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Abstracts

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FM01-FM20: SHOULDER / ELBOW

FM01

Cost-utility analysis of shoulder arthroplasty: A Swiss health economic study

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Introduction: With increasing health care expenditures, knowledge about the cost-benefit ratio of surgical interventions such as total shoulder replacements becomes important for orthopedic surgeons, social insurances and health policy decision makers. However, little is known about the impact of total shoulder arthroplasty (TSA) on the quality of life and costs in Switzerland. Therefore, we examined the cost-benefit ratio of TSA implantation from a societal perspective in the setting of the Swiss health care system.

Methods: Patients with shoulder osteoarthritis and/or irreparable tear of the rotator cuff indicated for anatomical or reverse TSA were included in this prospective study. Quality of life (EQ-5D-5L; [index: 0-1]) and shoulder function (Constant Score [CS: 0-100]) were assessed one year before (pre-OP) and up to two years after surgery (post-OP). Their relationship was explored by regression analysis. Sixteen major Swiss insurance companies provided direct medical cost data including costs of all health-related diagnoses. Indirect costs were assessed using the work productivity and activity impairment questionnaire. The pre-OP year served as control period. Mean costs to gain one extra quality adjusted life-year (QALY) were estimated by calculating the incremental cost-effectiveness ratio (ICER; [perspective: social health / accident insurances; time horizon: 2 years]).

Results: A total of 151 patients (mean age 71 years; 22% working; 58% female; 19% trauma) were included. The mean EQ-5D-5L index improved from 0.68 (pre-OP) to 0.89 and 0.88 at 1 and 2 years post-OP respectively ($p < 0.001$), and was significantly associated with CS improvement ($p < 0.001$). Mean direct medical costs were 11,765 CHF (pre-OP), 34,809 CHF (1 year post-OP) and 11,501 CHF (2 years post-OP). Pre-OP 33 patients worked, whereof 6 were completely on sick leave due to shoulder problems. Thirty patients returned to work, on average, 72 days after surgery. The ICER was 62,205 CHF per QALY gained (95%CI: 43,036 to 81,373 CHF/QALY) until 2 years post-OP compared to the control period.

Conclusion: This study is the first to analyse real world cost data and calculate the cost-utility ratio after TSA in Switzerland. Our ratio clearly falls below the often suggested 100,000 CHF/QALY threshold for Switzerland. By applying a time horizon of more than 2 years post-OP, ICER values below 60,000 CHF/QALY are attainable.

FM02

Effect of critical shoulder angle, glenoid lateralization and humeral inclination on range of motion in reverse shoulder arthroplasty

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Introduction: Recent studies used computer simulations to determine effects of humeral and glenoid variations on range of motion (ROM) and bony impingements after reverse shoulder arthroplasty (RSA), but none investigated how different configurations of lateralization or neck shaft angle (NSA) affect shoulder ROM in different scapular morphologies. The purpose of the present study was therefore to evaluate the effects of lateralization of the center of rotation (COR) and NSA on shoulder ROM after RSA in patients with different scapular morphologies.

Methods: 3D-computer models were constructed from computed tomography scans of 12 patients with CSA of 25°, 30°, 35° and 40°. For each model, shoulder ROM was simulated and evaluated at a NSA of 135° and 145° and lateralization of 0 mm, 5 mm and 10 mm for 7 standardized motions: glenohumeral abduction, adduction, forward flexion, extension, internal rotation with the elbow at 90° of abduction, as well as external rotation with the arm at 10° and 90° of abduction.

Results: In all models, CSA did not seem to influence ROM, but greater lateralization achieved greater ROM for all motions in all configurations.

Internal and external rotation at 90° of abduction were impossible in most configurations, except in models with 25° CSA.

Conclusions: Post-operative ROM following RSA depends on multiple patient and surgical factors. This study based on computer simulation suggests that there is no influence of CSA on ROM after RSA, while lateralization increases ROM in all configurations. Furthermore, increasing subacromial space is important to grant sufficient rotation at 90° of abduction. In summary, increased lateralization of the center of rotation and increased subacromial space improve range of motion in all CSA configurations.

FM03

Cow-Hitch-Suture Cerclage for Fixation of the Greater Tuberosity In Fracture RTSA

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Introduction: Complex proximal humerus fractures in the elderly can be treated with reverse total shoulder arthroplasty (RTSA). Healing of the greater tuberosity (GT) is associated with higher patient satisfaction and better clinical outcome. Stable refixation of the GT is crucial for GT healing and different methods are described. It was the aim of this cadaver study to compare the biomechanical stability of GT refixation obtained with the so-called “Cow Hitch” with that of the standard suture cerclage technique.

Methods: A four-part proximal humerus fracture was created through a deltopectoral approach on 10 fresh-frozen human cadaveric shoulders. A CT scan was performed preoperatively to ensure the comparability of the fractures. In one group the GT was reattached to the stem of the RTSA with the “cow hitch” suture cerclage technique while in the control group the reattachment of the GT was accomplished using the conventional GT refixation technique recommended for the tested implant (Zimmer® Anatomical Fracture: operative Technique). The shoulder was fixed in beach chair position and the surrounding tissue was not dissected to simulate a real condition. After surgery a CT scan was performed and the humeri were then explanted. Humeri were potted in cylinders and tested with an uniaxial material testing machine in a modified test setup previously described by Brianza et al. (Brianza et al. *Clinical Biomechanics* 2010). Hereby 5000 loading cycles with forces from 250-350N were applied while any motion of the tuberosities was recorded with a telecentric camera.

Results: Overall, after 5000 loading cycles, the cow hitch group showed a significant and substantial reduction of bone fragment movement between first and last cycle (0.82 ± 0.45 mm) compared with the control group [4.32 ± 3 mm ($p < 0.05$)]. The Cow Hitch group also showed higher ultimate failure forces (1302 ± 259 N vs. 1121 ± 301.2 N), however those differences were not significant.

Conclusions: GT reattachment with the “cow hitch” suture cerclage showed 520% less movement of the fracture parts upon experimental loading compared with currently recommended suture cerclages in an in-vitro 4-part proximal humeral fracture model. Whether this higher fixation strength results in more reliable bony healing of the tuberosities and thus better clinical outcome needs to be investigated in clinical studies.

FM04

Neck Shaft Angle After Reverse Shoulder Arthroplasty

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Background: Implant size and geometry, together with the humeral cut level and entry point, can all influence humeral stem alignment in RSA. It has been reported that lower NSA can reduce scapular notching, heterotopic ossification, and pain, while improving range of motion, notably in adduction. Short uncemented and convertible stems are gaining popularity as they preserve bone stock and facilitate revision surgery, though they remain more difficult to align than long stems that serve as intramedullary guides. The aim of this study was to evaluate differences between expected and postoperative neck shaft angle (NSA) in reverse shoulder arthroplasty (RSA).

Methods: The authors retrospectively reviewed immediate postoperative radiographs of a consecutive series of 159 patients, comprising 57

men (36%) and 102 women (64%), who underwent RSA with a short uncemented convertible stem with constant NSA of 145°. The parameters measured included NSA, defined as the angle between the diaphyseal axis and the perpendicular to the reversed tray, and canal fill ratio (CFR), calculated by dividing the mediolateral width of the stem by that of the inner bone cortex, both measured perpendicular to the diaphyseal axis 1 cm below the medial calcar-prosthesis junction. The inter-observer agreement was excellent for both NSA and CFR (intraclass correlation coefficients of 0.85 and 0.81, respectively).

Results: The postoperative NSA was 149°±7.9° (range, 133.5°–176.5°) and CFR was 57.7%±8.2% (range, 38.6%–74.0%). The mean postoperative NSA was greater than expected by 4.0°±7.9° (range, -11.5°–31.5°), exceeding 5° of valgus in 71 shoulders (45%) and exceeding 5° varus in 15 shoulders (9%). Univariable linear regression revealed that absolute deviation between expected and postoperative NSA (misalignment) decreased significantly with CFR (beta, -13.1; p = 0.023).

Conclusions: While short uncemented stems offer several advantages in RSA, they remain challenging to align within the humerus, particularly if undersized. Misalignment of 5° or more was observed in more than half this series, and surgeons should reduce such alignment errors that may compromise clinical and radiographic outcomes.

FM05

Mid- to long-term clinical and radiological results of polyethylene total shoulder arthroplasty in B2 glenoid

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Introduction: Although the anatomical shoulder prosthesis is a well-established treatment, there are many unanswered questions about the survival of these implants in different glenoid morphology. The results in patients with a biconcave glenoid (B2) have historically been less predictable. It was the purpose of this study to analyze mid- to long-term outcome of anatomical total shoulder arthroplasty in Walch B2 glenoid.

Methods: Forty-four patients with a mean age of 65 (range, 36–78) years at surgery were either personally reviewed (n = 40) or had a telephone consultation (n = 4) after a mean follow-up of 9.7 (range, 5–17) years. There were 7 patients (16%) with previous non-arthroplasty surgery. Patients were examined clinically and radiographically every 2 to 5 years until final follow-up.

Results: The mean absolute and relative Constant score (aCS; rCS) had improved from 38 (± 1) to 76 points (± 9; gain of 38 points; p < 0.001) and from 47% (± 19) to 93% (± 13; gain of 46%; p < 0.001). Significant improvements were seen in mean pain scores (5 to 15 (out of 15) points; p < 0.001), active anterior elevation (100° to 158°; p = 0.002), abduction (80° to 155°; p = 0.009), external rotation (18° to 40°; p = 0.001) internal rotation (6° to 9°; p = 0.009) and SSV (40% to 90%; p < 0.001). One or more complications were recorded in 4 patients (8%) after a mean of 11.3 years (3 aseptic loosening, 1 infection). Estimated survivorship (based on Kaplan Meier Analysis) without failure of the TSA was 98% at 10 years and 92% at 15 years.

Conclusion: Although the results after 10 years demonstrate a complication and failure rate of 8%, Total shoulder arthroplasty for Walch B2 glenoids yields substantial improvement in shoulder function and subjective outcome with excellent survival rates and significant improvement of pain, anterior elevation, abduction, ER and IR.

Keywords: Total shoulder arthroplasty; B2 glenoid,

FM06

Reverse shoulder arthroplasty in the treatment of glenohumeral instability

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Introduction: Glenohumeral instability is a rare indication for primary reverse total shoulder arthroplasty (RTSA) accounting for less than 1% of the indications in the literature. It was the aim of this study to analyze the clinical and radiographic outcome of RTSA for recurrent instability after failed operative repair or instability associated with major bone loss in the elderly.

Methods: A retrospective matched case-control study was performed. 11 shoulders treated with RTSA for instability (cases) were compared with 22 matched shoulders treated with RTSA for rotator cuff insufficiency (controls). Clinical and radiographic outcomes were compared.

Results: The median follow-up was 74 (interquartile range [IQR] 18) months in cases (range, 22 to 171 months) and 70 (IQR 13) months in controls (range, 23 to 172 months). In the case group the median age was 74 years (IQR 18) and 70 years (IQR13) in the control group. There were no significant differences between both groups in the satisfaction score, the pre- and postoperative absolute and relative Constant scores and the complication rate. Active range of motion, tended to be superior in the controls for mean flexion (130° versus 110° p = .15), abduction (143° versus 100°, p = .16) and external rotation (28° versus 20°, p = .86) without the differences reaching statistical significance, possibly due to the small sample size. Postoperative dislocation was neither recorded in cases nor in controls, but subjective insecurity regarding stability was reported once in both groups.

Conclusion: RTSA seems to represent a valuable treatment option in glenohumeral instability for an elderly population with large bone loss or as a salvage procedure after failed operative, glenohumeral stabilization. Postoperative instability was not observed in the case and the control group

FM07

Autologous chondrocyte implantation for treatment of focal cartilage defects of the humeral head

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Autologous chondrocyte implantation (ACI) constitutes an established treatment option for focal articular cartilage defects of the knee. However, literature regarding its use in the glenohumeral joint is scarce and the management of cartilage defects in the shoulder remains a challenge. The aim of this study was to evaluate the clinical, radiologic and arthroscopic results after ACI with three-dimensional (3D) spheroids of human autologous matrix-associated chondrocytes for treatment of focal articular cartilage lesions of the humeral head.

7 male patients (mean age 39.5 [range: 18–55] years) with a grade IV cartilage defect of the postero-central humeral head were treated with ACI between 2011 and 2016. A chondrocyte sample was harvested during a staging arthroscopy for external cultivation and cell expansion. The ACI was conducted by an open approach in 3 cases and arthroscopically in 4 cases. The patients were assessed by clinical [range of motion, Visual Analogue Scale (VAS), Subjective Shoulder Value (SSV), Constant Score (CS), American Shoulder and Elbow Surgeons (ASES) Standardized Shoulder Assessment Form] and radiological (true anteroposterior, axillary and y-views) examination. Additionally, the cartilage defect was re-evaluated arthroscopically in 5 patients.

After a mean follow-up period of 35 (range: 22–58) months, the SSV averaged 91 (range: 70–100) % compared to a SSV of 49 (range 30–60) % preoperatively, VAS averaged 0 at rest and 1 (range 0–2) during exercise, CS 94 (range: 80–100) points and ASES 96 (range 90–100) points. All patients presented with a full range of motion and stated that they would repeat and/or recommend this surgical treatment. The mean preoperative cartilage defect size was 3.3 (range: 2.3–4.5) cm². During the arthroscopic re-evaluation 7 (range: 4–12) months postoperatively, complete coverage of the cartilage defect was observed in 4 cases while a circumferential residual defect of 0.25 cm² was present in one case. One patient suffered from a postoperative adhesive capsulitis, which was successfully treated by an arthroscopic arthrolysis and capsular release. Two patients showed a grade I secondary osteoarthritis (according to Samilson Prieto).

ACI using 3D-chondrocytes spheroids for treatment of focal articular cartilage lesions of the humeral head achieves satisfactory clinical results during a short to mid-term follow-up period and leads to successful coverage of grade IV cartilage lesions.

FM08

Synovasure test is not helpful in predicting shoulder PJI

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Introduction: Periprosthetic joint infections (PJIs) remain a challenging complication after joint arthroplasty. The antimicrobial peptide alpha-defensin has been proven as a new synovial fluid biomarker with high sensitivity and specificity in diagnosing PJIs in patients with hip or knee joint arthroplasty. However, only little data is available on the diagnostic accuracy of alpha-defensin in shoulder PJIs.

Methods: Between June 2016 and June 2018, 60 consecutive patients with a painful shoulder prosthesis and a diagnostic shoulder aspiration

were prospectively enrolled in the study. The Musculoskeletal Infection Society (MSIS) diagnostic criteria were used to diagnose a PJI. Beside routine serum (C-reactive protein, erythrocyte sedimentation rate) and synovial (white blood cell count, polymorphonuclear cell percentage, bacterial culture) laboratory parameters according to the MSIS criteria, alpha-defensin was measured in the synovial fluid using the lateral flow alpha-defensin test (Synovasure®). Patients were excluded if the Synovasure test could not be performed (due to dry or low amount of aspirate) or interpreted (due to bloody aspirate), or if patients had taken antibiotics within 2 weeks before testing.

Results: Finally, we included 29 patients (12 men, 17 women) with a mean age of 70 years (range, 50-92 years), in which a PJI was detected in five cases (Staphylococcus aureus n = 2, Staphylococcus epidermidis n = 2, Cutibacterium acnes n = 1). There were four false-positive and two false-negative Synovasure® test results, leading to a sensitivity and specificity of 60% and 83%, respectively. The positive predictive value was 40% and the negative predictive value was 90%.

Conclusion: Given the low accuracy of the Synovasure test in this study, it is not helpful in predicting shoulder PJIs, but may be helpful for ruling out shoulder PJIs due to a high negative predictive value.

FM09

Thinking Outside the Glenohumeral Box: Hierarchical Shape Variation of the Periarticular Anatomy of the Scapula Using Statistical Shape Modeling.

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Introduction: Variation in the shape of the glenoid and periarticular anatomy of the scapula, including variation in acromial overhang, coracoid angulation and glenoid inclination, has been related to rotator cuff tearing, primary osteoarthritis, and shoulder instability. Yet, a perspective on the hierarchical influence of anatomic variance of these structures is still lacking. The goal of this study was to identify the hierarchy of shape variation of periarticular scapular anatomy in relation to the glenoid in non-pathologic shoulders.

