptom had unfavorable effects on survival. Survival rates were decreased by increasing the size of the tumor. In our study, the patients that received local radiotherapy had better survival rates unlike adjuvant chemotherapy had no reliable effects. Age, tumor size, localization, histopathological diagnosis, metastasis, stage and local radiotherapy are the prognostic factors on survival.



2414

### The role of HTRA-1 positivity to predict recurrence of giant cell tumor of bone

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**Introduction and Purposes:** HTRA1 is a serine protease that acts as tumor suppressor to inhibit tumor cell growth. This protein is expressed by osteoblasts, thus it plays an important role on woven bone, osteoid production and angiogenesis. The aim of this study is to define the role of HTRA1 in giant cell tumor of bone (GCT) and investigate the role in recurrences.

**Materials and Methods:** Thirty-four patients with the diagnosis of GCT who has a follow-up more than 12 months enrolled in this study. Patients who received denosumab treatment prior to surgery excluded from the study. The patients were evaluated for age, gender, localization, treatment modalities, primary or recurrent tumors, Campanacci stage, follow up recurrences and recurrence treatment modalities. The staining of HTRA1 in giant cells and mononuclear tumor cells were evaluated as five tiered system.

**Results:** The mean follow up time was 42,97 months. According to Campanacci staging system, 8 patients had grade 1, 15 patients had grade 2, 11 patients had grade 3 disease. Twenty-two patients were treated with curettage- cement (internal fixation n: 7), 6 patients were treated with resection and reconstruction with prosthesis, 4 patients were treated with curettage-grafting (internal fixation n:2), 1 patient was treated with resection and reconstruction with vascularized fibula and one patient was treated with excision due to his soft tissue recurrences. The HTRA-1 staining of giant cells and mononuclear cells displayed grade 1 (n:2, n:4), grade 2 (n:5, n:12), grade 3 (n:6, n:2), grade 4 (n:7, n:8), grade 5 (n:14, n:8), respectively. There was no correlation with local recurrence and HTRA-1 positivity.

**Conclusions:** Local recurrence is the most important problem in the treatment of GCT. Hence adjuvant therapies such as extensive curettage and cement reduce local recurrence rates, molecular and immunohistochemical markers must be investigated to predict recurrence probability. In this study HTRA-1 did not show any correlations to predict recurrence in GCT.

2419

## Preliminary results of a novel knee arthrodesis system after uncontrolled periprosthetic knee joint infection

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**Introduction and Purposes:** Uncontrolled infection is a devastating complication of knee arthroplasty. Removal of implants and resection of necrotic tissues often results in significantly reduced bone stock presents a reconstructive challenge for orthopaedic surgeons. Furthermore, irreparable extensor mechanism injuries are frequently encountered and necessitates knee arthrodesis as the only viable option. We present our preliminary result of a novel intercalary endoprosthetic knee arthrodesis system (S-Link Estasâ, Sivas, Turkey) after uncontrolled periprosthetic knee joint infection.

**Materials and Methods:** In a retrospective case series, 13 consecutive patients who underwent knee arthrodesis after failed ipsilateral TKA secondary to infection from 2016-2018 with at least 1 year of follow-up were enrolled. The average age of patients at the time of operation was 62 (range 60-91) with an average follow-up of 14 (range 12-32) months. Post-operation ambulation status, fusion rate, time to fusion, complication rates and eradication of infection were analyzed.

**Results:** Arthrodesis with intercalary endoprosthetic knee arthrodesis improved the ambulation with 61% (8/13) of the patients unable to ambulate before surgery and 100% (13/13) of the patients able to ambulate at their most recent follow up ( $p < .05$ ). Fusion after index arthrodesis was achieved on 11 (84%) patients. Mean time to union was 8 (range 3-14) months. Two patients (15%) underwent additional plating after 6 months of index arthrodesis due to delayed healing. No persistent infection and no periprosthetic fracture were noted at the final follow-up.

**Conclusion:** Preliminary results of intercalary endoprosthetic knee arthrodesis system reveals good functional outcomes and prevents recurrent infection in the patients who have failed total knee arthroplasty due to uncontrolled periprosthetic knee joint infection.

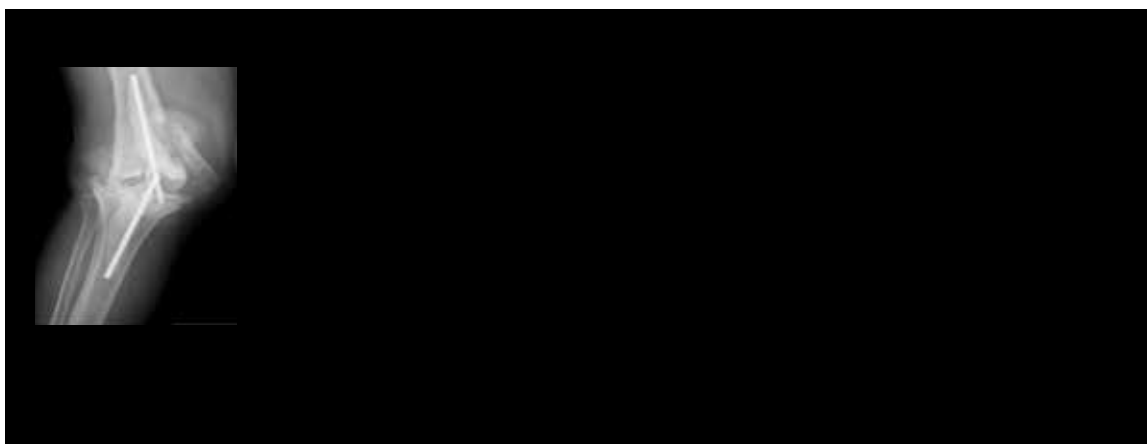


Figure 1. Pre-operative and immediate post-operative x-rays of a 55 years old male who underwent right knee arthrodesis with intercalary endoprosthetic knee arthrodesis system after uncontrolled periprosthetic infection.

## 2423

### **Chondrosarcoma of the bone over 70 years old: similar clinical features but different options of treatment?**

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**Introduction and Purposes:** Population is getting older and the incidence of atypical chondroid tumors (ACT) and chondrosarcomas (CS) increases with age. People older than 70 years old are usually more fragile and affected by other diseases. The aim of this study is to evaluate in the common practice of a regional reference centre for bone tumors which are the options for the patients diagnosed with chondrosarcoma when over 70 years old.

**Materials and Methods:** In the period 2010-18, 37 patients over 70 years old have been treated (maximum age 89 ys). 35 biopsies have been performed, 33 patients were surgically treated. The final diagnosis was 5 ACT/CS G1, 15 CS G2, 8 CS G3, 5 dedifferentiated CS. The performed treatment, comorbidities, complications, survival have been analyzed

**Results:** The surgical approach varied according to the histologic grade from biopsy. Surgery was complicated in 10 cases for infection (3), prosthetic stem loosening (3), allograft reabsorption (1), abdominal hernia (1), haematoma requiring surgery (1), peroneal nerve palsy (1). At the last follow up 18 patients are alive, 7 lost at follow up, 12 dead. The average survival from the diagnosis was 30 months (range 1-168) and the major causes for death were not oncological.

**Conclusions:** Over the age of 70 years several extra-oncological features should be considered. Biopsy could be sometimes the only treatment or even avoided. 2 patients received exclusive radiotherapy, nobody chemotherapy, and 2 were referred to palliative care. Even if oncologists affirmed to have other therapeutic options apart from surgery, they are seldom performed in people over 70. Other comorbidities should be carefully considered with anesthetists and major surgery should be proposed according to general conditions if the patient over 80 and his/her caregivers are strongly motivated. Palliative care support is strongly advised in this group of patients.

2424

## Bipolar Head vs Acetabular Replacement in Proximal Femur EndoProsthetic Replacement which is the best choice?

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**Introduction and Purposes:** It is debated whether to replace (THA) or not (Hemi) the acetabulum while implanting a proximal femur EndoProsthetic Replacement (PFEPR) after oncologic resection. Different criteria have been evaluated: age, diagnosis, prognosis, implant characteristics, resection length, acetabulum conditions, comorbidities.

**Materials and Methods:** A retrospective analysis of the functional outcomes, perioperative complications, and long term results has been conducted using data stored prospectively in our unit database regarding PFEPR with no acetabular involvement implanted for oncological purpose in the period 2002-2017. A score has been developed to help the decisional process. In patients with less than 11 points, hemiarthroplasty was advised

**Results:** 76 PFEPR were reviewed. 11 THA at first surgery (14,5%). We observed 11 cases of dislocation (5 Total, 6 Hemi) treated with closed reduction (3), open reduction (3), and implant revision (6 cases in total, 3 with snap cup to revise Hemi). 3 infections occurred (2 Hemi, 1 Total). 26 patients died in the first 3 years postop (17 in the 1<sup>o</sup> year). 6 cases of acetabular erosion (7,9%) requiring surgery (1 patient refused). We retrospectively calculated each patients's score: 46 cases <11 points, 30 cases >11 points (vs 11 Total). Hypothetically we would have avoided 5 cases out of 6 acetabular erosion, but we would have implanted 10 cups in patients dead within 3 years and 1 cup in a patient with postoperative infection. The functional results at 6 and 12 months were comparable.

**Conclusions:** The use of an acetabular cup in PFEPR could be considered at first surgery. An evaluation of survival should be accurately performed. When a hemiarthroplasty is implanted an accurate follow up should be performed in order to prevent huge revisions when symptomatic. Larger case series are advised to confirm these results in order to improve implant survival.

	1st	2nd	3rd
Age	<16ys	>56ys	16-56ys
Diagnosis	Multiple mets	Solitary mets	Primary
Prognosis	Poor <5ys	Good >5ys	
Implant characteristics	Modular, changeable effort	Modular fixed effort	Custom made block
Acetabulum	No arthritis	Mild arthritis	Severe arthritis
Comorbidities	Severe Active infection	Absent	No major concerns
Resection length	<15cm	>15cm	

Table 1- decisional scoring system

Table 1: decisional scoring system

2427

## Denosumab's changing experience continues – A single institutions experience in 140 cases

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**Introduction and Purposes:** Giant cell tumour (GCT) is one the most common primary benign tumour of the bone. Denosumab halts the osteolysis by giant cells thereby down staging the tumour, helping in performing less morbid procedures. We report the incidence of local recurrence (LR) in patients operated following neo-adjuvant denosumab for GCT and compare the post-operative functional and oncological outcome of patients operated with and without neo-adjuvant denosumab.

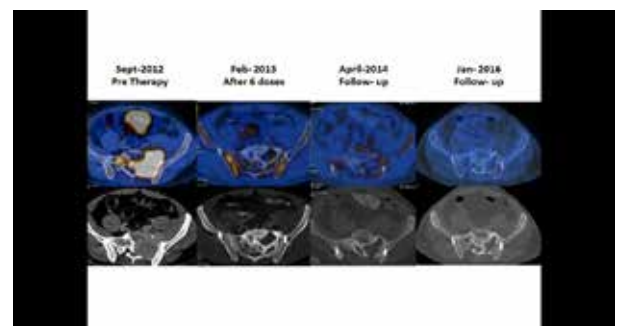
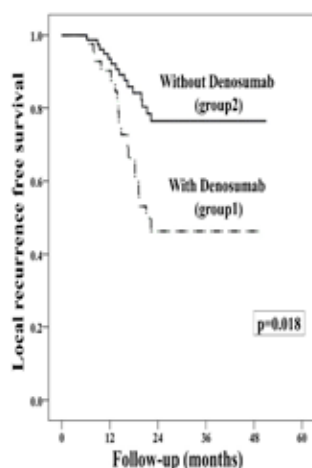
**Materials & Methods:** 186 patients with a mean age of 32.8 years undergoing surgery for GCT between June 2010 to October 2017 were retrospectively divided into: group1- receiving neo-adjuvant denosumab (n=140) and group 2- operated without denosumab (n=46). The mean follow-up period was 35months. The perioperative characteristics and outcome were compared between the two groups and the factors for LR of GCT were analyzed.

**Results:** The incidence of LR among patients operated after neo-adjuvant denosumab therapy was 42.8% and was significantly high compared to patients without denosumab (11.6%,  $p < 0.001$ ). On multivariate logistic regression analysis, use of denosumab as neo-adjuvant was the only factor independently associated with LR following surgery ( $p = 0.002$ ). Patients operated without denosumab had better LR free survival (log rank,  $p = 0.018$ ) (Figure. 1), although the MSTS scores post-surgery at serial intervals were comparable between the two groups ( $p > 0.05$ ).

**Conclusions:** Denosumab is independently associated with increased local recurrence following surgery for GCT. Denosumab must be used cautiously in patients whom down staging the disease burden outweighs the possible chance of local recurrence.

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2428

## Sarcomas of the extremities: comparing local recurrence after incisional and core needle biopsy

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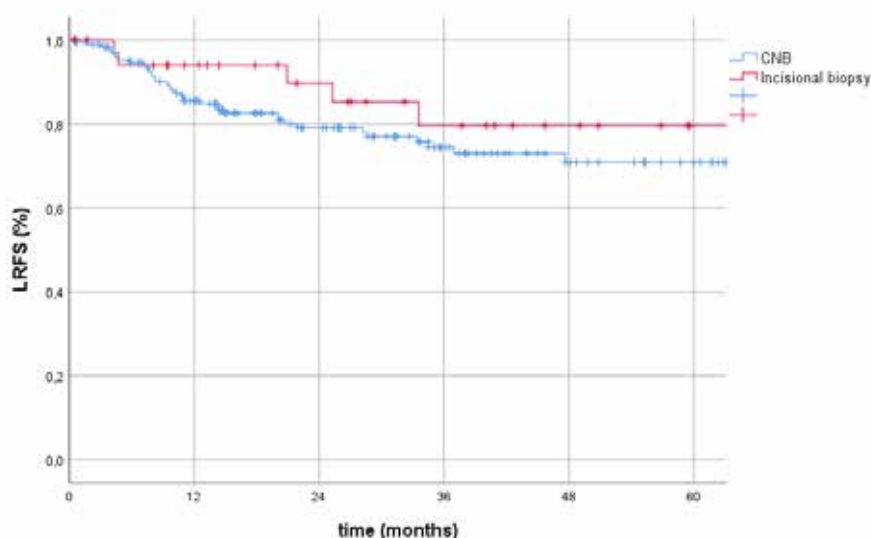
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**Introduction:** Established "gold standard" in diagnosing of extremity sarcomas is still the open biopsy. Increasingly more core needle biopsies (CNB) are used. Some authors argue that in latter an excision of the biopsy scar, to prevent local recurrence (LR), is not necessary. We hence analysed all of our patients in respect to LR after both types of biopsy.

**Patients and Methods:** Inclusion criteria had been histology proven extremity sarcoma, biopsy in our center and wide (R0) resection of the tumour. We prospectively evaluated 209 Patients, treated between 2012 and 2017. We evaluated location of the tumor, affected tissue (soft tissue vs. bone), biopsy type, LR and survival of the patient. All patients with incisional biopsy underwent resection of the biopsy tract, in all patients with CNB the biopsy tract was not resected. Statistical evaluation was performed by chi-quadrat-test and Kaplan-Meier-Curves.

**Results:** 36 (17,2%) incisional and 173 (82,8%) CN biopsies were performed in 209 patients. The diagnosis was bone sarcoma in 88 cases (42,1%) and soft tissue sarcoma in 121 cases (57,9%). 28 tumors (13,5%) were G1, 72 (34,8%) G2 and 107 (51,2%) G3 sarcomas. In 42 (20,1%) patients local recurrence of the tumor was evident in follow-up. 37 of those were diagnosed in 173 cases (21,4%) with CNB, 5 of 36 cases (13,9%) after incisional biopsy (Fig.1,  $p=0,307$ , n.s.). In subgroup analysis, tissue (bone or soft tissue) did not affect results. Grading proved to be a significant parameter of local recurrence. In subgroups defined by grading the type of biopsy did also not influence LR. In relation much more CNB had been performed in G2/3 tumors.

**Conclusion:** This study confirms that core needle biopsy without excision of the biopsy tract does not significantly increase the risk of local recurrence. If incisional biopsy is used, the biopsy tract must be excised.





2430

## One stage intramedullary total femoral replacement for post-irradiation proximal femur non-union and ipsilateral knee osteonecrosis

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**Introduction:** Total femur replacement is indicated for limb salvage when the entire femur is affected by tumor, infection, failed fracture fixation or arthroplasty. However, it requires adequate soft tissue coverage to avoid postoperative infection and provide limb function. In presence of extensive soft tissue loss and postirradiation muscular atrophy this treatment option may not be feasible. We present the use of the MUTARS Intramedullary Total Femoral Replacement (ITFR) for post- irradiation proximal femur fracture non-union associated with an ipsilateral knee osteonecrosis.

**Purpose:** To present a complex case of a 58 year old female patient with a history of thigh soft tissue sarcoma and failed postirradiation fracture fixation associated with an ipsilateral postirradiation knee osteonecrosis and severe valgus knee deformity.

**Materials and Methods:** A 58-year-old female underwent excision of a soft tissue sarcoma of the thigh followed by irradiation 8 years ago. At 7 years postoperatively, she had a peritrochanteric pathological fracture treated with intramedullary nailing. One year later, she referred to our hospital because of acute hip pain complicated by knee pain and severe genu valgus deformity. The patient could not stand and walk. Plain radiographs revealed a peritrochanteric fracture non-union with concomitant femoral nail breakage and total collapse of the lateral femoral condyle resulting in a more than 35 degrees valgus knee deformity. The knee range of motion was 0 to 20 degrees. Given the sarcoma resection and irradiation, reconstruction of the proximal femur by the means of a proximal femoral replacement megaprosthesis was the only option. As for the knee joint, knee osteonecrosis and valgus deformity required the use of a constrained knee prosthesis with a stemmed femoral component. Concomitant use of both prostheses would create a stress riser in the irradiated femoral diaphysis, while a total femoral replacement would come with a highly possible postoperative periprosthetic infection, given the irradiated soft tissue of the femur and unpredicted function, therefore should, preferably, be avoided.

**Results:** We used the MUTARS ITFR (Implantcast©) prosthesis and instrumentation to reconstruct the whole femur in one stage surgery. Skin incisions were separately made in hip (posterior approach) and knee (lateral parapatellar approach). First the proximal femur was removed at the level of fracture, utilizing an extended posterior hip approach along with the broken femoral nail in two parts. Then the knee joint was exposed, supplementing the lateral parapatellar approach with a tibial tubercle osteotomy. After the osteotomies of distal femur, intramedullary nail with distal femoral component was inserted. The knee replacement was done using a CM prosthesis. Then the proximal femoral replacement megaprosthesis body was connected within the remaining proximal end of the intramedullary femoral shaft. Postoperatively, the knee alignment has been corrected to slight valgus (<5 degrees), while the leg has been lengthened 3.4cm. At 6 months postoperatively, the patient is able to walk with a crutch, without pain. Despite the inferior quality of the proximal thigh soft tissues, due to previous irradiation, no complications, such as infection or dislocation, occurred.

**Discussion:** Total femur replacement is originally reserved for tumor patients or extremely complex revision cases. However, it may be associated with a high rate of complications, such as infection, dislocation and Trendelenburg gait. ITFR has advantages such as remaining bone stock, attachment of muscles, significantly lower risk of infection, dislocation, lower cost and revision capability. To our knowledge, this is the first reported indication of this prosthesis in a tumor complicated patient, since the previous references refer to periprosthetic fracture cases. The previous reported results of 4 cases in total, utilizing the same concept but not the same device, are at least promising, comparing to our own also very good mid-term result.

**Conclusion:** The ITFR is a smart device based on an interesting and useful concept of retaining bone stock. We believe that it can certainly stand as a reliable alternative, if not first choice, in rare complex cases requiring simultaneous ipsilateral proximal and distal femoral replacement.

2437

## The use of healthcare services two years before diagnosis in Danish sarcoma patients 2000-2013

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**Background:** Sarcoma is a rare type of cancer with non-specific symptoms and uncertain aetiology. Thus, timely diagnosis of sarcomas is a clinical challenge. The aim of this study was to investigate the use of healthcare services 24 months preceding a sarcoma diagnosis compared to a matched cohort.

**Materials and Methods:** The study was a retrospective, population-based, matched cohort registry-study. Patients with sarcoma in Denmark 2000-2013 were identified in the Danish Sarcoma Registry (n=2167) and matched 1:10 on gender, age and listed general practice. Using a binomial regression model, incidence rate ratios were calculated for face-to-face contacts in general practice, inpatient and outpatient visits, surgery, paraclinical examinations, and diagnostic imaging. Analyses were stratified for sarcoma subtypes, grade, stage, gender, and presence of comorbidity.

**Results:** The sarcoma patients had a significantly increased Incidence Rate Ratios in use of healthcare services compared to the matched cohort a year before their diagnoses. An increase in consultation rates was seen 11 months before diagnosis for inpatient visits, 9 months before diagnosis in general practice and outpatient visits, 8 months before diagnosis for paraclinical examinations, and 4 and 3 months before diagnosis for diagnostic imaging and surgery, respectively. There were no clinical significant differences in length of increased consultation rates between sarcoma type, stage and grade. Sarcoma patients with comorbidity had persistently higher consultation rates compared to patients without comorbidity.

**Conclusions:** The use of healthcare services among sarcoma patients increased several months before diagnosis in all healthcare sectors. The results reveal a diagnostic time window and a potential to refer, diagnose, and treat sarcoma patients in a timelier manner.

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### Primary treatment with an osteointegrative percutaneous prosthesis system for parossal osteosarcoma G1 after transfemoral amputation in a 42-year-old patient

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**Introduction:** Primary bone tumors are a rare entity among tumor diseases. This also includes low grade parossal osteosarcoma, allowing an overall prognosis with a 95% long-term survival rate. If an operation to preserve the extremities is not possible, amputation is often followed by exoprosthetic treatment. A new alternative is the primary surgical treatment with osteointegrated percutaneous prosthetic system (OPPS). Up to now there is hardly any data available in the literature.

**Methods:** A 42-year-old patient (BMI 32.3 kg/m<sup>2</sup>) was treated for several years with suspected myositis ossificans of the right leg. Due to increasing movement restrictions and progressive x-ray findings, the histopathological securing of a parossal osteosarcoma was performed. Staging showed no evidence of further suspicious tumor manifestations. A limb preservation was not possible due to the pronounced locomotive findings. At the explicit consent of the patient, transfemoral amputation was performed on the right with a wide tumor resection and primary preparation for OPPS (CL-Exo-Fix femoral stem 17x140mm, ESKA Orthopaedic, Lübeck, Germany). Two months later, the successful ostomy system with coupling to an exoprosthesis (Genium X3 with Triton Heavy Duty foot, Ottobock, Duderstadt, Germany) followed.

**Results:** Amputation was performed 20 cm distal to the trochanter major. After amputation and implantation of the femoral stem, the wound healed properly with adequate soft tissue coverage. Ostomy was possible without complications. After 5 days, the prosthesis was coupled for the first time. The patient showed rapid mobilization during physiotherapy and was discharged promptly into rehabilitation.

**Conclusion:** The use of an osteointegrated percutaneous prosthetic system after amputation in tumor resection represents a further therapy option for tumor patients with amputation indication without the need for adjuvant radiation/chemotherapy and should be included in the therapy portfolio.

2441

## Which is the proper timing for the treatment of pathological fracture of the proximal femur in elderly people? Literature review and algorithm proposal

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**Introduction and Purposes:** Femoral fractures of the elderly (> 65 years) are one of the most widespread problems in traumatology; current guidelines recommend that patients should be operated within 24 hours to reduce complications. The proximal femur is one of the most frequent site in the limbs for pathological fractures from metastases, interfering with other oncological treatments. The orthopedic surgeon is often the first to manage such patients; the aim is to investigate the need for early surgical treatment in patients with pathological fracture of the proximal femur and to define a flowchart on the clinical-diagnostic pathway.

**Materials and Methods:** A review of the literature on diagnostic tools and therapeutic options in bone metastases was conducted. At the same time, an analysis was carried out of the current guidelines on the timing of proximal femoral fractures in the elderly, comparing similar clinical issues.

**Results:** Surgery must be adapted to the patients and their clinical situation as there are several treatment options. The Jacofsky-Haidukewych's algorithm has been modified by adding timing about when diagnostic and/or therapeutic procedures should be performed from the admission.



Figure 1: Flowchart for the management of pathological fractures in elderly people

**Conclusions:** Proper imaging is essential in the management of bone metastases. Good clinical management including chemotherapy and radiation therapy improves pain control and reduces bone disease progression. All orthopedists must doubt a pathological fracture from bone sarcoma and, if confirmed, seek advice from the center of oncological orthopedics. Algorithms help standardize procedures and improve multidisciplinary management. A pathological fracture of the proximal femur is an important clinical issue, but the surgeon should not be in a hurry to treat the patient without having performed all the necessary investigations. A mistake can have devastating consequences.

2443

### Tumor cell seeding in the biopsy tract and its clinical significance in osteosarcomas

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**Introduction and Purposes:** The reasons behind the removal of the biopsy tract in osteosarcomas are not well known, and studies about tumor seeding in the biopsy tract have generated conflicting results. This study is designed to evaluate the presence and possible clinical significance of tumor cell seeding in the biopsy tract of osteosarcomas.

**Materials and Methods:** We prospectively evaluated 55 cases of osteosarcomas for tumor cell seeding and other clinical and pathologic prognostic parameters. All the tumors were localized in long bones of the extremities (31 in femur, 7 in fibula, 9 in tibia, 7 in humerus, and 1 in ulna). Tumors that were located in flat bones were excluded, because the biopsy tract is rather short in those locations, and they may have some diagnostic difficulties. Patients were followed up clinically and radiologically in 3-month. Patients who were lost to follow-up were excluded, and only the patients with complete information were included in the study. All the diagnostic biopsies were obtained with an 8-gauge coaxial cutting needle. Clinicopathological variables were compared using Fisher's exact test. Survival analyses were performed using the Kaplan-Meier test. Logistic regression analysis was used to ascertain the effects of variables; P values less than 0.05 were accepted as significant.

**Results:** Eleven cases (20%) involved microscopic tumor foci in the biopsy tract. The higher local recurrence rates ( $P = 0.005$ ) and worse recurrence-free survivals ( $P = 0.009$ ) were observed in patients with tumor cell foci in the biopsy tract. Mitotic rate, tumor cell pleomorphism, and matrix production in main tumor foci were higher in cases with tumor seeding ( $P = 0.047$ ,  $P = 0.012$ , and  $P = 0.005$ , respectively)

**Conclusion:** Tumor seeding in the biopsy tract is a fact in osteosarcomas. The higher local recurrence rates are more likely to occur in cases with tumor seeding.

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## LUMIC endoprosthetic reconstruction after periacetabular tumor resection: mid-term results

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**Introduction and Purposes:** LUMIC endoprosthesis was recently revealed as a modular device to reconstruct periacetabular defects following tumor resections with low rate of mechanical complications and failure. We aimed to analyze mid-term outcomes of LUMIC endoprosthetic reconstruction after periacetabular resection of primary bone sarcomas and carcinoma metastases.

**Material and Methods:** We retrospectively reviewed the charts of 17 patients [10 male, 7 female; mean age 47 (38-64) years] in whom a LUMIC endoprosthesis [Implantcast, Buxtehude, Germany] was used to reconstruct a periacetabular defect after internal hemipelvectomy for a pelvic sarcoma or carcinoma metastasis. The tumor was pathologically diagnosed as Ewing's sarcoma in five, chondrosarcoma in nine and bone metastasis from carcinoma in four. Internal hemipelvectomy included type II resection in 12, type II+III in 3, and type I+II/I+II+III in 2 patients. Trivera tube [Implantcast, Buxtehude, Germany] was used in 13 patients to augment reconstruction and to prevent dislocation. Follow-up periods ranged from 1 to 5 years (mean 28 months).

**Results:** Oncological outcomes were died of disease in 7 cases, no evidence of disease in 7, and alive with disease in 3. Implant survival rate was 94%; 1 patient with implant loosening required revision of LUMIC prosthesis at 18 months follow-up. The mean Musculoskeletal Tumor Society functional score was 60% (range, 50-80%). The overall complication rate was 47% (7), 35.2% required re-operation [early mechanical debridement for deep infection (2); open reduction under general anesthesia for dislocation (2); wound revision (1); endoprosthesis revision (1)]. One patient with pelvic obliquity was followed conservatively.

**Conclusions:** At mid-term follow-up, Lumic endoprosthesis demonstrated a low rate of mechanical complications and failure. Even though the overall complication rate was high, this reconstruction method provided a stable pelvis with good functional and radiological outcomes in the management of periacetabular malignant tumors.

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2445

## Very rapid response of a large thoracic spindle-cell sarcoma carrying the TPM3-NTRK1 fusion to neoadjuvant treatment with the tropomyosin receptor kinase inhibitor larotrectinib

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**Introduction and Purposes:** Neurotropic tropomyosin receptor kinase (NTRK) genes code for tropomyosin kinase receptors (TRK). NTRK-gene fusions occur in a wide variety of cancers and are potent oncogenic drivers. Targeted TRK-inhibition has now emerged as a treatment option for NTRK-gene fusion positive tumors. We report the dramatic response of a large thoracic sarcoma to selective TRK-inhibition.