Methods: Computed tomography scans of 31 cadaveric scapulae, verified to be free of pathology, were three-dimensionally reconstructed. Statistical shape modeling and principal component analysis identified the modes of shape variation across the population. Corresponding linear and angular measurements quantified the morphometric variance identified by the modes. Linear measures were normalized to the radius of the inferior glenoid to account for differences in scaling of the bones.

Results: The first 5 modes captured 89.7% of total shape variation of the scapula. Apart from size differences (Mode 1: 33.0%), acromial anatomy accounted for the largest variation (Mode 2: 32.0%). Further modes described variation in glenoid inclination (Mode 3: 11.8%), coracoid orientation and size (Mode 4: 9.0%), and variation in coracoacromial (CA) morphology (Mode 5: 3.1%). The average scapula had a mean acromial tilt of $49 \pm 7^\circ$, scapular spine angle of $61 \pm 6^\circ$, glenoid inclination of $84 \pm 4^\circ$, coracoid deviation angle of $26 \pm 4^\circ$, coracoid length of 3.7 ± 0.3 glenoid radii, and a CA base length of 5.6 ± 0.5 radii.

Conclusion: The acromion exhibited the highest variance of all periarticular anatomic structures of the scapula in relation to the glenoid. The identified shape modeling modes explain the large variance in standard clinical scapular measures across human cohorts.

FM10

Posterior Acromial Extent Predicts Glenoid Version in Normal and Osteoarthritic Shoulders

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Introduction: Various measures of acromion morphology have been related to shoulder disorders and treatment outcomes. Our objective was to test correlations between two specific acromion landmarks and glenoid version/inclination in both normal and osteoarthritic (OA) shoulders.

Methods: CT scans of 120 young (≤ 40 years) normal and 202 OA scapulae were analyzed in 3D using a reliable semi-automated method yielding a scapular coordinate system, glenoid version and inclination, and two specific acromion landmarks: the acromion angle (AA) and the most anterior point of the acromioclavicular (AC) joint. These two points were characterized by their three coordinates in the scapular coordinate system (x: postero-anterior, y: infero-superior, z: medio-lateral, origin: spino-

glenoid notch projected on the medio-lateral scapular axis). We performed stepwise multiple linear regressions to estimate glenoid version and inclination from AA and AC coordinates. We further included age, gender, height and weight as additional predictors.

Results: For normal scapulae, there were strong and moderate correlations between acromion landmarks and glenoid version ($R^2 = 0.64$, $p < 0.001$, $RMSE = 3.2^\circ$), and inclination ($R^2 = 0.56$, $p < 0.001$, $RMSE = 3.6^\circ$), respectively. For glenoid version, AA posterior extent was the most important predictor, while AC superior extent was the most important predictor for glenoid inclination. AA and AC lateral extents, age, height and weight were not correlated with glenoid version or inclination. Regressions were affected by gender, but followed the same trend for males and females. For OA scapulae, similar significant correlations were obtained for glenoid version ($R^2 = 0.29$) and inclination ($R^2 = 0.42$).

Conclusion: This study demonstrates a link between the morphology of the acromion and glenoid, in both normal and OA shoulders. Two specific acromion landmarks can be utilized to predict both glenoid version and inclination. They characterize the posterior and superior acromial coverage, extent, and offset relative to the medio-lateral scapular axis. Our analysis suggests that AA posterior extent in young normal subjects might be considered as a risk factor for the development of glenohumeral OA in the elderly. If confirmed, the 3D measure of the posterior acromial extent could be estimated from Neer x-ray views.

FM11

Contribution of Scapula and Humerus to Overall Elevation in Patients with Excellent, Average and Poor Function after Reverse Shoulder Arthroplasty

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Introduction: Substantial differences in range of motion (ROM) can be observed after reverse shoulder arthroplasty (RSA). We speculated that scapulothoracic rather than glenohumeral contribution to overall elevation in patients with poor mobility is the limiting factor. Therefore, this study identified the individual participation of scapula and humerus to thoracohumeral elevation in patients with excellent, average and poor function after RSA.

Methods: Of 24 patients between 6 and 24 months after surgery, 6 presented with excellent ($> 145^\circ$), 12 with average ($90-145^\circ$) and 4 with poor elevation in scapular plane ($< 90^\circ$). The glenohumeral and scapulothoracic contribution to elevation was assessed using a 3D-motion capture system. Additionally, a clinical exam including passive glenohumeral motion and abduction strength was performed. Correlations between laboratory and clinical parameters were calculated.

Results: The excellent and average group initiated their motion with a higher glenohumeral participation than the poor group, who started with larger scapulothoracic contribution. When elevation approached 90° , the scapulothoracic and glenohumeral shares were about equal in the excellent group while the scapulothoracic contribution remained higher for the poor group. Deficits in using the full capacity of possible glenohumeral range were observed predominantly in poor and average groups. Maximum possible elevation was strongly correlated with passive glenohumeral motion range ($r = 0.62$) and moderately with abduction strength ($r = 0.49$).

Conclusions: Contrary to our hypothesis, the cause of poor global elevation was a reduced glenohumeral contribution. Passive glenohumeral mobility and abduction strength were limited predominantly in the poor group. If the scapulothoracic mobility compensates for insufficient glenohumeral contribution, satisfactory ROM can be achieved. Relevant restriction of scapula motion occurred concomitantly with reduced glenohumeral participation and did not present itself as an independent factor. Thus, the glenohumeral portion of elevation appears to be the key to good overall mobility. As the movement characteristics are highly individual, the analysis of the patient-specific motion pattern can detect the weak point during elevation and might help to target specific exercises during physical therapy.

FM12

Early versus delayed surgical treatment of high grade acromioclavicular joint dislocations

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Aim: To compare functional outcomes of early and delayed surgical treatment of high grade acromioclavicular joint (ACJ) dislocations.

Background: Although non-operative treatment of low-grade ACJ dislocations is widely accepted, the benefits of surgical treatment of high-grade ACJ dislocations remains controversial. Only few studies compared outcomes of early versus delayed surgical treatment of high-grade ACJ dislocations, but none of them used specific or contemporary techniques or scores.

Methods: We retrospectively reviewed 43 consecutive patients who underwent open stabilization of high-grade ACJ dislocations (Rockwood types \geq III): 23 underwent early stabilization (<2 weeks after injury), performed with tied acromioclavicular and coracoclavicular cerclages, while 20 underwent delayed stabilization, performed by the modified Mazzoca technique. Patients were evaluated clinically at mean follow-up of 3.5 years using ACJI and Taft scores, as well as pain on visual analogic scale, subjective shoulder value (SSV) and overall satisfaction. Multi-variable regressions were performed to test associations between post-operative scores and timing of surgery, age gender, and Rockwood types.

Results: The two groups did not differ in terms of preoperative patient characteristics or ACJ Rockwood types. At last follow-up, there were no significant differences between early and delayed surgery in terms of ACJI score (84.4 ± 14.6 vs 88.3 ± 14.3 , $p = 0.171$), Taft score (10.0 ± 1.3 vs 10.7 ± 1.3 , $p = 0.085$), pain (0.3 ± 0.6 vs 0.7 ± 1.1 , $p = 0.263$), SSV (95.1 ± 7.8 vs 92.5 ± 9.0 , $p = 0.352$) or satisfaction (9.6 ± 0.9 vs 9.4 ± 1.1 , $p = 0.444$). Multi-variable analyses confirmed that timing of surgery has no impact of ACJI and Taft scores.

Conclusions: Both early and delayed surgical treatment of high-grade ACJ dislocations showed satisfactory results. Early surgical treatment may not be appropriate in all cases, as most patients could benefit from non-operative treatment, and if necessary, can be operated with success at a later stage surgery.

FM13

Long-term Results of the Arthroscopic Bankart Procedure for Recurrent Anterior Shoulder Instability in Patients Older than 40 Years

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Introduction: Several studies have suggested that age over 40 years is a risk factor for outcome after stabilization procedures. So far, no long-term results about the arthroscopic Bankart procedure in elderly are available. It was therefore the purpose of this study, to analyze our long-term results of the arthroscopic Bankart procedure for recurrent anterior shoulder dislocation in patients of at least 40 years of age.

Methods: Twenty-nine consecutive patients (30 shoulders) with a mean age of 49 (range, 40 - 69) years at surgery were personally evaluated at a mean follow-up of 13 (range, 9 - 18) years. Three patients (10%) received a concomitant single-tendon rotator cuff repair. Long-term results were assessed clinically and radiographically including CT scanning at final follow-up. Recurrent instability was defined as anterior apprehension or recurrent overt instability (subluxation and redislocation).

Results: Recurrent instability persisted in 10 shoulders (33%) and a recurrence of dislocation occurred in seven shoulders (23%) after a mean of 7.4 years. Redislocation was significantly associated with severe dislocation arthropathy ($p = 0.025$) and revision surgery ($p < 0.001$). Revision surgery was necessary in eight patients (27%) and included two re-Bankart and six Latarjet procedures. In the remaining 22 shoulders, the final overall result was rated as good or excellent and the relative preoperative Constant score and SSV were significantly improved ($p < 0.001$). Dislocation arthropathy was severe in 7 shoulders (32%) and had progressed by at least 2 grades in 11 patients (50%). Patients with severe dislocation arthropathy had already shown degenerative changes preoperatively as opposed to those who ultimately had mild or moderate ($n = 15$) dislocation arthropathy ($p = 0.002$).

Conclusion: Although the majority of patients remained satisfied up to 19 years postoperatively, the arthroscopic Bankart procedure for recurrent anterior shoulder instability in patients older than 40 years is associated with a high redislocation and revision rate. One third of the patients showed signs of severe dislocation arthropathy, which was found to be associated with recurrent instability and with preoperative degenerative changes.

FM14

Glenoid defect size depends on glenoid defect orientation in patients with recurrent traumatic anterior shoulder instability

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Introduction: Clinical and biomechanical studies have emphasized the importance of defect size and orientation in patients with recurrent traumatic anterior shoulder instability (RTASI). The typical categorization of glenoid defects as anterior and anterior-inferior neglects potential anterior-superior oriented defects. The aim of this study was to quantify and compare glenoid defect orientation with defect size in patients with RTASI.

Methods: 50 scapulae with RTASI and glenoid bone loss evident on computed tomography scans were 3D reconstructed. Defect size was defined as the percentage represented by the missing surface segment with respect to the best-fit glenoid circle. Defect orientation was visually categorized as anterior, anterior-superior, or anterior-inferior by two different investigators, and quantified as the angle between the line tangential to the defect and the glenoid center plane. Mean defect size of the subclasses were compared using t-tests. Inter- and intra-rater reliability was assessed by the intraclass correlation coefficient (ICC) for linear measures and by Cohen's kappa coefficient for orientation subclasses.

Results: Mean glenoid defect size was $14 \pm 7\%$ (range, 2% to 32%), and mean glenoid defect orientation was $1 \pm 7^\circ$ (range, -17° to 20°). Anterior-superior defects were smaller than anterior (8% vs. 14%, $p = 0.032$) and anterior-inferior defects (8% vs. 21%, $p = 0.003$). Anterior defects were smaller than anterior-inferior defects (14% vs. 21%, $p = 0.009$). Within the three subclasses of defect orientation, anterior ($n = 36$), anterior-superior ($n = 6$), and anterior-inferior ($n = 8$) an orientation angle of 8° and -8° was found to be the cutoff between subclasses. Reliability of the linear and categorical variables was excellent ($ICC \geq 0.979$ and $kappa \geq 0.813$, respectively).

Conclusion: Although the majority showed an anterior defect orientation, a distinct but previously overlooked anterior-superior subgroup, with smaller defect sizes, is present within the RTASI population. Anterior-inferior defects appear to have the largest defect size. These findings are important for surgical reconstruction as well as biomechanical testing of instability.

FM15

Clinical and radiological risk factors for secondary dislocation of conservatively treated humeral head fractures.

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Introduction: Proximal humeral head fractures account for ~5% of fractures. Most can be treated conservatively, but some may dislocate secondarily. Clinical and radiological risk factors for secondary dislocation were evaluated.

Methods: Proximal humeral fractures treated conservatively were included. Clinical records were scanned for neurological disorders, alcohol abuse, smoking, diabetes or dementia. On plain radiographs, Neer classification, osteoporosis (Tingart, Deltoid Tuberosity Index (DTI)), and osteoarthritis were assessed. Dislocation was defined as translation of at least 5 mm on follow-up x-rays. "Medial hinge" was considered intact, if the medial cortices were in line on AP-view. "Coverage index" was defined as the ratio between the radius of the humeral head and the distance between the rotational center of the head and the axis of the shaft. Statistic evaluation was performed using ANOVA, t-test and Firth logistic regression models.

Results: From 2015 to 2018, 363 patients (364 fractures) were treated at our institution. 118 underwent surgery (31%), of these 106 ORIF and 12 arthroplasties. 240 were treated conservatively, 42 patients (17.5%) were lost to follow-up. Mean age was 70 years (range 26-99) with an average follow up of 82 days. According to Neer's classification, there were 24 one-part fractures and 175 more complex fractures (2;3;4-part: 132;42;1). Secondary fracture dislocation occurred in 66 patients (33.2%). Clinical risk factors were alcohol abuse (odds ratio 56.5 $p < 0.05$), smoking (2.3), diabetes mellitus (1.3), dementia (1.6), female gender (1.7) and right hand dominance (2.4). Neurological disorder (0.3) was not a risk factor. Relevant radiological risk factors were osteoarthritis (OR 18.6 $p < 0.05$) and osteoporosis (OR 44.5). In case of a disrupted medial hinge (OR 38.5 $p < 0.01$) or an insufficient "coverage index" below 70% ($p < 0.04$), secondary dislocation occurred significantly more often

(OR 38.5 and . Neer's classification had no influence on dislocation rate (Neer I 33%, II 35%, III 28%, IV 0%).

Conclusion: In our patients group, 33% of patients showed a secondary dislocation of >5 mm. Patients with alcohol abuse and with a low DTI are at risk for secondary dislocation. If medial hinge is disrupted or coverage index is less than 70% on AP or Neer's view, secondary dislocation has to be anticipated.

FM16

Changes of supraspinatus muscle volume and fat fraction after successful or failed arthroscopic rotator cuff repair.

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Introduction: Muscle atrophy and fatty infiltration are limiting factors for successful rotator cuff (RC) repair. Quantitative data regarding these hallmarks of degenerative muscle changes after RC-repair in man are scarce. With the recently introduced Dixon – MRI technology, 3-dimensional volume and fat fraction analysis of the whole rotator cuff muscle has become possible. It was therefore the purpose of this investigation to perform a quantitative analysis of atrophy and fatty infiltration of the supraspinatus muscle following healed and failed RC-tendon to bone repair.

Methods: Muscle volume and intramuscular fat fraction were measured preoperatively and at 3 and 12 months postoperatively in 19 failed and 21 healed arthroscopic supraspinatus tendon repairs using full muscle volume segmentation and MRI DIXON sequences.

Results: In both groups the muscle volume initially decreased 3 months after RC-repair by -3% (intact-) ($p = 0.140$) and -10% (failed repair) ($p = 0.004$) but recovered between 3 and 12 months to 103% ($p = 0.274$) in intact and 92% ($p = 0.040$) in failed repairs compared to the preoperative volume (difference of change between groups preoperative – 12 months: $p = 0.013$). The supraspinatus muscle's fat fraction did not significantly change after successful repair (6.5% preoperative, 6.6% after 3 months and 6.7% after 12 months (all $p = n.s$). There was however a significant increase from 7.8% to 10.8% at 3 months ($p = 0.014$) and 11.4% at 12 months ($p = 0.020$) after failed repair (difference between groups at 3 months follow-up $p = 0.018$ and at 12 months follow-up $p = 0.001$).

Conclusion: RC tendon tear induced fatty infiltration can be almost stopped and muscle atrophy can even be slightly reversed after successful arthroscopic RC repair. In case of a failed repair these changes are however further pronounced during the first 3 post-operative months but seem to stabilize thereafter. The assessment of the small but probably clinically relevant changes in fat content requires however the use of quantitative measurement protocols such as the MRI Dixon sequence.

* FM17

Acromial morphology is associated with different partial rotator cuff tear patterns

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Introduction: The benefit of an isolated arthroscopic acromioplasty in subacromial impingement syndrome is currently controversially discussed in the literature. This is especially true since the genesis of rotator cuff tears often does not result from a direct subacromial conflict but from degenerative biological and patho-biomechanical processes. However, clinical experience shows that a subgroup of patients can still benefit from this intervention in the longer term. Assuming that bursal sided partial tears of the supraspinatus tendons are rather the result of a direct subacromial conflict in contrast to articular sided tears (PASTA), the question arises whether there is a morphological risk configuration of the acromion which is associated with a bursal sided partial tear of the supraspinatus tendon.

Methods: Between 2011 and 2017, all patients who underwent an arthroscopic repair of either an articular sided (PASTA) or bursal sided supraspinatus tear (BST) were identified. Two groups were made (45 PASTA vs. 28 BST). In both groups, omometric parameters on standard ap and axial shoulder radiographs were analyzed. On the ap radiograph, the short sclerotic line, defined by the visible sclerotic line formed by the mediolateral border of the acromion, was measured. The CSA and AI were also measured. On the axial radiograph, length and mediolateral width of the acromion were measured. In addition, the distance between a line at square angle from the center of the glenoid to the tangent on

the medial border of the acromion was measured. This parameter was called medial border offset.

Results: There was a significant difference in mean length of the short sclerotic line in both groups (PASTA: 16.24, BST: 13.09 mm, $p = 0.008$). The difference in the ratio of mediolateral border to length of the acromion was statistically significant ($p = 0.021$), with BST having slightly greater acromial length than PASTA (59 vs. 56 mm). The medial border offset was 42.9 in BST vs. 37.7mm in the PASTA group ($p = 0.021$). There was no statistically significant difference of CSA and AI.

Conclusion: Our data support that narrow mediolateral acromial morphology and larger medial border offset is associated with bursal sided supraspinatus tears. Further clinical investigations are warranted to proof whether patients with this specific omometric characteristics may benefit from isolated acromioplasty.

FM18

Factors predicting the outcome following arthroscopically-assisted stabilization of acute acromioclavicular joint dislocations

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Introduction: Factors influencing the radiographic outcome after arthroscopically-assisted stabilization of acute high-grade acromioclavicular (AC) joint dislocations remain poorly investigated.

Methods: We performed a retrospective analysis of patients who underwent arthroscopically-assisted stabilization for acute high-grade AC joint dislocations. The following determinants of the radiological outcome were examined in an uni- and multivariable regression analysis: timing of surgery, initial reduction of the AC-joint, isolated coracoclavicular- (CC-) versus combined CC- and AC-stabilization, ossifications, age and obesity. In addition, the association between radiographic (CC-difference, dynamic horizontal translation (DPT)) and clinical results (Subjective Shoulder Value, subcategory "subjective" of the Taft-Score and "pain" of the Acromioclavicular Joint Instability Score pain scale) was evaluated.

Results: One hundred and four patients with a mean (\pm SD) age of 38.1 ± 11.5 years were included into this study. Mean (\pm SD) postoperative follow-up was 2.2 ± 0.9 years. Compared to patients with an over reduced AC-joint post-surgery, the CC-difference was 1.4 mm (95% CI, -0.1-2.9; $P = .060$) higher in patients with anatomical reduction and 3.4 mm (95% CI, 1.3-7.3, $P = .006$) higher in those with incomplete reduction. For patients aged 50 years and above, the CC-difference was 1.9 mm (95% CI, 0.1-3.6 mm; $P = .041$) higher. Patients with anatomical reduction were 3.1 times more likely to develop DPT than those with an over reduced AC-joint (95% CI, 1.2-7.9; $P = .017$). An incompletely reduced AC-joint was 5.3 times more likely to develop DPT versus an over reduced joint (95% CI, 2.1-13.4; $PP = .039$). Patients who underwent isolated CC-stabilization were 4.8 times more likely to develop complete DPT (95% CI, 1.1-21.0; $P = .039$) than patients with additional AC-stabilization. We observed a trend of partial and complete DPT in patients aged 40 and above (95% CI, 0.9-2.9; $P = .091$). Inferior clinical outcome was noted in patients with higher CC-difference values and DPT.

Conclusion: Our results suggest that AC joint stability is determined by the initial joint reduction, stabilization technique applied and patient age.

FM19

The effect of suprascapular nerve decompression in patients with rotator cuff tear evaluated.

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Introduction: Rotator cuff (RC) tears and their repair may cause traction damage to the suprascapular nerve, potentially causing pain or weakness of the supraspinatus (SS) and infraspinatus (IS) muscle. Arthroscopic suprascapular nerve decompression has been advocated as an adjunct to RC repair to prevent or treat suprascapular nerve impairment. The effect of this procedure on the electromyographically measurable nerve function has, however, never been studied yet.

Methods: Nineteen consecutive patients with MR-arthrography documented RC tear and normal preoperative EMGs of the SS and IS, who underwent arthroscopic RC repair, were enrolled in this controlled, prospective trial. Nine patients were randomized to undergo, ten not to un-

dergo a decompression of the suprascapular nerve. Patients were assessed clinically (Constant score, mobility, pain, strength, subjective shoulder value), radiographically (MRI) and electromyographically preoperatively, at 3- and at 12-month follow-up.

Results: There was no difference between the release and the non-release group in any clinical parameter at any time point, except for active anterior elevation which only significantly improved in the release group at 1-year f-up. There was also no difference in fatty infiltration of the cuff muscles in the two groups, except an increase in fatty infiltration for the infraspinatus muscle in the decompression group over the course of our study. Three out of the nine patients in the release group had pathological EMG findings at three months. These pathological findings recovered fully at twelve months in two and had incompletely recovered in one patient at 12 months.

Conclusion: In the presence of normal EMG findings, suprascapular nerve release added to arthroscopic RC repair is not associated with any clinical benefit, but with electromyographically documented impairment of nerve function in one out of three cases. Suprascapular nerve release does therefore not seem to be justified as an adjunct to RC repair if preoperative EMG findings document normal suprascapular nerve function.

FM20

Mobilization After Superior Rotator Cuff Repair: Sling versus No-sling. A Randomized Prospective Study

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FM21-FM37: FOOT

FM21

Prevalence of peripheral artery disease in patients with disturbed wound healing following elective foot and ankle surgery

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Introduction: Disturbed wound healing (DWH) following elective foot and ankle surgery is an unfavourable event associated with a number of known risk factors such as smoking and diabetes. The purpose of this study was to determine if peripheral artery disease (PAD) is a potential risk factor that contributes to an increase in disturbed postoperative wound healing.

Methods: In a case-control study we analyzed all patients undergoing elective foot and ankle surgery between January 1, 2014 and December 31, 2017 at two institutions and identified 51 patients with postoperative DWH. After matching for age and sex with 51 control patients from the same cohort without DWH all 102 patients were evaluated for PAD.

Results: The prevalence of PAD was significantly higher in the DWH group compared to the control group (41.2% vs. 19.6%, $p < 0.01$). This difference was even more distinctive for patients with any abnormal ABI (51.0% vs. 19.6%, $p < 0.001$). After adjustment for diabetes, hypertension, hypercholesterolemia and smoking any abnormal ABI or a history of PAD remained an independent risk factor for DWH.

Conclusion: In this dual-center study postoperative disturbed wound healing in patients undergoing orthopedic foot and ankle surgery was associated with significantly higher rates of PAD. These findings suggest that preoperative evaluation for PAD could be a helpful tool to identify patients at high risk for the development of postoperative wound complications undergoing foot and ankle surgery.

FM22

Long-term prognosis of patients with nonoperatively treated osteochondral lesions of the talus: An observational 14-year follow-up study

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Introduction: The optimal treatment for osteochondral lesions of the talus (OLTs) is still debated. Whereas numerous techniques have been

Background: Patients are commonly advised to wear a sling for 4–6 weeks after rotator cuff repair (RCR) despite negative effects of early immobilization and benefits of motion rehabilitation. The study aimed to compare clinical and radiographic outcomes up to 6 months following RCR with sling immobilization and without sling immobilization.

Methods: We randomized 80 patients scheduled for arthroscopic repair of small or medium superior rotator cuff tears into 2 equal groups: 'sling' and 'no-sling' groups. Passive mobilization was performed in both groups during the first 4 postoperative weeks followed by a progressive active mobilization.

Results: The two groups had similar preoperative patient characteristics, function, or adjuvant procedures. At 10 days, there was no difference in pain among the two groups (5.2 ± 2.3 vs 5.2 ± 1.9 , $p = 0.996$). In comparison to the sling group, the no-sling group showed greater external rotation (23.5 ± 15.6 vs 15.3 ± 14.6 , $p = 0.017$) and active elevation (110.9 ± 31.9 vs 97.0 ± 25.0 , $p = 0.038$) at 1.5 months, as well as better active elevation (139.0 ± 24.7 vs 125.8 ± 24.4 , $p = 0.015$) and internal rotation ($>T12$ in 50% vs 27.5%, $p = 0.011$) at 3 months. Ultrasound revealed no differences at 6 months in tendon thickness anteriorly ($p = 0.472$) or posteriorly ($p = 0.639$), bursitis ($p = 1.000$), echogenicity ($p = 0.422$), or repair integrity ($p = 0.902$). Multi-variable analyses confirmed that ASES score increased with patient age (beta, 0.60; $p = 0.009$), SANE decreased with sling immobilization (beta, -6.3; $p = 0.014$), and that pain increased with sling immobilization (beta, 0.77; $p = 0.022$).

Conclusions: No immobilization after RCR is associated with better early mobility and functional scores in comparison to sling immobilization. Postoperative immobilization with slings may therefore not be required for patients treated for small or medium tears.

described to treat these lesions surgically, the natural history of nonoperatively treated OLTs is scarcely known. This is the first study to investigate the long-term results of nonoperatively treated OLTs after a minimum follow-up of 10 years.

Methods: 48 patients (50 ankle joints) with nonoperatively treated small OLTs, who had been previously evaluated after a mean follow-up of 4.3 (range, 2–10) years (= FU1), were again enrolled for a long-term follow-up (= FU2). Ankle pain was evaluated with the visual analog scale (VAS), ankle function with the American Orthopaedic Foot and Ankle Society (AOFAS) score, and sports activity with the Tegner Score.

Results: 24 patients (26 ankle joints) participated in this study (FU2) after a mean follow-up of 14.2 (range, 11–20) years. There were 14 men and 10 women with a mean age of 41 (range, 10–69) years at the time of diagnosis of the OLT. 2 patients had undergone a cartilage procedure since FU1 due to persistent pain, were rated as failure of nonoperative treatment, and excluded from the final analysis. Ankle pain reduced from the time of diagnosis (VAS, 2.9+–3.1 points) to FU1 (1.7+–1.5 points), and to FU2 (1.4+–2.1 points). In contrast, the Tegner score decreased over time (at diagnosis: 5.4+–1.7 points, at FU1: 4.8+–2.3 points, at FU2: 3.9+–1.7 points), with 38% of all study participants reporting ankle pain as the main cause for the reduction of sports activity. The AOFAS score was only available at FU2, with an average of 90+–14.0 points. 75% of the patients stated their ankle condition as improved compared to the time of diagnosis.

Conclusion: The majority of patients with nonoperatively treated small osteochondral lesions of the talus showed good clinical long-term results for activities of daily living. However, more than a third of the patients reduced their sports activity due to persistent ankle pain.

* FM23

Plaster splint versus external fixator after reduction to bridge time until definitive surgical fixation in malleolar fracture-dislocations

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Introduction: Malleolar fracture-dislocations are regularly associated with concomitant soft tissue trauma. After initial reduction it is often necessary to bridge the time to definitive surgery.

In the case of open fractures or polytrauma the external fixator (EF) is the method of choice. It offers the possibility to observe the skin and swelling without additional risk of iatrogenic pressure lesions.

In many swiss hospitals the EF is the method of choice in all fracture-dislocations of the ankle, even in patients without polytrauma or open

fractures, even though a plaster splint fixation after reduction is generally well tolerated without additional anaesthesia, incisions or the concomitant risk of pin track infection. We hypothesized that after reduction, the majority of closed isolated fracture-dislocations of the ankle can temporarily be splinted in a plaster of the lower leg before definitive surgery, avoiding EF for conditioning of the soft tissue.

Methods: We performed a retrospective data analysis of consecutive cases from 2007–2017 treated in a single Level 1 trauma centre with either EF or plaster. We included malleolar fracture-dislocations, converted to definitive ORIF over time, age >15y, complete records (digital X-ray, reports) with a follow up of at least 6 months. We excluded patients with open fractures, polytrauma, multiple fractures of the lower extremities and immediate definitive Fixation or no conversion to ORIF. A statistical analysis was performed.

Results: 162 fractures were eligible for analysis after application of the in- and exclusion criteria. 37 were treated with EF and 125 with plaster. The baseline data showed no significant difference between these groups (age, gender, side, diabetes, use of anticoagulation or steroids, osteoporosis, BMI, ASA score) with the exception of more smokers in the EF group. There were no significant differences in complications (necrosis, wound healing disorders, infection, CRPS) between the groups. The time to definitive surgery showed no significant difference. Time to discharge was longer with EF compared with plaster (16 vs 14 days, $p = 0.03$).

In 125 patients treated with plaster 22 (17.6%) showed a secondary loss of reduction with conversion to external fixator in 17 (13.6%) cases within a mean of 2 days.

Conclusion: In most cases of an isolated closed ankle fracture-dislocation the reduction can be splinted with plaster without risks of additional surgery until definitive fixation.

FM24

Clinical and Radiological Mid- to Long-term Results Following Direct Fixation of Posterior Malleolar Fractures Through a Posterolateral Approach

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Introduction: The role of a posterior malleolar fragment (PMF) in ankle fractures and its need for fixation are controversial. Promising short-term clinical and radiological outcomes following direct fixation of the posterior malleolus have been published. However, long-term clinical and radiological results are still missing.

The purpose of the present study was to retrospectively evaluate the clinical and radiological mid- to long-term outcome following direct fixation of posterior malleolar fractures through a posterolateral approach.

Methods: 36 patients treated with direct fixation of the posterior malleolus were evaluated after a follow-up of 3 to 12 years. The PMF size comprised 9% to 56% of the tibial articular surface. Direct PMF fixation through a posterolateral approach using either posterior buttress plating or screws. The American Foot and Ankle Society scale (AOFAS) and the Visual Analog Scale (VAS) were used to evaluate postoperative ankle function and residual pain, respectively. Ankle range of motion (ROM) was documented and compared to the unaffected side. Posttraumatic osteoarthritis was assessed using a modified Weber score and the Kellgren & Lawrence (K&L) scale. Articular incongruity was recorded as a postoperative step-off > 1 mm in the distal tibial articular surface on the lateral X-rays. Subgroup analyses were performed to reveal possible negative prognostic factors (age, body mass index, smoking, PMF size, articular incongruity).

Results: The mean AOFAS score was 90±13.1 points, and the mean VAS 1.5±1.9 points, representing a good functional outcome. 92% of the patients were very satisfied or satisfied with the postoperative course. There was a significant, but clinically irrelevant, ankle plantarflexion and dorsal extension difference between the affected and unaffected ankle at the final follow-up. The PMF size showed no influence on the clinical outcome. Postoperative articular incongruity was seen in 5 patients. 39% of the patients showed poor results in the Weber score, whereas 53% had a progression of osteoarthritis > 2 grades on the K&L scale.

Conclusion: Direct fixation of posterior malleolar fractures through a posterolateral approach leads to good clinical mid- to long-term results with a high satisfaction rate but shows concerning progression of post-traumatic ankle arthritis.

FM25

How are obese patients doing after surgically treated ankle fractures? complications and long-term functional outcome

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Background: Obesity is widely accepted as a risk factor for surgical complications following foot and ankle surgery. Current literature suggest more complications and worse functional short-outcomes in obese population. Our objective was to assess the association of BMI with complications and long-term patient-reported outcomes (PROs) in patients after surgically treated ankle fractures. Moreover, results of the Manchester-Oxford Foot Questionnaire (MOXFQ), a validated instrument to assess outcomes after foot and ankle surgery, have not yet been reported in this clinical context.

Methods: Data from all operatively treated ankle fractures between January 2002 and December 2012 were collected retrospectively from electronic health care records and included in a database. Information on BMI at surgery (categorized as normal weight, overweight and obese) and comorbidities (ASA score, diabetes) were retrieved from anaesthesia records and fracture type from operative reports and radiographs (Weber classification; uni-, bi-, trimalleolar). Complications included wound dehiscence and infection. PROs were assessed using the postal survey MOXFQ. Associations between BMI and outcomes were evaluated in uni- and multivariable regression analyses.