**Materials and Methods:** A 3 year old boy developed respiratory symptoms caused by a huge tumor of the right hemithorax. Histology was spindle cell sarcoma NOS with myopericytic/hemangiopericytoma-like features. The tumor did not respond to conventional chemotherapy (vincristine, actinomycin D, ifosfamide). When next generation sequencing revealed a TPM3-NTRK1 fusion, the boy was enrolled into the SCOUT study of the oral TRK-inhibitor larotrectinib (NCT02637687). At screening, he was in poor general condition (Lansky performance score 50%), dyspneic, mostly bedridden, required tube feeding and intermittent oxygen supplementation. Maximum tumor diameter on chest X-ray was 11 cm, tumor extension upon MRI 10.6 x 9.6 x 7.5 cm (approx. 380 cm<sup>3</sup>).

**Results:** Treatment with 100mg/m<sup>2</sup> larotrectinib solution BID (2x2.5 ml) was initiated. By day 4, there was already marked clinical improvement: dyspnea resolved, the boy began to eat. On day 8, maximum tumor diameter on X-ray had receded to 7 cm, Lansky score was 70% and the boy discharged. The nasogastric tube was removed day 11. A 1<sup>st</sup> scheduled control MRI after 8 weeks demonstrated residual tumor of 5.1 x 4.6 x 4.2 cm (approx. 50 cm<sup>3</sup>), corresponding to a partial remission (RECIST1.1). His Lansky score was now 90%. The patient is scheduled to continue larotrectinib until surgery of the tumor residue.

**Conclusions:** Selective TRK-inhibition by larotrectinib offers a novel and highly specific therapeutic option for NTRK-gene fusion positive sarcomas. Screening sarcomas without other known oncogenic drivers for NTRK-fusions should be considered.

2446

### Iliac wing osteosarcoma. A challenge for total reconstruction

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**Objective and Introduction:** Intramedullary osteosarcoma is the most common malignant primary bone tumor. It usually occurs in young patients and it's diagnosed late, being high grade tumors with extracompartmental involvement. Pelvic location suppose a surgical and therapeutic challenge, and amputation could be the only alternative of treatment. Thanks to the new technologies in arthroplasty and the custom made devices, we can develop radical tumour resection and to preserve the functionality of the patient without affecting the prognosis of the disease.

**Material and methods:** We present a case of a 31-year-old woman with left iliac wing osteosarcoma, with acetabular and adjacent soft tissue involvement and metastasis with multiple bilateral pulmonary nodules, stage IV (T2b, N1, M0). After initiating chemotherapy with CDDP-Adriamycin, the patient present clinical and radiological improvement of the lesion, which allows the surgical approach of the lesión. The case was presented in a multidisciplinary tumor committee and finally, it was decided to perform radical resection of the lesion (Figure 1) at the level of the iliac bone, acetabulum and femoral head together with adjacent musculature and reconstruction of the segment by a custom-made prosthesis anchored to the sacrum, pelvic branches and femoral component (Figure 2).

**Results:** The patient performed a postoperative period without incidences, correct radiological control (Figure 3) with adequate hematological level and began the exercises of muscular rehabilitation, achieving ambulation with the help of a walker after the second week of surgery. It does not present immediate surgical complications and no changes at 3 months of follow-up.

**Conclusion:** Thanks to these new custom-made prosthetic devices, it is possible to perform functional restoration surgeries after a complete exeresis of the tumor. Te goal in this type of patients is a multidisciplinary approach follow by an optimal tumor response to chemotherapy and an adequate rehabilitation that allows the success of surgery preserving functionality without affecting the patient's prognosis.

Figure 1. Intraoperative tumoral resection with 3D model and cut-guide

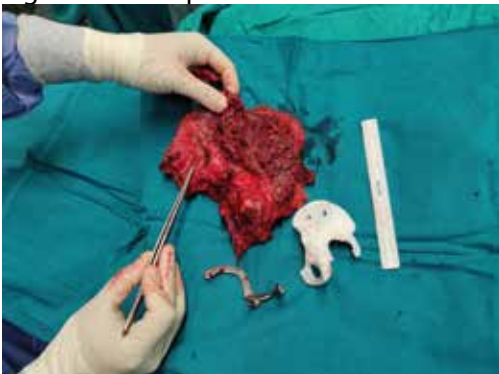


Figure 2. Prosthesis custom made

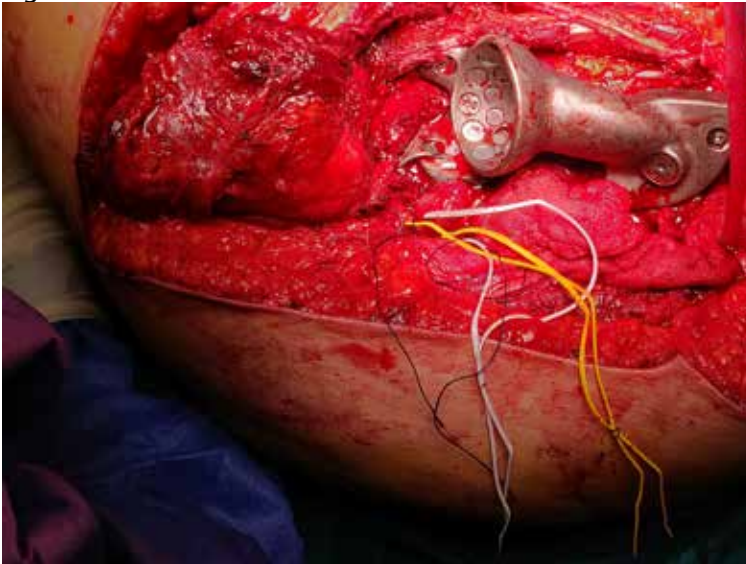


Figure 3. Radiological control with custom made prosthesis



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## Isolated tumoral calcinosis in the hip mimicking periarticular infection. Case report and literature review

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**Introduction and Purposes:** Tumor calcinosis is a rare pathology characterized by the accumulation of calcium hydroxyapatite crystals (1-2). Present a case of tumoral calcinosis and discuss the diagnostic approach based on the current literature.

**Materials and Methods:** Patient older than 50 years with a multifactorial avascular necrosis of the femoral head, in whom tumoral calcinosis is identified in images and confirmed with histopathological findings. A review of the literature is subsequently made from articles published in English, which were located in indexed databases.

### Results:

- Case report: A 65-year-old female patient with a medical history of moderately differentiated infiltrating ductal breast cancer IIIB diagnosed 21 years ago. In 2017, limping and progressive pain in the right hip are documented. Radiographs of the hip reveal a collapse of the femoral head. In the soft tissues, multiple opaque cloudy like images are identified bilaterally. Histopathological analysis revealed a clean background with proteinaceous material and occasional histiocytes, associated with increased calcium deposits.
- Literature review: The treatment of massive periarticular calcinosis should be individualized and will depend to a large extent on its underlying cause. The excision of tumoral calcinosis lesions is a good choice if they are limiting the function or have a joint compromise that generates significant pain and restriction for daily life activities (1-2).

**Conclusions:** Tumor calcinosis is a benign pathology that behaves like a great imitator and in most cases it is associated with hereditary diseases of metabolic phosphate dysfunction (1-2).

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2451

### **Tibial turn-up for femoral reconstruction, an uncommon type of rotationplasty: case report and systematic literature review**

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**Introduction and Purposes:** Tibial turn-up is a type of rotationplasty that is rarely described. The purpose is to present the technique, and evaluate all the available literature.

**Materials and Methods:** After reporting a case using this technique, a systematic literature search using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines was performed. The available literature until December 2018 was assessed and methodologically qualified with the Modified Coleman Score.

**Results:** We present the case of a tibial turn-up in a 33 years old male patient in order to treat a chronic osteomyelitis. The progression was satisfactory and the patient was able to wear prosthesis once the flap healed.

In the systematic review, 17 articles (1 case series and 16 case reports) were identified with a mean Modified Coleman score of 46 (43 - 50). A total of 30 cases (19 males/11 females) were described, with a mean follow up of 33 months (2 - 180). The mean age at the time of treatment was 30.9 years old (4 - 68). The reasons to use this technique were: oncologic resections (12 patients) or infections (18 patients). The technique was described to reconstruct 2/3 of the femur in 17 patients, or the whole femur in 13 patients. Solvable wound complications were reported in 20% of the cases. The use of external prosthesis was achieved in 86% of cases. Five patients required further surgery to do a refashion of the stump (3 patients) or a final high amputation (2 patients).

**Conclusions:** Tibial turn-up is a useful technique to reconstruct long supracondylar stumps when the femur cannot be preserved. This technique may be considered in oncologic conditions, infection cases or after failed limb salvages.

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2455

## Non image-guided core needle biopsies can be safely used to improve diagnostic efficiency for soft tissue tumors

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**Introduction:** Percutaneous biopsy has been reported to reduce the rate of complications and cost, while maintaining a high diagnostic accuracy for diagnosis of soft tissue tumor. In many cases, this percutaneous biopsy could be performed without radiological guidance (NIGB), in a referral center, without increasing the failure rate. The aim of this study is to assess histological diagnosis accuracy of NIGB, to compare this technique to performance obtained with image-guided (IGB) and open-biopsy (OB) during the same period and to attempt to identify risk factors for failure.

**Materials and Methods:** This is a continuous, single-center retrospective study. NIGB was proposed to patients when the tumor was easy to palp clinically and considered appropriate for NIGB by the surgeon. Patients with anticoagulation medication or an history of hemostasis disease were not eligible for the technique. We reported the failure rate and the diagnostic delay for the three techniques.

**Results:** 337 were patients were included: 141 patients (41.3%) had a NIGB, 81 (24.0%) had an IGB, and 115 (34.1%) an OB. The failure rate was 9.9% (14 patients) for NIGB. Eleven were non-contributive and 3 were errors of diagnosis; all 14 cases were reviewed during our regional multidisciplinary meeting for further diagnosis strategy, with no consequences of the NIGB failure for patients. The failure rate of IGB was 18.5% (15 patients), with no significant difference with NIGB and 6.9% (8 patients) for OB. Diagnostic delay was significantly shorter for NIGB. We found no risk factor of failure for NIGB. We didn't report any complication, regardless of the biopsy technique used.

**Conclusion:** When performed in a referral center by the patient's surgeon, a non-image-guided core needle biopsy is a safe procedure which ensures an equivalent diagnostic accuracy for soft tissue tumors, while reducing the diagnostic delay.



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### **An unusual cause of superficial peroneal nerve entrapment**

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**Introduction and Purpose:** We describe 3 patients who presented with symptoms of superficial peroneal nerve palsy due to compression by a distant tumour. Peroneal nerve palsy due to schwannoma is well documented, however we present a novel observation of nerve entrapment due to the presence of a distant tumour within the deep fascia of the leg.

**Materials and Methods:** The superficial peroneal nerve branches from the common peroneal nerve, coursing within the lateral compartment of the leg before dividing into medial and lateral branches to supply the foot. It pierces the deep fascia emerging into the subcutaneous fat 10-15cm above the lateral malleolus. At this point the nerve is vulnerable to compression against the deep fascia.

**Results:** Presenting symptoms were pain over the dorsum of the foot and altered sensation in the supero-lateral aspect of the leg. The nerve was entrapped at the point of emerging from deep fascia in all 3 cases. All patients were treated with excision of tumour, release of deep fascia and nerve decompression.

**Conclusions:** Tumours around or close to nerves can cause compression. As our cases illustrate it is important to consider the diagnosis of tumour at a distant location in any patient presenting with a nerve entrapment syndrome at an uncommon site.

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### **Oncothermia for the bone and soft tissue sarcoma**

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**Objective:** Oncothermia (modulated electrohyperthermia: mEHT), is a new approach developed to overcome the problems of traditional hyperthermia by the precise impedance-matched system and modulated radiofrequency current flow to the malignant tumors.

**Methods:** The treatment of oncothermia was made by the device EHY2000 (Oncotherm, Hungary). The applied electrode was 30 cm in diameter; patients were lying in the supine position on the water-mattress of the treatment bed. We applied step-up heating protocol starting with 60 W rising to 140W. Oncothermia was carried out once/twice a week. The session had 60 minutes duration. We have studied oncothermia involving 8 sarcoma patients (6 male, 2 female; average age: 57.5 years old) having advanced metastatic or recurrent disease, being incurable by the standard therapy protocols. Histological findings were confirmed to 3 undifferentiated pleomorphic sarcoma, 1 alveolar soft part sarcoma, 1 pleomorphic leiomyosarcoma, 1 liposarcoma, 1 mesenchymal chondrosarcoma and 1 chordoma of the sacrum. The targeted area was 3 primary tumors and 5 metastatic tumors. The average number of treatment times per a patient was totally 38.4 times (ranging from 9 to 164).

**Results:** All patients felt comfortable warming around the targeted area during the treatment. Elevated body temperature was mild, but some patients showed systemic sweating. There was no adverse effect; skin blisters, erythema or dermatitis were not observed. Among the 8 patients, we have stabilized the disease in 2 patients (25%) during an half year at least (SD). After that, the tumors showed progressive. But their quality of life was improved according to their subjective reports. Other 6 patients (75%) showed progressive disease (PD). Discussion: Hyperthermia is expected as a less aggressive antitumor treatment strategy and sometimes it could be applied even in the cases when the conventional treatments (cancer surgery, radiation, chemotherapy) are failed. When the only palliative care is selected by the informed consent, oncothermia is recommended to be a valid option with few adverse effects on advanced cancer patients.

**Conclusions:** Our present study shows the feasibility of oncothermia as a possible therapy for advanced sarcoma cases when the standard therapies fail.

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## Short-term neoadjuvant denosumab and extended curettage for locally advanced giant cell tumor of bone: a single-center study

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**Introduction and Purposes:** While some previous studies suggested efficiency and tolerability of denosumab, a report asserted that neoadjuvant use may increase the risk of recurrence after curettage.<sup>1</sup> Meanwhile, data on its long-term toxicity are still lacking.<sup>2</sup> Thus, we analyzed a series of patients who underwent short-term neoadjuvant denosumab and extended curettage (NDEC) for locally advanced giant cell tumor of bone (GCTB).

**Materials and Methods:** We retrospectively review the medical records on patients who underwent NDEC for GCTB from 2016 to 2018. Cases that were administered denosumab for recurrent lesions, over four months preoperatively, or postoperatively were excluded.

**Results:** There were seven females and five males, with the median age of 31 years. Most common location of lesion was the distal femur. One patient visited after pathologic fracture had occurred. Campanacci grade was 3 in nine cases and 2 in three. Eight patients were administered denosumab five times, and four six times. In one case, it was intraoperatively too difficult to distinguish normal bone and neoplastic tissues due to excessive new bone formation. Median operation time was 135 minutes. Median postoperative follow-up time was 16 months. No critical complications were identified. Local recurrences or pulmonary implants did not develop.

**Conclusions:** Short-term NDEC might be effective for locally advanced GCTB. Radiologic monitoring during neoadjuvant treatment would be essential to prevent excessive new bone formation. Further studies on more cases with longer follow-up period should be mandatory.

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2464

### **Intentional close margin on sciatic notch during internal hemipelvectomy associates with proper clinical outcome**

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**Introduction and Purposes:** Pelvic tumour resection is challenging and associated with considerable mortality and high morbidity. The difficulty of pelvic resection is due to the difficulty in controlling postoperative complications. Infection and wound healing problems are the most frequent postoperative complications that occur after pelvic tumour resection. Both problems are closely related to poor local blood flow. We intentionally preserve the gluteal arteries to reduce the postoperative complications following pelvic tumour resection by maintaining gluteal muscles blood flow. The detachment of gluteal arteries from the sciatic notch is required for this procedure and entails intentionally close margins. We aimed to assess the relationship between the local recurrence rate and intentionally close margins to preserve both arteries.

**Materials and Methods:** Between 2010 and 2018, a total of 10 internal hemipelvectomies (5 men and 5 women; mean age, 54.1 years) were performed; these included seven cases of P2/3 internal hemipelvectomies and three cases of P1/2/4, P1, and P1/4 internal hemipelvectomies, respectively. The pathological diagnoses were chondrosarcoma in 6, osteosarcoma in 3, and Ewing sarcoma in one case. In all surgeries, the inferior gluteal arteries were preserved. The superior gluteal arteries were preserved in two surgeries.

**Results:** The mean follow-up duration was 31.7 months (3–97 months). The postoperative complication rate was 10.0% (one of the 10 surgeries); it was a postoperative deep infection requiring debridement. The closest margins were at the sciatic notch and less than 5 mm in all cases. There was no tumour recurrence in any case. All other patients achieved complete disease-free survival.

**Conclusion:** There was no local recurrence following the intentionally close margins to preserve both gluteal arteries during internal hemipelvectomy. The postoperative complication rate in our cases was lower than previously reported rates. The reported overall complication and wound infection ranged from 45% to 60% and 29% to 77% respectively. We therefore conclude that intentionally close margins are worth considering to preserve both gluteal arteries, contributing to a reduction in the postoperative complication rate.

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## Metastatic Marjolin's ulcer after 10 years of the amputation of an osteomyelitis: a case report

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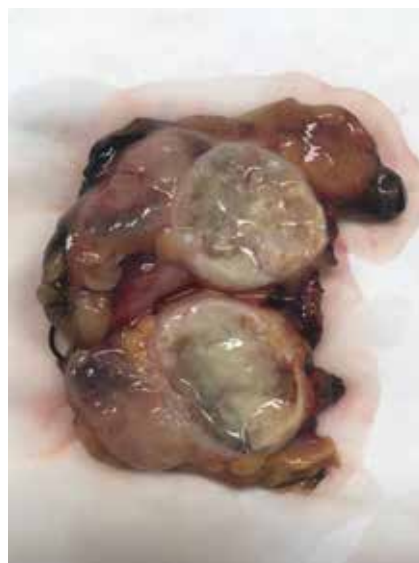
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**Introduction and Purposes:** Marjolin's ulcer is a very uncommon tumour related with chronic wounds, specially with chronic osteomyelitis and burnt patients. This kind of squamous cell carcinoma normally produces metastases when diagnosed, and they are found in more than 27% of patients, being the locoregional metastases a sign of bad prognosis. When they appear, they lead to death within 2–3 years.

**Materials and Methods:** We present a clinical case of a isolated locoregional metastases of a Marjolin's Ulcer that appeared 10 years after the amputation of the distal phalanx of the third finger of the hand because a chronic osteomyelitis.

**Results:** After the full body study, the patient didn't have other metastases or other lesions. We developed an amputation of the right arm because of the supuration and discomfort of the patient. After the amputation, the diagnose was confirmed and after 6 months of evolution the patient has not developed other metastases.

**Conclusions:** We present a very atypical case of metastatic Marjolin's Ulcer that appeared after 10 years of the resection of the chronic wound that produced it as a locoregional metastasis that was treated because of the supuration and the discomfort that produced to the patient. The patient has a very bad prognosis, but after 6 months of evolution after the amputation, he is free of disease and no other metastasis have been shown. This special squamous cell carcinoma has an atypical development, what produces necrosis around the tumour and makes more difficult to develop metastasis than other kind of malignant tumours. That could explain why after 10 years of the removal of the primary Marjolin's Ulcer, he has developed the clinical metastatic disease. Finally this case is useful to understand that Marjolin's Ulcers nearly always develop metastases, but it may take some further time before the metastases are clinically relevant.



2475

## Individual risk evaluation for local recurrence and distant metastasis in Ewing sarcoma: a multistate model

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**Introduction and Purposes:** Investigate the effect of surgical margins, histological response and radiotherapy (RT), considering individual patient characteristics on local recurrence (LR), distant metastasis (DM) and death in Ewing sarcoma.

**Materials and Methods:** 982 patients treated according to EURO-E.W.I.N.G 99 with surgery after induction chemotherapy were included. A multistate model (Figure 1) with initial state surgery, intermediate states LR, pulmonary metastasis (DM<sub>pulm</sub>), other DM±LR (DM<sub>other</sub>) and final state death was estimated. Hazard ratios (HR) along with 95% confidence interval in brackets were estimated using Cox proportional hazards.

**Results:** Risk factors for transition to: LR are pelvic location HR 2.04(1.10-3.80) and marginal/intralesional resection, HR 2.28(1.25-4.16); DM<sub>pulm</sub> are <90% necrosis HR 2.13(1.13-4.00) and previous pulmonary metastasis HR 4.90(2.28-8.52) and DM<sub>other</sub> are histological response, HR 1.56(1.09-2.23) for 90-99% necrosis and HR 2.66(1.87-3.79) for <90% necrosis, and previous bone/other metastasis, HR 3.08(2.03-4.70). Disease extent, HR 8.08(4.01-16.29) for pulmonary metastasis and HR 10.23(4.9-21.36) for bone/other metastasis, and <90% necrosis, HR 6.35(3.18-12.69), are risk factors for surgery to death. RT seems protective for LR, HR 0.52(0.28-0.95) and death, HR 0.45(0.26-0.76). In case of LR only time to recurrence (0-24 months) is prognostic for survival, HR 3.79(1.34-10.76). In the presence of new DM only previous bone/other metastasis remain prognostic, HR 1.74(1.1-2.75).

**Conclusion:** Disease extent and histological response are main risk factors for progression to DM or death. Pelvic tumor site and intralesional/marginal resection are important risk factors for LR. Given that disease progression occurred prognostic value of disease extent and histological response decreases. RT seems protective for LR and survival. New insights presented here can assist in deciding on the optimum treatment strategies for Ewing sarcoma.

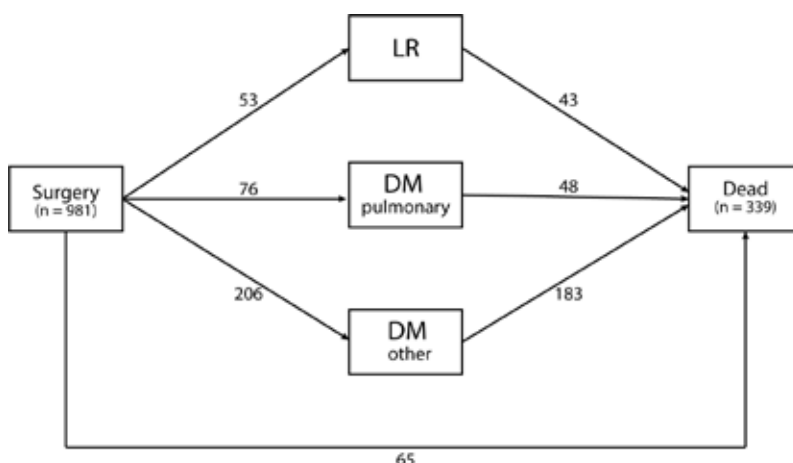


Figure 1 – Multistate model



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## Safety of distraction osteogenesis in osseous neoplasms: A review of 38 patients undergoing distraction osteogenesis for reconstruction of large osseous neoplastic defects

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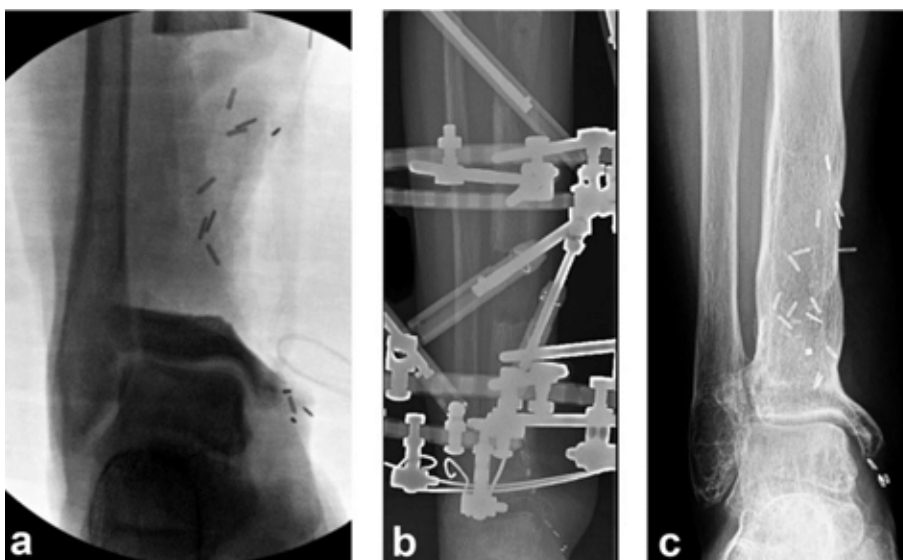
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**Introduction and Purposes:** The use of distraction osteogenesis is common in situations of trauma or infection, but less reported in patients for oncological diagnoses.

**Materials and Methods:** We evaluated 38 patients with primary bone sarcomas who underwent resection and DO reconstruction at our institution between 08/2014 and 08/2018. Data were collected regarding demographics, oncologic characteristics, treatment details and postoperative complications. Functional outcomes were assessed using the Musculoskeletal Tumor Society scores.

**Results:** Mean age at the time of lengthening surgery was 18 years (6-62 y.). Osteogenic sarcoma was the most common diagnosis with 20 (53%) cases. 29 (76%) tumors were high-grade. In 34 (90%) cases, the defect was in the lower extremity. 27 (71%) patients underwent bone transport with an external device. All surgical margins were free of tumor, the mean narrowest margin was 12 mm (0.5-40mm). The mean total defect size and total length of regenerate bone was 14.7 cm (9-25 cm) and 14.1 cm (4-25 cm), respectively. 28 (74%) patients received chemotherapy, and 1 (3%) patient radiation therapy. Mean follow-up time was 2.3 years (minimum 1 year). Mean MSTS score at the last follow-up visit was 25 (13-30). The rate of complications requiring revision surgery was 50% with infection being the most common type of complication. At the end of the observation period, no patient had signs of local recurrence. 30 (79%) patients had no evidence of disease, 8 (21%) patients had distant metastasis.

**Conclusion:** We found no enhanced risk of local recurrence with DO techniques when performed in the same bone as the initial tumor. Functional scores show those who undergo DO reconstruction show significant trend with increasing MSTS scores over time.



a) resection of the right distal tibia due to synovial sarcoma with osseous involvement  
b) application of a multiplanar external fixator for bone transport  
c) 3 years after surgery

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## A reliable approach for the resection of posteroinferior tumors of the femoral neck

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**Introduction:** The benign lesions of the femoral neck include a group of neoplastic that according to their location and symptomatology depends on their treatment.<sup>1-5</sup> The lateral hip approach, with trochanter osteotomy and controlled dislocation is the most used in these pathologies.<sup>6-8</sup> but multiple complications are reported.<sup>9,10</sup> The objective of our study was evaluate a series of patients with benign bone tumors located in the posteroinferior region of the femoral neck, treated by oncological resection by medial hip approach, and to determine (1) functional results, (2) failure rate of the surgery, (3) time to failure and (4) causes of failure.

**Materials and Methods:** A series of patients was retrospectively analyzed, 16 patients matched with the inclusion criteria (patients with benign tumors of the femoral neck; located in the posteroinferior region of the neck; operated by a hip medial approach in the same institution, by the same surgical team, with a minimum follow-up of 24 months). For the functional evaluation we used MSTs and active range of movement was evaluated. Demographic analysis, local recurrence and complications were recorded.

**Outcomes:** Of the 16 patients included in the analysis, 69% were male (11/16) and 31% were female (5/16). The mean follow-up of the series was 50 months and the median age was 25 years. The most frequent primary benign tumor was osteochondroma (7/16), followed by Chondroblastoma (3/16) and osteoid osteoma (2/16). The average size of the tumors was 6 cm. Mean MSTs was 28 and the median time for returning full weight bearing was 5 weeks. 87% of patients improved the range of joint mobility compared to preoperative. (p: 0.037). 12% of patients had a local recurrence and the mean time to recurrence was 12 months. The type of tumor that presented RL was GCT and synovial chondromatosis. 19% of patients presented complications. 1 of them with synovial chondromatosis that presents an intra articular osteophyte with occasional pain. Another patient with a diagnosis of GCT presented for two consecutive years to surgery claudication of the gait and pain that resolved with kinesiological treatment. The last patient with Multiple Hereditary Exostosis presented a fracture of greater trochanter at 3 week of postoperative. 12% of the patients were reoperated. a) The patient with de soft tissue LR of GCT was operated to resect the tumor for the same approach b) and the patient with the greater trochanter fracture It was treated in a conserved means but when persisting the pain, a pseudoarthrosis was suspected and 3 months after the fracture was operated.

**Conclusion:** The tumors of the femoral neck that are located in the posteroinferior quadrant are difficult to access, requiring large surgeries to be resected and present multiple associated complications. The medial hip approach is a safe approach, which avoids many of the serious complications and allows an early deambulation.

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## microRNA-138-5p as a worse prognosis biomarker in pediatric, adolescent, and young adult osteosarcoma

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**Introduction and Purpose:** Osteosarcoma (OS) is the most common primary malignant bone tumour with two peaks of incidence, in early adolescence and the elderly. Patients affected with this malignancy often present metastatic disease at diagnosis, and despite multimodality therapy, survival has not improved substantially over the past 3 decades. Recently, miR-138-5p, proposed as a crucial intracellular mediator of invasion, has been recognised to target the Rho-associated coiled-coil containing protein kinase 2 (ROCK2). Dysregulation of ROCK1 and ROCK2 was also described in OS, being associated with higher metastasis incidence and worse prognosis. Nonetheless, the specific roles of miR-138-5p in pediatric and young adult OS and its ability to modulate these kinases remain to be established.