Results: Of 2045 patients that had surgery between 2002-2012, 210 filled in the survey (mean age 46yrs, 52% men, Weber C fractures 22%, trimalleolar 25%). Of those, 54% were normal weight, 34% overweight, and 12% were obese. The risk of wound dehiscence/infection was 4 times higher in obese vs. normal/overweight (16% vs 4.3%; diabetes-adjusted OR 4.2, 95%CI 1.1-15.7). MOXFQ results obtained on average 13yrs after surgery (range 6-16yrs) significantly worsened with increasing BMI category. This was observed for all sub-scores (pain, single index, social interaction, walking) in unadjusted and adjusted analyses, the latter taking into account age, sex, types of fracture, and diabetes. Effect sizes of score differences between normal weight and obese patients were 0.50-0.68.

Conclusion: Obesity was independently associated with a higher risk of wound dehiscence/infection. Obese patients had worse long-term outcomes in all four domains of the Manchester-Oxford Foot questionnaire compared to those with normal weight.

* FM26

Mid- to long term outcome of intra-articular calcaneal fractures: a maximum-care trauma center experience of 140 surgically treated cases.

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Introduction: The aim of this retrospective monocentric study was to investigate the mid- to long term functional outcome of surgically treated intraarticular calcaneus fractures in a maximum care trauma center.

Methods: 140 Patients that underwent surgery of intraarticular calcaneal fractures between the years 2002 to 2013 were invited to participate. 83 patients were available for a clinical and radiological follow-up. Outcome measures were AOFAS hindfoot score, VAS, SF 36 questionnaire, complications and number of revision surgeries. The fracture patterns in the preoperative CT scans were classified according to the Sanders classification. The Boehlers angle was recorded pre-, postoperatively and at the time of the final follow-up. The radiographs at the final follow-up were examined for signs of subtalar arthritis. 33 patients that were not able or willing to attend the clinical and radiological examination were interviewed via telephone.

Results: Mean follow up was 91 months (range 12-183). The complication rate was 29% (11% wound healing, 5% infection, 7 non-unions). Six out of seven non-unions occurred in smokers. The rate of subsequent surgery was high (77%). Implant removal made up the majority and was performed in 86 feet. Signs of subtalar arthritis (joint space narrowing, sclerosis, osteophytes) were found in 70 % of the cases. 22 secondary subtalar fusions were performed after a mean of 29 months, two of those patients developed non-union with subsequent revision. Logistic regression did not show independent risk factors for subsequent subtalar fusion. Of the 5 primarily fused Sanders IV fractures three had to be revised, one twice. Only one healed without adverse events within 4

months. The AOFAS score was higher in Sanders IV fractures that needed secondary fusion compared to primary fusion (64 vs 50). Mean AOFAS-hindfoot score was 75 (Sanders I: 99, Sanders II: 74, Sanders III: 77, Sanders IV: 70). Mean VAS score was 65 (Sanders I: 15, Sanders II: 58, Sanders III: 56, Sanders IV: 74).

Conclusion: Intraarticular calcaneus fractures are serious injuries with unfavourable outcome in many patients. Our data can contribute to improve the decision making in the surgical treatment of intraarticular calcaneal fractures. Despite the small sample size of our study we do not advocate primary subtalar fusion due to a less desirable outcome and a high revision rate. Smoking seems to have a clear impact on the outcome which should be considered in a shared decision making.

* FM27

Spatiotemporal gait analysis and functional outcome after surgical treatment of calcaneal fracture in children

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Introduction: Intraarticular displaced calcaneal fractures are rare in children and adolescent and necessitate open reduction with internal fixation (ORIF). The purpose of this study is to evaluate the functional and clinical outcome in children and adolescent who had an ORIF for a displaced intra-articular calcaneal fracture, and to compare their spatiotemporal gait parameters using foot worn inertial sensors with a control group.

Method: We performed a case-control study. We analyzed 6 patients in our tertiary pediatric orthopedic and traumatologic unit and 15 controls. There were no significant differences in age (patients 15.5±2 years, controls 13.47±1.9 years) between cases and controls. Clinical examination and radiographic analysis, with AOFAS hind foot functional score were performed for patient group. Patient and control groups performed a continuous 200 meter linear walk at their self selected pace wearing the inertial sensors. Limb related spatio-temporal parameters were compared between control and patient groups, and between affected and healthy limb in the patient group. Non parametric Mann-Whitney test and locally weighted scatterplot smoothing regression analysis were used.

Results: 6 patients and 15 controls enrolled for the study. AOFAS score in the patient group was 82.03 (68-97) with lowest values in sagittal motion and hind-foot motion. Bohler's radiological angle ranged from -3.99° (-24-13) pre- to 31.5° (16-70) postoperatively. All patients returned to the same sport level than before. Temporal parameters were similar between the two groups. For spatial parameters stride length (1.62m ± 0.07 vs 1.47m ± 0.09, p = 0.001), 3D path length (104.15%±0.55 vs 106.45%±1.42, p < 0.00001) and min toe clearance (0.016cm±0.005 vs 0.023cm±0.01, p = 0.03) were decreased in patient group with significant differences, and peak angular velocity during swing (4.69m/s±0.32 vs 4.43m/s±0.27, p = 0.029) was increased in patient group.

Discussion: While ORIF for calcaneal fractures in children and adolescent lead to good functional results compared to a control group, spatiotemporal gait analysis objectivizes differences in spatial parameters. Limitation in the subtalar mobility with a diminished range of motion in inversion and eversion is a potential explanation for the diminished toe clearance and the 3D path length. Further and larger study are needed to confirm our results and evaluate the long term evolution.

* FM28

Staged Revision With Antibiotic Spacers for Hindfoot Infections vs. One-Stage Revision Using an Ilizarov Ringfixator

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Introduction: The treatment of hindfoot infections with a two-stage revision surgery using an antibiotic-loaded cement spacer, followed by internal fixation is an established treatment strategy. If the soft tissue situation is critical or if patients do have severe comorbidities, external fixation using an Ilizarov ringfixator is advocated and might be performed as a one stage treatment. The purpose of the study was to determine the likelihood of infection control, radiological consolidation and clinical outcome in those two groups.

Methods: Between 1995 and 2015, we treated 12 patients with a two-stage procedure using an antibiotic-loaded cement spacer (TS), followed by antibiotic therapy and hindfoot arthrodesis with internal fixation. 5 patients were excluded (deceased due to old age or moved abroad), leaving 7 patients for analysis at a min. FU of 24 months. 13 patients were treated with an Ilizarov ringfixator (IR). 2 were excluded (deceased due

to old age), leaving 11 patients for analysis. The primary outcome was infection control and radiological consolidation on standard foot X-rays. Clinical outcome was assessed with the AOFAS hindfoot score.

Results: Successful infection control in TS was 86% (6/7 patients) vs. 73% (8/11 patients) in the IR group. The mean AOFAS score at latest FU in the TS group was 75 (vs. 70 in the IR group). Radiological consolidation rate in the TS group was 70% (5/7 patients) vs. 73% (8/11 patients) in the IR group. No significant difference could be found between the rate of infection control, postoperative AOFAS score and radiological consolidation (p>0.05). This might also be due to the small sample size.

Conclusion: A one-stage arthrodesis using an Ilizarov ringfixator and the established two-stage procedure with an antibiotic-loaded cement-spacer, followed by internal fixation led to a comparable outcome. The Ilizarov ringfixator could therefore be considered as a treatment option, when soft tissues or comorbidities do not allow internal fixation. In our study, no significant difference in both groups could be found regarding clinical outcome measured by the AOFAS hindfoot score, radiological consolidation and infection control. However, our study is underpowered and further research with a bigger sample size is needed.

FM29

The Effect Of Subtalar Motion On Calcaneal Osteotomies

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Background: There is evidence that the subtalar joint may compensate for supramalleolar deformities and thereby slower or halt progression of ankle arthritis. The mobile subtalar joint may also compensate for the effect of realigning osteotomies of the calcaneus and the tibia. The compensation is limited by the joint orientation and limited ROM (arthritic joint, tarsal coalitions, previous fusion).

Material & Methods: 11 fresh-frozen human lower leg cadaver were mounted into a carbon frame. High resolution ankle TekScan sensors were fixed in the ankle joint. 300 N load were applied according to half body weight and Achilles tendon pull was simulated. The center of force (COF) migration, max. pressure (Pmax), and the area loaded were measured in the ankle with 10 mm varus / valgus sliding calcaneus osteotomy and 10° varus / valgus SMOT. A CT evaluation of subtalar anatomy (curvature of posterior facet) was conducted and the correlation of posterior facet curvature and subtalar motion and the correlation of subtalar motion and SMOT/COT effect calculated.

Results: The COF migration was significant for valgus COT and for both SMOT versus the initial position, while the varus SMOT versus the varus COT. Pmax and area loaded changed but not significantly. There was a significant correlation of posterior facet curvature and subtalar motion (r = 0.87), a moderate inverse correlation of subtalar motion and COT effect (r = -0.52), and a poor inverse correlation of subtalar motion and SMOT effect (r = -0.27). In contrast, in a previous study with a stiff cavovarus model significant COF migration and peak pressure changes were found in the ankle joint for all lateral closing SMOT and valgus COT.

Conclusions: The compensatory capacity of mobile subtalar joint limits effect of COT more than SMOT, likely because the subtalar joint is closer to COT than to SMOT. Biomechanically, the COT is therefore less effective in influencing ankle joint pressure than SMOT. The effect of the COT is more reliable in stiff subtalar joints. The curvature of posterior facet correlates with subtalar ROM.

FM30

How many screws are necessary for subtalar arthrodesis? A retrospective study

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Introduction: Subtalar Arthrodesis is an established surgical procedure for subtalar pathologies which are not responsive to conservative treatment. Although good clinical results are reported in literature, nonunion occurs in up to 24% if risk factors such as smoking, BMI>30, and ankle fusion are present. Biomechanical studies show a higher compression and higher torsional stiffness for a fixation with three screws compared to two screws. However, clinical data to compare these fixation techniques are still missing.

Methods: This study is a retrospective analysis of all patients (n = 122) undergoing isolated subtalar arthrodesis between January 2006 and April 2018. Of all patients 35 underwent subtalar arthrodesis with 3

screws and 87 patients with 2 screws. Mantel-Cox model analysis was performed to investigate the differences between number of screws and time to revision, consolidation and full weight bearing. Fisher's exact-test was performed to compare revision- and complication-rate between these groups such as influence of risk-factors.

Results: In this cohort (n = 122), pseudoarthrosis was observed in 20% in 3 screw- and 22% in 2 screw fixation with need for revision arthrodesis in 21% (2 Screws) and 9% (3 screws). However, these differences were not significant for primary surgery (p = 0.183). In patients with prior operations (n = 61) or risk factors (ankle fusion and smoking) re-arthrodesis was significantly more common in patients with only 2 screws used (p = 0.025 and p = 0.045 respectively). No significant difference of groups regarding revision surgery other than re-arthrodesis was found (p = 0.68). Furthermore, no significant difference was found between time to consolidation and the number of implanted screws (p = 0.14).

Conclusions: Our results show a higher revision rate due to non-union in 2 screw fixation compared to 3 screw fixation in subtalar arthrodesis. However these differences were only significant in patients with prior operations or identified risk factors for non union. Revision rate other than rearthrodesis did not differ between the two groups.

Our study supports the use of three screws in subtalar fusion in patients with prior operations or risk factors for non-union. Although the results also favor the use of three screws in primary arthrodesis further studies are necessary to generalize the recommendation of the use of three screws in all patients.

* FM31

Radiological analysis of hind- and midfoot arthrodesis using an Ilizarov ringfixator

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Introduction: The Ilizarov ringfixator (IR) is an established technique for surgical reconstruction of the hind- and midfoot. Patients with relevant comorbidities often do not qualify for a surgical foot reconstruction with internal fixation, due to high complication rates. In those patients, performing an arthrodesis using an IR often is the only available alternative. In this study, we analyzed the radiological outcome.

Methods: Between 2009 and 2016, 53 patients were treated with a hind- or midfoot arthrodesis using an IR, who did not qualify for internal fixation. 6 patients were excluded (deceased due to old age). This left 47 patients for analysis (mean FU of 5.3 y). The primary outcome included radiological consolidation rate and achieved correction of foot alignment, measured on standard foot radiographs and CT scan. The amount of correction of the original deformity was analyzed by measuring established angles for Pes planovalgus.

Results: 27 patients received a hindfoot arthrodesis only (fusionrate 68%). The others received either a midfoot (n = 10) or a midfoot and hindfoot arthrodesis (n = 10), with fusionrates 50% and 68% respectively. The achieved correction of foot alignment was determined by measuring angles for Pes planovalgus pre- and postoperatively (talonavicular coverage angle, lateral talar-first metatarsal angle, calcaneal pitch, lateral talocalcaneal angle and Kite's angle). The difference between pre- and postoperative talonavicular coverage angle was significant (p = 0.00023; 21.56° vs. 6.9°). The difference between pre- and postoperative lateral talar-first metatarsal angle was also significant (p < 0.05, 21.37° vs. 7.07°). Mean preoperative Calcaneal pitch was 8.39° (vs. 14.60° postoperative). This was also statistically significant (p < 0.05). The lateral talocalcaneal and Kite's angle did not differ significantly pre- and postoperatively (p > 0.05). However, these angles were already within the normal range preoperatively.

Conclusion: Hindfoot and midfoot arthrodesis with an IR does lead to a good fusion rate even in patients with severe comorbidities, who do not qualify for internal fixation. The limb could be preserved in 86. The Ilizarov technique is a good tool to correct complex foot and ankle deformities for patients with severe comorbidities. Statistically significant improvement of preoperative foot malalignment could be achieved.

FM32

Foot reconstruction in Charcot feet using the Ilizarov ring fixator reliably leads to ambulatory patients

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Failed conservative treatment and complications are indications for foot reconstruction in Charcot arthropathy. External fixation using the Ilizarov principles offers a single stage procedure for deformity correction and resection of osteomyelitic bone. The aim of this study was to determine whether external fixation with an Ilizarov ring fixator leads reliably to a shoeable or braceable foot. Twenty-nine patients treated with an Ilizarov ring fixator for Charcot arthropathy were reviewed. Information collected included demographic and clinical data. Radiologic fusion at final follow up visit was assessed on conventional radiographs. Mean follow up period was 35.11 ± 29.49 (range 5.3 – 107) months, mean time of external fixation was 112.9 ± 29.79 (range 71 – 233) days. Two patients needed below knee amputation. Of the remaining 27 patients, most could be fitted with an orthopaedic shoe and only two needed lower leg orthoses. 26 (96.3%) patients maintained ambulatory status, 23 (85.2%) without assistive devices. Total or partial radiologic fusion was reached in 10 (34.5%) of our patients. Presence of an ulcer and osteomyelitis were significantly associated with secondary amputation. Ambulatory status was independent from radiologic fusion. These findings encourage limb salvage and deformity correction in this difficult-to-treat disease.

* FM33

Mobile-Bearing Total Ankle Replacement Leads to Higher Short-term Revision Rates when Compared to Fixed-Bearing: A Cohort of 246 Patients within Three-Year Follow-Up Treated with 2 Implants of Similar Design

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Background: Total ankle replacement has become more frequent. However, it remains unclear whether the polyethylene component should be mobile- or fixed-bearing.

Objectives: The study's primary objective is to compare mobile- versus fixed-bearing prostheses of same design in terms of rates of and reasons for reoperation. The latter includes revision without implant removal and failure with implant removal and conversion to salvage arthrodesis.

Methods: Two hundred forty-six consecutive patients underwent total ankle replacement with the same basic implant, but either mobile-bearing or fixed-bearing, and were prospectively followed since the intervention. All patients were recruited, operated upon and followed by the same two senior surgeons. Health data, radiological findings, clinical follow-up, and all reoperations related to the index total ankle replacement were documented. Outcome of both groups was compared at a three-year follow-up point.

Results: From 2004 to 2015, two successive groups were formed, one of 171 consecutive patients that had mobile-bearing implants (2004-2013) followed by a group of 75 consecutive patients with fixed-bearing (2012-2015). The mobile-bearing group required 33 reoperations (8 failures), while the fixed-bearing had 11 reoperations (2 failures) within the 3 year follow-up point. Survival analysis showed better short-term outcome in the fixed-bearing group as compared to the mobile-bearing group.

Conclusions: The fixed-bearing design has higher survival rate over time and lower reoperation probability already within 3 years post index surgery. Younger age (<60y) is a predictive factor for reoperation (OR 0.5, CI 0.2 – 1.0, P = 0.07), while preoperative hindfoot mal-alignment is not.

FM34

Rate and Reasons for Revision after First Metatarsophalangeal Joint Fusion - a Cohort of 120 Consecutive Cases

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Background: Little is known about the rate and reasons for revision after first metatarsophalangeal (MTP1) fusion using latest fixation techniques. While it is commonly assumed that nonunion accounts for most reoperations, we hypothesized that malposition is the leading cause of revision. The purpose of this study was to determine the rate and reasons for revision after MTP1 fusion using cup- and cone-reamers and latest locking plate technology.

Method: Between 2015 and 2017, 120 consecutive MTP1 fusions in 114 patients were performed with a low profile, precontoured titanium dorsal locking plate and a plantar metatarsophalangeal screw. The rate and reasons for revision within a minimum one year follow-up period (mean 16 months; range, 12–26) after index procedure were determined and analyzed. Revision was defined as any reoperation following the index procedure excluding hardware removal.

Results: Seventeen of 120 feet (14%) underwent revision. Four patients developed a nonunion (3.3%) and needed revision, and 11 feet (9%) required revision for symptomatic malposition; insufficient extension and excessive valgus accounted for the majority. Two patients required medial sesamoidectomy. No infection or wound healing problems occurred. Twelve patients requested hardware removal.

Conclusions: The revision rate for nonunion after MTP1 fusion with latest locking plate technology is low. Symptomatic malposition is the leading cause of revision with a reoperation rate threefold higher than for nonunion. Excessive valgus and insufficient extension account for most malposition.

FM35

The role of the anterior talofibular ligament in acquired flat foot deformity and in operative correction by lateral calcaneal lengthening

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Introduction: Several risk factors for adult acquired flatfoot (AAF) deformity have been identified in literature. To this date, little attention has been paid to the lateral ligament complex and its influence on AAF, although its anatomic course suggests a restriction to flatfoot deformity. The aim of this study was to assess the influence of the ATFL on AAF deformity and on radiologic outcome following common operative correction by lateral calcaneal lengthening.

Methods: We reviewed all patients that underwent lateral calcaneal lengthening for correction of AAF deformity between January 2008 and July 2018 at our clinic. Patients were grouped into those with an intact ATFL and those with an injured ligament on preoperative MRI. Two independent readers assessed common radiographic flatfoot parameters on preoperative and postoperative radiographs.

Results: 64 flatfoot corrections in 63 patients were included, whereby the ATFL was intact in 39 cases, and in 25 cases the ligament was injured. A statistically significant difference between both groups was found for preoperative talocalcaneal-angle ($p = 0.032$) and talonavicular uncoverage-angle ($p = 0.018$), with more severe AAF deformity in patients with an injured ATFL. No difference between the two groups could be observed regarding the success of surgical correction or surgical consistency after lateral calcaneal lengthening. ICC between the two readers showed “almost perfect” agreement for the talometatarsal-angle (0.924), talocalcaneal-angle (0.887) and talonavicular uncoverage-angle (0.948), and “substantial” agreement for calcaneal inclination-angle (0.640).

Conclusion: The ATFL seems to influence the extent of AAF deformity with regard to the talocalcaneal-angle and talonavicular uncoverage-angle. In patients undergoing lateral calcaneal lengthening, the integrity of the ligament seems not to influence the degree of correction or the consistency of the postoperative result.

* FM36

Biomechanics of Ankle Ligament Reconstruction – A Cadaveric Study to Compare Stability of Reconstruction Techniques Using One or Two Fibular Tunnels and Allografts

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Introduction: Acute lateral ankle sprain is one of the most common injuries and a domain of conservative treatment. Still, more than a third of

patients develop chronic ankle instability and need surgery to restore lateral stability. A reliable approach is an anatomic lateral ligament reconstruction using an allograft and 2 fibular tunnels. A recently introduced 1-fibular tunnel reconstruction approach might reduce risk of intraoperative complications and ultimately improve patient outcome. However, it is unknown if these approaches are biomechanically equivalent in terms of joint stability. We hypothesized that both reconstruction techniques have similar biomechanical properties (joint laxity and stiffness) and are similar to the intact joint condition.

Methods: 10 Thiel-conserved cadaveric ankles were divided into 2 groups. Both groups were tested in 3 stages: intact, dissected and reconstructed lateral ankle ligaments - using either the 1- (R1) or the 2- (R2) fibular tunnel technique. To quantify stability in each stage, anterior drawer (ADT) and talar tilt (TTT) tests were performed. Anterior translation forces of 10 to 50N were used in the ADT, and inversion torques of 1.1 to 3.4 Nm where used for the TTT. Both tests were done in 0, 10 and 20 degrees of either plantarflexion (ADT) or dorsiflexion (TTT). Bone displacements were measured using motion capture, from which laxity and stiffness were calculated. Finally, reconstructed ligaments were tested to failure with a maximal applicable torque (MAT) in inversion. A mixed linear model was used to describe the outcomes.

Results: There were no significant differences between intact and reconstructed ankles in calcaneotibial stability during the ADT, nor talo- and calcaneotibial stability during the TTT. When comparing R1 and R2 independently to the intact ankles, no significant difference in stability was found ($p > 0.05$) for any flexion angle (Calcaneotibial sagittal laxity difference; R1 to intact: mean 0.83 ± 0.46 mm, R2 to intact: mean -0.38 ± 0.45 mm). Also, no difference ($p > 0.05$) was found when comparing the MAT of R1 (mean 9.1 ± 4.4 Nm) to R2 (mean 8.9 ± 4.8 Nm).

Conclusion: Lateral ankle ligament reconstruction with an allograft using 1-fibular tunnel has equal biomechanical stability to the 2-tunnel approach and should be considered as a promising option for the surgical therapy of chronic ankle instability, with the potential to reduce intraoperative complications.

* FM37

Two-Year Follow Up after Autologous Matrix-induced Chondrogenesis (AMIC) in Patients with an Osteochondral Lesion of the Talus.

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Introduction/Purpose: The treatment of osteochondral lesions in the talus remains challenging. In recent years a promising technique, the autologous matrix-induced chondrogenesis (AMIC) has been described, a technique combining micro fracturing with application of a collagen matrix. The aim was to analyze the clinical follow up two years after surgery and define risk factors for inferior outcome.

Methods: This prospective study included 16 consecutive patients, who underwent AMIC for an osteochondral lesion of the talus at our institution. We compared preoperative and at two years follow up the following clinical scores: AOFAS (American Orthopaedic foot and ankle score), FFI (foot functional index) and VAS (visual analogue scale) pain and satisfaction. Further, clinical scores at two years were correlated with BMI, age, gender and size and stage osteochondral lesion according to Happle. Additionally outcome after primary AMIC and revision surgery was compared.

Results: FFI increased from 50 ± 16 preoperative to 30 ± 24 at follow-up (p -value: 0.017). VAS pain increased from 5.6 ± 2.0 to 2.8 ± 2.7 (p -value: < 0.001). AOFAS (67 ± 12 to 78 ± 21) and VAS satisfaction (7.2 ± 2.6 to 7.6 ± 2.8) change was not significant. AOFAS and FFI did not correlate with BMI, age, gender or size and grade of the osteochondral lesion. Patients with primary AMIC or revision surgery had a similar preoperative AOFAS (69 ± 11 versus 64 ± 14) and FFI (54 ± 14 versus 42 ± 17). At follow-up, patients with primary AMIC showed superior AOFAS (86 ± 11 versus 65 ± 27 , p -value: 0.049) and FFI (17 ± 16 versus 52 ± 20 ; p -value: 0.001).

Conclusion: Increased clinical outcome was found two years after AMIC in patients with talus cartilage lesion without previous surgery.

FM38-FM52: HIP

FM38

Mid term results after in situ pinning and hip arthroscopy for mild SCFE: A minimum 5-year follow-up

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Introduction: In situ pinning of mild slipped capital femoral epiphysis (SCFE) results in an aspherical head-neck junction and therefore labrum and cartilage damage. Arthroscopic osteochondroplasty can successfully correct the head-neck junction, however, mid term results remain unknown.

Methods: In a retrospective and consecutive series, 9 patients (5 males, 4 females) with a mean age of 12 years (range, 11 to 15) at index surgery were included. All patients were treated for mild SCFE with in situ pinning and hip arthroscopy correcting the head-neck junction. After at least 5 years postop, all patients were assessed using the WOMAC and Harris Hip score. Radiographs and MRIs were made at 3 months and at least 5 years postoperatively. Antero-superior alpha angles were measured on radial reconstruction sequences. The cartilage and labrum damage was identified.

Results: The mean slip angle was 23° (range, 17 to 29) The WOMAC score (0 best result) averaged 0.4 points (range, 1.4 to 0) and the HHS 100 points (99 to 100) at latest follow-up. The mean ROM for flexion and internal rotation at 3 months was 102° (SD 11.7) and 27° (SD 7), respectively. At least 5 years postoperatively the mean flexion and internal were 101° (SD 4.6) and 22° (SD 6.2), respectively. There was no significant change in alpha angles in the antero-superior sector over time. The mean alpha angle three months postoperatively was 50° (range 36–65°, SD 8.7°) and 51° at last follow-up (range, 36° to 61° SD 7.2). New superficial cartilage damage on either the acetabular or femoral side were seen in 3 and 2 patients, respectively. Progressive labral degeneration was present in 2 patients.

Conclusion: In situ pinning and hip arthroscopy for the correction of mild SCFE reveals stable morphological correction and adequate clinical results at mid term. However, there is some joint deterioration, but without negative impact on subjective and clinical outcome after 5 years.

* FM39

Occult periprosthetic fractures of the acetabulum in THA using an elliptic cup design

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Introduction: Periprosthetic fractures of the acetabulum are a known complication of primary THA. Occult periprosthetic fractures are not recognized during surgery neither on routine postoperative plain radiograph. The rate for hemispherical and peripheral self-locking cups has been described as 8.4% by using postoperative CT scans. The rate for elliptical cups remains unknown.

Aim of the present study was to define (1) the rate of fractures of the acetabulum, (2) their location and (3) the clinical outcome when using elliptical cups.

Methods: Between 2014 and 2018 we retrospectively analyzed 115 CT scans in 114 patients after primary cementless THA with elliptical cups using a direct anterior approach at our institution. Rate of occult periprosthetic acetabulum fractures, localization of the fracture, and the radiological and clinical outcome at short-term were analyzed.

Fracture and non-Fracture group were compared with regard to demographics and short term outcome.

Results: 4 occult fractures (3.5%) were identified. Three fractures involved the posterior wall. All patients run through an uneventful routine postoperative rehabilitation. Patients with occult fractures showed similar postoperative HHS and WOMAC scores at 3 and 12 months. There was no cup loosening at latest follow-up (mean FU 18.5 months, range 6-31 months).

Conclusion: Occult periprosthetic fractures of the acetabulum using an elliptic cup design occurred in 3.5%. This is less frequently than with press fit impaction of other cup designs. Clinical and radiological outcome was not impaired by the occurrence of an occult periprosthetic fracture of the acetabulum.

FM40

Open reduction and Internal Fixation Might be a Valuable Alternative to Stem Revision in Vancouver B2 Periprosthetic Femoral Fractures

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Background: The purpose of this study was to compare the clinical and radiological outcomes following open reduction and internal fixation (ORIF) of Vancouver B2 periprosthetic femoral fractures versus stem revision (SR) surgery.

Methods: We retrospectively analysed data of 31 and 33 patients treated by two experienced surgeons with ORIF and SR, respectively, for a Vancouver type B2 fracture between 2004 and 2016. Instability of the implant was assessed pre-operatively on the radiographs and confirmed at operation. According to surgeon's preference, one consultant conducted SR, whereas the other orthopaedic surgeon performed ORIF in all of his cases. Perioperative complications, intraoperative blood loss, revision rate and mortality were recorded. Patients were followed up clinically and radiologically for an average of 43 months. Harris Hip Score and patient satisfaction were also obtained.

Results: Both groups did not significantly differ in the American Society of Anesthesiologists (ASA) score, Charlson comorbidity index, body mass index, age and sex. Compared to SR, patients treated with ORIF had a decreased blood loss, transfusion rate, operation duration and mortality. Radiographic subsidence was similar in both groups, as were total complication and re-operation rate. Relative risk for complication and re-operation was 0.45 and 0.7, respectively, in favour of ORIF.

Conclusions: ORIF might be a valuable alternative to SR in the treatment of Vancouver type B2 periprosthetic fractures with shorter operation duration, lower blood loss and similar complication rate compared to SR. Especially elderly patients might benefit from a lower mortality rate linked to the less complex ORIF procedure.

FM41

The impact of heterotopic ossifications on self-reported functional outcomes after total hip replacement using the direct anterior approach

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Introduction: Heterotopic ossifications (HO) is a relatively frequent complication following total hip replacement (THR), but is rarely clinically relevant unless it severely impedes range of motion. The Brooker classification is commonly used to describe the extent of HO from AP radiographs. HO overlapping with native bone in AP views is often difficult to characterize. Therefore, we tested whether HO is underestimated in single AP views versus AP and Lateral (Lat) views. Finally, we evaluated the impact of HO on functional outcomes after THR through direct anterior approach (DAA).

Patients and methods: From a cohort of 715 patients with DAA THR, we found 185 had visible HO. In addition, 226 patients without HO were randomly selected as controls, so in total 411 patients were included in this study (52.8% male; 47.2% female). The functional outcomes were evaluated with the Oxford Hip Score (OHS) and the Core Outcome Measures Index (COMI-hip). The extent of HO was evaluated using the Brooker Score in the AP and Lat views.

Results: In 72% of the cases, Brooker scores in AP and Lat views were the same. In the 28% with a difference, 80% were Brooker 0 or 1 in AP, and no systematic over- or underestimation was found. In the following, we consider Brooker score as the maximum of the score in AP and Lat views. In this cohort, Brooker scores increased significantly with age ($p < 0.001$) and was higher in males ($p < 0.001$). In terms of functional outcomes OHS and COMI scores were not affected by gender, but decreased with age ($p < 0.05$). While HO grades 1 to 3 had no impact on outcomes, patients with HO grade 4 reported significantly lower overall functional outcomes (COMI Score + 1, $p < 0.05$; OHS -10, $p < 0.01$), but not pain specific.

Conclusion: Similar to other THR approaches, in DAA, heterotopic ossifications occur more often in men than in women and their incidence

increases with age. While Brooker scores up to 3 did not affect outcomes, patients with highest grade HO (4) report reduced functional outcomes, but not necessarily more pain.

* FM42

Long-term outcome after Hip reconstruction including a Dega type of pelvic osteotomy in patients with cerebral palsy and closed triradiate cartilage

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Introduction: Hip reconstruction is an established procedure in pediatric patients with neurologic hip dislocation. It includes a combination of corrective femoral, pelvic modified Dega osteotomy, an open reduction and soft tissue correction when indicated. An open triradiate cartilage provides the advantage of a high plasticity of the bone which prevents an intraarticular fracture of the acetabulum and allows postoperative adaptation of shape. Some cases with dislocated hips, however, arrive late. A hip reconstruction is still feasible as shown earlier but the long-term risk for osteoarthritis, recurrence of dislocation and functional outcome is unknown.

Methods: We retrospectively analyzed 43 hips in 37 patients who had a hip reconstruction including proximal femoral derotation, shortening, and varus osteotomy and a periacetabular modified Dega osteotomy at least. In all cases the triradiate cartilage was closed at time of surgery. Age at surgery was 15 years and 2 months on average, follow up time 13 years 5 months.

Results: Mean Kellgren Lawrence score at final follow up was significantly higher ($P < 0.00001$) than preoperatively. In only 3/43 hips pain was a problem, one of them got an arthroplasty 12 years 4 months after hip reconstruction. The sphericity of the femoral head did not change between shortly after surgery and last follow up. Reimers' migration index was stable over the years and was not higher at last follow up compared to shortly after surgery ($P = 0.857$). We found no significant difference in the sagittal hip range of motion and change of GMFCS level. There was no influence of spondylodesis, GMFCS level, preoperative and short-term postoperative migration percentage or additional soft tissue procedures on the development of osteoarthritis.