**Materials and Methods:** Thus, in the present study, the expression levels miR-138-5p were evaluated in a consecutive cohort of exclusively pediatric and young adult primary OS samples.

**Results:** In contrast to previous reports that included adult tissues, our results showed upregulation of miR-138-5p associated with reduced event-free survival and relapsed cases. In parallel, ROCK1 mRNA levels were significantly reduced in tumour samples and negatively correlated with miR-138-5p. Similar correlations were observed after studying the profiles of ROCK1 and ROCK2 by immunohistochemistry.

**Conclusions:** Our data present miR-138-5p as a consistent prognostic factor in pediatric and young adult OS, reinforcing its participation in the post-transcriptional regulation of ROCK kinases.

2485

## Institutional review of chondromyxoid fibroma of bone with specific focus on the pelvis

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**Introduction and Purposes:** Chondromyxoid fibroma (CMF) is a benign cartilaginous tumour of bone that can occur at any site, frequently in long bones during the 2nd/3rd decades of life. A correct imaging diagnosis is seldom suggested, due to its rarity and non-specific appearances. The pelvic bones are less frequently affected and pelvic CMF (pCMF) poses particular diagnostic challenges [1]. The aim was to describe the clinico-radiological and pathological features of pCMF compared to those of extra-pelvic (eCMF) sites.

**Materials and Methods:** We retrieved 100 cases between 1998- 2018.

**Results:** Sites included tibia (29), foot and hand (21), fibula (8), femur (6), skull (5), rib (5), ulna (2), humerus (2), clavicle (1), pelvis (21: 17 ilium, 2 pubis, 1 acetabulum, 1 sacrum). Mean age was 31.5y (range 5-68). Mean age of eCMF was 28.3y (range 5-68) whereas the pCMF was 43.8y (range 11-66). Of the 79 eCMF, 52% were female, whereas 66.6% of pCMF were female. Management was curettage (9), resection (4), follow up only (3), no information (5). Size of pCMF ranged 19-102mm (mean size:57mm). 19/79 of eCMF had one recurrence between 12-120 months and 2/19 had a second relapse between 4-57 months. The pCMF had no recurrence during a median follow-up of 21 months. When available, common imaging diagnoses of pCMF was chondrosarcoma, myeloma or carcinoma, whereas in eCMF giant cell tumour, aneurysmal bone cyst and non-ossifying fibroma was queried. Where imaging was available, all pCMF were intramedullary, presenting with cortical destruction/erosion; 2 were surface lesions. No difference in histology was seen between pCMF and eCMF.

**Conclusions:** pCMF affects older patients with female predominance. It poses diagnostic challenge as the radiology is non-specific, raising the possibility of malignancy. Clinical, radiological and pathological correlation is required for correct diagnosis and management.

2488

### Cross-cultural adaption, translation and validation of the Toronto Extremity Salvage Score (TESS) for patients with bone and soft tissue sarcoma in German speaking countries

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**Objective:** The preferred treatment of malignant bone and soft tissue tumors is limb salvage surgery. To measure physical functioning of the affected extremity, the Toronto Extremity Salvage Score (TESS) as a precise instrument has been applied. The aims of this study were to translate and culturally adapt the German version of the TESS as well as to explore its convergent reliability, validity and re-test reliability.

**Study design:** Patients after limb salvage surgery for malignant bone or soft tissue (n= 46; 32 lower extremity, [LE]; 14 upper extremity [UE]) were asked to fill out the German TESS two times (t1: visit, t2: via post) and the SF-36 once.

**Methods:** The TESS for the upper (UE) and lower (LE) extremity was translated from English into German back translated into English for validation, and then culturally adapted. The reliability was assessed with Cronbach's alpha ( $\alpha$ ). The validity was measured with the Spearman rank correlation coefficient (r) between the German TESS and the SF-36 physical functioning (pf) subscale. Furthermore, the re-test reliability was calculated with the intraclass correlation coefficient (ICC).

**Results:** An excellent result was revealed for the internal consistency for both questionnaires (LE t1:  $\alpha$ = 0.924, t2:  $\alpha$ = 0.952; UE t1:  $\alpha$ = 0.957). A statistically significant correlation was found between the SF-36 pf subscale and the German LE TESS ( $r$ =0.697). The ICC between baseline (t1) and re-test (t2) was 0.952.

**Conclusion:** Initial evidence was found that the German TESS is a valid and reliable instrument in patients after surgical treatment for malignant bone or soft tissue sarcoma. Regarding the UE more data have to be collected, due to sarcoma being a rare disease and the consequently low number of patients, correlation with the SF-36 physical functioning subscale might have been lower as expected.



**2497**

### **Press fit vs cemented femoral stems in arthroplasty for oncologic indications**

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Limb salvage has largely replaced amputation in the treatment of primary bone tumors and encompasses multiple reconstructive modalities. Currently there is no consensus regarding which modality (cemented or press fit) is superior. There remains a need for analysis of which components, surgical techniques, or patient factors contribute to failure, and how this should influence choice of reconstruction modality in a given patient.

We identified 81 patients treated with resection of primary bone tumor and subsequent arthroplasty with either a cemented or press fit femoral stem. In press fit stems, the width of the canal, stem, and diaphysis were measured at the base, middle, and distal end of the stem. In cemented stems, the stem, diaphysis, and width of the cement mantle were measured at the base, middle, and distal end of the stem. Failure was defined as any event that led to revision of the implant.

There was no significant difference in overall failure rates between patients with a press fit stem versus cemented stem. The median stem to canal ratio in press fit implants was 0.91 and 0.72 in cemented, and median cement mantle width was 2.75mm.

The failure rate was not significantly different with press fit versus cemented femoral stems, suggesting that both are appropriate methods of post-resection reconstruction. Age was inversely associated with failure in cemented stem, indicating that press fit is the more appropriate option for younger, active patients. However, the stability of a cemented stem may improve durability and survival in patients with higher BMI.

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**2498**

### **Survival of mega-endoprosthetic reconstructions after two-stage revision surgery for periprosthetic joint infection**

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Mega-Endoprosthetic Reconstruction offers patients an important option for limb salvage. Periprosthetic joint infections (PJI) are a devastating complication that affect between 1-10% of patients and commonly result in additional invasive procedures, amputation, and sometimes death. This study evaluates mega-endoprosthetic reconstruction survival after PJI and two-staged reconstruction using a cement spacer.

22 patients treated at MGH between 1990-2015 were included in the study. These charts were examined for incidence of complications, predictors of complications, impact of size of defect as a predictor of complications (>10cm vs. <10cm), and functional outcomes (EQ-5D and LEFS Questionnaire).

After the two-stage revision and re-implantation there was a 43% chance of complication. 8 patients were treated for recurrent PJI, two patients were treated for mechanical failure of the reconstruction. In this series there was a 17% chance of amputation following two-stage revision surgery. Spacers of greater than 10 cm yielded 90% of the complicated surgeries and 38% of the non-complicated surgeries. Spacers of less than 10 cm yielded 10% of the complicated surgeries and 62% of the non-complicated surgeries.

83% of patients in the study retained their limb at a minimum of two years post-operative follow up. The data confirmed that as the size of the bony defect increases, the patient had a higher probability of undergoing more surgeries in the future. Additionally, those with complications were more likely to result with an amputation. The questionnaires suggested moderate functionality despite the invasiveness of limb salvage surgery. This information leads us to believe that a mega-endoprosthetic PJI can be successfully managed using a two-stage revision with cement spacer, though the complication rate remains high and the surgeon must be mindful of how much bone is resected before re-implantation.

2507

## Be aware of zebras: biphasic synovial sarcoma diagnosed in the planta pedis of a young woman who was admitted after trauma

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**Background:** Synovial sarcomas usually occur in teenagers and young adults of both sexes, and frequently present in the deep soft-tissues of the lower extremities. Herein, we present the case of a young woman, in whom synovial sarcoma was diagnosed incidentally after fracture of her metatarsal bone.

**Case Presentation:** The 22-year old woman had suffered a severe trauma as a heavy table had fallen onto her right forefoot. Due to persisting pain, swelling and extensive haematoma, MRI was performed. It showed a fractureline in the diaphysis of the 5th metatarsal bone. In addition, a small, well-circumscribed lesion (21x35x14 mm) was visible in the deep soft tissues of the planta pedis. The lesion was located between the osseous structures of the ventral tarsus and the deep muscular compartment. It appeared to be heterogeneous, poorly vascularised, lobulated, and non-infiltrative. After biopsy, histological and molecular analysis led to the diagnosis of a biphasic synovial sarcoma (SS18-SSX +). Staging was negative. An amputation of the lower leg was suggested to the patient. The patient refused any therapy and turned towards complementary medicine even though several informative conversations were held with her and her family by doctors and clinical psychologists.

**Discussion:** In this case, several circumstances coincided which carry the risk to delay proper diagnosis, such as an initially slow, well-circumscribed tumour growth. The lesion in our patient was diagnosed after a severe trauma and coincided with a fracture of the metatarsal bone and severe haematoma. Thus, it might have been mistaken for a posttraumatic alteration. The fact that the patient refuses (potentially curative) therapy and prefers complementary medical treatment once again illustrates how difficult it can be to guide patients in their medical decisions, particularly in cases where limb amputation is unavoidable.

2508

### Treatment of recurrence of osteosarcoma in children

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**Introduction:** The results of treatment of recurrence of osteosarcoma depend on the operability of the tumor, the interval of occurrence of relapse, the use of chemotherapy.

**Materials and Methods:** During the period from 2009 to 2018, 13 children with a relapse of osteogenic sarcoma aged 9 to 16 years were treated in the children's department of the Kiev Cancer Center, the average age was 14 years. The number of relapses in one patient was from 1 to 8. Chemotherapy was given to 9 out of 13 children. Primary chemotherapy was carried out according to the protocol ISG-S5G 1 or «UNDIOR-99». A radical operation was performed in 12 of 13 patients. Relapse chemotherapy was based on 1st line chemotherapy drugs: methotrexate 12g / m<sup>2</sup>, ifosfamide 15g / m<sup>2</sup>, carboplatin 600 mg / m<sup>2</sup> + etoposide 600 mg / m<sup>2</sup> and 2nd line of chemotherapy: endoxan 2.5g / m<sup>2</sup> + etoposide 500 mg / m<sup>2</sup>. Gemzar with docetaxel was used in adjuvant chemotherapy.

**Results:** 9 of 13 children (69%) with recurrence of osteosarcoma remain alive at a follow-up period of 4 to 10 years.

**Conclusions:** The effectiveness of first-line chemotherapy is an important prognostic indicator (p < 0.05) of the survival of children with recurrence of osteogenic sarcoma.

2509

**Periplocin, the most anti-proliferative constituent of *Periploca sepium*, specifically kills liposarcoma cells by death receptor mediated apoptosis**

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**Background:** During a screening of Chinese plants traditionally used for cancer and related diseases, extracts of the root bark of *Periploca sepium* Bunge showed strong cytotoxic activity.

Aim of the study was the isolation and identification of the cytotoxic compounds from *P. sepium* and the investigation of the effects and mechanism of action on different cancer cell lines.

**Methods:** Extracts with different polarities of the root bark of *P. sepium* were tested for their anti-proliferative effects. The most active extract was subjected to activity-guided fractionation using different chromatographic methods. The most active compound was further investigated on sarcoma cell lines regarding its effects concerning apoptosis, DNA damage and death receptor expression.

**Results:** We isolated the cardiac glycosides periplocin, glucosyl divostroside, periplogenin, periplocymarin and periplocoside M with periplocin exhibiting the lowest IC<sub>50</sub> value against leukemia and liposarcoma cells. Liposarcomas are rare tumors within the heterogeneous group of soft tissue sarcomas and respond poorly to conventional treatments. Periplocin led to growth inhibition and apoptosis induction by changing the expression of death receptors and inducing DNA double strand breaks in SW-872 cells.

**Conclusion:** Periplocin displays a promising mechanism of action in sarcoma because altering the death receptor expression is an interesting target in sarcoma treatment especially to overcome TRAIL resistance.

2510

## First application of three-dimensional (3D) design custom-made uncemented prosthetic stem for distal femoral cemented megaprosthesis revision

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**Introduction and Purposes:** 3D design, which is widely used in orthopedics, can be applied for precise distal femoral megaprosthesis revision. This research aimed to present and evaluate the design, perioperative management, and midterm clinical outcomes of a 3D design custom-made uncemented prosthetic stem.

**Methods:** Between January 2014 and January 2016, seven patients received 3D design custom-made uncemented prosthetic stem revision at our institution. Clinical records and radiographs were evaluated retrospectively.

**Results:** The antecurvature radian of the revision stem averaged at 3.6°. There were no hardware-related complications during the follow-up (range 24–48 months). The Musculoskeletal Tumor Society score at the last follow-up was significantly higher than that before. The range of motion of the affected knee, and the scores of pain, function, emotional acceptance, support, walking and gait all improved significantly.

**Conclusion:** The 3D design custom-made prosthesis, characterized by its individually and precisely designed uncemented stem, offers an alternative option for distal femoral cemented prosthesis revision. Besides, the perioperative management is also crucial.

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2511

### **Lymph vessel infiltration in diffuse-type tenosynovial giant cell tumour: aggressive disease in a 17-year old girl**

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**Background:** Diffuse-type tenosynovial giant cell tumours (dt-TGCT; formerly: pigmented villonodular synovitis) is a rare disease which is most frequently observed in the knee joint. Imatinib or dual inhibitors of CSF1R and KIT are being discussed as potential options in advanced, recurrent and/or progressive disease.

**Case Presentation:** A 20-year old woman was diagnosed with dt-TGCT of her right knee joint at the age of 17. Arthroscopic surgery was followed by combined anterior compartment arthroscopy and posterior open synovectomy due to recurrence. Histology confirmed dt-TGCT without distinct malignant transformation. However, the tumour infiltrated the lymph vessels. Staging was negative. Soon afterwards the tumour recurred again. Ventral and dorsal open synovectomy and radiosynoviorthesis were performed. Another progression was verified several months later. Due to an extensive extraarticular involvement, the patient is currently being treated with imatinib. After short-term treatment pain and effusion have improved. Long-term results are warranted.

**Discussion:** High recurrence rates are common in dt-TGCT (up to 92%). Treatment regimens of (recurrent) dt-TGCTs remain a topic of debate, though valueable algorithms have been proposed. Mastboom 2017 even reported above-knee amputations in patients in whom all other treatments have failed. Our patient has undergone multiple surgeries for severe diffuse-type dt-TGCT that infiltrated the lymph vessels in the absence of other criteria of malignant transformation. These histological features are extremely uncommon. The patient is currently on systemic treatment with imatinib.

**Conclusion:** Lymph-vessel infiltration can occur in dt-TGCT. We suggest to follow the patient up with contrast-enhanced MRI of the adjacent lymph node station (pelvic MRI). Systemic treatment options targeting the CSF/CSF1R-axis induced a short-term symptom relief in our patient. However, long-term results are warranted.



2526

## Metabolic predictors of treatment response in patients with Osteosarcoma and Ewing's sarcoma

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**Introduction and Purposes:** PET imaging is a valuable technique for the follow-up of patients affected by sarcoma. Our aim is to determine the relationship of serial [18F]FDG uptake of the primary tumor with the histologic response in children and young adults with osteosarcoma (OS) or Ewing's sarcoma (EW).

**Material and Methods:** We prospectively analyzed patients affected by OS or ES between 2006 and 2018. Patients were treated with chemotherapy and radiotherapy with or without surgery. Serial [18F]FDG PET/CT imaging at baseline (t0), after neoadjuvant (t1) and adjuvant chemotherapy (t2) were obtained. Maximal standardized uptake value (SUVmax) among with delta changes for the primary lesion and  $\Delta$ SUVmax for the surrounding soft tissue compartment were assessed. After surgery, patients were categorised according to the histological response. Responders were defined in the presence of a tumor necrosis (TN) >90%; otherwise they were classified as non-responders. Repeated measures ANOVA, linear regression and Pearson correlation analysis were applied as appropriate.

**Results:** Forty-one patients (responders n=15, non-responders n=20, surgery not performed in 6 patients) were considered. A significant reduction of SUVmax at t1 ( $p<0.01$ ) and t2 ( $p<0.01$ ) was observed. TN showed a positive relationship with the delta changes of SUVmax at t1 ( $p<0.01$   $r=0.5$ ) and t2 ( $p<0.01$   $r=0.5$ ). A similar association was observed between TN and the  $\Delta$ SUVmax.  $\Delta$ SUVmax values of 4.7 at t1 and 7.5 at t2 were able to identify responders (sensitivity 0.8 and 0.8, specificity 0.8, and 0.7 respectively for t1 and t2).

**Conclusions:** PET-derived parameters showed a positive correlation with histological response. Moreover,  $\Delta$ SUVmax after neoadjuvant and adjuvant chemotherapy acts as a predictor of histological response. Thus, it could be useful to stratify patients according to their therapy response.

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### Proximal tibial sarcoma. An extensor-mechanism preserving custom implant

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**Introduction:** Management of bone tumours located in the proximal tibia is challenging. Limb salvage reconstructive considerations given the peri-articular proximity of a tumour can include potential sacrifice of the joint and compromise of the extensor mechanism. A number of options are published in this group; use of massive allograft to reconstruct the defect, joint sparing prosthesis, and proximal tibial endoprosthetic replacement. Complications for these techniques include infection, mechanical failure, and functional disability.

**Methods:** We 2 present case studies with malignant diagnoses, where an alternate custom endoprosthetic design has been used. This is a joint sacrificing and extensor mechanism retaining design. Each implant was manufactured by Stanmore Implants Worldwide (Stryker Ltd), Elstree, England. This comprised; standard metal rotating hinge/standard mets femoral component and agluna treated shaft. Between these components is an HA-coated internal shaft that is inserted through the proximal tibial bone block which includes the tibial tuberosity. The proximal shaft component includes a HA-coated collar into which the internal shaft is secured via bolts. A cemented stem is inserted into the distal tibia.

**Results:** Neither case reported infection. The first patient required a manipulation under anaesthetic 6 weeks post operatively. Extensor function remains intact with no lag and both have knee range of movement 0 to >90°. Ingrowth of the HA-bone interface is noted.

**Conclusion:** This is a small series, and time from surgery is short (3 and 11 months respectively). However, we have shown prompt return to weightbearing function for these patients, with no signs of early complications. The functional advantages of this system could be beneficial to a subset of patients with tumours of the proximal tibia.

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**Staging work up in chondrosarcoma: is a bone scan warranted for the metastatic workup of chondrosarcoma? A retrospective study**

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**Objective:** To assess the value of a bone scan in the metastatic workup of a patient diagnosed with chondrosarcoma of bone

**Design:** Retrospective analysis.

**Methods:** 487 patients of extremity chondrosarcomas were identified with the help of nuclear imaging records and pathology department data base over a period of 12 years. Their clinical, radiological and histopathological details were retrieved from case files and electronic medical records. All cases were staged with a CT scan of thorax and bone scan or a whole body PET-CT. All reported and suspicious cases of metastasis were reviewed again by an experienced radiologist for this study. 52 patients had to be excluded from the study due to incomplete staging modalities.

**Results:** 435 patients were available for final evaluation. No grade I chondrosarcoma (51) had evidence of metastasis. In the remaining high grade chondrosarcomas (384), isolated lung metastasis was seen in 9% (35 cases) (grade II-31, grade III-4), combined lung and bone metastasis was seen in 1% (4 cases) (all grade II) and isolated bone metastasis was seen in 0.8 % (3 cases) (grade II-2, grade III-1).

**Conclusion:** The present study shows that the incidence of bony metastasis in extremity chondrosarcomas is extremely low. A non contrast CT thorax would be adequate for staging in conventional chondrosarcomas. In light of the present results we feel bone scan may be omitted from the staging work up of conventional skeletal chondrosarcomas. It may be reserved for only symptomatic patients.

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### Salvage vs resection in proximal femur benign aggressive lesion: challenges in decision making

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**Aims and Objectives:** To assess oncological and mechanical outcomes in salvage or resection of proximal femur benign aggressive lesion.

**Material and Methods:** We analysed 31 cases operated from 2004-2015, of benign aggressive lesions of proximal femur with age range of 7-47. M:F=25:6 with a median follow-up of 52 months. Decision for salvage versus resection was based on ability to achieve adequate disease clearance, bone quality, presence of pathologic fracture.

**Results:** The histologies were Giant Cell Tumor (23), Chondroblastoma (4), Aneurysmal Bone Cyst (01) and Osteoblastoma (01). 18 were primary at presentation, 11 were recurrent. 7/18 and 5/11 presented with pathologic fractures. 11 cases needed resection, 18 needed curettage. Curettage cases included 1 vascularised iliac crest graft, 12 non vascularised grafts, 2 cases with bone cement and 3 cases of curettage alone. Of the 12 pathologic fracture cases, 4 had curettage, 8 had resection. Of the 4 salvages, 2 had soft tissue recurrence at median of 55 months both of which were excised. Eventual salvage rate was 25% as 1 had AVN, needing replacement. LR rate in salvage vs resection group was 50% vs 12%. Of the 17 cases without pathologic fracture, 14 had curettage and 3 had resection. Eventual salvage rate was 64.7% (as 1 had LR, 2 had AVN all needing replacement). 11 cases were recurrent at presentation of which 5 could be successively salvaged (45%) compared to 6 cases which needed resection (54%). Both groups had 1 local recurrence case each. On follow-up of 18 salvage, 4 needed surgery (3 hip replacement for AVN, 1 corrective osteotomy for subtrochanteric malunion) (22.22%). 1 of 14 resection cases of resection at presentation needed revision of bipolar cup (7%).

**Conclusion:** Salvage of proximal femur in benign aggressive lesions is recommended provided adequate disease clearance can be obtained. Though salvage when feasible is recommended even in pathologic fracture, presence of pathologic fracture is a strong predictor for resection.

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## Nutritional predictors of wound complications in patients with soft tissue sarcomas of the lower extremities

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Soft tissue sarcomas (STS) of the lower extremities (LE) frequently require high-risk surgeries that leave patients with complex wounds [1,3]. Past studies have identified a variety of tumor characteristics and treatment courses as risk factors for wound complications (WC) [2,3]. The following research questions were investigated:

- Are there routinely collected physiological indicators associated with the development of WC in patients with LE STS?
- Do BMI and smoking status (SS) impact STS wound healing?

633 patients from our institution were identified as having a LE STS removed from 1992-2017 with adequate records for analysis. Patients with missing variables were excluded from analysis. Postoperative plasma glucose (PG) levels were significantly higher among patients with WC compared to those without ( $p < 0.01$ ) in multivariate analysis and showed predictivity in ROC analysis (AUC=0.74, CI: 0.68,0.79). Preoperative albumin ( $p < 0.01$ ) and hemoglobin ( $p = 0.04$ ) were lower among patients with wound infections compared to those without. PTT, INR, WBC and platelet count values had no effect on WC. Smoking elevated risk for a WC by 14.6% (OR:1.67,  $p < 0.01$ ). BMI had no effect on WC. Post-op PG levels, pre-op albumin levels and SS are useful nutritional variables in predicting WC in STS removal procedures. Pre-op hemoglobin is also a weaker predictor for infections. Orthopaedic oncology services should consider these findings in the implementation of their nutritional optimization protocols for LE STS patients.

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**2544**

### **Use of ultrasound in diagnostics and therapy of musculoskeletal tumors**

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Ultrasound (US) is a useful imaging method as well as guiding method for some invasive procedures in many parts of medicine. This method is easily available, cheap and without radiation dose. In hands of orthopaedic surgeon with some experience it makes perfect supplement to clinical examination and for the first evaluation of a lump it is really beneficial.

US as imaging method enables us the assessment of the tumor localisation, size, demarcation, echostructure and vascularisation as well as the relation to the neighborhood particularly to the large vessels and nerves. US represent for us the basic method of choice for postoperative follow – up of our patients after soft tissue tumor resections (in some cases also for bone tumors) with the aim of early detection of local recurrence.

US as guiding method could not only served for guiding of punctual biopsies but could be used for preoperative planning or for intraoperative detection of the lesion and for correct resection borders achievement.

We would like to present our rich experiences with using of ultrasound in musculoskeletal oncology.



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### Three dimensional printed customized endoprosthesis for massive defect of pelvic pubic ramus: prosthesis design and surgical techniques

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**Introduction:** Three dimensional(3D) printed endoprosthesis has been widely applied and developed in the field of orthopedics. And the reconstruction of region III of pelvis is still imperfect that cause many complications. This paper describes 3D printed prosthesis of region III of pelvis design and surgical techniques through retrospective study.

**Purpose:** To describe prosthesis design and surgery techniques in region III hemipelvectomy.

**Materials and Methods:** 4 patients underwent hemipelvectomy and customized 3D printed endoprosthesis reconstruction between Apr 2018 and Oct 2018. Pelvic bone data was measured by software Mimics Medical and Geomagic Studio. Operations were performed with the help of osteotomy guides.

**Result:** Mean diameter of residual pubis is 25.175mm (21.7-25.6). Mean osteotomy length is 66.5mm(55-80). Mean screws number is 4(3-5). Trabecular structure porosity is 65%. Mean intraoperative time and blood loss is reduced compared to routine operation. The mean MSTs score was 25(24-26). Bone-implant integration could be observed.

**Conclusion:** The 3D printed endoprosthesis may be a feasible option for the reconstruction of pelvic pubic ramus followed hemipelvectomy. And for prosthesis design, operation procedure and peripheral soft tissue are of equal importance besides the matching of defects.

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2556

## Reconsidering the vascular anatomy of rectus femoris: a cadaveric dissection study

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**Introduction and Purposes:** In 2010 Moschella et al described lower leg posterior compartment reconstruction following sarcoma resection, using ipsilateral free-functional rectus femoris musculocutaneous flap<sup>1</sup>. The vascular anatomy of rectus femoris needs to be fully understood to ensure its safe harvesting and proper function following reconstruction. Classical descriptions state the proximal arterial insertion into rectus femoris can be expected 10 - 15 cm from the anterior superior iliac spine (ASIS)<sup>2</sup>. Our aim was to investigate these anatomical figures.

**Materials and Methods:** Dissection of 20 embalmed thighs from 10 cadavers was conducted. Distance of arterial insertions into rectus femoris from the ASIS were recorded. This cohort was 60% male of median age 79. Statistical significance defined as  $p < 0.05$ .

**Results:** 5%, 50% and 45% of muscles demonstrated 1, 2 and 3 arterial insertions respectively. The mean distance of proximal, middle, and distal insertion was 13cm (SD 2.6), 15cm (SD 2.8), and 18cm (SD 4.1) respectively. There was no difference in the heights of vessel insertion between dual and tri vessel supplied muscles. There was a significant difference in mean proximal-distal difference between dual and tri vessel supplied muscles. These results were replicated when data were expressed as a % of cadaver height.

**Conclusions:** In contrast to classical literature we report a greater range of pedicle insertion heights. We believe these findings support both the safety, and diverse utility, of rectus femoris free flap harvest. Larger studies are required to validate these data, and support transition of these findings into clinical practice.

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### **Application of a novel epineural dissection technique for the treatment of liposarcoma with sciatic nerve involvement**

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**Introduction and Purposes:** The aim of this study was to evaluate the functional outcome and tumour control rate of patients with sciatic nerve involvement from liposarcomas of the posterior thigh, who underwent nerve preserving surgery utilising epineural dissection.

**Materials and Methods:** We included twenty-eight patients of mean age 58.36 (32 to 84) who were surgically treated with marginal resection and epineurectomy for liposarcoma with known sciatic nerve involvement between March 1997 and January 2010. Mean follow up was 52.8 months (1 to 100). All patients underwent preoperative staging and follow up at our Sarcoma Clinic, local and systemic recurrences were recorded; functional outcome was assessed by applying the Toronto extremity salvage score (TESS).

**Results:** Sciatic nerve involvement extended for 13–30 cm. Soft tissue reconstruction was required in 3 cases. Twenty-four patients underwent postoperative adjuvant radiotherapy. There was no local recurrence of disease within any of the patients. Three patients have died of unrelated causes. Compared to a group-matched cohort of 28 patients without sciatic nerve involvement there were no significant differences in local and systemic recurrence rate or postoperative survival.

**Conclusions:** We conclude that sciatic nerve preserving surgery is possible and safe when using a planned epineural dissection in large volume tumours encasing the sciatic nerve.

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## Clinical outcome of free vascularized fibular graft for reconstruction of large bone defect after tumor excision

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**Background:** Reconstruction of a large bone defect following tumor resection is a challenging issue in tumor surgery. Among various options available, free vascularized fibular graft is one of the best biological reconstructions that maintains physiologic bone metabolism and therefore can promise stable bone union. We reviewed the clinical outcome of reconstruction with free vascularized fibular graft (VFG) fixed with locking plate.