Conclusion: There are radiological signs of osteoarthritis which possibly occur due to an intraarticular acetabulum fracture during bending down the acetabulum. Nevertheless, a hip reconstruction in patients with cerebral palsy and closed triradiate cartilage remains a valuable option as it results in a stable, painless hip for many years.

* FM43

The Bi-Planar Opening of the Acetabulum and its Impact on Femoro-Acetabular Impingement and Orientation of Prosthetic Acetabular Sockets

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Introduction: Femoro-acetabular pincer impingement is highly determined by the acetabular containment, the orientation of the opening plane and the three-dimensional (3D) contour of the acetabular limbus. This study hypothesizes that two distinct partial opening planes of the acetabulum can be identified: an anterior one determining hip flexion and internal rotation and a posterior one determining hip extension and external rotation. In total hip arthroplasty (THA) the corresponding cup contours are responsible for the similar prosthetic impingement urging orientation closer to the anterior or posterior acetabular rim. The objective of this study was to determine the orientation of all these planes, the TAL included.

Methods: 120 anonymized computer tomograms (CTs) without hip disorders were evaluated measuring the 3D-contours of the right and left acetabula, the sphere of both acetabular and femoral head joint surfaces using the least-square method for 3D-plane and sphere approximation. The orientations of the partial anterior, posterior and the mean acetabular plane were assessed in anatomic terms. Additionally, the TAL-based recommended cup orientation has been determined. All orientations were referenced to the coronal plane and the anterior pelvic plane (APP).

Results: The partial anterior and posterior acetabular planes show a saddle-roof-like configuration. The median saddle-roof angles range from 24° to 29° and are widely scattered. The anterior partial acetabular plane is anteverted by about 34° and inclined 54°, whereas the posterior

is anteverted by about 7° and inclined 58°. The saddle-ridge is tilted anteriorly from 20° to 24°. The mean acetabular orientation is 21° anteversion and 51° inclination, which highly correlates to recommended TAL-referenced individual cup orientations. The APP is tilted posteriorly up to -22° and anteriorly up to 18°. No significant differences between male and female individuals were found.

Conclusion: The least-square based plane approximation reveals an anterior and posterior partial acetabular opening plane. The anterior plane is less inclined but more anteverted enhancing flexion whereas the posterior one is more inclined but less anteverted enhancing extension. This complies with recommendations given for prosthetic cup placement and periacetabular osteotomy. The TAL method highly correlates with the mean anatomic acetabular orientation; however, less inclination is recommended for prosthetic cup placement.

* FM44

Total hip arthroplasty through the direct anterior approach with and without the use of a traction table; a matched-controlled, retrospective, single surgeon study.

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Introduction: The majority of hip surgeons performing the direct anterior approach (DAA) use some form of specialized operating table to make this exposure easier. However, these devices can exert tremendous forces and there have been commonly reports of trochanteric fractures as a result. On the other hand, performing total hip arthroplasty (THA) through the DAA without the use of an orthopaedic table can be more time-consuming and technically more demanding, with the possibility, however, of comparing the leg length intraoperatively. Therefore, the purpose of the present study was to compare complication rates, clinical outcomes, and component positioning after THA through the DAA in patients which were operated through the DAA with and without the use of a traction table.

Methods: 75 consecutive patients who received THA through the DAA with the use of an orthopedic table in our institution were matched for gender, age, ASA Score and BMI with 75 patients who received THA through the DAA from the same surgeon without the use of an orthopedic table. The intraoperative and postoperative complications as well as the clinical (Harris Hip Score) and radiologic outcomes were assessed retrospectively.

Results: Patients who were operated with the use of a table had a decreased surgical duration but similar hospital stay, surgery related complications and mortality compared to their counterparts without the use of a table. No statistical significant difference was observed regarding the functional outcome with both groups showing statistically significant improvement of the HHS. Regarding acetabular ante-version, inclination, horizontal and vertical center of rotation there was no statistically significant difference. The leg length discrepancy was statistically significantly more accurate in the group without table ($p < 0.01$).

Conclusion: The use of a specialized orthopedic table does not increase the intra- and postoperative complication rate. Performing, however the operation without the use of a table can significantly increase the accuracy of restoring the leg length postoperatively.

* FM45

Effect Of Stepwise Implementation Of An Enhanced Recovery Pathway For Elective Total Hip Arthroplasty.

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Background: Enhanced recovery programs in total joint arthroplasty have been shown to reduce length of stay (LOS) without compromising results. Yet there are no data for a swiss population. A new standardized treatment protocol was introduced in 01/2014 and continued as an enhanced recovery program in 01/2018 by adding a standardized preoperative workup and involving all care providers at one hospital. The effect of these changes on clinical parameters should be studied.

Methods: All patients with primary osteoarthritis of the hip were included consecutively. The operations were performed or supervised by a single surgeon. No drains were used, urinary catheters and opioids should be avoided and pain medication should be given perorally. Full weight-bearing was encouraged. Discharge was suggested when the patient fulfilled

defined criteria and felt prepared to leave the hospital. Data were collected prospectively. Three consecutive series of 50 patients were analyzed: The first 50 patients treated according to the new protocol, a second series two and a half years after its introduction and the first 50 patients in the enhanced recovery program. All patients had a follow-up six weeks and three months postoperatively.

Results: No patient was lost for analysis. The mean LOS (postoperative nights) decreased from 7.1 (1st series) to 5.5 (2nd series) and 4.8 days (3rd series) ($p < 0.001$), patients admitting at the day of surgery increased from 28% to 66% and 100% ($p < 0.001$). Patients without dispense of opioids increased from 6% to 24% and 34%. Three blood transfusions occurred in the first and second series and no in the third series, the mean dHb was similar (27.0 mg/l, 27.0 mg/l, 26.7 mg/l) ($p = 0.98$). The number of patients discharged directly home increased from 54% to 60% and 78% ($p = 0.031$). There were three adverse events in each series.

Conclusion: The new pathway was appreciated by patients and staff. It led to a decreased LOS and an increase in patients discharged directly home. The introduction was safe but in the first series it could not be provided in many cases. In the second series the protocol was established and followed more strictly, leading to significant improvement in outcome. Additional progress was noted when starting with the enhanced recovery program, which might further improve when it has become more established too. Additionally, there is a need for broader acceptance for shorter LOS and discharging home in the population.

FM46

Contact force path in total hip arthroplasty: Effect of cup medialization in a whole-body simulation

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Introduction: Cup medialization down to the true acetabular floor in Total Hip Arthroplasty with a compensatory femoral offset increase seems to be mechanically advantageous for the abductor muscles due to the relocation of the lever arms (body weight lever arm decreased, abductor lever arm increased). However, there is a lack of information so far about the effects of this reconstruction type at the head cup interface, compared to an anatomical reconstruction (that maintains the natural lever arms). We therefore performed a whole body simulation analysis comparing medialized vs. anatomical reconstruction in THA to analyze the effects on

- 1) contact force magnitude at the head cup interface
- 2) contact force path in the cup
- 3) abductor activity

Methods: Musculoskeletal simulations were performed to calculate the above-mentioned parameters using inverse dynamics analysis. The differences between the virtually implanted THAs were then calculated to compare the medialized vs. anatomical reconstruction.

Results: Cup medialization with compensatory femoral offset increase led to:

- 1) a maximum reduction in contact force magnitude at the head cup interface of 6.6%
- 2) a similar contact force path in the cup in terms of sliding distance and aspect ratio
- 3) a maximum reduction in abductor activity of 17.2% (gluteus medius)

Conclusion: In our opinion these potential biomechanical gains do not generally justify a fully medialized reconstruction, especially in younger patients that are more likely to undergo revision surgery in their lifetime. Cup medialization should be performed until sufficient press fit and bony coverage of a properly sized and oriented cup can be achieved.

FM47

Reduced Femoral Torsion can cause Anterior Intraarticular and Subspine Extraarticular Femoroacetabular Impingement

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Introduction: Femoroacetabular impingement (FAI) is pathologic contact between the acetabulum and proximal femur due to cam- or pincer-FAI. But it remains unclear whether decreased Femoral Torsion (FT) causes anterior intra- or extra-articular hip impingement. Therefore, we evaluated symptomatic hips with decreased FT, using CT-based virtual

3D ROM and impingement simulation and compared this group to patients with normal FT and to asymptomatic patients and questioned:

- (1) What is the osseous range of motion?
- (2) Where are the osseous femoral and acetabular impingement zones located?
- (3) Is impingement located extra- or intra-articular?

Methods: We performed an IRB-approved, retrospective comparative analysis of a total of 84 hips in 68 patients. Of them, 37 hips in 24 symptomatic FAI patients had decreased FT. These hips were compared to 21 hips of 18 symptomatic patients with anterior FAI with normal FT (10–25°) and 26 asymptomatic hips with no FAI morphology and normal FT. All FAI patients were symptomatic and presented with anterior hip pain and a positive anterior impingement test. They underwent pelvic CT scans to measure FT according to Murphy et al. Decreased FT was defined as FT <5°. The 37 hips with decreased FT presented both with and without cam and pincer FAI. All 84 hips were evaluated using CT-based 3D models and a validated 3D ROM and impingement simulation.

Results: (1) Hips with FAI combined with decreased FT have a significantly lower mean flexion ($114 \pm 8^\circ$ vs $125 \pm 13^\circ$, $p < 0.001$) and internal rotation (IR) at 90° of flexion ($18 \pm 6^\circ$ vs $32 \pm 9^\circ$, $p < 0.001$) compared to the asymptomatic control group. We found no difference for IR in 90° of flexion for hips with FT <5° without a cam or pincer-type deformity compared to hips with FT <5° combined with a cam-type deformity.

(2) The maximal acetabular impingement zone for hips with decreased FT was located at the 2 o'clock position and ranged from 1 to 3 o'clock.

(3) In hips with decreased FT, 95% of the impingement locations were located intra-articular and 32% were combined intra- and extra-articular FAI tested in 90° of flexion and 0° of adduction. Adding 10° and 20° of adduction, extra-articular FAI was detected in 68% and in 84% of the hips with decreased FT in 90° of flexion.

Conclusion: Hips with FAI and decreased FT demonstrate less flexion and internal rotation in 90° of flexion compared to the asymptomatic control group. Anterior hip impingement can be caused by decreased FT.

FM48

Gender-specific patterns of hip muscle weakness in patients with hip osteoarthritis and associations with hip morphology and symptoms

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Introduction: Previous studies showed inconsistencies with regards to the presence and extent of hip abductor and flexor weakness in patients with hip osteoarthritis (OA), which may be due to different prevalence of female and male patients in the evaluated samples. In addition, gender seems to be a major determinant of both hip OA-related morphological changes, and of the presence of specific underlying adult hip morphologies. Aim of this study was to evaluate gender-related differences in hip abductor and flexor muscle weakness and their associations with hip morphology and symptoms in patients with hip OA.

Methods: Fifty-one patients with hip OA (24 women, 27 men) were recruited. Hip abductor and flexor muscle weakness was assessed as strength asymmetry using dynamometry, and hip pain during strength evaluations using a visual analogue scale. Hip morphological features of the OA hip (OA severity, femoral head migration, osteophytes) and adult hip (alpha angle, center edge angle, crossover sign, posterior wall sign, neck shaft angle) were assessed on anteroposterior pelvic radiographs. Hip symptoms were assessed using the Oxford Hip Score (OHS).

Results: Men demonstrated larger hip flexor asymmetry than women (20% vs. 10%, $P = 0.025$), and similar hip abductor asymmetry (6% vs. 12%, $P = 0.166$). Hip flexor weakness significantly correlated with the OHS ($r = -0.434$, $P = 0.034$) in men, and was associated with the posterior wall sign (global acetabular retroversion) in all patients, with individuals with posterior wall sign showing larger hip flexor weakness than individuals without (29% vs. 12%, $P = 0.004$). Hip abductor weakness significantly correlated with alpha angle (cam morphology) in men ($r = 0.450$, $P = 0.021$), and pain during maximal hip abductor contractions in women ($r = 0.587$, $P = 0.007$).

Conclusion: Patients with hip OA present gender-specific hip flexor weakness. Hip flexor and abductor weakness in hip OA seems to be associated with underlying adult hip morphology and/or hip symptoms, rather than with hip OA-related morphological changes. Future research should investigate the biomechanical and physiological reasons underlying these findings.

FM49

Rates of Muskulo-Skeletal-Morbidity Grades (MSM) and Influence on the Outcome After Primary THRDr. Jörg Huber¹; Dr. Christoph Lienhard; PD Dr. Ulrike Held²¹ *Stadtspital Triemli Zürich*; ² *Institut für Epidemiologie, Biostatistik und Prävention / Universität Zürich*

Introduction: In the EUROHIP study 2/3 of patients coming for primary THR had polyarticular complaints/ spine disease. Polyarticular/spine pathology have a strong influence on the outcome of THR (J Bone Joint Surg am 2017; 99:1428-37). The patients can be classified in 4 grades of MSM: grade 1 one major joint (affected hip), 2 >1 major joints, 3 a major joint and spine, 4 >1 major joints and spine. We wanted to measure the rates of different MSM grades in patients coming for unilateral THR in a single center and their impact on outcome.

Methods: In a prospective consecutive outcome study, all patients treated with primary THR between 01/2015 and 12/2016 were included with a complete follow-up at 12 months. Exclusion criteria were patients with tumor, neoplasia, infection, withdrawal of study consent and incomplete follow-up. All patients had THR through an anterior minimally invasive approach by 2 experienced surgeons with an extension table (Implants: Vitamys-Optimys, Fa. Mathys or Avantage-Weber Fa. Zimmer-Biomet). The symptoms were assessed with the validated Pationnaire questionnaire pre-, and 12 months postoperatively. The MSM grade was assessed at the primary visit. The statistical evaluation was "classic" with median scores preop/postop and mean average REPPs (relative effects per patient). The MSM grades were compared regarding age, symptom score. The influence of the MSM grade was calculated for each sub-cohort (mean average REPP).

Results: 98 patients could be included, 6 of them had to be excluded because of incomplete data. Of the remaining 92, 52 (56.5%) were women; the mean age was 72.7 years (from 31 years to 95). The mean score in the t-test decreased significantly from 45 to 15, the mean average REPP was 0.63 (1 to -1). The rates of MSM were grade 1 30/92 (33%), grade 2 15/92 (16%), grade 3 23/92 (25%) and grade 4 24/92 (26%). The mean average REPP for the sub cohorts were 0.78 for MSM grade 1, 0.77 for grade 2, 0.57 for grade 3 and 0.41 for grade 4.

Conclusions: Two-thirds of the patients coming for primary THR have polyarticular/spine diseases (MSM grades 2 to 4). In particular, the MSM groups with spine involvement (Grade 3 and 4) had a greater influence on the REPPs in this study with worse outcome. The MSM grade seems to be an important prognostic factor for worse outcome after primary THR.

FM50

Can pre-operative intraarticular injection predict pain relief after total hip arthroplasty?Dr. Thorsten Jentzsch¹; Yann Meyer²; Dr. Ines Unterfruner¹; PD Dr. Andrea B. Roskopf¹; Prof. Dr. Christian W. A. Pfirrmann¹; PD Dr. Patrick Zingg¹¹ *Balgrist University Hospital*; ² *University of Zurich*

Introduction: Intraarticular steroid injection of the hip for osteoarthritis is commonly recommended. It usually combines steroids with local anesthesia to confirm the joint as source of pain. We hypothesized an association between pain relief after injection and arthroplasty of the hip.

Methods: This was a retrospective cohort study between 2016-2018 at a single institution. It included all consecutive patients (n = 88) who received fluoroscopic-guided intra-articular injection of the hip with a contrast agent, an anaesthetic, and steroid in 2016 before subsequently undergoing total hip arthroplasty. Pain scores were assessed at baseline pre-injection, 15 minutes (min) post-injection, at first clinical follow up post-injection and pre-operatively, and at last follow up postoperatively. Responders were defined as patients with absolute reduction in pain score ≥ 20 (on a numeric rating scale of 0-100) points. The primary outcome was the similarity of the response to injection after 15 min / at the first clinical follow up and last follow up (i.e. different direction of response versus (vs) same direction). The Wilcoxon matched-pairs signed-ranks test, McNemar's test, and Spearman correlation were used.