**Methods:** Retrospective review of medical record was done for 21 patients who underwent reconstruction of the bone defect with microsurgical vascular fibular graft after tumor excision. Median follow up period was 44.0 months. The median age of the patients at the time of surgery was 14.0 years old. (range, 9-63) Tibia (n=11) and femur (n=6) were the most common sites for the graft. Three cases were on humerus and one case was on radius. The mean bony defect was 12.4cm and the mean length of the harvested fibula was 20.1cm. All grafts were stabilized to its host bone with locking plates.

**Results:** All patients were free of disease at final follow up and no local recurrence was reported. Nineteen of 21 patients recovered preoperative range of motion after the surgery. All VFGs were transferred successfully. Bone union was achieved in 16 of 21 patients. Two patients required additional auto bone graft for nonunion, which eventually achieved bone union at final follow up. Stress fracture of the grafted fibula occurred in one patient, which was healed spontaneously with the support of locking plate.

**Conclusions:** Our data suggests that free vascularized fibular graft is a satisfactory option for reconstruction of massive bone defect after tumor resection.

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### Safe distance from osteosarcoma to bone cutting surface for wide excision

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**Purpose:** To achieve local control of sarcoma, tumor removal with wide surgical margin is important. Nevertheless, the concept of wide margin is ambiguous. The aim of this paper was to suggest safe distance from tumor to resection surface, focusing on bone tissue.

**Methods:** Among 238 patients who underwent surgeries for osteosarcoma for past eleven years, 166 patients with high grade osteosarcoma patients in the long bone were identified. In all, 197 osteotomized surfaces were finally analyzed. The bone margin distance was measured as the distance between the bone cutting surface and the tumor border from the pathologic report.

**Results:** Of 13 patients who had local recurrence, one patient experienced local recurrence on the bone cutting surface and the rest of local recurrences were from soft tissue margins. The prevalence of local recurrence at the bone cutting surface was 0.5% (1/197). There was no local recurrence at bone cutting surface when bone cutting was performed with the distance more than 2cm from osteosarcoma (0/149). For the bone cutting surface at the epiphysis or metaphysis of long bone, there was no local recurrence (0/28) regardless of the margin width from the tumor. In survival analysis by the distance of the bone margin, the 5-year survivals were 90% and 87% for the patients with less than 2 cm bone margin and more than 2cm bone margin, respectively. There was no statistical significant difference between two survival curves.

**Conclusion:** For the bone margin distance, 2 cm of bone margin is enough to prevent local recurrence. For the good responder of chemotherapy, pathological negative margin with less than 2 cm is sufficient for local control of bone cutting surface. Moreover, bone cutting through the epiphysis or metaphysis is safer than that through the diaphysis. In conclusion, when close bone cutting to the osteosarcoma has a significant effect on postoperative limb function, limb salvage surgery with narrow bone margin can be considered in carefully selected patients.

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### Giant cell tumor of bone and pregnancy

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**Introduction and Purposes:** Few previous articles reported that giant cell tumor of bone (GCTB) shows dramatic changes during pregnancy. Some researchers tried to prove the expression of estrogen and progesterone receptors on the tumor and suggested hormonal influence. However, conclusive evidence is lacking. Others focused on immunologic change during pregnancy. Although oncofetal antigens are similar to fetal antigens, none demonstrated expression of the antigens on the tumor. Therefore, it might be coincidental because affected patients are often of childbearing age when the tumors generally show a high incidence.<sup>1</sup> To find up causal relationship, we tried to investigate the comprehensive data on GCTB at pregnancy.

**Materials and Methods:** We retrospectively reviewed the medical records of patients diagnosed as occurrence or recurrence of GCTB during pregnancy and peripartum period. The Eastern Asian Musculoskeletal Oncology Group participated in this project.

**Results:** Five cases were analyzed, with a median age of 27 years; two had recurrent lesions. Although patients recognized symptom at median five gestational weeks (GW), radiologic evaluations were delayed by median 24 GW. All lesions showed Campanacci grade 3. For immediate treatment, two patients had caesarean section and one artificial abortion. In one patient who underwent surgery for a recurrent lesion, local relapse and pulmonary metastasis were identified seven months after operation. Median follow-up time was four years.

**Conclusions:** All lesions showed aggressive feature. We are collecting more cases through multi-national-multi-institutional cooperation and need detailed obstetrical information. Experimental studies related to hormonal and immunologic impact should be performed additionally.

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**Curettage as first surgery for bone giant cell tumor can be effectively performed by early-career orthopaedic surgeons**

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**Introduction and Purposes:** This study aimed to assess whether years of surgical practice and specialty in orthopedic oncology are associated with local recurrence rates, functional results, and complication rates following curettage of giant cell tumor of the bone (GCTB).

**Material and Methods:** We retrospectively reviewed the medical records of 203 patients who had been diagnosed with histologically confirmed extremity GCTB and had undergone curettage at a single institution between 1990 and 2013, with a minimum follow-up of 24 months. The curettage was performed by 21 surgeons who specialized in orthopedic oncology and 13 surgeons who did not. Patients were divided into three categories on the basis of the surgeon's years in practice, defined as the period from each surgeon's date of board certification to the date of each curettage: (1) Group 1: less than 10 years in practice, (2) Group 2: 10–19 years in practice, and (3) Group 3: 20 or more years in practice.

**Results:** The rate of local recurrence was 15.3% (31/203 patients). The median follow-up time was 84.2 months. Uni- and multivariate analyses revealed that years in practice and the specialty of orthopedic oncology were not associated with recurrence-free survival. Moreover, these two variables did not have a significant effect on functional results or complication rates.

**Conclusions:** Neither years of surgical practice nor specialty in orthopedic oncology had a significant effect on local recurrence rates, functional results, or complication rates. Thus, curettage for GCTB may be suitably performed as a first surgery by early-career fellowship-trained orthopedic oncologists.

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### Establishment of sarcoma cell lines

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**Introduction and Purposes:** Sarcomas represent a heterogeneous group of tumors, covering the entire age spectrum from children, adolescents and young adults to the elderly. Tumor diversity, intratumoral heterogeneity and partly chemoresistance of sarcomas require personalized therapy approaches and precision medicine to offer patient-oriented targeted therapy or immunotherapy based on the underlining molecular landscape of these tumors. The establishment of cell lines represents an ideal system for the testing of therapies, but can also be very useful for further research gaining insights into the biology of sarcomas.

**Material and Methods:** Currently we have six different sarcoma primary and cell lines in culture, respectively, clear cell sarcoma, dedifferentiated liposarcoma, extraskeletal mesenchymal chondrosarcoma, myxofibrosarcoma and synovial sarcoma. Tumor cells that can be further passed and survive the Hayflick limit are characterized in molecular biological and genetic details. To characterize the cells, growth curves, colony formit unit assays, cell cycle, CNV and mutation analyses are performed. STR analyses are performed for identification.

**Results:** Currently, the extraskeletal MesenchamI Chondrosacome is the most promising cell line that has been successfully characterized using the above methods.

**Conclusion:** Not all sarcomas have the ability to grow and become potential cell lines. However, important data can be generated during cultivation. The detection of cytokines and growth factors from the beginning of cultivation plays an important role in optimizing the medium. The ratio and timely separation of tumor cells from cancer associated cells also play an important role in cultivation and provide further information on the biology of tumors.

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### **Socioeconomic mortality risk factors in soft tissue sarcoma patients**

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**Introduction and Purposes:** In addition to influencing general population level health outcomes, socioeconomic factors are related to prognostic outcomes in patients with specific medical diagnosis such as cancers (Aizer 2013). By looking at a large national oncologic database we sought to evaluate how specific socioeconomic markers compare to traditional biomedical attributes in serving as risk factors for mortality outcomes in patients with soft tissue sarcomas.

**Materials and Methods:** Patient cases and associated all-cause mortality outcomes were taken from the SEER (Surveillance, Epidemiology, and End Results) oncologic database. Variables available for analysis included traditional biomedical attributes (sarcoma histology, tumor size, etc), in addition to socioeconomic variables such as education level and population density of counties patients live in, amongst other variables.

**Results:** Exploratory univariate analysis revealed patients identifying as unmarried, uninsured, black, and living outside of high tier socioeconomic areas were at risk for poor mortality outcomes. Multivariate analysis controlling biomedical risk factors indicated patients living outside of urban (hazard ratio [HR], 1.12) or high socioeconomic counties (HR, 1.12), as well as patients identifying as black (HR, 1.24) or unmarried (HR, 1.31), had significantly poorer mortality outcomes than their comparator groups.

**Conclusions:** While biomedical risk factors such as age and tumor size can aid in identifying patients at risk for poor outcomes in orthopaedic oncology practices, socioeconomic patient characteristics are also important when considering patients at risk for poor outcomes. Such information can aid in identifying patients in need of greater resources for purposes of health equity.

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## A case report on myopericytomatosis of the foot including molecular identification of a PDGFRB mutation

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**Introduction:** We report a case of myopericytomatosis arising around the left ankle of a 73-year-old man. This sarcomatous tumor has been described only a few times in worldwide literature.(1) Histologically, it is characterized by diffuse infiltration of innumerable discrete nodules composed of myoid cells that show a perivascular pattern. In immunohistochemistry, these cells are smooth muscle actin (SMA) positive. PDGFRB gene alterations have been reported in myopericytoma and myopericytomatosis.(1) PDGFRB is a receptor tyrosine kinase that is involved in signaling processes linked to vascular development.(3) Recently, the receptor has been successfully targeted in a child with refractory multiple infantile myofibromatosis, a condition also associated with PDGFRB mutation.(4)

**Purposes:** The aim of this report is to share the clinical presentation and to expand the spectrum of genetic findings.

**Materials and Methods:** MRI, biopsy, histology, immunohistochemistry, and targeted next-generation sequencing were employed. We used RegioSARC VEGF Panel to analyze the coding sequences of VEGFR 1-3, FGFR1, KIT, PDGFRB, RAF1, RET1, TIE2 and TP53. The patient was treated surgically with local excision for tumor mass reduction, as wide resection was impossible a priori based on the delicate anatomical region with important structures in close proximity.

**Results:** Genetic analysis revealed a missense mutation of PDGFRB [p.W566R (c.1696 T > C), exon 12]. Surgical excision with R2 margins led to local disease control (1 year follow up).

**Conclusions:** PDGFRB alterations seem to play a pathogenic role in myopericytic lesions and are a shared feature of myopericytoma and myopericytomatosis. Currently, myopericytomatosis is best treated surgically, but there is growing evidence that pharmaceutical targeting of PDGFRB may be beneficial.

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### Total femur replacement with the MUTARSTM System in sarcoma patients - A systematic analysis of prosthetic failure modes and associated risk factors

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**Background:** Femur is the most frequent localization of bone sarcomas. Resection of the whole bone and reconstruction with total femoral replacement can be necessary in patients (PTS) with locally advanced tumors, however little is known about failure modes of this rare reconstruction method and possible risk factors.

**Methods:** We performed retrospective analyses of 31 PTS with primary malignant bone or soft tissue tumors, who underwent resection of total femur and reconstruction with MUTARSTM at our department 1998-2017. Failure modes were classified according to Henderson et al. Non-parametric analyses were performed with the Mann-Whitney-U-Test. Implant survival was calculated with the Kaplan-Meier method and compared with log-rank test.

**Results:** Mean follow-up amounted to 54 mos. (1-235). 17 PTS (55%) developed a prosthetic failure after a mean interval of 32 mos. (1-155). Implant survival probability was 74% after 1 and 35% after 5 yrs. Extra-articular resections ( $p < 0.001$ ), age  $> 40$  yrs ( $p = 0.029$ ) and BMI  $> 25$  ( $p = 0.001$ ) were associated with higher risk for prosthetic failure. Amputation was necessary in 7 PTS after a mean interval of 13 mos. (0-58) after first implant failure. The most common failure mode was infection (9 PTS). Extra-articular resections ( $p < 0.001$ ), BMI  $> 25$  ( $p = 0.007$ ), age  $> 40$  yrs ( $p = 0.009$ ), chemotherapy ( $p = 0.028$ ) and pathological fracture ( $p = 0.040$ ) were significantly associated with higher infection probability. Radiotherapy ( $p = 0.193$ ), reconstruction length ( $p = 0.716$ ) and duration of primary surgery ( $p = 0.689$ ) had no influence.

**Conclusion:** Total femoral reconstruction is a feasible alternative to primary amputation in PTS with locally advanced sarcomas. Older and overweight PTS and PTS undergoing chemotherapy or extra-articular resections need to be informed about the high risk of prosthetic failure. Infection was the most common failure mode in our cohort. However, risk factors we identified in our analysis can hardly be influenced by the treating physicians.

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### Differences in the Elixhauser and Charlson Comorbidity Indices in patients with malignant bone cancer

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**Introduction:** Patients with orthopedic malignancies are at increased risk for surgical complications compared to the general population. The Elixhauser and Charlson Comorbidity indices aggregate the effect of disease burden on clinical prognosis. We assess their applicability for risk assessment in patients with bone cancer and compare their predictive values.

**Methods:** The Nationwide Inpatient Sample 2001-2013 database was queried for all cases of malignant bone cancers using ICD-9 codes. Outcomes of interest included mortality, prolonged length of stay, non-routine discharge (defined as a destination other than the patient's home), and thromboembolic events. Secondary analysis was completed on subgroups of patients undergoing excision procedures. Indices were compared using receiver operating characteristic (ROC) curves and the areas under the curve (AUC).

**Results:** A weighted total of 110,442 patients were included in this study. The ECI was a better predictor of having a pulmonary embolism (PE) compared to the CCI (AUC=0.814 vs. 0.637) in the total population. On subgroup analysis, the ECI had good predictive value for non-routine discharge in patients undergoing excision procedures of the upper limb, the clavicle, scapula, or thorax, and the lower limb (AUC=0.734, 0.773, and 0.649, respectively). The ECI had excellent predictive value in measuring risk of PE in patients in both the surgical and non-surgical cohorts (AUC=0.809 and 0.814). The ECI and CCI were also good predictors of mortality in the total population (AUC=0.718 and 0.739).

**Conclusions:** The ECI is superior to the CCI in predicting risk of most complications in this study. These indices may have differences in clinical utility and highlight the importance of addressing patient comorbidities prior to treatment of cancer of the bone.



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### **Risk factors for venous thromboembolism in patients with malignant bone cancer**

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**Introduction:** Venous thromboembolism (VTE) represents a major cause of morbidity and mortality in patients with malignant bone cancer. The objective of this study is to evaluate predictive risk factors for VTE using a national dataset.

**Methods:** The Nationwide Inpatient Sample (NIS) database 2001-2013 was queried for patients with malignant bone cancer using ICD-9 codes. Surgeries were defined using ICD-9 procedural codes, defining excision of lesion of bone. Data was weighted using NIS provided trend and discharge weights. Chi square analysis was performed to determine significant predictors of VTE, including location. Binary logistic regression was then used to account for demographic and other significant variables.

**Results:** A total of 69,323 patients were included for final analysis. Incidence of VTE was 1,630 (2.4%). Logistic regression showed that being female was protective against VTE (OR=0.77), while patients age 30-50, 51-60, and  $\geq 61$  were associated with increased risk (OR=1.61, 2.24, and 2.73, respectively). Additionally, increased risk of VTE was seen in patients who were paralyzed (OR=2.31), had metastatic cancer (OR=2.03), hypercoagulability (OR=3.75), and pathologic fracture (OR=1.48). Secondary analysis revealed that tumors of the clavicle, ribs, or sternum and short bones of the lower limb were associated with decreased likelihood of VTE, while tumors of the pelvis, sacrum, or coccyx were associated with increased likelihood of VTE (OR=0.56, 0.29, and 1.42, respectively). No other excision procedures were related to VTE, and there were no racial differences in our analysis.

**Conclusions:** While the rate of VTE remains small, the potentially devastating effects make identification of risk factors paramount. Patients age 30 and over, along with patients who had tumors of the pelvis, sacrum, or coccyx and those paralyzed, with metastatic disease, hypercoagulability, and a pathologic fracture were at increased risk of VTE in our analysis.

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## Predictors of outcomes after orthopaedic tumor resection: an analysis of 14,767 cases from a national database

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**Background:** Resection of bone and soft tissue tumors has lowered cancer-related mortality rates in orthopaedic patients but is not without risk. These patients are often surgically and medically complex and consequently have relatively high rates of complications, length of stay, and readmission. To date, data on the relationship between the location of tumor surgery are lacking. There is also a paucity of large, nationally sampled data on predictors of complications specific to orthopaedic tumor surgery.

### Questions/Purposes:

1. What are the complication rates after tumor resection in orthopaedic patients?
2. What are the significant predictors of postoperative complications after orthopaedic tumor surgery?
3. Is there a relationship between location of tumor surgery and outcomes?

**Patients and Methods:** A retrospective cohort study was conducted using The American College of Surgeons National Surgical Quality Improvement Program database (NSQIP) to identify bone tumor resections performed between 2005 and 2014. Resections were subdivided by location into upper extremity and shoulder, lower extremity and hip, and spine. Chi-square and multivariate logistic regression were used to identify significant predictors of complications, including 30 day mortality, wound disruption, superficial, and deep surgical site infections, and bleeding. Complications were also grouped into 5 categories: wound, hematologic, respiratory, cardiac, and renal. Analysis was performed on both individual and grouped complications.

**Results:** After search criteria were applied, 14,767 procedures involving bone tumors were identified. 4,659 (31.6%) involved the upper extremity or shoulder, 7,503 (50.8%) involved the lower extremity or hip, and 2,605 (17.6%) involved the spine. In addition to identifying significant predictors for each complication, analysis revealed that tumor procedures of the lower extremity or hip were significantly associated with increased risk of superficial surgical site infection (OR 3.89, 95% CI 1.49-10.15), deep surgical site infection (OR 8.43, 95% CI 1.73-41.01), any wound complication (OR 4.35, 95% CI 1.91-9.94). Tumor procedures of the spine were associated with increased risk of deep surgical site infections (OR 6.52, 95% CI 1.04-40.93) and any wound complication (OR 2.59, 95% CI 1.00-6.67). Procedures of the upper extremity and shoulder were not significantly associated with any complication.

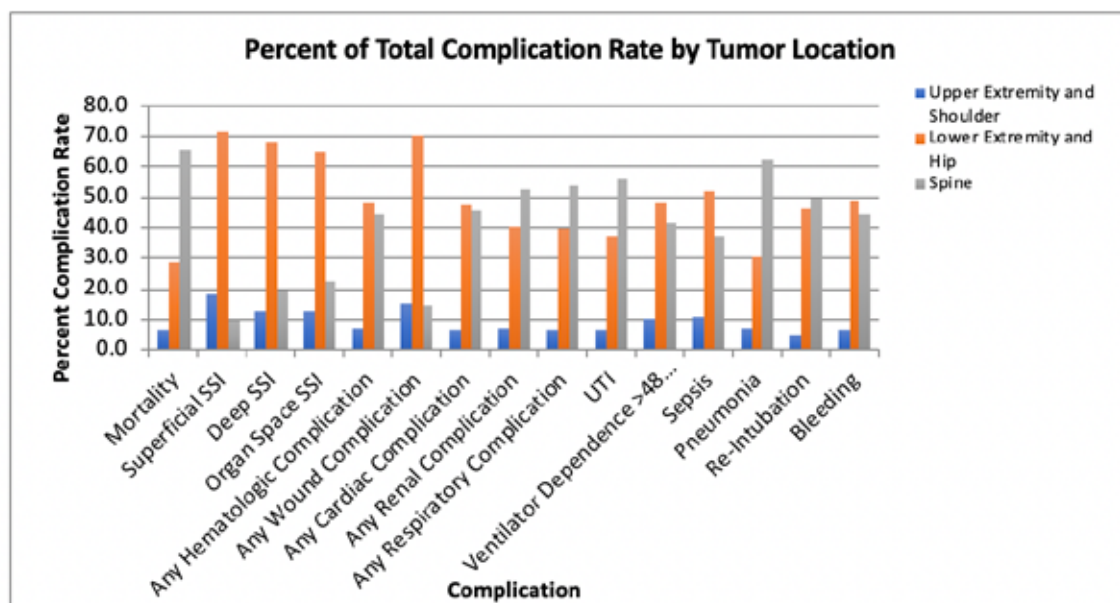
**Conclusions:** Predictors of outcomes after bone and soft tumor resection varied based on complication. Notably, procedures of the lower extremity, hip, and spine were found to be significant predictors of wound complications and surgical site infections. Upper extremity and shoulder procedures were not associated with any increased complication risk. Identification of these perioperative risk factors may allow clinicians to plan accordingly and optimize patient care, but further research in the form of a case-control study may be able to establish a causal relationship.

Table 1: Significant Predictors of Complications after Bone and Soft Tumor Resection Surgery (p<0.05)

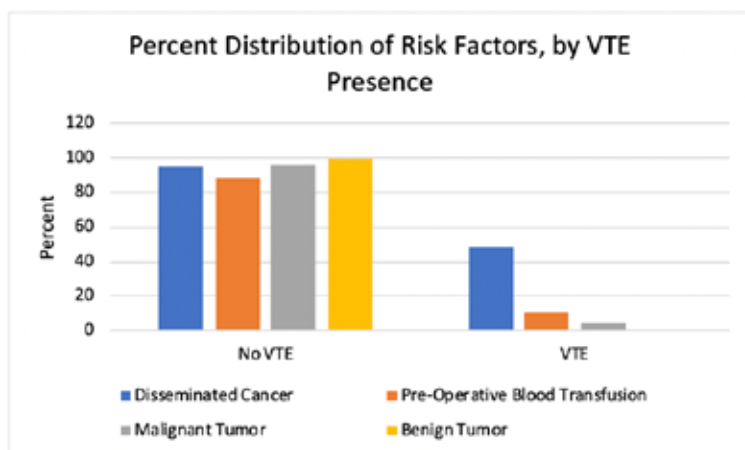
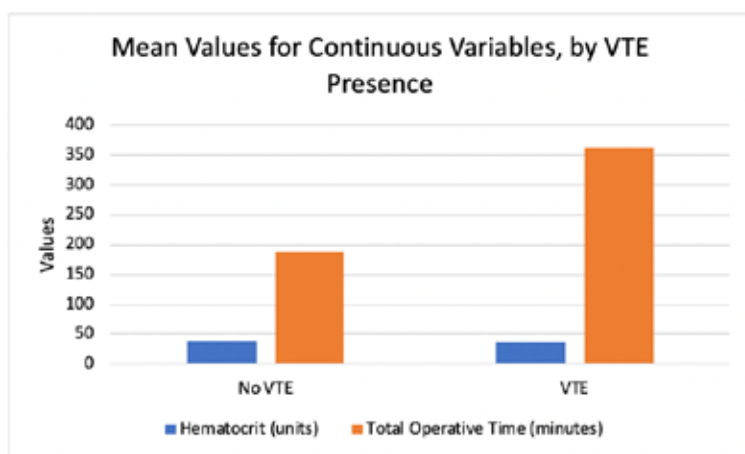
Complication	Predictors	OR (95% CIa)
Death	Female	0.45 (0.21-0.99)
	Central Nervous System Tumor	2.64 (1.02-6.88)
	Disseminated Cancer	4.78 (2.13-10.76)
	Dyspnea	2.55 (1.06-6.1)
	Impaired Functional Status	8.13 (3.75-17.64)
	Prior Operation within 30 days	4.07 (1.27-13.07)
	Steroid Use	3.95 (1.72-9.07)
Superficial SSIIb	Obesity	1.61 (1.21-2.15)
	Recent Weight Loss	2.49 (1.19-5.23)
	Systemic Sepsis	3.47 (1.75-6.88)
	Radiation History	2.69 (1.53-4.75)
	Tumor of Lower Extremity and Hip	3.89 (1.49-10.15)
Deep SSI	Female	0.53 (0.31-0.92)
	Radiation History	3.35 (1.34-8.4)
	Previous PCI	2.75 (1.17-6.47)
	Paraplegia	4.25 (1.26-14.33)
	Open Wound	3.04 (1.42-6.51)
	Tumor of Lower Extremity or Hip	8.43 (1.73-41.01)
Bleeding Complication	Tumor of Spine	6.52 (1.04-40.93)
	Age 65 and Over	1.6 (1.12-2.28)
	Female	0.69 (0.5-0.95)
	Obesity	1.43 (1.02-2)
	Systemic Sepsis	2.66 (1.27-5.57)
	Radiation History	2 (1.11-3.61)
	Hypertension requiring medication	1.43 (1-2.03)
	Dyspnea	0.37 (0.17-0.81)
	Disseminated Cancer	3.19 (2.09-4.86)
	Chemotherapy	4.18 (2.49-7.02)
Any Wound Complication	Female	0.69 (0.55-0.87)
	Obesity	1.47 (1.15-1.86)
	Systemic Sepsis	2.26 (1.21-4.2)
	Radiation History	2.95 (1.86-4.69)
	Paraplegia	2.26 (1.12-4.55)
	Open Wound	1.58 (1.02-2.46)
	Hypertension requiring medication	1.37 (1.06-1.78)
	Tumor of lower extremity or hip	4.35 (1.91-9.94)
	Tumor of Spine	2.59 (1-6.67)
Any Hematologic Complication	Age 65 and over	1.36 (1.01-1.84)
	Obesity	1.44 (1.09-1.91)
	Recent Weight Loss	3.12 (1.69-5.76)
	Systemic Sepsis	4.3 (2.41-7.7)
	Radiation History	2.36 (1.41-3.97)
	Hypertension requiring medication	1.49 (1.11-2.01)

	Disseminated Cancer	2.63 (1.81-3.83)
	Chemotherapy	3.58 (2.21-5.78)
	Bleeding Disorder	1.68 (1.01-2.78)

a Confidence Interval - b Surgical Site Infection - c Chronic Obstructive Pulmonary Disease - d PCI Percutaneous Coronary Intervention



SSI Surgical Site Infection



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## Epidemiology, incidence, and survival of liposarcoma sub-types: SEER database analysis

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**Background:** Liposarcomas are uncommon malignancies arising from fat cells that often develop in areas with deep soft tissue. Despite an incidence rate of 1:400,000, they remain the most common adult soft tissue sarcoma and based on the data in the Surveillance, Epidemiology, and End Results (SEER) Database, make up approximately 12.8% of all sarcomas. Sub-types of this disease include: well differentiated, Dedifferentiated, myxoid, round, mixed, pleomorphic, and fibroblastic. Different subtypes have different characteristics, but the rarity of these disease makes study on the unique personality of each subtype very difficult. One approach is to use large population based databases to study large numbers of these tumors. The purpose of this study was 1) to evaluate patient demographics, clinical behavior, incidence, and survival for liposarcoma sub-types and 2) to determine if there was a difference in the epidemiology, overall survival, and 5-year survival rate between the seven sub-types of Liposarcoma recorded in the SEER database.

**Methods:** The National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) database was used to search for patients diagnosed with all sub-types of Liposarcoma between 1973 and 2014. Patient demographics, tumor characteristics, incidence, and survival trends were all analyzed. Differences in the epidemiology, overall survival, 5-year survival rate, and incidence were also analyzed using ANOVA statistical test, a Chi-squared analysis, and pairwise tests with correction of multiple factors with the Holm-Bonferroni procedure. Significant differences were based on a  $p < 0.05$ .

**Results:** There were a total of 11,680 patients were identified in the SEER database. The highest rate of metastasis was seen in dedifferentiated subtype (11.9%). Dedifferentiated and pleomorphic subtypes had the worst overall survival with a 4.9 and 5.3 years respectively. Myxoid and Well dedifferentiated liposarcoma had the highest rate of 5 and 10-year survival. The presence of higher grade tumor, age > 35 years, and metastasis at presentation were significantly correlated with survival months ( $p < 0.05$ ). There were no significant differences in the survival was found between gender or race between all of the subtypes ( $p > 0.05$ ).

**Conclusion:** This study represents a population database study on liposarcoma demonstrating that useful information can be gleaned from population database analysis for rare tumors. The results help to identify significant differences between the subtypes, allowing a better understanding of the personality of each subtype. By highlighting the difference between these subtypes, such as differences in metastatic rate and 5-year survival, this study helps the treating physician by allowing a more informed understanding of the expected behavior of each subtype, which can be critical for decision-making in patient care.