Results: The median age was 64 (interquartile range 22) years and there were 49 (56%) females. The median pain scores were higher pre-injection (68 (30) points) compared to post-injection after 15 min (18 (40) points; $p < 0.001$), post-injection after a median of two (2) months (50 (40) points; $p < 0.001$), and post-injection after arthroplasty after a median of 15 (5) months (2 (15) points; $p < 0.001$). Sixty-nine (78%) cases had the same response post-injection after 15 min and post-operatively ($\rho =$

0.58), compared to 32 (36%) cases with the same response post-injection and post-operatively ($\rho = 0.25$) ($p < 0.001$). The response post-injection after 15 min was better than the response post-operatively in five (6%) patients, and worse in 14 (16%) patients.

Conclusion: The response to the local anaesthetic 15 min after injection may be a better predictor for the response to hip arthroplasty than the response to steroids several weeks after the injection. A fair amount of patients respond well to hip arthroplasty despite non-response to infiltration. Most patients with osteoarthritis may expect an even better pain relief after total hip arthroplasty compared to the diagnostic and therapeutic phase after injection of a local anaesthetic and steroid.

FM51

Different Responder Rates 3 And 12 Months After Primary THR? - Lower Rates in Higher Muskulo Skeletal Morbidity (MSM) Grades

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Introduction: The outcome after primary THR can be measured as responder rate. This rate correlates to the patients having a reduction of symptoms and disabilities as defined by OMERACT-OARSI (OsteoArthritis and Cartilage (2004) 12, 389–399). The published responder rates vary from 85.4% to 95% with different follow ups from 6 to 12 months. We had the impression, that some patients have more complaints 12 months postoperatively compared to 3 months. The aim of this study was to analyze the responder rates and changes 3 months and 12 months for primary THR in a single center.

Methods: In a prospective consecutive outcome study, all patients with primary THR between 01/2015 and 12/2016 were included with a complete follow-up 3 and 12 months postoperatively. Excluded were patients with tumor, neoplasia, infection, withdrawal of study consent and/or incomplete follow-up.

All patients had THR on an extension table with a minimally invasive approach by 2 experienced surgeons. Implants used were Vitamys-Optimys, Fa. Mathys or Avantage-Weber, Fa. Zimmer-Biomet.

The symptoms were assessed with the validated Pationnaire pre-, 3- and 12 months postoperatively. The MSM grade was assessed at the primary visit (grade 1: one major joint, 2 >1 major joint, 3 one major joint and spine, 4 >1 major joint and spine).

Each patient was classified as "responder" or "non-responder" depending on his relative effect (REPP) for 3 and 12 months postoperatively. For further analysis the cohort was stratified in 4 different grades of MSM.

Results: 98 patients could be included, 6 of them had to be excluded because of incomplete data. Of the remaining 92, 52 (56.5%) were women; the mean age was 72.7 years (from 31 years to 95). The responder rates for all patients were at 3 months 90.2% and 12 months 88.0%. Between 3 months and 12 months 6 patients changed their responder status: 4 responders became non-responder (all MSM grade 4) and 2 non-responders became responder (one MSM grade 1 and 2). In the group MSM 1, 2 the responder rates raised between 3 and 12 months, in MSM 3 it remained unchanged and in MSM 4 it declined from 91.7% to 75%.

Conclusions: The responder rate 3 months after THR is higher (90.2%) than after 12 months (88%). In MSM grade 1 to 3 the responder rates raise or stay; in MSM grade 4 it declines to 75%. MSM seem to be an important factor to influence the outcome 3 and 12 months postoperatively.

FM52

Can we measure Treatment Quality for THR? – Measuring “Effects” and “Side-Effects” of Total Hip Replacement (THR) in a Pilot StudyDr. Jörg Huber¹; Dr. Christoph Lienhard; Prof. Peter Rohner²¹ *Stadtspital Triemli Zürich*; ² *HSG St. Gallen*

Introduction: The quality of a surgical treatment is not clearly defined although often mentioned. A logical concept might be to measure the positive and negative aspects like in pharmacotherapy e.g. "effects" and "side-effects". The positive aspects ("effects") can be measured as responder rate, defined by OMERACT-OARSI (OsteoArthritis and Cartilage (2004) 12, 389–399). The negative aspects ("side effects") include mortality and morbidity. The morbidity rate is difficult to measure exactly but the reoperation/reduction rate in the first year postoperatively seems to be a good approach (most complications occur within the first year). In this study we measured the quality of THR with responder rate, mortality, and morbidity rate in a single center.

Methods: In a prospective consecutive outcome study, all patients treated with primary THR between 01/2015 and 12/2016 were included with a complete one year follow-up. Excluded were patients with tumor, neoplasia, infection, withdrawal of study consent and incomplete follow-up. All patients had MIS THR on an extension table by 2 experienced surgeons. The symptoms were assessed with the validated Pationnaire questionnaire. Each patient was classified as “responder” or “non-responder” depending on his relative effect (responder = REPP>0.2). One year after THR each patient was checked for mortality, reoperations, and reductions also in other hospitals.

Results: 98 patients could be included, 6 of them had to be excluded because of incomplete data. Of the remaining 92, 52 (56.5%) were

FM53-FM67: KNEE

FM53

Kinematically aligned total knee arthroplasty reproduces native patellofemoral biomechanics during deep knee flexion

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Purpose: Implant positioning for kinematically aligned total knee arthroplasty (TKA) differs from conventional mechanically aligned TKA. This difference may affect patellofemoral (PF) biomechanics after TKA. This cadaveric study tested the hypothesis that kinematically aligned TKA would restore PF biomechanics to the native condition better than mechanically aligned TKA.

Methods: Seven pairs of fresh-frozen cadavers were tested. All specimens were mounted on a customized knee testing system and digitized using a Microscribe instrument to measure patellar kinematics in terms of patellar varus/valgus rotation, medial/lateral position, flexion/extension rotation and proximal/distal position at knee flexion angles of 0°, 30°, 60°, 90°, and 120°. The medial and lateral PF joint contact pressure distributions at 120° of knee flexion were measured using a K-scan system. All patellae remained unresurfaced. For each pair, one knee was randomly assigned to kinematically aligned TKA and the other to mechanically aligned TKA performed using the conventional measured resection technique. During kinematically aligned TKA, the amount of femur and tibia resected was equivalent to implant thickness to maintain the patient-specific joint line. All patellar kinematics were measured and compared between the native condition and after surgery.

Results: The patellae of mechanically aligned TKA rotated more valgus and was positioned more laterally compared with those of kinematically aligned TKA at knee flexion angles $\geq 90^\circ$. Neither the patellar flexion/extension rotation nor the proximal/distal position differed between either prosthetic knee design and the native knee at all flexion angles. The contact pressure distribution between the medial and lateral PF joint after kinematically aligned TKA were similar to those of the native knee, while the lateral PF joint contact pressure after mechanically aligned TKA was higher than that of the native knee ($p = 0.038$).

Conclusions: Kinematically aligned TKA better restores patellar kinematics and PF contact pressure distribution to the native condition than mechanically aligned TKA during deep knee flexion. These findings provide clues to understand why kinematically aligned TKA is associated with less anterior knee pain and better PF functional performance compared to mechanically aligned TKA. Patients undergoing kinematically aligned TKA may experience a more normal feeling during deep knee flexion activities.

FM54

Does Posterior-stabilized Prosthesis Affect Knee Motion and Stability when Performing Kinematic Aligned Total Knee Arthroplasty?

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women; the mean age was 72.7 years (from 31 years to 95). The responder rate for all patients was 88.0% after 12 months. One patient (ASA 4) died within a month postoperatively (Mortality rate 1%). One patient had a fall and periprosthetic femur fracture requiring reoperation (Morbidity rate: 1%) and no infection/luxation in this period. In SIRIS the rate for reoperations was 1.7% in the first postoperative year.

Conclusions: Three variables (Responder rate, mortality rate and reduction/reoperation rate) give a first insight in quality measurement of THR. The measurement requires strict follow ups, a patient questionnaire for routine and additional effort to follow also the patients not showing up after a year. This is a pilot study and needs careful Interpretation because of low numbers of THR. Further studies are required.

Introduction: The kinematically aligned (KA) total knee arthroplasty (TKA) has emerged to reproduce more physiologic knee motion and stability after TKA. One of the most important principles of KA TKA is to restore native laxity. The preservation of posterior cruciate ligament (PCL) and the use of cruciate retained (CR) prosthesis are essential prerequisites for performing KA TKA. However, there is no information regarding how posterior stabilized (PS) prosthesis affects postoperative biomechanics following KA TKA. The objective of this cadaveric study was to determine whether PS prosthesis would affect knee motion and stability when performing KA TKA.

Methods: Seven fresh-frozen cadaveric knees (average age 65.4 years) were used. Native knee were tested first and than CR TKA was performed. Following complete test of CR TKA, PS TKA was performed. Both CR and PS TKAs were performed with standard KA TKA technique, using the same model of a single-radius CR or PS prosthesis (LOSPA; Corentec). The specimens were securely mounted on a custom knee testing system and digitized with a MicroScribe device to measure knee motion and laxities at knee flexion angles of 0°, 30°, 60°, and 90°. Medial and lateral femoral rollbacks and tibial axial rotation during the range of motion (ROM) were recorded. Anterior-posterior, internal-external rotation, and varus-valgus laxities after application of 60-N loading were also measured.

Results: Although lateral femoral rollback during the whole ROM of both CR and PS TKA were decreased compared to the native knee ($p > 0.05$), there were no group differences between CR and PS TKA ($p > 0.05$). In addition, no group differences in medial rollback and tibial axial rotation among native, CR and PS TKA were found ($p > 0.05$). In terms of laxity, postoperative internal and external rotation changes after CR and PS TKA were similar to those of native knee. Varus and valgus laxities of both CR and PS TKA were similar to those of native knee with the exception of increased varus laxity after CR TKA at knee flexion angles of 30°.

Conclusion: PS prosthesis provided similar rollback and laxities compared with CR prosthesis when performing KA TKA. During the early flexion range, PS prosthesis may provide even more posterior and varus stability than CR prosthesis. Given similar motion and stability, PS TKA can be used when performing KA TKA, especially in PCL insufficiency or severe deformity.

FM55

A posterior translation of more than 10 mm in stress radiographs indicates an insufficiency of the PCL in CR TKA

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Purpose: A posterior flexion instability due to insufficiency of the posterior cruciate ligament (PCL) in cruciate retaining (CR) total knee arthroplasty (TKA) is an important but underdiagnosed problem. Increased posterior translation can be measured on stress radiography in posterior drawer position. However, it is not clear how much posterior translation proves an insufficiency of the PCL. The purpose of the study was to define a cut-off value that indicates a PCL insufficiency in CR TKA.

Methods: In this retrospective study 24 patients (male : female 13:11, right : left 13:11, mean age \pm standard deviation 60 ± 7 years, range 42-68 years) with symptomatic flexion instability and suspected PCL-insufficiency in CR TKA were included. The registry database was searched for patients with CR TKA without flexion instability to serve as an age- and sex-matched control group. Twenty-four patients (male:female 13:11, mean age 60 ± 10 years, range 46-84 years) were included. Posterior translation was measured twice by two observers in a posterior drawer position on stress radiographs in 30° and 90° flexion in a two

week interval. Inter-rater reliability was between 0.62 and 0.91 and intra-rater reliability was between 0.77 and 0.95 which can be referred to very good. The two groups were compared with t-tests and chi square test. P-values were two-sided and considered statistically significant if smaller than 0.05.

Results: Symptomatic patients showed significant more posterior translation on stress radiographs in 30° and 90° flexion. Mean posterior translation was 6.7 mm (30°) and 14.5 mm (90°) for the symptomatic group and 2.2 mm (30°) and 6.4 mm (90°) for the control group.

Sensitivity and specificity testing of categorized variables revealed the best true positive and true negative correlations for 90° posterior drawer radiographs with a cut-off value of 10 mm (91.7%).

Conclusion: Stress radiographs including the posterior drawer position in 90° flexion should be part of the diagnostic algorithm in patients with suspected flexion instability. A displacement of more than 10 mm in CR TKA strongly indicates an insufficiency of the PCL.

* FM56

Current TKA alignment concepts do not aim to achieve the native coronal alignment of a patient

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Background: Coronal alignment is a key factor for a good outcome in total knee arthroplasty (TKA) but the optimal alignment has been under debate in recent years. Several studies reported better functional outcomes for patients with a preoperative varus when their postoperative alignment was still in slight varus. These results raise the question if the goal for the TKA alignment should be defined according to the native alignment of the patient. Interestingly, the TKA alignment goals have not been compared with the alignment found in native non-osteoarthritic knees yet. The purpose of these study was therefore to compare the coronal alignment goals of different TKA concepts to the alignment found in native non-osteoarthritic knees. To enable a detail comparison the recently introduced functional knee phenotype were used.

Methods: The hospital registry was searched for patients older than 16 and younger than 45 years, who received a CT according to the Imperial Knee Protocol. Patients with prosthesis, osteoarthritis, fractures or injury of the collateral ligaments were excluded. Finally, 308 non-osteoarthritic knees of 160 patients remained (102 males and 58 females, mean age ± standard deviation (SD) 30±7 years). The alignment of each leg was phenotyped according to the functional knee phenotype concept. The alignment goals of the three most used TKA alignment concepts were correlated with different functional knee phenotypes. The mechanical TKA concept was linked to functional knee phenotype: NEUHKA0° + VARFMA3°+ VALTMA3° and the anatomical TKA concept to: NEUHKA0° + NEUFMA0° + NEUTMA0°. The restricted kinematic TKA concept could be linked to nine functional knee phenotypes. The percentage of the population with these functional knee phenotypes was assessed.

Results: A “mechanical” functional knee phenotype (NEUHKA0° + VARFMA3°+ VALTMA3°) was found in 5.6% of the male and in 3.6% of the female population. A “anatomical” functional knee phenotype (NEUHKA0° + NEUFMA0° + NEUTMA0°) was found in 18% of the male and 17% in female population. Five of the nine phenotypes linked to a restricted kinematic TKA alignment concept were found in this population (5 male, 4 female, 4 mutual). They represented 31.3% of all males and 45.1% of all females.

Conclusion: The current TKA alignment concepts do not aim to achieve the native coronal alignment of the patient, which might be one reason for the relatively high percentage of unhappy patients.

FM57

Kinematically aligned total knee arthroplasty reproduces more native rollback and laxity than mechanically aligned total knee arthroplasty: A matched pair cadaveric study

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Introduction: A growing body of evidence supports that kinematically aligned (KA) total knee arthroplasty (TKA) provides superior clinical outcomes and satisfaction than mechanically aligned (MA) TKA. Our Hypothesis is that KA TKA would better restore knee biomechanics to the native condition than MA TKA.

Methods: Seven pairs of cadavers were tested. For each pair, one knee was randomly assigned to KA TKA and the other to MA TKA. During KA TKA, the sizes of femur and tibia resections were equivalent to implant thickness to align with the patient-specific joint line. MA TKA was performed using conventional measured resection techniques. All specimens were mounted on a customized knee-testing system and digitized. Knee motions measured during flexion included rollback, axial tibiofemoral rotation, and laxities, specifically varus-valgus laxity, anterior-posterior translation, and internal-external rotation.

Results: The pattern of knee motion following KA TKA was similar to the native knee. However, following MA TKA, both medial and lateral rollback and tibiofemoral axial rotation were decreased relative to those of the native knee. Valgus laxity was restored following KA TKA, whereas varus laxity was restored following MA TKA. Anterior translation was increased regardless of the alignment strategy. In addition, rotational laxities were restored after KA TKA, but external rotation laxity increased after MA TKA.

Conclusion: KA TKA restores femoral rollback and laxity to the native condition better than MA TKA. KA TKA may enhance functional performance and provide a more normal knee sensation.

FM58

Evaluation of factors influencing proprioception in patients with knee osteoarthritis undergone total knee arthroplasty: a Systematic Review and Best Evidence Synthesis

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Introduction: Proprioceptive deficit may represent a key factor in the evolution of knee osteoarthritis (OA), and TKA impact on proprioception remains to be determined. The aim of this systematic review and best evidence synthesis was to analyze the available literature on factors and treatments that may influence proprioception in knee OA patients undergoing TKA.

Methods: A systematic literature search was performed on three medical electronic databases: PubMed, PeDRO, and Cochrane Collaboration. The Preferred Reporting Items for Systematic Reviews and Meta-analysis guidelines were used. Risk of bias analysis and best evidence synthesis were performed as well. Furthermore, three main aspects of the included articles we investigated: the presence of pre-operative, surgical, and post-operative factors influencing proprioception in OA patients undergoing TKA.