Table 1: SEER Demographic and Clinical Data

Variable	Well Differentiated	Myxoid	Round Cell	Pleomorphic	Mixed	Fibroblastic	De-Differentiated	P value
Total Number	4,298	3,241	304	1,203	453	17	2,164	
Median Age (years)	63	50	50	66	56	36	66	<0.001
Race								<0.001
- Caucasian	3,525 (82.0%)	2,694 (83.1%)	246 (80.9%)	1,004 (83.5%)	374 (82.6%)	15 (88.2%)	1,826 (84.4%)	
- African American	346 (8.1%)	309 (9.5%)	32 (10.5%)	111 (9.2%)	43 (9.5%)	1 (5.9%)	134 (6.2%)	
- Other	381 (8.9%)	210 (6.5%)	22 (7.2%)	85 (7.1%)	31 (6.8%)	1 (5.9%)	195 (9%)	
Gender								<0.001
- Males	2,551	1,895	168	714	279	6	1,448	
- Females	1,747	1,346	136	489	174	11	716	
- Male to Female Ratio	1.5	1.4	1.2	1.5	1.6	0.5	2.0	
% Female	40.6	41.5	44.7	40.6	38.4	64.7	33.1	
Metastases	131 (3.0%)	127 (3.9%)	26 (8.5%)	67 (5.6%)	25 (5.5%)	0 (0%)	201 (0.9%)	<0.001
Grade								
1	4,095	828	15	44	79	4	168	
2	60	873	42	71	70	6	188	
3	31	242	89	316	101	1	673	
4	20	171	84	416	94	0	843	
Not reported	92	1,127	74	356	109	6	292	1,061

a Not otherwise specified

Table 2: SEER Liposarcoma Survival Rates based on Kaplan-Meier Analysis, by Subtype

Subtype	1-Year Survival Rate	2-Year Survival Rate	5-Year Survival Rate	10-Year Survival Rate	Overall Survival (Years) Median, (IQRa)
Well Differentiated	0.958	0.924	0.823	0.669	15.8 (7.4-26.3)
Myxoid	0.931	0.880	0.764	0.636	17.8 (5.5-N/A)
Round Cell	0.811	0.719	0.549	0.467	7.5 (1.7-25.3)
Pleomorphic	0.817	0.706	0.512	0.348	5.3 (1.7-16.2)
Mixed	0.872	0.773	0.628	0.498	9.7 (2.3-23.2)
Fibroblastic	0.941	0.941	0.941	0.753	NAb
De-differentiated	0.816	0.703	0.494	0.321	4.9 (1.6-14.0)

a Interquartile Range, b not applicable due to failure of mortality to fall below 0.500

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### Analysis of clinical cases of CT-guided conformal cryoablation treatment of painful osteolytic bone metastases

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**Objectives:** To assess the safety and local efficacy of CT-guided conformal cryoablation in treating osteolytic bone metastases.

**Methods:** Forty-eight cases of patients with osteolytic bone metastases admitted to our hospital from September 2009 to September 2017 (all had been pathological diagnosed, assigned a visual analogue scale (VAS) pain score greater than 4, and were without any pain relief after treatment with bisphosphonate drugs for two months) were retrospectively analyzed. Of these cases, 26 were male, and 22 were female. The average age was  $60.4 \pm 14.0$  years (range 29-83 years). The cases had a total of 67 lesions. Routine blood tests, imaging and examinations were conducted preoperatively, and a surgical plan was developed. Then, CT-guided conformal argon-helium cryoablation therapy was performed. All patients and their guardians signed the informed consent agreement. Enhanced CT examinations were performed immediately after treatment and two months after treatment to assess treatment effectiveness and complications. The patients were respectively preoperatively evaluated and assigned a VAS pain score one month and two months after treatment, and these values were then statistically analyzed.

**Results:** Within 2 months, no local recurrence was observed, and the treated lesions exhibited no noticeable intensification on the enhanced CT images. In four patients, new metastatic lesions occurred but without serious complications. The preoperative average pain score was  $7.23 \pm 1.43$  and decreased to  $4.11 \pm 0.77$  one week after treatment and  $2.34 \pm 0.94$  two months after treatment.

**Conclusion:** CT-guided conformal cryoablation therapy of osteolytic bone metastases completely covers the lesion by arranging the cryoprobes according to the lesion's location and shape to achieve good local effectiveness with a rather high level of safety.

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### **Osteosarcoma of the pelvis from the Bone Tumor Registry in Japan**

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**Introduction and Purposes:** Osteosarcoma of the pelvis is a particularly difficult to treat. The aim of this study was to describe the nationwide statistic of osteosarcoma of pelvis in Japan by analyzing data from the Bone Tumor Registry in Japan, and to identify features predictive of a poor outcome.

**Materials and Methods:** We identified 150 patients with high grade osteosarcoma arising in the pelvic bone using the Bone Tumor Registry during 2006-2015. The mean age of those was 55 years (9 to 88). Forty patients had metastases at the time of presentation. For local treatment of pelvis, surgical resection was performed for 55 patients and carbon iron radiotherapy for 39 patients.

**Results:** Overall survival at two years was 47.9% for all patients and 58.2% for localized patients. Factors associated with a poor outcome were metastases at diagnosis, older than 60 years, larger than 12cm, without surgical resection, and without chemotherapy. There was the significant association between absence of surgical resection and metastases at diagnosis, older than 60 years, or a diameter >12cm. Overall survival at two years was 72.5% for the patients with surgical resection, 60.4% for the patients with carbon iron radiotherapy, and 8.5% for others.

**Conclusions:** The poor outcome of pelvic osteosarcoma is attributed to both patient demographics including metastasis at presentation, older patient age, and large tumor size and treatment modalities which depends on patient demographics. The patients who treated with surgical resection does not have poor outcome. Carbon iron radiotherapy could be a choice for unresectable pelvic osteosarcoma.

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## **Tumor-induced osteomalacia of the sole presenting as a crippling illness in a postmenopausal woman: a case report**

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**Objective:** Tumor-induced osteomalacia is a rare and intriguing paraneoplastic syndrome leading to hypophosphatemia and osteoporosis. The clinical symptoms are usually nonspecific, such as bone pain, fractures, muscle weakness and fatigue, which makes the diagnosis elusive.

**Methods:** We describe a case of a postmenopausal woman with crippling bone pain and weakness, who had been underdiagnosed as simple osteoporosis and osteoarthritis for three years even with fine-needle aspiration biopsy of the offending lesion in her sole.

**Results:** Hypophosphatemia of 0.51mmol/L (normal range 0.81-0.145mmol/L) with normal serum calcium and PTH were noted. Serum FGF-23 was tested and found elevated (193.4 pg/mL [NR, 10–50]). MRI for her right sole showed a 2×3 cm<sup>2</sup> soft tissue mass with distinct boundary. After surgical removal of the tumor in her sole, we observed an immediate relief of her symptoms, with VAS score improved from 5/10 preoperatively to 2/10 five days postoperative. The serum phosphate increased almost simultaneously to 0.71mmol/L on surgical removal, and it became normal two days postoperative. Histology showed a phosphaturic mesenchymal tumor. And the immunohistochemistry (IHC) showed positive expression of CD56, negative expression of CD34, PCK, SMA, Des, CD99, D2-40, NSE, and the positive rate for Ki67 was 1-5%. The patient returned to normal life as a housewife two months later, and there were no signs of recurrence at the one-year follow-up.

**Conclusions:** While pain from osteoarthritis and osteoporosis is very common in postmenopausal women, doctors should never overlook history-taking and physical examination, as well as the possible diagnosis of Tumor-induced osteomalacia.

Key words: fine-needle aspiration biopsy, hypophosphatemia, phosphaturic mesenchymal tumor, oncogenic osteomalacia, osteoporosis

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## Experience of interstitial permanent I(125) brachytherapy for extremity soft tissue sarcomas

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**Aims:** Soft tissue sarcomas are uncommon, but relatively aggressive tumours. Although surgical resection remains the primary therapeutic modality for all localised tumours, brachytherapy combined with function-preserving excision is a popular treatment for extremity soft tissue sarcomas. The objective of this study was to evaluate the effect of interstitial permanent brachytherapy using I(125) seeds in patients undergoing the combined modality in the management of soft tissue sarcomas at our institution.

**Materials and Methods:** Between January 2007 and January 2012, 110 adult patients aged 18-86 years (median = 44 years) with extremity soft tissue sarcomas and who underwent interstitial permanent brachytherapy as part of the local treatment were included in this study. Treatment included wide local excision of the tumour and brachytherapy using a permanent I (125) implantation. Complications were assessed in terms of wound complication and peripheral nerve damage.

**Results:** After a median follow-up of 43.7 months, the local control, disease-free survival and overall survival for the entire cohort studied were 74, 54 and 77%, respectively. The actual rates of wound complications requiring reoperation and nerve damage were 4.5 and 1.8%, respectively.

**Conclusions:** We conclude that interstitial permanent brachytherapy with I(125) after function-preserving surgery results in a satisfactory outcome in patients with extremity soft tissue sarcomas and the complication rate is low.

**Keywords:** Extremity; I(125); interstitial brachytherapy; radiotherapy; soft tissue sarcoma

2597

## **Surgical management of metastatic lesions of the proximal femur with pathological fractures using intramedullary nailing or endoprosthesis replacement**

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**Introduction and Purposes:** Endoprosthesis replacement (EPR) and intramedullary nailing (IMN) are two most commonly applied surgical methods used to treat proximal metastatic lesions; however, the indications remain controversial. This study aimed to evaluate the clinical, functional and oncological outcomes of patients who underwent EPR compared to IMN for the treatment of proximal femur metastases to investigate the surgical indication.

**Materials and Methods:** 88 patients with proximal femur pathological fractures secondary to metastatic tumors admitted between January 2005 and December 2014 to West China Hospital were retrospectively studied. 57 patients were treated with EPR and 31 patients, with IMN. Surgery time, blood loss, hospital stay, Musculoskeletal Tumor Society score (MSTS), survival, recurrence and complications were analyzed.

**Results:** The median follow-up period was 12.9 (3-98) months. The median survival time in EPR was 10.0 months and 7.5 months in IMN. Surgery time was  $142.6 \pm 22.7$  min in EPR group and  $98.7 \pm 19.5$  min in IMN group ( $P < 0.001$ ). Significantly less blood loss was observed in IMN group ( $345.2 \pm 66.4$  ml) than in EPR group ( $631.5 \pm 103.6$  ml;  $P < 0.001$ ). The median hospital stay in EPR group was 8 days and 5 days in IMN group ( $P < 0.001$ ). Local recurrence rate was 10.5% (6/57) in EPR group and 25.8% (8/31) in IMN group ( $P = 0.074$ ). Complication rates were 10.5% (6/57) in EPR group and 29.0% (9/31) in IMN group ( $P = 0.038$ ). MSTS score was higher in IMN compared with EPR at 6 weeks postoperatively ( $P < 0.001$ ), while EPR group demonstrated a higher score at 6 months postoperatively ( $P < 0.001$ ).

**Conclusions:** EPR has better functional outcomes and higher life quality with lower complication rates in the long term. IMN is best indicated for extremely limited patient's life expectancy.



2598

## Chondrosarcoma of the pelvis: surgical management options and outcomes of 41 cases

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**Background:** Treatment of chondrosarcoma of the pelvis is challenging for the orthopedic oncologists due to its low rates of survival and high rates of local recurrence. Therefore, we report on our investigation in a large series of 41 cases in our center, providing oncologic and functional outcomes of surgical approaches to chondrosarcoma.

**Methods:** A retrospective study was performed in 41 patients with localized pelvic chondrosarcoma initially surgically treated in our hospital between 2007 and 2015. Of these 41 patients, 23 were male and 18 were female, and the average age at initial operation was 26.48 (15-45) years. The median duration of follow-up was 5 (3-10) years.

**Results:** The number of patients with grade-1 chondrosarcoma, grade-2, grade-3 and grade-4 (undifferentiated chondrosarcoma) are 22, 10, 2 and 7 respectively. Hemipelvectomy was performed in 13 patients to achieve local tumor control and limb-salvage procedure in the other 28 patients. 13 patients (14%) had local recurrence and 11 (10%) had distant metastases. 25 patients (69%) were alive with no evidence of disease, 10 (20%) had died of the disease, six (9%) had died of unrelated causes, and one (2%) was alive with disease at the time of the final follow-up. Inadequate wide surgical margin correlated with local recurrence ( $p < 0.001$ ). High-grade chondrosarcoma correlated with poor overall survival ( $p < 0.001$ ). All patients that underwent a limb-salvage procedure could walk in the final follow-up, with a mean functional score of 77% (the system of Musculoskeletal Tumor Society).

**Conclusions:** Adequate surgical margin of pelvic chondrosarcoma may lead to longer survival time. Tumor grade is highly correlated with overall or disease-free survival.

Keywords: Pelvis; chondrosarcoma; survival; hemipelvectomy; limb-salvage; surgical margin.

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## Surgical options and outcomes for pelvic bone metastasis

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**Background:** Treatment of pelvic bone metastasis is challenging and controversial. This study aimed to report surgical options and outcomes.

**Methods:** A retrospective study was performed in 27 patients (15 male and 12 female) with pelvic bone metastasis treated in our hospital between 2004 and 2015. The average age at surgery was 60.5 (16-84) years. Surgery were planned based on location of the lesion, metastasis of other organs and general conditions of the patients. Group A (n=9) with isolated weight-unbearing metastasis (region I or III), good general conditions and no vital organ metastasis underwent en bloc resection and bone cement implantation. Group B (n=5) with multiple metastasis and poor general conditions underwent I125/bone cement implantation following curettage. Group C (n=13) with isolated weight-bearing metastasis (region II) underwent hemipelvectomy with reconstruction. Radiological, VAS, MSTs and SF-36 were analyzed.

**Results:** The median follow-up was 25 months. The mean survival for Group A, B and C was 37, 9 and 30 months, respectively. The mean pre-, postoperative and 6-month postoperative VAS for Group A was 8.4, 5.4 and 4.2. For Group B, 8.7, 5.2 and 5.0. For Group C, 9.1, 5.0 and 4.5. The mean postoperative and 6-month postoperative MSTs for Group A was 22.2 and 21.5. For Group B, 16.7 and 18. For Group C, 20.05 and 23.3. The mean pre-, postoperative and 6-month postoperative SF-36 for Group A was 35.1, 75.5 and 68.0. For Group B, 20, 60.5 and 50. For Group C, 25.45, 86.2 and 88.0. Significant differences were noted for VAS and SF-36 respectively, between pre- and postoperatively.

**Conclusions:** Surgical options based on location of metastasis, presence of vital organ metastasis and general conditions of the patients could yield good functional outcome and better quality of life.

2600

**Effects of mechanical loading on the degradability and mechanical properties of the nanocalcium-deficient hydroxyapatite-multi (amino acid) copolymer composite membrane tube for guided bone regeneration**

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**Introduction and Purposes:** This study focuses on a novel membrane tube for GBR, which was prepared by a nanocalcium-deficient hydroxyapatite-multi(amino acid) copolymer (n-CDHA-MAC) composite.

**Methods:** The biomechanical strength and degradability of this membrane tube under mechanical loading after immersion in phosphate-buffered solution were investigated to evaluate the effects of mechanical loading on the membrane tube. The membrane-tube group with no mechanical loading and femora bone were used as controls.

**Results:** The compressive strength and bending strength of n-CDHA-MAC membrane tubes were  $66.4 \pm 10.2$  MPa and  $840.7 \pm 12.1$  MPa, which were lower than those of the goats' femoral bones ( $69.0 \pm 5.5$  MPa and  $900.2 \pm 17.3$  MPa), but there were no significant ( $P < 0.05$ ) differences. In the in vitro degradability experiment, all membrane tubes were degradable and showed a surface-erosion degradation model. The PH of solution fluctuated from 7.2 to 7.5. The weight and mechanical strength of loaded tubes decreased more quickly than nonloaded ones, with significant differences ( $P < 0.05$ ). However, the strength of the loaded group after degradation achieved  $20.4 \pm 1.2$  MPa, which was greater than the maximum mechanical strength of 4.338 MPa based on goat femoral middle stationary state by three-dimensional finite-element analysis.

**Conclusions:** n-CDHA-MAC membrane tubes have good biomechanical strength during degradation under mechanical loading. Therefore, this membrane tube is an ideal GBR membrane for critical size defects of long bones in goats for animal experiments.

2601

### Analyzing the behavior of a porous nano-hydroxyapatite/polyamide 66 (n-HA/PA66) composite for healing of bone defects

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**Introduction:** The aim of this study was to analyze the behavior of the porous nano-hydroxyapatite/polyamide 66 (n-HA/PA66) composite grafted for bone defect repair.

**Materials and Methods:** Biological safety of the porous n-HA/PA66 composite, a cytotoxicity test, sensitivity test, pyrogen test, and a hemolysis test were carried out. Macroscopic observations and radiological, histological, and scanning electron microscope analysis based on the rabbit models of tibia defects with grafted porous n-HA/PA66 composite were conducted. And a retrospective review was performed for 21 patients treated with porous n-HA/PA66 composite grafts following bone tumor resection.

**Results:** The biological safety experiments revealed that porous n-HA/PA66 composite had no cytotoxicity, no sensitization effect, no pyrogenic reaction, and that its hemolysis rate was 0.59% (less than 5%). In the animal experiments, density of new bone formation was similar to the surrounding host bone at 12 weeks. After 26 weeks, the artificial bone rebuilt to lamellar bone completely. In the clinical study, no wounds issues or fractures. At a mean follow-up of 5.3 years, the mean Musculoskeletal Tumor Society's (MSTS) 93 score was 29.3 points (range: 28-30 points) and mean radiopaque density ratio was  $0.77 \pm 0.10$ . The radiologic analysis showed that porous n-HA/PA66 composite had been completely incorporated with the host bone about 1.5 years later.

**Conclusion:** In conclusion, this study indicated that the porous n-HA/PA66 composite had biological safety, and good biocompatibility, osteoinduction, and osseointegration. Thus, the porous n-HA/PA66 composite is an ideal artificial bone substitute and worthy of promotion in the field.

**Keywords:** artificial bone materials; biomaterial; bone defects healing; bone grafting; porous n-HA PA66 composite (n-HA/PA66)

2602

## Total ulna replacement with a 3D printed custom-made prosthesis after en bloc tumor resection

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**Purpose:** Primary malignancy with extensive involvement of the ulna is a treatment challenge. The aim of this study was to describe a novel limb-salvage technique after en bloc ulna tumor resection, and the early clinical/functional outcome of a patient.

**Methods:** A 17-year-old male with osteosarcoma involving 4/5 of the left ulna was admitted in our center. Due to his favorable response to neoadjuvant chemotherapy, one-stage total ulna replacement with 3D-printed custom-made prosthesis was prepared. The whole procedure took 4 h, and intra-operative blood loss was 300 ml. Postoperative pathology revealed conventional osteosarcoma with extensive degeneration and necrosis (>90%), and the margin was clear.

**Results:** At 12 months after surgery, the patient was disease free. The function of limbs was almost completely restored. And there was no evidence of recurrence, dislocation or instability in the X-ray.

**Conclusions:** With favorable chemotherapy and 3D printing technique, limbs might be saved even in some extreme conditions.

Keywords: limb salvage, 3D printing, osteosarcoma, total ulna replacement, function

2603

## Total femoral prosthesis replacement following resection of femoral malignant tumors

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**Background:** The essential factor for the good functional outcome after total femoral prosthesis replacement (TFR) was the preservation of muscles around the femur. Patients with extensive muscles invasion usually means a wide surgical resection and less preservation of muscles. Rectus femoris is important to the stability of the prosthesis. We studied the interrelation between the tumor invasion the rectus femoris and the functional outcome after TFR.

**Methods:** Between 2010 and 2017, 14 patients with a mean age of 44.8 years were treated for femur tumor with TFR. We categorized the cases into 2 groups: group A (with rectus femoris invasion) and group B (without rectus femoris invasion). Outcome was evaluated by gait analysis, Musculoskeletal Tumor Society Score (MSTS) and Harris hip score (HHS), and complications, by the ISOLS method modified in 2014.

**Results:** The average MSTS and HHS score of group A was  $17.6 \pm 3.1$ ,  $55.38 \pm 13.30$ , whereas the average score of group B was  $23.0 \pm 4.8$ ,  $80.17 \pm 6.24$ . There was significant difference between the groups in MSTS ( $p = 0.02$ ;  $< 0.05$ ) and HHS ( $p = 0.001$ ;  $< 0.05$ ). The group without rectus femoris invasion also achieved better limb function (supporting and gait) and active ROM ( $p < 0.05$ ).

**Conclusions:** Patients treated with total femur resection and TFR, which without rectus femoris invasion had a better limb function, and greater active hip ROM than those who with.

Keywords: Femur, Tumor, Total femoral prosthesis replacement, Limb-salvage, rectus femoris invasion



2604

## Total talar replacement with a novel 3D printed modular prosthesis for tumors

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**Purpose:** Widely accepted surgical reconstruction for tumors of the talus is arthrodesis, which may associate with poor limb functions. The aim of this study was to present a novel reconstruction with ankle function preserved after en bloc talus tumor resection.

**Method:** A 43-year-old female with mesenchymal sarcoma of the talus was admitted in our center. Total talar replacement with 3D-printed modular total talar prosthesis was prepared for reconstruction. The 3D-printed modular total talar prosthesis was designed exactly as the mirror image of the contralateral talus with complete filling of the sinus tarsi and subtalar joint space. The upper modular component of prosthesis was made of high molecular weight polyethylene (UHMWPE), and the lower component, titanium alloy. Pre-drilled holes in three directions were prepared for screw fixation of the subtalar joint.

**Result:** The patient underwent en bloc talus resection through anterior approach, followed by reconstruction with the 3D-printed prosthesis. The whole procedure took 2 h, and intra-operative blood loss was 50 ml. At the last follow-up our patient was disease free, and she could walk almost normally without any aid or pain. The Musculoskeletal Tumor Society (MSTS) score was 26/30. The American Orthopedic Foot and Ankle Society (AOFAS) score was 91/100. The range of motion for dorsiflexion and plantar flexion was 40 degrees. And no abnormalities were observed in the roentgenograph.

**Conclusion:** Total talar replacement with a 3D-printed modular prosthesis may be an effective procedure for patients with tumors of the talus as it could maintain ankle function.

**Keywords:** bone tumors, sarcoma, reconstructive surgery, high molecular weight polyethylene, limb salvage, en bloc resection

2605

## The effects of surgical treatment with chondroblastoma in children and adolescents in open epiphyseal plate of long bones

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**Background:** Chondroblastoma commonly originates in the epiphyseal plate of long bones. An aggressive curettage is recommended. However, it might jeopardize an open epiphyseal plate and incur limb shortening and deformity for the young patients. This study aims to explore influences on limb growth and development for aggressive curettage.

**Methods:** We retrospectively reviewed 18 cases of long bone chondroblastoma with open epiphyseal growth plate during March 2004 to October 2010 in our center. 7 females and 11 males with mean age of  $11.6 \pm 2.0$  years old were included. All patients were treated with meticulous intralesional curettage and inactivity with alcohol followed by bone grafts. All cases were followed up  $8.2 \pm 1.7$  years (5-11.5 years).

**Results:** All had no local recurrence and distance metastasis. The length of the affected limb was short,  $18.47 \pm 7.22$  mm (1.5-30 mm). There was no obvious relativity with tumor activity ( $p = 0.061$ ). Meanwhile, there were obvious relativity with the greatest dimension of the lesion (TGD) ( $P = 0.003$ ), the vertical dimension between edge of lesion and epiphyseal line (TVD) ( $p = 0.010$ ), and area ratio of lesion to local epiphysis (lesion/growth plate) ( $p = 0.015$ ). The MSTS93 (Revised Musculoskeletal Tumor Society Rating Scale 93) and SF-36 (Medical Outcomes Study 36-Item Short-Form Health Survey) had been significantly improved ( $p < 0.01$ ).

**Conclusion:** Managing of chondroblastoma located in open epiphyseal plate of a long bone with meticulous curettage, inactivity, and bone grafts can control tumor progression and recurrence effectively. Meanwhile, early detection and prompt surgical treatment intervention, which reduced significantly the tumor to influence limb growth and development, get encouraging limb function.

Keywords: Chondroblastoma, Epiphysis, Open epiphyseal plate, Limb-length, Children and adolescents

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### In vitro stress effect on degradation and drug release behaviors of basic fibroblast growth factor--poly(lactic-co-glycolic-acid) microsphere

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**Objective:** To study the degradation and basic fibroblast growth factor (bFGF) release activity of bFGF - poly(lactic-co-glycolic-acid) microsphere (bFGF-PLGA MS) under stress in vitro, including the static pressure and shearing force-simulating mechanical environment of the joint cavity.

**Method:** bFGF-PLGA MSs were loaded into self-made static pressure and shearing force loading instruments to study microsphere degradation and drug release experiments. Microsphere morphology, quality, and weight-average molecular weight of polymer were also analyzed.

**Results:** In the static pressure loading experiment, bFGF-PLGA MSs at different pressure were stable initially. The trend of molecular weight change, quality loss, and bFGF release was consistent. Meanwhile, microsphere degradation and bFGF release rates in the 4.0 MPa pressure loading group were faster than those in the normal and 0.35 MPa pressure loading groups. It was the fastest in the shaking flask group, showing a statistically significant difference ( $P < 0.0001$ ). In the shearing force loading experiment, there were no distinctive differences in the rates of microsphere degradation and bFGF release between experimental and control group. Meanwhile, microsphere degradation and bFGF release rates by shaking flask oscillation were obviously faster than those by shearing force only ( $P < 0.0001$ ).

**Conclusion:** There are significant bFGF-PLGA MS degradation and bFGF release due to interaction between extraction stress and time. Static pressure has a conspicuous influence on bFGF-PLGA MS degradation and release, especially at 4.0 MPa. The shearing force has a slight effect on bFGF-PLGA MS degradation and drug release. Shaking flask oscillation has a significantly distinctive effect.

**Keywords:** PLGA; basic fibroblast growth factor; drug release; microsphere; poly(lactic-co-glycolic-acid); stress

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## Clinical analysis of zoledronic acid and ibandronate in the treatment of metastatic bone disease

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**Introduction:** The aim of this study was to compare the efficacy and toleration of zoledronic acid and ibandronate in the treatment of metastatic bone disease.

**Methods:** We retrospectively studied 26 patients with metastatic bone diseases which were histological diagnosed between 2008 and 2011. 12 patients were in zoledronic acid group and 14 in ibandronate group. All of the patients were treated with 4mg zoledronic acid every four weeks, or 4 mg ibandronate for four consecutive days and then 4mg ibandronate every four weeks. The visual analogue scale (VAS), skeletal-related event (SRE), time to first SRE - T-SRE, bone turnover markers were monitored during the follow-up.

**Results:** Acute-phase (flu-like) reactions were recorded in zoledronic acid group. The pain of the Ibandronate group was palliated significantly compared to zoledronic acid group in the first month - VAS was significantly lower at the sixth month in both groups. There wasn't statistically significant for the change of bone turnover marker in the two groups. Ibandronate and zoledronic acid were similar in the parameter of SRE and T-SRE. Ibandronate was less affected the renal function compared to zoledronic acid seemingly, but there wasn't statistical significance ( $p > 0.05$ ).

**Conclusions:** Both of the two bisphosphonates have good therapeutic effect and tolerance. The adverse effect of Ibandronate is lighter than zoledronic acid. The loading dose administration of Ibandronate could rapid relief of metastatic bone pain than zoledronic acid, which may improve the quality of life better than zoledronic acid.

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### **Enchondroma and atypical cartilaginous tumor of the knee and osteoarthritis - Case series, literature review and management recommendation**

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**Introduction and Purposes:** Enchondromas (EC) of the knee are prevalent in 2-3% of the population in MRI-studies. For solitary enchondromas the risk of malignant transformation is reported between 1-4%. Radiologic signs accompanying increased risk of malignant transformation are cortical thickening, deep endosteal scalloping (>2/3 of the cortex) or permeative growth, peritumoral marrow edema and large size (more than 5-7 cm). Specific reports on risk of malignant transformation for this location and management recommendations for EC or atypical cartilaginous tumors (ACT) of the knee and osteoarthritis is lacking; we performed a retrospective case series to analyse treatment and outcome of patients with EC/ACT of the knee and osteoarthritis and a literature review.

**Materials and Methods:** We searched our database for patients with the diagnoses EC/ACT and osteoarthritis of the knee between 2005 and 2018. Diagnosis was confirmed by histopathologic investigation or typical radiologic findings.

**Results:** We retrieved 22 patients, f:m 15:7 with EC/ACT of the knee and osteoarthritis. In all but four total knee arthroplasty (TKA) was performed, whereof one navigated and one tumor-prosthesis after resection of high-grade chondrosarcoma. EC/ACT were treated with curettage alone (n=5), or curettage plus bone cement (n=6), tricalciumphosphate (n=3), autologous spongiosa (n=1) or allograft (n=1). Five enchondromas were not touched surgically. To last follow-up no progression in size or recurrent tumor was found.

**Conclusions:** Our results reflect the heterogeneous treatment procedures due to missing guidelines. To avoid intraarticular contamination in case of malignancy we recommend TKA without touching the lesion (navigated or standard implantation of TKA) for EC without radiologic signs of malignancy and radiologic follow-up; for EC/ACT with radiologic signs of malignancy we recommend biopsy according to tumororthopedic standards, histopathologic work-up and upon histologic result TKA +/- curettage of the EC/ACT.

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### Quantitative single photon emission computed tomography computed tomography for differentiation between enchondroma and grade I chondrosarcoma

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**Introduction and Purposes:** Although differentiation between central chondroid tumors is important, their parallelism makes it a diagnostic conundrum for clinicians and radiologists. Recent advances have allowed single photon emission computed tomography computed tomography (SPECT/CT) to measure radiotracer distribution quantitatively.<sup>1</sup> This study aimed to analyze the efficiency of quantitative SPECT/CT for differentiating grade I chondrosarcomas (CSs) from enchondromas.

**Materials and Methods:** Patients with enchondroma and CS in the long bones who had bone SPECT/CT between 2015 and 2018 were included.

**Results:** Fourteen out of 34 patients had CS. There was no significant difference in age and tumor size between the enchondroma and CS groups. Twenty-nine patients had whole body bone scan, and those with CS demonstrated significantly higher incidence of greater radionuclide uptake in the lesion than in anterior iliac crest. CS had a significantly higher incidence of hyperemia in blood pool image. Mean standardized uptake value (SUV) and maximum SUV (SUVmax) in CS were significantly higher than those in enchondroma. Median SUVmax was 13.55 (2.84-19.19) in enchondroma and 20.24 (10.86-78.1) in CS. The areas under receiver-operating characteristic curve (ROC) were 0.875 and 0.757 for SUVmax and mean SUV (SUVmean). In the pairwise analyses, the area was significantly greater in SUVmax than in SUVmean. We determined that the best cut-off point was 7.3 for SUVmean and 16.0 for SUVmax with which to maximize sensitivity and specificity. Sensitivity and specificity for SUV max and SUVmean were 85.7 and 75.0, and 78.5 and 70.0.

**Conclusions:** While it is still challenging to distinguish enchondroma and CS in the long bone, quantitative SPECT/CT might facilitate differentiation. Further studies should be mandatory.

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2614

## Treatment of limb-length discrepancy related to Ollier's disease: a systematic review of literature

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**Introduction and Purposes:** The management of limb deformity, shortening and bone defects in patients with Ollier's disease is a major challenge. Aims of this study were 1) to summarize and compare the different surgical treatments; 2) to evaluate the outcome and 3) possible prognostic factors

**Materials and Methods:** A systematic review of literature through 1998 to 2017 has been performed. Sixteen articles have been found: a total of 112 patients suffered limbs deformities because of Ollier's disease. They have been surgically treated with techniques that comprised osteotomies and external fixation, sometimes combined with intramedullary nails, epiphysiodesis or lengthening nailing. We investigated the bone healing index (HI), the distraction index (DI), the distraction time, the average length gained, the total treatment time and the complications.

**Results:** The mean average age at the time of first surgery was 12 years old. A total of 194 segments have been surgically treated, 15 of which in the upper limbs, the rest in the lower limbs. External fixation, circular or monolateral, is the most used technique. The Ilizarov external fixator has been used in 109 segments being the most frequently used device. Significant differences in terms of HI have been reported when the external fixation was combined with intramedullary nails. Epiphysiodesis or similar techniques were most frequently used in the past. Early consolidation, pathological fractures, joint stiffness and pin track infections are the most common complications.

**Conclusions:** Surgical implants and available techniques allowed complete correction of patients' limb-length discrepancy in most of the cases. The elongation of the affected limb, associated with correction of angular defects, was the only valid option. However, there is currently no standard consensus concerning the optimal surgical technique and implant.

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2615

### **Chondroblastoma: no recurrence with cryosurgery in long-term follow-ups**

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**Objective:** Chondroblastoma is a rare primary bone tumor of young people that typically arises in the ends of the long bones. It occurs most commonly in the second decade of life. Extended curettage must be considered for the primary treatment and adjuvant therapies are recommended to decrease the recurrence rate. Cryosurgery is a safe adjuvant technique applied in our clinic in the treatment of benign aggressive bone tumors. In this study, we had the intention to report our chondroblastoma case series with long term follow-ups treated both surgical and conservatively and no recurrence at all.

**Patients and Methods:** Between 2004 and 2017, 13 patients were diagnosed for chondroblastoma by the multidisciplinary bone and soft tissue tumor council of our institute. There were 5 male and 8 female patients, mean age was 32.3. 7 of these cases were located around the knee, while 3 at shoulder, 2 around hip and 1 at ankle. 8 patients were treated with extended curettage and grafting and subsequent cryotherapy. 3 patients were diagnosed with chondroblastoma and treated conservatively. 2 patients had undergone surgery in another institute. Mean follow-up period was 10.3 years.

**Results:** No recurrence was observed during 10 year follow-up. Osteoarthritic changes were observed in 9 patients (7 knee, 2 hip) because of the periarticular localisation of the tumor. These patients were treated with non surgical methods. There was no neurovascular complication in any patient after the surgery and the follow-up period.

**Conclusion:** A well performed extended curettage is the first and the most important step in the treatment of chondroblastoma. Addition of adjuvant therapy such as cryotherapy may enhance the treatment results and significantly decrease the recurrence rate of this disease.

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### Extra abdominal desmoid tumor cases and clinical follow-up results

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**Introduction:** Extraabdominal desmoid tumor or aggressive fibromatosis, is a benign tumor although its invasive nature. Despite being a benign soft tissue tumor, extensive resection is usually performed while surgery is considered. There is no clear consensus on surgical and post-surgical treatment. Our aim in this study is to share the experience of our clinic with extraabdominal desmoid tumor.

**Materials and Methods:** Extraabdominal desmoid tumor cases referred to the Ondokuz Mayıs University Medical Faculty Hospital between 2004-2018 were examined retrospectively using the local database. The parameters used for the study were age, gender, localization, surgical treatment, relapse and recurrence after surgery, surgical margin relation with relapse and duration of follow-up.

**Statistics:** The chi-square statistic is 0.6061. The p-value is 0.436275. The result is not significant at  $p < 0.5$ . The two-tailed P value equals 0.6169. The association between rows (groups) and columns (outcomes) is not to be statistically significant.

**Results:** A total of 29 extraabdominal desmoid tumors were diagnosed between 2004 and 2018. Seven patients were removed from the study due to lack of data after evaluation. Gender distribution of the remaining 22 patients was 17 female, 5 male and mean age was 36.1 (min 22, max 63). The most common localization was the hip region (5/22). In our study with a maximum of 6 recurrences in one patient, recurrence was observed in a total of 7 patients (35%). 20 of 22 patients underwent surgery and two patient were treated with conservative methods. The mean follow-up of all patients was 8 years (min 4 months-max 13 years). In term of 18 patient who underwent surgery, the surgical margin was negative in 11 patients and the surgical margin was positive in 7 patients. Two of 11 patients with negative surgical margin had recurrence. Recurrence was observed in 3 of 9 patients with positive surgical margin. No recurrence was detected in 2 patients who did not undergo surgery. Surgical margins were not correlated with recurrence ( $p < 0.5$ ). A female patient with paravertebral involvement, who underwent surgery and had a positive surgical margin, had local recurrence after 12 years. While 17 of the 18 surgeons performed extensive resection, 1 patient underwent marginal resection.

**Conclusion:** Despite the fact that the desmoid tumor is a benign tumor, it is a soft tissue tumor which must be closely follow-up due to local recurrences even after extensive surgical resection due to its invasive nature. In our study, there was no significant relationship between the positive and negative surgical margin and recurrence. It should be kept in mind that even after 12 years of surgery, local recurrence may occur.

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## Synovial hemangioma of the subacromial space causing glenohumeral subluxation: a case report

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**Introduction:** Synovial hemangioma is a rare, benign, vascular tumor of the synovium leading to joint pain and swelling. It may arise not only from the intraarticular region but also from the bursae or tendon sheaths<sup>1</sup>. The vast majority of published cases have involved the knee joint with around 200 reported cases<sup>2</sup>. Rare cases involving other sites have also been documented but none on the shoulder joint. To our knowledge, a case of synovial hemangioma involving the subacromial space of the shoulder has yet to be described in literature<sup>3</sup>.

**Case Report:** We report a case of a 39-year-old female with right shoulder pain of 4-year duration. There was no history of trauma or any inflammatory or infectious diseases. Physical examination of the right shoulder revealed a flatter contour of the deltoid muscle compared to the contralateral side. Active and passive range of motion was 120° of forward flexion, 10° of external rotation and 90° of abduction. Radiographs showed inferior subluxation of the glenohumeral joint [Figure 1]. Magnetic resonance imaging displayed a 3.1 cm x 2.6 cm x 2.5 cm soft tissue lesion on the subacromial bursa, compressing the tendinous junction of the supraspinatus muscle [Figures 2, A & B]. We suspected that a mass effect produced by the lesion is causing the shoulder subluxation.

**Materials and Methods/Results:** Open shoulder surgery was done to proceed with the excision of mass [Figures 3, A & B]. Postoperative radiograph showed relocation of the glenohumeral joint with restored acromio-humeral interval [Figure 4] Histopathologic evaluation led to a diagnosis of synovial hemangioma [Figures 5, A, B & C]. Upon follow-up at 6 months, patient denied pain and limitation in shoulder range of motion.



Figure 1 Preoperative anteroposterior radiograph of the right shoulder showing inferior subluxation of the glenohumeral joint

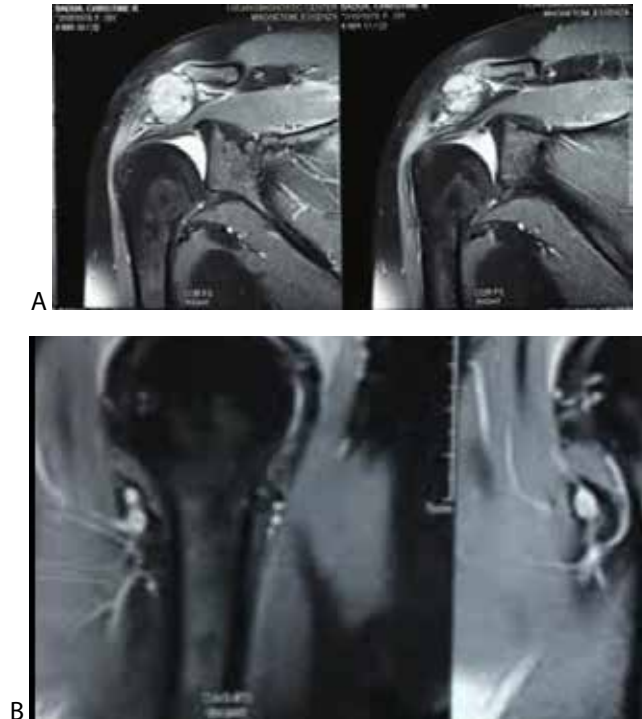


Figure 2. Preoperative coronal [A] and sagittal [B] MRI (T1-weighted) showing a contrast enhancing soft tissue mass in the subacromial bursa with compression of the supraspinatus attachment causing tendinosis, without any signs of tear or edema

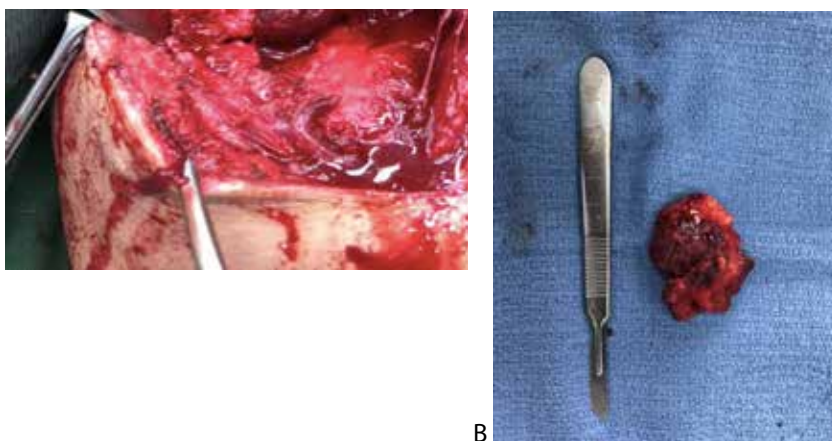


Figure 3 [A] Intraoperative view into the subacromial space showing the soft tissue mass reflected from the undersurface of the deltoid muscle, compressing the myotendinous junction of the supraspinatus muscle  
[B] Cut section measuring 5 cm x 4 cm x 2 cm disclose a dark brown to black homogenous parenchyma





Figure 4 - Postoperative anteroposterior radiograph of the right shoulder showing a relocated glenohumeral joint

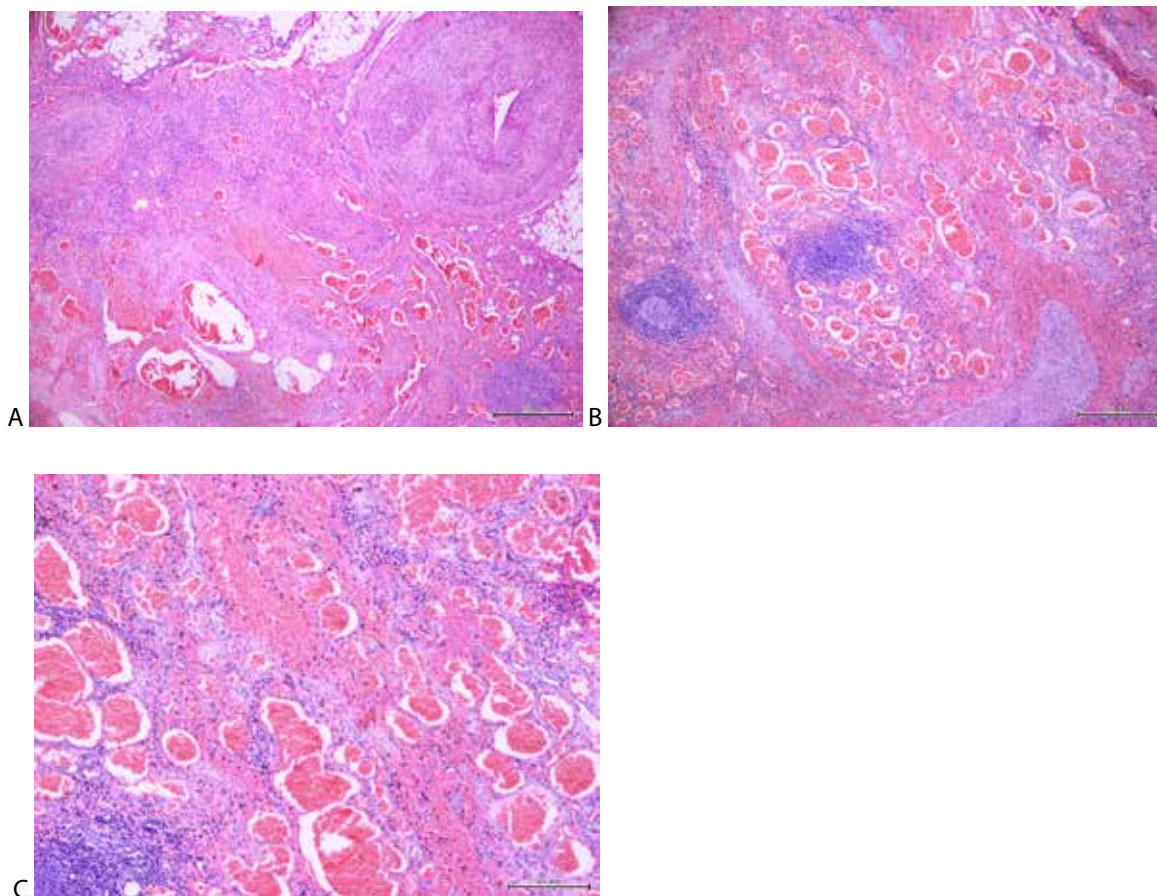


Figure 5 Hematoxylin and eosin histology on scanner [A], low power [B], and high power [C] views showing varisized malformed blood vessels (capillaries) with vascular dilatation (cavernous) filled with red blood cells lined by a single layer of endothelial cells consistent with synovial hemangioma



**Conclusion:** We have reported an extremely rare case of a patient with synovial hemangioma of the right shoulder with secondary compression - but without injury - to the rotator cuff. Our case is particularly exceptional since the lesion resulted in subluxation of the glenohumeral joint. Diagnosis of synovial hemangioma through plain radiographs and MRI is helpful but difficult and inconclusive; histopathology remains the gold standard. A high index of suspicion is always essential as prompt diagnosis and surgical management can prevent progressive secondary joint degeneration. Our patient was treated successfully by excision of mass through open shoulder surgery with satisfactory outcome.

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## Periacetabular resection at a single institution: do outcomes differ by method of reconstruction?

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**Introduction:** Limb salvage after periacetabular resection includes several options for reconstruction, The purpose of this study was to investigate the outcomes and functional results following various treatments following periacetabular resection.

**Methods:** Twenty-five patients (9 male, 14 female) with pelvic tumor underwent type II acetabular resection (Enneking-Dunham system) from 1993 to 2018 by three fellowship trained musculoskeletal oncologists at a single institution. Diagnoses were Chondrosarcoma (9), Ewing's (4), Giant Cell Tumor (4), Osteosarcoma (3), Pseudotumor (2), Undifferentiated Pleomorphic Sarcoma (1), and Renal Cell Carcinoma (1). Complications were documented and functional outcomes were assessed using the Musculoskeletal Tumor Society (MSTS) scoring system.

**Results:** Mean age was 44.7±22.7 years. Mean follow-up was 95±76 months. Complications were comparable between type II resection alone (11) and with additional resection [type III (8), type I (2), type I and III (3), type I-IV (1) [4/11 (36%) vs. 5/14 (35%); OR 1.03; p=0.99]. Patients treated with allograft (2 osteoarticular, 7 allograft prosthetic composite) suffered a 55% complication rate (2 infection, 1 loosening, 1 dislocation, 1 fracture), with mean MSTS scores of 79%. Patients treated with custom endoprosthesis (6) suffered a 33% complication rate (2 local disease progression in GCT) with mean MSTS scores of 76%. Patients treated with a saddle prosthesis (4) suffered a 25% complication rate (seroma) with mean MSTS scores of 40%. Patients without reconstruction (5) had no complications with mean MSTS scores of 60%.

**Conclusion:** Several options exist for reconstruction of type II acetabular reconstructions, it is important to consider patient medical comorbidities, functional goals, and time constraints prior to reconstruction. While patients implanted with allograft or custom endoprostheses have better MSTS scores, they had higher complications. Patients without reconstruction have lower MSTS scores but lower complications.

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## Clear cell chondrosarcoma of bone: review of our experience. A low grade malignant bone tumor with an unpredictable behaviour

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**Introduction and Purposes:** Clear cell chondrosarcoma (CCC) is a variant of conventional chondrosarcoma commonly considered as low grade malignant bone tumor with an unpredictable behavior. We reviewed our cases of CCC from 1997 and report 3 cases with aggressive behavior.

**Materials and Methods:** 11 cases of CCC treated at Istituto Ortopedico Gaetano Pini were reviewed at a mean follow up of 121 months (4-236). Clinical, surgical and histological details were collected, oncological outcomes were analysed. Available imaging studies were reviewed.

**Results:** 11 cases were primarily treated at our institution, 10 male and 1 female, mean age at diagnosis was 52 (25-73). Distal femur was the most frequent site (4) followed by proximal femur (3), proximal humerus (1), proximal tibia (1), scapula (1) and sacrum (1). No one presented a synchronous lesion at diagnosis. 8 patients were originally treated with wide (6) or marginal (2) surgical margins. One was treated with wide margin after few weeks from initial curettage, one was treated with curettage and one was considered not suitable for surgery (sacrum). 3 cases showed an aggressive behaviour with local recurrence and metachronous bone metastases. One patient recurred 7 years after the first treatment (wide margins) and had late bone metastases at 23 years. One, treated with wide margins had late bone metastases at 10, 17 and 18 years. One, initially treated with marginal resection, had early local recurrence (10 months), progressive skeletal diffusion of the disease from 17 months after the diagnosis and lung metastases at 5 years. This patient died of disease at 10 years.

**Conclusion:** While excision with wide margins remains the first choice in the treatment of CCC of bone, the behaviour of this low grade tumor is peculiar and unpredictable. Long follow up is mandatory.

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### **Sarcomas occurring around the elbow. Clinicopathological features and outcomes**

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**Introduction and Purpose:** Elbow is a rare location for bone and soft tissue sarcoma, which incidence was reported as 2-13 % of all sarcomas in the upper extremity. Due to the unique anatomical structure such as an adjacency to neurovasculature or complex joint mechanics, the outcome of sarcomas occurring around the elbow might be different from that occurring other parts. The purpose of this study was to reveal the clinical features and outcomes of sarcomas occurring around the elbow.

**Patients and Methods:** Thirty patients (soft tissue; 25 patients, bone; 5 patients) with malignant bone and soft tissue tumors occurring around the elbow in our centre from 2006 to 2018 were included in the analysis. Definition of the elbow was the location from mid 1/2 of the upper arm to mid 1/2 of the forearm. Disease status included 18 primary cases, 4 recurrent cases, and 8 post-insufficient resection cases. Mean age was 61.5 years old (6 to 85 years old) and the mean follow-up period was 50.5 months (2 to 113 months). Myxofibrosarcoma (MFS) was the most common subtype (n = 9), following undifferentiated pleomorphic sarcoma and synovial sarcoma. Overall survival (OAS) and local control rate (LCR) were calculated using the Kaplan-Meier method. Functional outcome was evaluated according to the Musculoskeletal Tumor Society (MSTS) score.

**Results:** R0 margin was obtained in 27 (90%) patients. On the other hand, amputation was performed in 7 patients, which means that the limb salvage rate was 77 %. Two patients with myxofibrosarcomas demonstrated local relapse, although no patient died of disease. Five-year OAS was 100% and 5-year LCR was 93%. Comparing MFS and other subtypes, LCR of the MFS cohort was significantly poor (P=0.018). Median MSTS score was 70% (33% to 100%).

**Conclusion:** The outcomes of sarcomas occurring around the elbow were similar to other extremity sites. However, MFS in the elbow demonstrated poorer local control than that in other sites.

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## Occult phosphaturic mesenchymal tumor of bone: a one center's review. Diagnostic challenges and clinical outcomes

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**Introduction and Purposes:** Tumour-induced osteomalacia (TIO) is a rare paraneoplastic syndrome characterized by severe hypophosphataemia and osteomalacia associated with phosphaturic mesenchymal tumors (PMT). Lack of awareness of the clinical manifestations of the disorder often leads to diagnostic delay, failure of diagnosis or misdiagnosis.

**Material and Methods:** The clinical features, diagnostic procedures, treatment, and outcomes of 6 patients were reviewed retrospectively.

**Results:** Three male and 3 women treated between 2000-2017 (mean age 58, range 36-73). All patients manifested progressive bone pain, muscle weakness. Serum phosphorus values were low in all patients (mean 0.45). Technetium-99m octreotide bone scan was performed. 4 femur, 1 sacrum, 1 acetabulum, 1 foot and 1 humerus interested. All patients underwent surgery and histopathology confirmed the PMT origin. We performed three resections and prosthesis implant (2 proximal femur, 1 hip custom made), two tumor curettage and one radio frequency CT guided ablation (sacrum). We experienced two local recurrence treated by resection and prosthesis implant. At a mean follow-up of 2 years (2-13) patients had no metastasis or other complications. All patients are followed by rheumatologist for drug therapy with high dosage phosphorus.

**Conclusions:** Locating phosphaturic mesenchymal tumors responsible for TIO is often challenging. Although complete tumor resection confers a good prognosis in most patients, surveillance for recurrence and metastasis is necessary. Before surgery or when surgery is not indicated, oral phosphate can alleviate symptoms and metabolic imbalance.

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## Intercalary biological reconstruction in osteosarcoma patients with epiphyseal involvement: walking on the razor's edge

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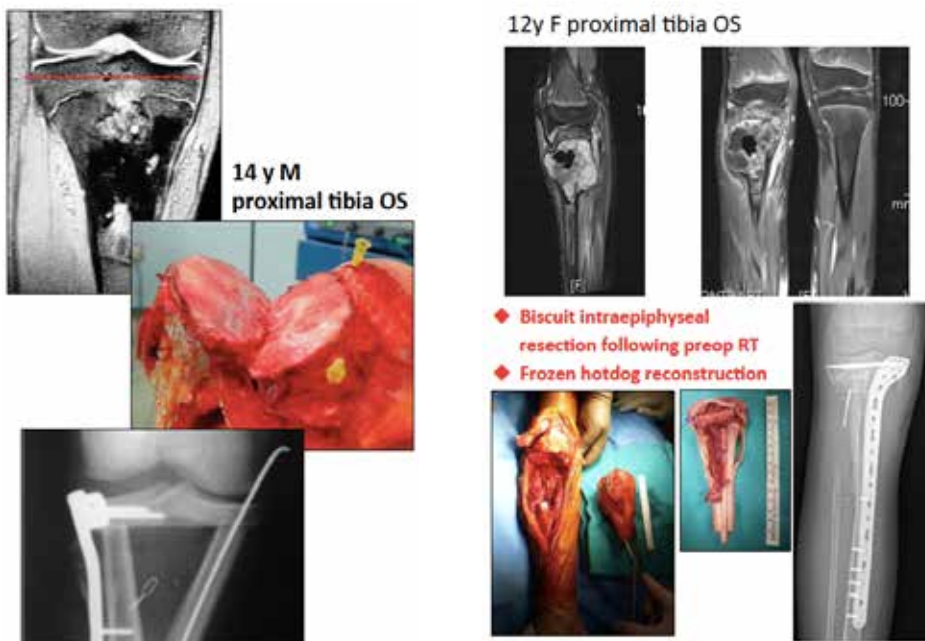
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**Introduction:** Intercalary resection and biological reconstruction in osteosarcoma (OS) cases with epiphyseal involvement is very challenging in terms of resection technique, marginal safety concerns and fixation difficulty. This study aims to evaluate radiographic, functional and oncological outcomes in this select group of patients.

**Patients & Methods:** 10 OS patients (6M/4F) with epiphyseal involvement in preoperative MRI, who underwent intercalary biological reconstruction between 1990-2016, were analyzed retrospectively. Tumors were localized to proximal tibia (5), distal femur (4) and distal tibia (1). The mean age was 11 (5-15) years. All received preoperative chemotherapy and 2 received preoperative radiotherapy. Reconstruction was performed with vascularized fibula and cryodestructured bone combination (frozen hotdog) in 7 patients and with vascularized fibula alone in 3.

**Results:** Mean follow-up was 52 (15-165) months. Mean length of resected segment 17,4 (9,0-28,5) cm and remaining epiphyseal segment thickness was 13 (5-16) mm. Tumor necrosis was >95% in 6 patients and surgical margins were negative in all. Good to excellent radiographic ISOLS scores were achieved for fusion in 9 patients. Mean MSTS score was 83,3%. No local recurrence was observed. Distal tibia patient required ankle arthrodesis while joint salvage was maintained in the remaining 9. Mean number of complication-related-interventions was 0,6 (0-8).

**Conclusion:** Joint salvage is possible in osteosarcoma patients with epiphyseal involvement. The fixation difficulty due to limited bone stock is usually compensated with good healing potential of the epimetaphyseal region. Successful local control can be achieved with effective neoadjuvant treatment, meticulous preoperative radiological assessment and a very careful resection. Although local control rate was 100% in this patient series, a larger sample is necessary to better analyze overall oncological safety.





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### **Antibacterial hydrogel coating in the prevention of periprosthetic joint infection after bone reconstruction with megaprosthesis: a consecutive case series**

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**Introduction and Purpose:** Modular megaprosthesis is burdened by a relatively high complications rate, compared to primary joint replacements; post-surgical infection remains the most frequent and challenging, ranging from 7.4% in metastatic tumors to 21.7% in patients with a diagnosis of sarcoma. The aim of this retrospective consecutive case series was to assess the effectiveness of DAC<sup>®</sup> gel antibiotic-loaded, in reducing the infection rate following large bone resection and surgical reconstruction with a mega-prosthetic implant.

**Materials and Methods:** Forty-seven consecutive patients in three Centers received a megaprosthetic implant coated with Antibacterial-Loaded Hyaluronan Based Gel (ALHBG) following tumor resection and limb salvage surgical procedure. At surgery, mean age was 45.6±21.3 (range 13-85). The most common histologies were osteosarcoma (n=12) and chondrosarcoma (n=7); the most frequent sites were distal femur (n=17) and proximal femur (n=19).

**Results:** The average length of surgeries was 5.6±2.9 hours (range, 2-15). One patients died during the follow-up (18 months) due to their underlying malignancy. No intraoperative complications related to the use of ALHBG were reported. In the early postoperative period one superficial infection on the surgical incision with wound dehiscence was seen (at 15 days) that resolved without revision. No deep or organ space infections were seen in the post-operative follow-up. No complications related to the use of ALHBG were reported at follow-up.

**Conclusions:** Treating megaprosthesis with ALHBG may represents a safe and an effective procedure in the prevention of PMI in a high-risk population. Nevertheless, randomized prospective studies are necessary to confirm our preliminary results.

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**Can segmental resection of the spinal canal content (spinal amputation) increase local control in extracompartmental bone tumors of the spine? Is the neurological loss of function worth in order to aim at tumor-free margins? Case series of 8 patients at a minimum 2 years follow-up**

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**Background Context:** Treatment outcomes of primary malignant and benign aggressive bone tumors of the spine have been dramatically changed by the application of the musculoskeletal oncologic principles described by Enneking. However, the efficacy of spinal oncology surgery might be limited in specific situations by some unique features of spinal anatomy.

**Purpose:** The purpose of this study was to evaluate (1) if the segmental resection of the content of the spinal canal could provide an Enneking Appropriate (EA) tumor-free margin for local control of primary bone tumors surrounding and invading the canal and (2) the safety profile of the segmental resection of the neurostructures.

Study design: Retrospective review of prospectively collected data.

Methods: Database search was conducted with the following inclusion criteria: en bloc resection, segmental inclusion of the spinal canal content in the surgical specimen, histologically proven diagnosis, minimum follow-up of 2 years. Exclusion criteria were: piecemeal excision of the tumor (debulking), and diagnosis other than primary bone tumors (metastasis, or local extension of extraosseous tumors).

**Results:** A consecutive cohort of 8 patients (3 males, 5 females) was available for review. Only two were intact at presentation, while 6 were recurrent after previous violation of the tumor. Margin was wide in 4 cases, marginal in 3 and intralesional in 1. Two patients died within 3 months from the surgery for systemic disease progression or sequelae of the surgery. En bloc resection with segmental spinal canal content inclusion was able to achieve local control of the disease in 4 out of remaining 6 cases (66,7%) at average 68,7 months follow-up (range 12-174 months). The 2 patients in whom tumor recurred, it happened after 7 and 20 months. Of these patients: 1 died for sequelae of the surgery (after 12 months), and 1 died for causes unrelated to surgery (after 66 months). Of the patients in whom local control was achieved: 3 are free from disease at an average 98,7 months follow-up (range 38-174), and 1 died for systemic disease progression (after 38 months). As a consequence of surgery 7 patients had complete (ASIA A), and 1 had partial paraplegia (ASIA C). 7 out of 8 patients (87,5%) experienced overall 16 complications.

**Conclusion:** En bloc resection including the content of the spinal canal (spinal amputation) to achieve a tumor-free margin might be considered to perform an EA treatment for motivated patients.

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## Neoadjuvant radiotherapy for limb salvage in the setting of recurrent extremity osteosarcoma: the unconventional weapon

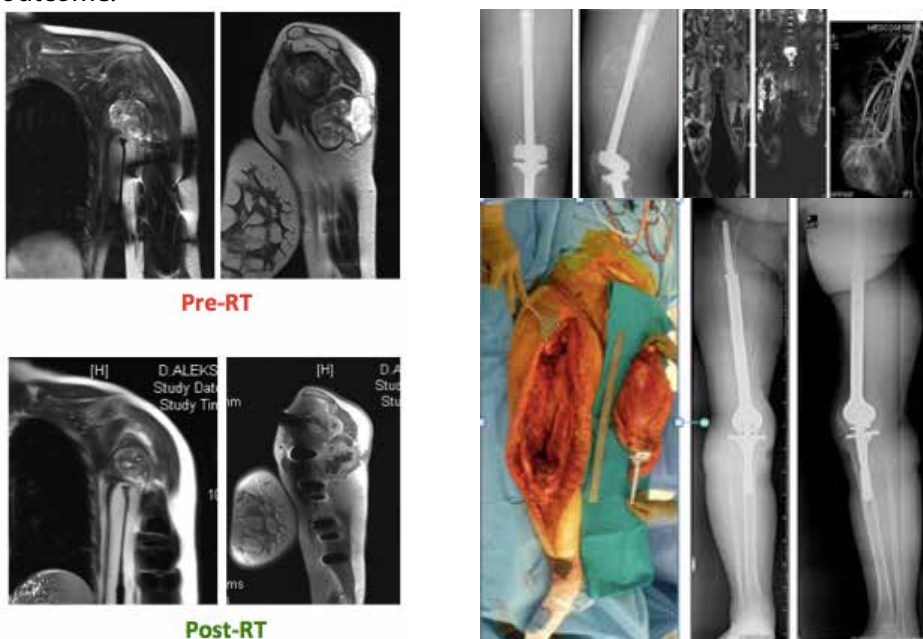
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**Introduction:** Avoiding an amputation in extremity osteosarcoma (OS) local recurrence (LR) is a challenge for the sarcoma surgeon since achieving safe margins with surgery alone is usually very difficult. Although OS is a conventionally radioresistant tumor, we propose that preoperative radiotherapy (PRT) facilitates safer tumor resection while preserving critical structures and thus making possible salvage of limb salvage (SoLS).

**Patients & Methods:** We retrospectively analyzed 15 SoLS procedures following PRT in 14 patients, who had undergone primary limb salvage for OS and were diagnosed with LR between 2003-2017. Mean age was 18 years (11-31). One patient underwent SoLS twice for a second LR. Short-course PRT (35Gy/10 fractions) was given preoperatively in all. Peritumoral edema regressed and tumor margins became defined in MR images after PRT. The anatomical locations were distal femur (9), proximal femur (2), proximal tibia (1), proximal fibula (1), proximal humerus (1) and distal humerus (1). Results: The LRs were observed after a mean period of 23.5 (6-65) months. The mean LR tumor volume was 139 (1,5-585) cm<sup>3</sup>, mean post-RT resected tumor volume was 93 (1-336) cm<sup>3</sup>. Surgical margins were all negative and mean necrosis ratio was 50%. Wound problems required further surgical interventions in 5 patients. Mean follow-up after SoLS was 29 months (6-179) and mean MSTS was 65% (30,0-86,7). Local recurrence rate was 6,7% while 78.6% of the patients developed distant metastases. Radiological tumor responses and necrosis rates did not correlate with local recurrence.

**Conclusion:** Although the therapeutic effect of PRT could not be justified with radiological and histological parameters alone, good local control rates encourage us to use this unconventional weapon to enhance safe resection of recurrent osteosarcoma lesions, with acceptable wound problems and satisfactory functional outcome.



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## Pathologic fracture in a 29-year-old patient secondary to chondroblastoma of the calcaneus

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**Introduction and Purposes:** Tumours of the calcaneus are extremely rare and misdiagnosis is frequent. The most frequent calcaneal lesions are simple bone cysts and intraosseous lipomas. Less than 2% of all bone tumours are chondroblastomas (CB). They are typically seen in long bone epiphysis of males in the second decade of life. Radiographic findings can mimic other lesions such as giant cell tumour (GCT) or aneurysmal bone cysts (ABC), therefore CB can be difficult to identify and diagnosis is often only confirmed by histological examination.

**Material and Methods:** A previously healthy 29 year old female arrived to the ER complaining about pain in his left ankle after twisting it. Physical examination showed intense swelling and pain in the hindfoot. X-ray exams showed a pathological calcaneus fracture surrounded by a lytic lesion. MRI and CT exams were performed with initial suspicion of ABC or GCT.

**Results:** To perform the differential diagnosis incisional biopsy was carried out and histological results were suggestive of ABC. A few days later, open curettage of the lesion was performed and sent for histological examination, the cavity was filled with bone cement (PMMA). The final histologic diagnosis was CB. The patient was immobilized in a short leg cast and instructed for non weight bearing for 6 weeks. Postoperative course was uneventful. The patient reported no pain during follow-up and returned gradually to normal activity.

**Conclusions:** CB of the calcaneus is a rare condition, difficult to correctly diagnose even with complete image studies, and a high index of suspicion is needed. Treatment is surgical: curettage and bone grafting or insertion of PMMA are the principal techniques.

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## Thoracic wall reconstruction with rib plates vs. artificial meshes following resection of malignant chest-wall tumours

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**Introduction and Purposes:** The reconstruction of resected ribs and soft tissue defects following extensive thoracic wall resection for malignant tumours can be difficult. Artificial meshes or rib-plates may be used to bridge bony defects. The aim of the present study was to analyse postoperative complications in patients undergoing thoracic wall resection for malignant tumours with subsequent mesh- or rib-plate reconstruction.

**Materials and Methods:** 25 patients from a single center were retrospectively included in the study (15 female, 9 male) treated between 2012 and 2018 for a malignant tumour of the thoracic wall with resection and reconstruction. Complications directly associated with the reconstruction itself and requiring another surgical procedure (grade 3B) were included.

**Results:** In 5 cases each, Ewing-sarcoma and breast cancer were the most prevalent diagnoses. A mean of 3 ribs were resected. 13 patients underwent rib plating with MatrixRIB-system (DePuy Synthes) ± artificial mesh, whilst in the remaining 12 patients, Omyra- or Prolene-meshes were used. In 10 patients, muscular flaps for soft tissue coverage were additionally harvested. 14 patients developed grade 3B-complications after a median of 5.5 months (interquartile range: 1-11 months). Wound healing deficits directly above rib plates were most common (n=5). 84.6% of patients with rib-plates developed complications (11/13), compared to 25.0% of patients with meshes only (3/12; X2-test, p=0.003). In the multivariate analysis, rib-plates remained a negative prognostic factor regarding development of complications, irrespective of age, gender and use of muscular flaps (HR: 9.4; 95%CI: 1.7-52.5; p=0.011).

**Conclusions:** Usage of rib-plates following thoracic wall resections for malignant tumours have a high complication and revision rate. Coverage with muscular flaps does not significantly reduce complication rates. Therefore, reconstruction with rib-plates should be carefully considered individually.



2644

## Establishment of 6 novel patient-derived sarcoma cell lines and 1 patient-derived carcinosarcoma cell line

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Sarcomas are a diverse group of rare malignant tumors, arising in mesenchymal tissue. Despite trials with new compounds, survival rates have stagnated over the past 20 years. There is a great need for preclinical models in sarcoma research, however, there is only a limited number of in vitro disease models commercially available for functional testing and target validation. A well accepted alternative to commercially available cell lines is the use of primary cell cultures. Unfortunately, their behavior is unpredictable with an uncertainty of successful establishment.

Tumor samples from 14 primary sarcoma patients were collected at the Ghent University Hospital. Samples were taken during tumor biopsy or resection. The group consisted of 13 high grade tumors (3 undifferentiated pleomorphic sarcomas, 2 osteosarcomas, 2 MPNST, 1 extra skeletal osteosarcoma, 1 carcinosarcoma, 2 synoviosarcomas, 1 malignant solitary fibrous tumor, 1 myxofibrosarcoma) and 1 atypical lipomatous tumor. One patient was treated with pre-operative radiotherapy before sampling. Samples were processed within 45 minutes of resection. The samples were minced into 1-2mm<sup>3</sup> pieces and suspended in a DNase I and collagenase II solution, following a GentleMax<sup>®</sup> protocol. Single cell suspensions were plated on a 6-well plate in two different kinds of media.

Single cell suspensions of the ALT and the pre-operatively treated patient were not able to form adherent monolayers. Five cell lines showed early senescence between the 2<sup>nd</sup> and the 4<sup>th</sup> passage. Six high-grade sarcoma cell lines and 1 carcinosarcoma cell lines are currently growing well, 4 of them have passed the 10<sup>th</sup> passage and all cell-lines are confirmed sarcoma cell lines by a specialized sarcoma pathologist by performing H&E staining and immunohistochemistry on paraffin-embedded slides of cell pellets.

Currently, further characterization is in process by performing short tandem repeat profiling, Incucyte experiments<sup>®</sup>, karyotyping and array-CGH.



2645

### **Electrochemotherapy for the treatment of bone metastases: the role in pain control and adjuvant to bone stabilization**

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**Introduction and Purposes:** Bone metastases are getting more frequent affecting frequently elderly people in poor general conditions. Sometimes it is difficult to control pain with drugs or radiotherapy. When surgery is the only solution, a minimally invasive system is desired. The aim is to evaluate the reliability of electrochemotherapy for the treatment of bone metastasis.

**Materials and Methods:** A retrospective analysis was conducted using data stored prospectively in our unit database. Diagnosis, age, site involved, soft tissue involvement, purpose of the treatment, pain control (VAS reduction), complications have been analyzed. Each case was preoperatively planned with a dedicated software. Cliniporator® VITAE (IGEA Medical, Carpi, Italy) was used after the insertion of percutaneous electrodes under 3D C-arm radiologic guidance and the intravenous administration of bleomycin dosed according to the body surface.

**Results:** In the period April 2016-January 2019 15 patients (mean age 65ys, range 54-86) were treated for 18 bone lesions from melanoma (1), epithelioid sarcoma (1), kidney (4), colon (4), thyroid (1), bladder (1), lung (2), and skin adnexal carcinoma (1). In 16 cases the bone metastasis involved the surrounding soft tissues. The purpose was exclusive pain control in 15 cases, and adjuvant for intramedullary fixation or ORIF in 3 cases. Pain control was achieved within one week postoperative (preop VAS >7, postop VAS < 3). No complications occurred.

**Conclusions:** Electrochemotherapy is a safe procedure for bone metastases in the long bones and in the pelvis, even if the cortex is destroyed and soft tissue are involved. It represents an excellent solution for the treatment of bone metastases and pain control when traditional surgery is not feasible for the type of lesion or the patient. In pelvic lesions 3D visualization is suggested (either CT or 3D C-arm). An osteosynthesis after the treatment is an option to maintain long term results and bone stability.

2653

## Revision rates for megaprotheses: a updated review of the literature and meta-analysis

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**Background and Objectives:** Outcomes of megaprotheses vary by anatomical site and design. We conducted a meta-analysis of megaprotheses of major joints over more than 30 years to look for design variables affecting the outcomes. Objectives: report survival, revision for mechanical/recurrence/infectious causes for proximal humerus (PH), proximal femur (PF), distal femur (DF), and proximal tibia (PT) megaprotheses and assess risk factors of revision for mechanical cause in knee protheses including fixation, modularity, and hinge type.

**Study Design & Methods:** Using PRISMA recommendations, English-written peer-reviewed articles reporting megaprotheses outcomes were included. Titles and abstracts which were selected were then retrieved for full-text inclusion and exclusion criteria assessment. Random effects meta-analyses were used to estimate pooled rates of events with the DerSimonian–Laird estimate. Simple approximation of 95 % confidence intervals is reported. Between studies variability was assessed with the I-squared statistics. Meta-regression models were built to assess the effect of moderators (anatomic site and modularity/fixation/hinge variables) on t outcomes.

**Results:** 72 articles were retrieved: 151 identifiable series according to anatomical site and design on 4359 patients. Median follow-up was 45 months. The 5-year revision rate was 20% [17% - 23%] (survival 80%). Revision rate for mechanical reason was 11% [9% - 13%] with significant differences between anatomical sites (15%, 6%, 9%, 13% for DF, PF, PH, and PT;  $P < 0.001$ ). Revision for infection was 6% [5% - 7%] with significant differences between anatomical sites (7%, 3%, 4%, 11% for DF, PF, PH, and PT;  $P < 0.001$ ). Local recurrence was 7.5% [6% - 9%] with no difference between sites. Fixation (cemented/uncemented,  $P = 0.83$ ), modularity (custom-made/modular,  $P = 0.31$ ), and hinge (fixed/rotating,  $P = 0.19$ ) had no effect on the risk of revision for mechanical reason.

**Conclusions:** The 5-year survival rate of major joints is 80%. Revision rate for mechanical reason is significantly different between anatomical sites (6% for PF to 15% for DF) so as for infection (5% for proximal humerus to 17% for proximal tibia). There is no significant effect of common design variables (fixation, modularity, or hinge) on the risk of mechanical revision.

2662

## **Rapid, marked and durable response of a large aneurysmal bone cyst to denosumab treatment in a 7-year-old boy**

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**I:** Case presentation of a rapidly progressive aneurysmal bone cyst (ABC) successfully treated with denosumab in a young child.

**M:** A 7-year-old patient presented with marked swelling of the right shoulder caused by a large tumor of the right glenoid/scapula, histologically proven to be an ABC. Shoulder function was limited and he was in considerable pain. At the time of biopsy he experienced very severe bleeding. The originally planned sclerotherapy with polidocanol could not be performed because contrast medium distributed both intraarticularly and into soft tissues. In order to reduce the size of the lesion (6x8,5x8,6 cm on MRI) and thus avoid mutilating surgery, we initiated off-label treatment with the RANK-ligand antagonist denosumab (60 mg/dose), administered concomitantly with calcium and vitamin D.

**R:** After initiation of treatment, pain abated instantaneously. The visible swelling decreased rapidly, shoulder function returned to normal. After 9 months (13doses), the size of the ABC had shrunk to 3,9x6x8 cm and denosumab was terminated. Five months thereafter, the boy experienced transient rebound hypercalcaemia, successfully normalized with furosemide. In addition, he developed lower extremity pain and gait abnormalities. X-ray examination (proximal right humerus, left wrist, both knees) revealed widening of growth plates and increased calcification of the adjacent metaphyses. Clinical symptoms dissolved after only a few weeks. Imaging of the now symptom-free boy months after the end of treatment revealed a residual mass of 2,6x5,7x6 cm. His growth was according to the percentiles.

**C:** Osteoclast inhibition by denosumab can result in a rapid, marked and durable response of an ABC. It remains to be seen if it can permanently replace local treatment. Treatment of young, growing individuals poses additional challenges. The relevance of side effects on the growth plate can be better appreciated with a higher number of younger children having been treated similarly.

2665

### Survival prediction of leiomyosarcoma patients using machine learning models

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**Background:** Leiomyosarcoma is a rare form of soft tissue sarcoma that is associated with poor overall survival. From an orthopedic oncology standpoint, the relevant predictors for poor outcomes remain unknown because prior studies include uterine leiomyosarcoma or surgical sites that are not relevant for an orthopedic surgeon.

Artificial intelligence advances have increased modeling predictive power while also increasing clinical applicability compared to standard techniques. In this study, we aimed to create a prognostic model using artificial intelligence to predict overall survival outcomes with two retrospective cohorts of leiomyosarcoma patients from both a national database and an institutional one.

**Methods:** This retrospective study utilized an institutional database from a large orthopedic oncology center (n=52) and the publicly available Surveillance, Epidemiology, and End Results Program (SEER) database of the National Cancer Institute (n=1047). Using age of diagnosis, grade, size, metastasis at diagnosis, and chemotherapy, 13 machine learning models were utilized to identify the most predictive survival model, based on ROC curves.

**Results:** The top four models: neural net, random forest, rpart, and svm correctly predict survival with accuracy greater than 77% and had an average area under the receiver operator curve (AUC) of 0.80. Three out of the four models correctly predicted with accuracy greater than 73% of the institutional data, and the random forest had the highest AUC of 0.831. Rshiny was used to make a user-friendly website that takes into account a patients unique factors and can accurately predict survival. The website link is: <https://mgh-ortho.shinyapps.io/LeioApp/>.

**Conclusion:** The random forest model retained accuracy in both the large database and the institutional database. Our model helps evaluate prognostic outcomes based on individualized patient factors.

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### Predictors of venous thromboembolism in patients with soft tissue sarcoma in the lower extremity

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**Introduction and Purposes:** Orthopedic surgery and soft tissue sarcomas independently increase the risk of developing venous thromboembolism (VTE). However, there are no established guidelines for how to treat patients with soft tissue sarcomas undergoing surgery. The risk of complication involved with pharmacologic prophylactic agents necessitates a thorough understanding of the relevant risk factors of deep vein thromboses (DVT) to guide the decision of which agents to employ.

**Materials and Methods:** 642 patients older than 18 years were treated for soft tissue sarcoma in the lower extremity. VTE, was defined as either DVT or pulmonary embolism, confirmed radiographically, within 90 days of surgery. Patient characteristics, tumor characteristics, treatments, and associated complications were tested for association with VTE using regression models with STATA 12.0.

**Results:** 28 patients out of 614 were diagnosed with VTE within 90 days of surgery. In total, the bivariate model found 8 clinically significant predictors ordered based on standardized coefficients: post-op (PTT) partial thromboplastin time ( $p=0.01$ ), pre-op PTT ( $p=0.01$ ), post-op chemotherapy ( $p=0.01$ ), metastasis at diagnosis ( $p=0.04$ ), additional surgery for metastasis or local recurrence ( $p=0.01$ ), histology ( $p=0.001$ ), wound complications ( $p=0.05$ ), and tumor size larger than 10cm ( $p=0.03$ ). DVT prophylaxis was a significant predictor of wound complications ( $p=0.04$ ) and infection ( $p=0.02$ ).

**Conclusions:** Identified risk factors for VTE are related to aggressive metastatic and large-size tumors that require treatments with periods of prolonged immobility. This patient population seems to be the one benefiting more from prophylaxis with agents such as Lovenox. The fact that wound complications and infections were predicted by DVT prophylaxis suggest that some patients are over treated and could benefit from Aspirin instead. Further research is required to assess the relative risk factors in a prospective study.

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## Reconstruction of the diaphysial bone defects after sarcoma resections with the vascularized fibula

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**Introduction:** Resection of the sarcomas located in diaphysis of the long bones create large bone defects. Vascularized fibula is an option for biologic reconstructions with or without structural bone graft.

**Patients and Methods:** The purpose of this study was to evaluate the outcome of 6 patients (mean age 14.6 years 6 to 34)) with a primary sarcoma located of the long bone diaphysis who had undergone wide resection and reconstruction with the vascularized fibular graft. The mean follow-up was 54.7 months (25 to 63) with no evidence of the disease at the last follow-up. The mean time to full weight-bearing was 25.3 weeks (16 to 36) and to complete radiological union 21.3 weeks (16 to 32). The mean Musculoskeletal Society Tumor Society functional score at final follow-up was 29 out of 30.

**Conclusion:** The vascularized fibula can be a good biologic reconstruction option for the defect of long bone diaphysis in selected patients with perfect functional results.

Patient 1



14 year old F, left femur diaphyseal osteosarcoma MRI and X rays.



Early postop

Recycling bone with the liquid nitrogen  
and vascularized fibula

2. Years postoperatively

Patient 2





12 years old M, Ewing sarcoma at the tibial diaphysis preoperative MRI and x rays after five years postoperatively.

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## A novel approach in treatment of infantile lymphangiomatosis of the extremity: Sirolimus

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**Background:** Lymphangiomatosis is a rare lymphatic system malformation which mostly effects infantile age group with neck and trunk involvement. The expanding lymphangioma may result in mechanical pressure of surrounding neurovascular structures and vital organs. Inadequate resections and high recurrences are inevitable due to the aggressive nature of the disease. This study aims to present the results of low dose sirolimus which applied pre and postoperatively in two extremity involvement of lymphangiomatosis cases.

### Case presentation:

**Case 1:** An infant with a postnatal evaluation of swelling in right upper extremity, right hemithorax and abdominal region was monitored for 2 months and the lesions were increased in diameter with abducted right arm and compression on brachial artery. The MRI demonstrated a 23x20x18 cm, multiloculated mass with septations, which is hypointense in T1 and hyperintense in T2 sequences. The biopsy revealed the diagnosis of lymphangiomatosis. The patient administered sirolimus 1,6 mg/m<sup>2</sup>/day in 2 fractions. Trimetoprim Sulphomethoxazole prophylaxis is also administered for *Pneumocystis Jirovecii* 3 times a week during treatment. A significant ROM increase in right arm with a decrease in lesions diameter is observed after 6 months treatment and patients is prepared for resection.

**Case 2:** A 19 months old toddler was examined with left thigh soft tissue masses without functional loss which are located anteromedial at proximal third to anteriolateral at distal third and a laterally localized mass. The MRI demonstrated a 13x2.9x6.4 cm anteromedial to anterolateral and 3.9x2.4x2.4 cm multiloculated mass with septation at lateral thigh between the fascia and subcutaneous tissue, which are hypointense in T1 and hyperintense in T2 sequences. The lesion was resected with the diagnosis of lymphangiomatosis. Recurrence was observed at postoperative 10 months. The standard treatment modality was applied and significant regression is observed at 2<sup>nd</sup> month of treatment.

**Conclusion:** Sirolimus emerges as a new treatment modality for patients with lymphangiomatosis and vascular malformations of lymphatic origin. Regarding our experience with these two patients, we recommend sirolimus as preoperative and recurrence treatment in similar cases. A multidisciplinary approach with pediatric oncology is essential. Yet larger series are required for better analyses.

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## Ewing sarcoma: oncological results in 88 patients treated with chemotherapy and limb salvage surgery

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**Introduction:** Ewing's sarcoma is a rare aggressive neoplasm, first described in 1921 by Dr. James Ewing. Although it can be localized in any part of the body, more frequently affects the extremities and pelvis. [1-5] It affects children and young adults more frequently, with a peak incidence in the second decade of life [3,5]. Ewing's sarcoma represents about 1.5% of all childhood cancers, and is the second most common type of bone sarcoma. [6,7] The diagnosis requires histological evaluation and confirmation with cytogenetic or molecular biology techniques. The defining characteristic of these tumors is the presence of a series of chromosomal translocations that culminate in the fusion of the EWSR1 gene, on chromosome 22, with one of several members of the ETS family of transcription factors. The most common of these translocations, t(11; 22) (q24; q12), present in approximately 90% of cases. The detection of these alterations by FISH, RT-PCR or more modern techniques such as new generation sequencing (NGS) allow, together with histological evaluation, an adequate diagnosis [8,9]. Chemotherapy is the first line of treatment. Most of the treatment protocols use neoadjuvant chemotherapy, followed by local treatment (surgery) and adjuvant chemotherapy. [10] The histological response to chemotherapy is possibly the most important prognostic factor. [11,12]. However, despite changes in drugs combination, in the last 3 decades, the overall survival of patients has not changed significantly. [6,13-15] In our country, Argentina, the lack of Ewing's sarcoma registries reflect in the absence of information regarding prevalence, treatment protocols and patient's outcome. The purpose of this study was to analyze a group of patients diagnosed with Ewing sarcoma of the bone, treated with chemotherapy and limb-salvage surgery. We aim to determine: (1) overall survival rate; (2) local recurrence rate; (3) oncological risk factors.

**Material and Methods:** A retrospective research from our oncology data base was performed between 1990 and 2017 and all patients with diagnosis of Ewing sarcoma, treated with chemotherapy and limb salvage surgery were included for analysis. The treatment protocol for all patients included in the study was: neoadjuvant chemotherapy + oncological resection surgery + adjuvant adjuvant. Depending on the margins of resection and response to chemotherapy, postoperative radiotherapy was associated or not. This decision was made by a multidisciplinary team and discussed at the bone sarcoma MDT. The pediatric patients used the VIDE protocol (vincristine, ifosfamide, doxorubicin, etoposide) developed by the EUROpean Ewing Tumor Working Initiative of National Groups 1999 (Protocol EURO-EWING 99) [16] and the adult patients were treated with the VAC / IE protocol (vincristine, cyclophosphamide, doxorubicin alternating with ifosfamide and etoposide). The Kaplan-Meier method was used to analyze overall survival. A logistic regression analysis was performed for the dichotomic variables: age (<16 vs > 16 years), sex (male vs female), primary location of the tumor (extremities vs central), response to chemotherapy (poor vs good), size tumor (<80 mm vs > 80 mm) and local recurrence (yes or no). For the multivariate analysis, only the variables with p < 0.15 were used. P values less than 0.05 were considered statistically significant.

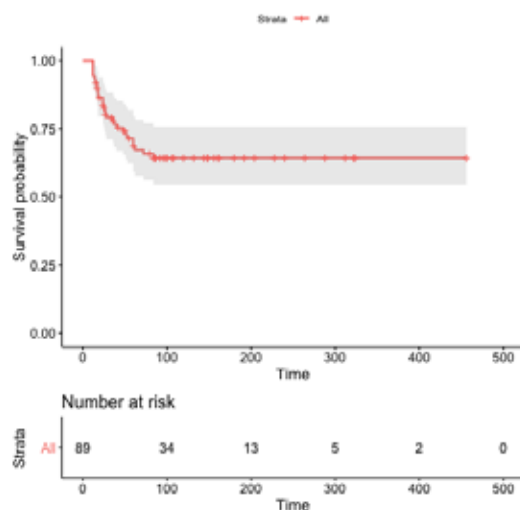
**Results:** A total of 88 patients were finally included in the study. Median age was 14.5 years (range 2-54) and median follow-up was 8.8 years (range 1-38). (Table 1)

Table 1: Demographic characteristics of the series.

Gender			
Male		Female	
60		28	
Age			
<16		>16	
59		29	
Follow-up			
105,9 months (12-456)			
Location			
Central		Extremities	
23		65	
26.14%		73.86%	
Margins			
Marginal		Wide	
18		70	
Necrosis			
< 0-89%		> 90-100%	
39	44.30%	49	55.70%
Local Recurrence			
Yes		No	
9	10.22%	79	89.78%
Metastasis			
Yes		No	
34	38.64%	54	61.36%

Overall survival rate was 79.5% (CI95%:71-88), 69% (CI95%:59-79) and 64% (CI95%:57-76) at 2, 5 and 10 years respectively. (Figure 1)

Figure 1: Kaplan Meier curve for Overall Survival analysis.



to chemotherapy (tumoral necrosis 0-89%) ( $p < 0.001$ ); b) age > 16 years-old ( $p = 0.01$ ); c) central tumor localization ( $p = 0.02$ ); d) local recurrence ( $p = 0.03$ ). Gender and tumor size were not significant prognostic factors. After multivariate analysis, response to chemotherapy remained statistical significant ( $p = 0.05$ ). Local recurrence-free survival rate at 2 and 5 years was 87% (CI95%:79-97). Tumor response to chemotherapy (0-89%) was the only significant factor for local recurrence ( $p = 0.05$ ).

#### Conclusion

We consider that limb-salvage surgery, with neoadjuvant and adjuvant chemotherapy, are the mainstays of treatment for Ewing's sarcoma, with an overall survival rate, at 5 years, of 69%. Response to chemotherapy is the most relevant prognostic factor, being associated with local recurrence and overall survival.

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## Functional outcome of the endoprosthetic replacement of the elbow at tumors – are we there yet?

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**Introduction:** Tumors around the elbow are rare. Although elbow joint is a complex joint, reconstructions of the elbow function after distal humerus resection could be done with a simple hinge-type tumor endoprosthesis. We hypothesize that the function of the humero-ulnar hinge joint thus remains full, and forearm function intact.

**Patients and Methods:** We performed an retrospective analysis of all patients with a hinge-type distal humerus tumor-endoprosthesis (mod. ImplanCast MUTARS), operated at our Department between 2008 and 2018. In total, we found eight patients matching our criteria. The diagnosis were osteosarcoma in three patients, and synovial sarcoma, rhabdomyosarcoma, chondrosarcoma, giant cell tumor of bone, and a metastasis of the hypernephroma in one patient each. A minimal follow-up was 3 months (range: 3-120 months).

**Results:** A postoperative range of motion was excellent in all patients, with a mean extension of 10° (range: 0-15) and a mean flexion of 125° (range: 120-140). Pro-supination was full in all patients. We noted a local complications in four patients: one early postoperative radial nerve palsy, one soft-tissue recurrence in giant-cell tumor after one year, one humerus stem instability after six months, and one metallosis seven years after the index operation.

**Conclusion:** Distal humerus tumor-endoprosthetic replacement provides a very good functional outcome. Local complication rate as well as oncologic outcome are yet to be analysed on a bigger cohort.



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### Use of intraoperative cell salvage in orthopaedic oncology

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**Introduction and Purposes:** Intraoperative cell salvage (ICS) has been used in orthopaedic surgery to manage intraoperative blood loss and minimize the need for blood transfusion as well as in cancer surgery, for example in gynaecological or urologic oncology<sup>1-2</sup>. However, it has not been routinely adopted in orthopaedic oncology which can result in significant bleeding. This is due to safety concerns about potential dissemination of malignant cells. The aim of the study was to investigate whether or not intraoperative cell salvage is safe for use in orthopaedic oncology surgery.

**Materials and Methods:** At our institution the Sorin Xtra cell salvage machine is utilized. It is used with Haemonetic filters (RS Leucocyte Removal Filter) and the blood is prepared in the standard fashion. In 9 patients who underwent excision of primary bone sarcoma cell salvage was used and the filters were retrieved and sent to histopathology for assessment of tumour cells.

**Results:** In all nine patients, no malignant cells were detected within the filters. Furthermore, none of the patients have developed metastases in a follow up period ranging from 2-18months.

**Conclusions:** This study suggests that intraoperative cell salvage is safe to use and reinfusion of salvaged blood has not been found to increase risk of metastases.

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### **Epidemiology, incidence, and survival of Ewing sarcoma: SEER database analysis**

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**Background:** Ewing Sarcoma (EWS) is a malignant, small, round, blue cell tumor that represents over 15% of primary bone sarcomas, making it the second most common primary bone sarcoma in children and adolescents. Although prognostic factors have been previously studied, evidence of the effects of patient and tumor characteristics on survival is scarce.

**Questions/Purposes:** This study is designed to 1) evaluate incidence, patient demographics including gender, race and socioeconomic status, and tumor characteristics of EWS, and 2) determine if these characteristics have an impact on 10-year disease-specific survival in patients with EWS.

**Patients and Methods:** This study is a population-based, concurrent retrospective database analysis of patients diagnosed with primary EWS of the bone from 1990-2015. Patients diagnosed prior to 1990 were excluded as socioeconomic data were not available. Patients without survival or staging data or with a previously diagnosed primary tumor were also excluded. In total, 1,732 patients were queried from the SEER Database. Frequency functions, Kaplan-Meier, and Cox regression models were used to analyze patient demographics, tumor characteristics, and survival outcomes.

**Results:** 1,732 cases of EWS were identified from the SEER Database. There was a male predominance in incidence (63.0%) with a majority falling in the age range of 11-20 (48.8%). The highest presented race is white (70.6%) followed by Hispanic (20.2%). Most tumors were located in the axial bones (56.0%), non-metastatic at presentation (65.7%), and less than 5 cm in greatest diameter (50.1%). Axial tumors were more likely to be associated with metastasis at presentation (40.8%) than appendicular tumors (26.0%), and black patients were more likely to present with metastasis at presentation (44.0%). Patients with Ewing Sarcoma had a 10-year disease-specific survival (DSS) of 54.1%. On univariate survival analysis, sex ( $p=0.046$ ), age ( $p<0.001$ ), race ( $p=0.013$ ), tumor location ( $p<0.001$ ), metastasis at presentation ( $p<0.001$ ), tumor size ( $p<0.001$ ), poverty quartile ( $p=0.006$ ), and composite socioeconomic status quartile ( $p=0.048$ ) had significant effects on DSS. On multivariate survival analysis, increasing age, black race, primary tumor of the axial skeleton, metastasis at presentation, unknown tumor size, and tumor size  $>8$ cm were found to be independent risk factors decreased DSS at 10 years.

**Conclusions:** To our knowledge, this is the largest study of demographics and survival in patients with Ewing Sarcoma of the bone. Smaller, non-metastatic tumors of the axial bone were most frequently reported. The highest incidence of EWS is in adolescent, white males. Patients with EWS have decreased 10-year disease-specific survival with increasing age, black race, tumor in an axial bone, metastasis at presentation, unknown tumor size, and tumor size  $>8$ cm. Gender and socioeconomic status did not affect disease-specific survival at 10 years. Axial tumors were more likely to metastasize, and black patients presented more frequently with metastasis. Further studies are needed to elucidate these differences.

Table I. Demographics and Univariate Disease-Specific Survival Analysis at 10 Years

Variable	N	%	10-Year DSS % (95% CI)	p-Value
Total	1732	100.0	54.4 (53.1-55.7)	
Sex				0.046
- Male	1091	63.0	50.7 (48.9-52.5)	
- Female	641	37.0	56.1 (53.8-58.4)	
Age				<0.001
- 0-10	369	21.3	73.6 (70.9-76.3)	
- 11-20	845	48.8	51.9 (49.9-53.9)	
- 21-30	273	15.8	44.4 (40.7-48.1)	
- 31+	245	14.2	33 (29.4-36.6)	
Race				0.013
- Black	50	2.9	29 (20.8-37.2)	
- Hispanic	350	20.2	53.4 (49.9-56.9)	
- Other	109	6.3	55.4 (49.6-61.2)	
- White	1223	70.6	53.3 (51.6-55)	
Tumor Location				<0.001
Appendicular	762	44.0	61.7 (59.6-63.8)	
- Non-Metastatic	564	74.0		
- Metastatic	198	26.0		
Axial	970	56.0	45.6 (43.7-47.5)	
- Non-Metastatic	574	59.2		
- Metastatic	396	40.9		
Tumor Spread				<0.001
- Non-Metastatic	1138	65.7	65.1 (63.4-66.8)	
- Metastatic	594	34.3	28 (25.7-30.3)	
Tumor Size				<0.001
- <5 cm	867	50.1	55.2 (52.7-57.7)	
- 5-8 cm	115	6.6	56.6 (51.8-61.4)	
- >8 cm	169	9.8	40.3 (36.4-44.2)	
- Unknown	581	33.6	51.7 (49.5-53.9)	
Education				0.252
- 1st Quartile	418	24.1	49.7 (46.8-52.6)	
- 2nd Quartile	441	25.5	53.5 (50.7-56.3)	
- 3rd Quartile	420	24.3	50.5 (47.5-53.5)	

-4th Quartile	453	26.2	56.4 (53.7-59.1)	
Poverty				0.006
-1st Quartile	336	19.4	50.6 (47.2-54)	
- 2nd Quartile	523	30.2	48.7 (46.1-51.3)	
- 3rd Quartile	427	24.7	59.3 (56.4-62.2)	
- 4th Quartile	446	25.8	52.5 (49.7-55.3)	
Income				0.405
- 1st Quartile	441	25.5	49.1 (46.3-51.9)	
- 2nd Quartile	441	25.5	56.4 (53.7-59.1)	
- 3rd Quartile	433	25.0	52.5 (49.6-55.4)	
- 4th Quartile	417	24.1	52.9 (49.9-55.9)	
SES Composite				0.048
- 1st Quartile	561	32.4	50.5 (47.9-53.1)	
- 2nd Quartile	427	24.7	50.8 (48-53.6)	
-3rd Quartile	371	21.4	59.2 (56.1-62.3)	
- 4th Quartile	373	21.5	52 (48.9-55.1)	

Calculated using Kaplan-Meier

Values shown are percent survival at 10 years and 95% confidence intervals

Significance p=0.05

**Table II. Multivariate Analysis of Variables at 10 Years**

<b>Variable</b>	<b>Hazard Ratio (95% CI)</b>
Sex	
- Male	Ref
- Female	0.860 (0.732-1.011)
Age	
- 0-10	Ref
- 11-20	1.771 (1.376-2.280)
- 21-30	2.380 (1.778-3.185)
- 31+	3.537 (2.650-4.722)
Race	
- White	Ref
- Black	1.590 (1.085-2.328)
- Hispanic	1.053 (0.853-1.299)
- Other	1.092 (0.779-1.530)
Tumor Location	
- Appendicular (C40.0-40.9)	Ref

-Axial (C41.0-41.9)	1.206 (1.024-1.420)
Tumor Spread	
- Non-Metastatic	Ref
- Metastatic	3.033 (2.590-3.552)
Tumor Size	
- <5 cm	Ref
- 5-8 cm	0.928 (0.678-1.270)
- >8 cm	1.645 (1.299-2.084)
- Unknown	1.226 (1.028-1.461)
Poverty	
- 1st Quartile	Ref
- 2nd Quartile	0.978 (0.764-1.252)
- 3rd Quartile	0.773 (0.520-1.151)
- 4th Quartile	0.784 (0.448-1.374)
SES Composite	
- 1st Quartile	Ref
- 2nd Quartile	1.136 (0.886-1.456)
- 3rd Quartile	1.112 (0.732-1.687)
- 4th Quartile	1.292 (0.734-2.276)

Calculated using Cox Regression

Values shown are hazard ratios and 95% confidence intervals

Includes all variables found to be significant in univariate analysis

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## Epidemiology, incidence, and survival of osteosarcoma sub-types: SEER database analysis

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**Background:** Osteosarcoma is the most commonly diagnosed primary malignancy of bone, particularly among children and adolescents. Sub-types of this disease include: telangiectatic, fibroblastic, central, chondroblastic, parosteal, periosteal, and small cell. Different subtypes have different characteristics, but the rarity of these disease makes study of the unique personality of each subtype very difficult. One approach is to use large population based databases to study large numbers of these tumors. The National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program of USA population-based data from 1973 to 2014 offers a unique opportunity to perform detailed analyses of incidence and survival of rare neoplasms.

**Questions:** The purpose of this study was 1) to evaluate patient demographics, clinical behavior, incidence, and survival for osteosarcoma sub-types and 2) to determine if there was a difference in the epidemiology, overall survival, and 5-year survival rate between the seven sub-types of chondrosarcoma recorded in the SEER database.

**Methods:** The National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) database was used to search for patients diagnosed with all sub-types of chondrosarcoma between 1973 and 2014. Patient demographics, tumor characteristics, incidence, and survival trends were all analyzed. Differences in the epidemiology, overall survival, 5-year survival rate, and incidence were also analyzed using ANOVA statistical test, a Chi-squared analysis, and pairwise tests with correction of multiple factors with the Holm-Bonferroni procedure. Significant differences were based on a  $p < 0.05$ .

**Results:** There were a total of 1,631 patients were identified in the SEER database. All patient demographic, clinical and tumor data can be found in Table 1. Survival and incidence data can be found in Table 2. The highest rate of metastasis was seen in the small cell sub-type (11.4%), which correlates with its lowest survival rate. Radiation therapy was much more likely to be used for this subtypes as well, which may indicate that more aggressive treatment was used. The overall survival differences were significant between groups, as were the 5-year survival rates, which showed that central and small cell osteosarcoma had the worst overall survival with a 23.2 and 29.5% 5-year survival respectively. This was followed by chondroblastic and telangiectatic subtypes with 5-year survival rate of 39.6% and 45.5% respectively. Parosteal osteosarcoma had the highest 5-year survival rate with 68.2%. Data on chemotherapy use or local recurrence rate was not available in the database. There were significantly more males in telangiectatic (62%) and chondroblastic (56%) than in parosteal (43%) ( $p < 0.05$ ). There were no significant differences in the survival months with respect to gender ( $p > 0.05$ ). There were no significant differences in terms of race between the seven sub-types ( $p > 0.05$ ). In addition, there were no significant differences in the survival rates between the subtypes ( $p > 0.05$ ). Grade I disease was mostly found in parosteal sarcoma (28%), and least likely in chondroblastic (1.4%). Grades III and IV were most likely to be found in chondroblastic (66.2%) and fibroblastic (65.5%), and least likely in parosteal (14.8%). Age was significantly positively correlated with survival months ( $p < 0.05$ ), indicating older patients had longer survival times. Tumor size was significantly negatively correlated with survival months ( $p < 0.05$ ), indicating patients with larger tumors had shorter survival times.

**Conclusion:** This study represents a population database study on osteosarcoma demonstrating that useful information can be gleaned from population database analysis for rare tumors. The results help to identify significant differences between the subtypes, allowing a better understanding of the personality of each subtype. By highlighting the difference between these subtypes, such as differences in metastatic rate and 5-year survival, this study helps the treating physician by allowing a more informed understanding of the expected behavior of each subtype, which can be critical for decision-making in patient care. There are limitations which are inherent in this type of study, such as unclear generalizability of the data, data are always a few years behind, some services, treatments, and parameters are not in the data, it is not a clinical database, and data are purely observational. Nonetheless, this type of study represents one method of gaining knowledge about rare tumors that would otherwise be difficult to gain in single or even multi-center studies. Further study will be needed to clarify the exact implications of the findings presented.



Variable	Telangiectatic (N=156)	Fibroblastic (N=307)	Central (N=91)	Chondroblastic (N=718)	Parosteal (N=264)	Periosteal (N=51)	Small Cell (N=44)
Clinical Variables							
Mean Age (years)	23.2	34.5	26.9	29.2	29.9	26.3	26.4
Gender							
Males	97 (62.2%)	152 (49.5%)	52 (57.1%)	403 (56.1%)	114 (43.2%)	30 (58.8%)	25 (56.8%)
Females	59 (37.8%)	155 (50.5%)	39 (42.9%)	315 (43.9%)	150 (56.8%)	21 (41.2%)	19 (43.2%)
M:F	1.64:1	0.98:1	1.33:1	1.28:1	0.76:1	1.42:1	1.32:1
Race							
Caucasian	124 (79.5%)	242 (78.8%)	63 (69.2%)	540 (75.2%)	195 (73.9%)	36 (70.6%)	33 (75.0%)
African American	21 (13.5%)	36 (11.7%)	22 (24.2%)	118 (16.4%)	44 (16.7%)	9 (17.6%)	8 (18.2%)
Asian	11 (7.1%)	28 (9.1%)	6 (6.6%)	56 (7.8%)	20 (7.6%)	5 (9.8%)	3 (6.8%)
Other	0 (0.0%)	1 (0.3%)	0 (0.0%)	4 (0.6%)	5 (1.9%)	1 (2.0%)	0 (0.0%)
Anatomical Site							
Bone	153 (98.1%)	292 (95.1%)	90 (98.9%)	682 (95.0%)	263 (99.6%)	51 (100.0%)	42 (95.5%)
Soft Tissue	2 (1.3%)	9 (2.9%)	0 (0.0%)	23 (3.2%)	1 (0.4%)	0 (0.0%)	1 (2.3%)
Skull	0 (0.0%)	4 (1.3%)	0 (0.0%)	9 (1.3%)	0 (0.0%)	0 (0.0%)	1 (2.3%)
Other	1 (0.6%)	2 (0.7%)	1 (1.1%)	4 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Neo-adjuvant Therapy							
Radiation Therapy	14 (9.0%)	30 (9.8%)	6 (6.6%)	88 (12.3%)	9 (3.4%)	1 (2.0%)	10 (22.7%)
Non-radiation therapy	142 (91.0%)	277 (90.2%)	85 (93.4%)	630 (87.7%)	255 (96.6%)	50 (98.0%)	34 (77.3%)
Tumor Data							
Average Size (cm)	9.6	9.1	9.9	10.4	8.2	8.3	10.4
Background Tumor Grade							
Grade I	3 (1.9%)	16 (5.2%)	8 (8.8%)	10 (1.4%)	74 (28.0%)	3 (5.9%)	1 (2.3%)
Grade II	2 (1.3%)	33 (10.7%)	6 (6.6%)	40 (5.6%)	78 (29.5%)	11 (21.6%)	0 (0.0%)
Grade III & IV	96 (61.5%)	201 (65.5%)	54 (59.3%)	475 (66.2%)	39 (14.8%)	23 (45.1%)	26 (59.1%)
N/A	55 (35.3%)	57 (18.6%)	23 (25.3%)	193 (26.9%)	73 (27.7%)	14 (27.5%)	17 (38.6%)
Metastasis (at presentation)	11 (7.1%)	15 (4.9%)	6 (6.6%)	57 (7.9%)	4 (1.5%)	2 (3.9%)	5 (11.4%)

Table 1: Demographic and Clinical data.

Variable	Rate of 5-Year Survival (%)	Overall Survival (months)	Incidence (per 100,000)
Telangiectatic	71 (45.5%)	81.9	0.008
Fibroblastic	158 (51.5%)	97.5	0.010
Central	21 (23.1%)	43.5	0.004
Chondroblastic	284 (39.6%)	73.1	0.013
Parosteal	180 (68.2%)	146.7	0.007
Periosteal	28 (54.9%)	90.4	0.004
Small cell	13 (29.5%)	56.4	0.002

Table 2: Survival Data for Osteosarcoma subtypes.

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### Treatment of chondrosarcoma: an assessment of outcome

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**Introduction:** Primary malignant bone tumors are rare and constitute up to 0.5% of all primary malignant tumours. Approximately 20% of them are chondrosarcomas. Chondrosarcoma is usually a slow-growing neoplasm which produces cartilage tissue.

**Objective:** The aim of this study was to assess the results of treatment in 93 patients with chondrosarcoma. The secondary goal was an attempt to identify prognostic factors.

**Material:** 93 patients, comprising 40 women and 53 men, aged 16-90 years, were treated at the Bone Tumor and Neoplasm Unit between 2002 and 2016. Their general condition was measured according to the Zubrod performance scale and their degree of disability measured in terms of the Modified Rankin Scale. Tumor size, location, tissue involvement, pathological fracture presence, distant metastases, and the presence of previous (benign) primary lesions which had undergone malignant transformation were taken into consideration.

**Methods:** All patients were followed up after treatment. Again, their general condition was measured in the Zubrod performance scale, degree of disability measured in the Modified Rankin Scale. Disease-free survival (DFS), recurrence-free survival (RFS), metastasis-free survival (MFS) and overall survival (OS) were evaluated. Gender dependence, age, histopathological type, diagnosis to treatment time interval, tumor size and location, presence of pathological fracture, type of primary lesion, grading and treatment method were analysed.

**Results:** A statistically significant correlation was confirmed for general condition measured in the Zubrod performance scale pre-treatment and the final score in the Zubrod and Rankin scale post-treatment. A similar correlation was found for degree of disability measured in the Modified Rankin Scale pre-treatment and the final score in Zubrod and Rankin. The final Rankin score was also influenced by age and treatment method.

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## Surgical technique: Limb lengthening by the soft tissue distraction and stem reconstruction by using cage and cement

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**Introduction:** Limb length discrepancy (LLD) is a challenging problem for the growing sarcoma patients. Several techniques are described in the literature to solve LLD in these patient group. In this technique, we combined distraction philosophy and tumor prosthesis.

**Patient and Technique:** 10 years old boy presented to our clinic with the Ewing's sarcoma of the right distal femur with involvement of the epiphysis. He is treated by the wide resection and reconstruction by the tumor prosthesis (Figure 1). After 5 years he came to clinic with 13 cm shortening and limping (Figure 2).

**Surgery:** We prepared custom made stem which is allow us soft tissue lengthening by using circular external fixator. In the first surgery, we changed femoral stem and put the external fixator to allow lengthening soft tissue. After adequate lengthening (10 cm) the patient went to the second surgery. The lengthened segment was wrapped by the titanium mesh and fixed by the two cables and inject the bone cement into the cavity of the titanium mesh. After that, the fixator was removed (Figure 3-4). In the last fallow up the patient can walk and run without supporting device and pain (figure 5).



Figure 1



Figure 2

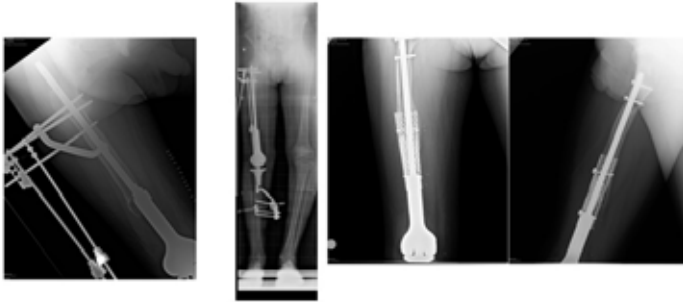


Figure 3



Figure 4



Figure 5

At the end of the treatment shortening is highly compensated.  
(total lengthening: 10 cm)

**Conclusion:** Non-biologic reconstruction for the growing child has a lot of challenges by the time. The shortening problem can be solved by this semi-biologic reconstruction method.

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**Treatment of a supraintercondylar multifragmented fracture of an infected distal femur, with silver-coated tumor endomegaprosis**

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**Introduction:** Bone infection is one of the major challenges in Orthopedics, so when it occurs in cases of joint fractures, it is often almost impossible to treat, evolving into chronic infection with disabling arthralgias. Often amputation is the solution.

**Materials and Methods:** A 46-year-old male patient with multischiroleal supraintercondylar fracture of the distal femur, fistulized and infected with methicillin resistant St. aureus (antecedents of supracondylar fracture of the left femur at 17 years). He underwent a 2-step surgical treatment. In a 1st time the resection of 17 cm of distal femur with several bone fragments, extensive tissue debridement, fistulectomy + spacer in metimethacrylate with gentamicin. Antibiotic therapy for 8 weeks. 2nd surgical time with joint reconstruction with total prosthesis of the left knee with distal endomegaprosthesis of the femur coated with silver.

**Results:** Joint reconstruction of the left knee with distal endomegaprosis of the femur coated with silver. After 2 months in bed before the first surgical time. He was able to wander with the support of two crutches from the 5th postoperative day of the 2nd surgery, until the 8th week and one from the 10th week. At the end of 8 months, the patient has negative PCR and is autonomous despite wandering with support of 1 Canadian in great routes.

**Discussion:** The use of silver-coated endomegaprotheses associated with aggressive tissue debridement allows the creation of conditions to treat complicated cases of infection in complex joint fractures. Silver-coated endomegaprosthesis allows osteoarticular reconstruction and contributes to the treatment of infection.

**Conclusion:** The resolution of this case, using a silver coated endomegaprosthesis to treat bone infection, in a multischiroleal joint fracture of the distal femur, proved to be a good solution, despite the short follow-up time.

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### Two cases of the osteosarcoma with delayed excretion of methotrexate due to abnormal fluid collection in the third space

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**Introduction:** We report two cases with delayed excretion due to fluid retention in third space after high-dose methotrexate therapy (HD-MTX).

**Materials:** Case 1 was 13 years old, male with the left femur osteosarcoma. In the HD-MTX administration of the 4th preoperative chemotherapy, delayed clearance was confirmed. Blood MTX concentrations after 6 hrs and of Day 2, 3, 4, 5, 6, 7 were 956, 12.4, 0.34, 0.24, 0.21, 0.25, 0.3  $\mu$ M respectively. We recognized delayed excretion and increased in leucovorin (LV) after Day 4. There was no deterioration of kidney function. He had cheek swelling, and fluid collection was found in his right maxillary sinus in CT on Day 7. He was punctured and aspirated by 43 ml of yellow serous liquid. The MTX concentration was as high as 4.02  $\mu$ M. On the next day, the blood MTX concentration was clearly 0.05  $\mu$ M. Adverse event due to delayed excretion was observed in oral mucosal ulcer. Case 2 was 12 years old, male with the right femur osteosarcoma. In the second preoperative chemotherapy, delayed excretion was confirmed. The blood MTX concentrations after 6hrs and of Day 2, 3, 4, 5, 7, 8 were 1258, 77, 6.4, 20, 0.69, 0.26, 0.18  $\mu$ M respectively which are abnormally high. Although there were no clinical symptoms, a small amount of ascites was observed around the rectum in CT at Day 3. Temporary elevation of serum creatinine value was observed but it improved promptly, renal function was maintained. Because drainage was difficult technically, we treated by increasing in LV dose and hydration. At day 9, blood MTX concentration was cleared to 0.1  $\mu$ M. During the course, Grade 1 hepatic dysfunction was observed but it improved without symptoms.

**Discussion:** In case 1, fluid collection occurred due to inflammation in the paranasal sinuses after chemotherapy, and improved with puncture drainage. Case 2 had fever and diarrhea before chemotherapy. Although ascites was lost in natural progress, we thought that it was caused by enteritis. There was no problem with renal function, concomitant medication or MTX administration method in both cases, and we thought that fluid retention in third space was the cause of elimination delay. We coped with drainage, LV therapy and hydration and avoided serious adverse events.

**Conclusion:** Fluid collection in third space is one of causes of the elimination delay of HD-MTX, and it is preferable to consider LV rescue therapy and drainage as much as possible.



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### Survival prediction of liposarcoma patients using machine learning models

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**Introduction and Purposes:** Liposarcoma is one of the most common soft tissue sarcomas. For patients with liposarcoma, individual outcomes predictions are hard to make. Recently, artificial intelligence advances have increased modeling prediction capabilities (Waljee 2014). In this study, we created prognostic models to predict overall survival outcomes of liposarcoma patients.

**Materials and Methods:** This study utilized two liposarcoma patient databases: an institutional database (n=38) and the publicly available Surveillance, Epidemiology, and End Results Program (SEER) database of the National Cancer Institute (n=748). Various machine learning algorithms were applied to the SEER database to create models predicting individualized 5-year survival outcomes. The best models were then validated on the institutional dataset.

**Results:** Variables deemed significant for predicting 5-year survival were patient age, tumor size, tumor grade, and presence of metastasis at diagnosis. After testing on the SEER dataset, two types of random forests and neural networks, respectively, were deemed the most predictive models by area under the receiver operator characteristic curve (AUCs), with all AUCs scoring in the 0.77-0.80 range. When tested on the institutional dataset, the model with the highest AUC was a random forest (0.75; 95% CI, 0.58-0.92).

**Conclusions:** Individualized survival outcome prediction has been difficult to perform for oncology patients, and when done is often cumbersome for clinicians to utilize. Using machine learning algorithms, accurate survival outcome predictions can be made easily for patients on an individual basis and is useable for a wide array of people via an online application.

#### References

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#### **Denosumab treatment in patients with Giant Cell Tumor of The Bone : our experience**

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**Background:** Giant cell tumour of the bone (GCTB) is a rare aggressive osteolytic primary tumour. Denosumab, a monoclonal antibody that reduces tumor associated bone lysis by inhibiting the action of RANK ligand, has been used to treat selected cases of GCT. We report the experience of the Orthopedic Oncology Department and Oncology Department of Spedali Civili of Brescia on the treatment of patients with GCTB, associated with pre and postoperative administration of denosumab.

**Materials and Methods:** Between february 2015 and february 2019, we analyzed 14 patients with GCTB. Twelve patients underwent treatment with Denosumab. There were 8 women and 6 men with a mean age of 35.5 years (range 18-48). The location of GCTB was in the upper limbs in the majority of cases (57%) The lower limb was involved in 4 cases (29%). One case was located in the lumbar spine (L3) (7%) and another one in the anterior thoracic wall (7%). Thirteen patients were treated for a primary lesion, and one patient at recurrence. Seven patients received neoadjuvant treatment with denosumab 120 mg (day 1,8,15,28 and every 4 weeks thereafter) for at least five months, 3 patients received adjuvant treatment, one patient was treated for recurrence, one patient underwent palliative therapy with denosumab for GCTB considered inoperable. The surgical timing was based on clinical and radiological findings (Campanacci grading). The minimum number of doses was 5 per patient (median, 13.75 range, 5-43) preoperatively. The minimum follow-up was 7 months (median, 20 months; range, 7-40 months).

**Results:** All patients were evaluated. Of the twelve patients undergoing treatment with denosumab, eleven were treated surgically: 7 with a curettage (63%), 4 with a resection (34%). In all patients undergoing treatment with Denosumab no disease recurrence was observed over a minimum follow up of seven months. In two of the three patients with metastatic disease at the time of diagnosis, no continuation of the disease was observed after treatment with Denosumab.

**Conclusions:** In our experience, the use of preoperative denosumab in patients with resectable GCTB was safe and allowed a less invasive surgical approach and good preservation of function. treatment. This therapy should be considered in the standard multidisciplinary treatment of advanced GCTB to facilitate surgery at a later stage, and thereby aiming at immediate local control. Even though several questions concerning optimal treatment dose, duration and interval and drug safety remain unanswered, denosumab is among the most effective drug therapies in oncology.