Results: The search identified 1601 records and, after screening, 19 papers were used for the analysis for a total of 676 patients. Proprioceptive accuracy, despite a general improvement after surgery, often remained impaired. Strong evidence was found for no influence of prosthesis design on proprioception after surgery. Moderate evidence was found for varus deformity negatively influencing proprioception, time elapsed from surgery positively influencing proprioception, and patellar resurfacing not influencing proprioception. Limited evidence was found for valgus deformity, OA grade, intact ACL and antero-posterior joint laxity negatively affecting knee proprioception, and for muscle strength and sensorimotor training not affecting proprioception. Conflicting evidence was found for better post-operative proprioception versus pre-operative level, and for better proprioception of the operated group versus age matched control.

Conclusions: Proprioception in OA patients undergoing TKA improves but still remains impaired after surgery. Taking the studies' risk of bias into account, the best evidence synthesis showed no evidence for influence of prosthetic design, highlighting that the best surgical and rehabilitative treatment options still remain unclear. This warrants for further research efforts to better manage proprioceptive impairment, and its effects in terms of clinical outcome, in knee OA patients undergoing TKA.

* FM59

Conversion of Unicompartmental to Totale Knee Arthroplasty with and without the use of navigation; A matched controlled retrospective analysis of 16 cases

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Introduction: Despite the excellent success rates of the modern unicompartmental knee arthroplasty (UKA), results of knee replacement registries still shows a relatively high revision and failure rate for UKA, particularly when compared with traditional total knee arthroplasty (TKA). Mostly, when revision is required, failed UKAs are converted to TKAs. The principal objective of this study was to compare the functional outcome and radiological position of implants in revision of UKA to TKA between computer navigation (CAS) and a matched control group operated by conventional surgery (CS).

Methods: We retrospectively included 8 consecutive patients (8 cases) with an average age of 69 (43–89) which underwent revision TKA from UKA from 2016 to 2018 with the aid of CAS. This group was matched according to age, gender, BMI, and ASA score with a control group of 8 patients (8 cases) which were operated from 2012 to 2016 by CS. The intra- and postoperative complications as well as the clinical and radiologic outcomes were assessed retrospectively. All patients were reviewed by two independent observers.

Results: In the CAS group, the average hip-knee-ankle (HKA) angle was $177.6 \pm 2.1^\circ$ ($175.5\text{--}179^\circ$). The average medial tibial mechanical angle (TMA) was $90.6 \pm 1.4^\circ$ ($89.3\text{--}92.0^\circ$) and the medial femoral mechanical angle (FMA) was $90.2 \pm 2.6^\circ$ ($87.6\text{--}92.2^\circ$). The tibial slope was $86.9 \pm 1.3^\circ$ ($86\text{--}88.2^\circ$). In the CS group, the average HKA angle was $177.1 \pm 8.4^\circ$ ($174.1\text{--}185.5^\circ$), the TMA was on average $89.7 \pm 3.2^\circ$ ($86.7\text{--}92.9^\circ$) and the FMA was $90.6 \pm 5.1^\circ$ ($85.5\text{--}93.5^\circ$). The tibial slope was $84.6 \pm 4.0^\circ$ ($83.4\text{--}88.6^\circ$). There was no statistically significant difference between the two groups on any of the radiological parameters studied but the radiological target of a post-operative HKA angle of $180 \pm 3^\circ$ was obtained in 45.4 % of cases in the CS group and 85.7 % of cases in the CAS group. There was no difference in the functional outcome between the two groups. No major complications were observed in both groups.

Conclusions: The radiological target of a post-operative HKA angle of $180 \pm 3^\circ$ was significantly higher in the CAS group. Though the increased accuracy of CAS cannot be supported directly in a superiority of the clinical outcome, the quality of the results in the CAS group suggest that this technique could provide precious assistance to less experienced surgeons performing this surgery.

FM60

A dedicated infrastructure for partial knee arthroplasty in outpatient setting: Preliminary results from a series of 60 cases.

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Introduction: The number of primary total knee arthroplasties (TKA) has been increasing and a key factor in its cost is length of hospital stay. Thus, we wish to reduce the latter while ensuring quality of care. Outpatient surgery is a solution. Partial knee arthroplasty (PKA) in an outpatient setting (OS) is little described. The aims of this study are to evaluate the complications and re-admission rates within the first 30 post-operative days, as well as patients' satisfaction and clinical scores post PKA in an OS.

Material and Methods: This retrospective study includes all patients who underwent PKA in an OS between 2014 and 2018. 60 PKA (51 patients) were performed. Complications and re-admissions within 30 days post-op were reported. Patient satisfaction was assessed using a satisfaction scale. Clinical scores (Knee Society Score (KSS) and Knee Outcome Osteoarthritis Score (KOOS)) were evaluated at the last control.

Results: 2 patients were re-admitted within 24 hours due to hematomas and uncontrolled pain, which did not require surgical revision. 31 patients were very satisfied, 22 satisfied and 6 disappointed. Out of the 51 patients, 9 underwent the same procedure on the contralateral knee. The mean knee score of the KSS increased from 68.7 ± 13 to 92.9 ± 11 and the mean KSS function score increased from 69.8 ± 15 to 93.1 ± 11 . The pain score of KOOS was 91.7 ± 8 , the symptom score 90.2 ± 10 , the current activity score 93.9 ± 8 , the sport activity score 76 ± 17 and the quality of life score 87.5 ± 14 .

Discussion: Our study demonstrates that performing PKA in an OS is safe. 90% of the patients were satisfied. The clinical scores are comparable to the clinical scores of PKA performed in an inpatient setting. However, prospective comparative studies are needed to determine the risk factors that may impact the achievement of PKA in an OS.

FM61

Midterm Clinical and Radiographic Outcomes of 126 Consecutive Patient-Specific Unicompartmental Knee Arthroplasties

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Aims: To report the accuracy of component positioning as well as the midterm clinical, functional and radiological outcomes following patient-specific instrumented (PSI) unicompartmental knee arthroplasty (UKA).

Methods: 126 PSI-UKA were included. The primary outcomes were UKA survival, complication, and failure rate. The tibial implant positioning was determined using plain radiographs. Functional assessment included Oxford Knee Score (OKS), Forgotten Joint Score (FJS), patient satisfaction and range of motion (ROM).

Results: The survival rate of PSI-UKA was 92% after a mean follow-up of 50 months. The complication and failure rate was 13.5% and 8%, respectively. The tibial component was accurately implanted in the desired frontal and sagittal alignment with a minor deviation of 0.4° (SD 1.9°) and 0.4° (SD 2.6°) to the preoperative planning. OKS increased from 24 (SD 8) points to 44 (SD 6). FJS was 86 (SD 23) and 86.5% of all patients reported to be satisfied at the final follow-up. Patient satisfaction was negatively correlated with patients' age ($p < 0.05$).

Conclusion: With PSI an excellent accuracy regarding component placement in UKA can be achieved. However, despite excellent survivorship and clinical outcomes, our data indicate that the PSI system is not superior to conventional UKA implantation methods.

* FM62

Radiolucent lines after TKA: A matched-pair analysis of a classic implant and its evolutionary design

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Introduction: Total knee arthroplasty (TKA) designs continuously evolve aiming for improved patient outcomes. However, recently there have been reports of higher incidence of radiolucent lines (RLL) for a modern TKA system. The purpose of the current study was to compare the radiographic outcome of a new TKA cruciate-retaining (CR) implant to its predecessor design.

Methods: A group of 100 patients undergoing TKA using the newer design (Attune) was matched by age and gender to 200 patients having the classic design (LCS). All patients underwent computer-navigated (Vector Vision, CT-free, optoelectronic, passive marker, Brain-Lab, Munich, Germany) primary TKA by the same surgeon using the same technique. Radiographs were taken before discharge, 2 months and 12 months postoperatively. Radiographic analysis was performed by three independent assessors at three different time points, using the Modern Knee Society Radiographic Evaluation System. RLL were only documented if they were detected by all three assessors and over 2mm.

Results: At 12 months postoperatively the incidence of RLL observed for the Attune was 12.4% ($n = 13$) vs. 8.2% ($n = 16$) for the LCS; ($p = 0.24$). Femoral Zone 2 was the most affected with 11.4% ($n = 12$) for the Attune vs. 6.1% ($n = 12$) for the LCS; ($p = 0.11$). No RLL were observed on the tibial component of the Attune, while in three cases there were RLL detected at the tibia of the LCS.

Conclusion: At one year follow-up we could not find a significant difference incidence of RLL between the two implants. Both the newer TKA and the predecessor design showed RLL predominantly at the posterior flange. The reason for the RLL remain a matter of speculation and might be due to the surgical technique.

Conclusion: At one year follow-up we could not find a significant difference incidence of RLL between the two implants. Both the newer TKA and the predecessor design showed RLL predominantly at the posterior flange. The reason for the RLL remain a matter of speculation and might be due to the surgical technique.

FM63

Contributing factors for ACL mucoid degeneration: a large case-control prospective study

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Background: Mucoid degeneration of the anterior cruciate ligament (ACL) can be a cause of knee pain. The etiology and the pathophysiology remain unclear. Different contributing factors have been proposed in the literature. The purpose of the study was to evaluate the prevalence of these contributing factors.

Methods: From November 2013 to February 2019 we retrospectively reviewed 77 patients with mucoid degeneration of the ACL. The diagnosis was made by use of magnetic resonance imaging (MRI). The posterior tibial slope (PTS) was measured on plain lateral radiograph. The presence of osteoarthritis (OA) and cystic changes in the LCA, as well as the intercondylar notch width, were assessed on MR images.

Results: 86 mucoid degeneration of the ACL were identified in 77 patients (49 men and 28 women). The mean patient age was 45.2 years (range, 18 to 75 years). Both knees were involved equally (47 right knees and 39 left knees). The mean PTS was 13.6° (range, 5° to 22°). Stage III-IV OA was identified in 39.5% of cases (34 knees). The presence of cystic changes in the LCA was seen in 79.1% of cases (68 knees). The mean intercondylar notch width was 15.7mm (range, 10 mm to 22mm). 18.6% of cases (16 knees) underwent arthroscopic treatment with complete resection of the LCA.

Conclusions: Increased PTS, presence of OA and narrowed intercondylar notch may be contributing factors in the development of mucoid degeneration of ACL.

FM64

ACL Remnant is not a Risk Factor for Development of Cyclops Syndrome after Anterior Cruciate Ligament Reconstruction: A Risk Factor Analysis of 3633 Patients from the XXX Database

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Introduction: Cyclops syndrome is an early postoperative complication in patients after anterior cruciate ligament (ACL) reconstruction. It is characterized by the proliferation of a fibrovascular tissue at the base of the ACL graft (cyclops lesion) inducing a knee extension deficit. Since its first description in 1990, the etiology and the risk factors in the development of this lesion are still debated.

The aim of the study is to evaluate the prevalence of cyclops syndrome in a large series of patients undergoing ACL reconstruction and then to identify if remnant preservation or any other parameter could significantly increase the risk of developing this pathology.

Methods: All patients with primary ACL reconstruction performed between January 2011 and December 2017 were included in the study. Patients who underwent a reoperation for debridement of a cyclops lesion were identified and the epidemiology of cyclops syndrome was defined by the incidence within the study population, stratified by key demographic parameters. Finally, a multivariate logistic regression was performed to identify risk factors associated with this pathology.

Results: 3633 patients (mean age: 29.0 ± 10.3 years) were included in the study. Most of patients underwent an ACL reconstruction with hamstring graft (88.5%) or Bone-patellar tendon-Bone graft (11.2%). ACL remnant covered ≥ 50% of the ACL graft in 1380 patients and <50% in 2081 patients. Cyclops syndrome was identified in 65 patients (1.8%). Multivariate Analyses confirmed that ACL remnant was not a risk factor for Cyclops syndrome. Additionally, no other parameter including demographics, type of sport, delay between injury and surgery, preoperative knee laxity, associated meniscal lesions and their treatment (suture or meniscectomy), or type of graft was significantly associated with the development of symptomatic cyclops lesions.

Conclusion: The incidence of cyclops syndrome after ACL reconstruction is very low. Additionally, its rate is not significantly increased by the preservation of the ACL remnant or by any demographic parameter.

FM65

The Stabilizing Role Of The Anterolateral Ligament In An ACL Intact Knee

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Background: The Anterolateral ligament (ALL) is a ligamentous structure located within the anterolateral complex of the knee. In ACL deficient knees, its contribution to knee stability has been well demonstrated and the absence of its reconstruction at the time of ACL reconstruction did not restore normal kinematics of the knee. However, in ACL intact knees, the role of the ALL in knee stabilization remains controversial.

Objectives: To determine the stabilizing role of the ALL in ACL intact knees at different degrees of knee flexion.

Study Design & Methods: Controlled laboratory study. Five fresh-frozen human cadaveric knees were tested using a 6 degrees of freedom robotic system (KUKA). After removal of soft tissues, the ALL was precisely identified. The system identified the passive path of the knee from 0 to 90° of flexion. Applying torques of 5 Nm in internal rotation and 134-N for anterior tibial translation, stability of the knee was tested at different flexion angles. Knee kinematic changes were measured after serial sectioning of the ALL and ACL and compared with the ALL/ACL intact state.

Results: Isolated sectioning of the ALL induced a significant increase in internal rotation of the knee at all degrees of flexion compared to ACL/ALL intact state (+3.84°, p = 0.0059). It also induced to a lesser extent an increase in anterior tibial translation (+ 0.61 mm, p = 0.017). Additional ACL sectioning in ALL deficient knee caused a further increase in internal rotation and anterior translation compared with ACL/ALL intact knee (+15.72°, p <0.001 and + 9.25 mm, p <0.001 respectively).

Conclusions: The results of this study confirm that the ALL is an important structure that provides rotatory and anterior stability in the ACL intact knee at all degrees of flexion. Isolated ACL reconstruction after combined ACL and ALL injury could thereby not restore the normal kinematics of the knee.

FM66

Contralateral side can be used reliable for three-dimensional meniscus sizing with MRI scan - retrospective analysis of 160 healthy menisci

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Introduction: Meniscus allograft transplantation is a valuable surgical option for chronic post meniscectomy syndrome. For best clinical results, the selected allograft should be as similar as possible. Three-dimensional (3D) meniscus sizing could be a new approach to improve the accuracy of meniscus matching. The contralateral anatomy might therefore be a suitable reconstruction template.

The purpose of this study was to compare the 3D shape of each right and left meniscus by bi-planar 3D meniscus segmentation of MRI scans.

Methods: 3D surface models of healthy menisci were created based on 40 bilateral MRI scans. For the creation of the models we applied manual segmentation algorithms on the MRI data in sagittal and coronal plane. For side-to-side comparison, each left meniscus model was mirrored and then superimposed to its corresponding right meniscus model. Differences between the meniscus pairs were assessed by width, length, height, mean/maximum distance of all surface points (i.e., Hausdorff distance). Inter- and intra-rater reliability, as well as accuracy of bi-planar meniscus segmentation was assessed by two different readers.

Results: The meniscus pairs were not significant different according to width, length and height (p = at least 0.138). Side difference of mean surface distances was 0.76mm (±0.13 SD) for medial and 0.78mm (±0.15 SD) for lateral meniscus.

Inter- and intra-rater reliability of meniscus width, length and height was hereby good to excellent (0.828-0.987).

Conclusion: The 3D shape of left and right meniscus is very similar. Therefore, the contralateral meniscus can be used as template for 3D meniscus allograft sizing.

FM67

Slope-reducing tibial osteotomy decreases ACL-graft forces and anterior tibial translation under axial load

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Introduction: Posterior tibial slope (PTS) represents an important risk factor for anterior cruciate ligament (ACL) graft failure, as seen in clinical studies. An anterior closing wedge osteotomy for slope reduction was performed to investigate the effect on ACL-graft forces and femoro-tibial kinematics in an ACL-deficient and ACL-reconstructed knee.

Methods: Ten cadaveric knees with a relatively high native slope (mean ±SD): slope 10° ±1.4°, age 48.2years ±5.8) were selected based on prior CT measurements. A 10° anterior closing-wedge osteotomy was fixed with an external fixator in the ACL-deficient and ACL-reconstructed knee (quadruple Semi-T/Gracilis-allograft). Each condition was randomly tested with both the native tibial slope and the post-osteotomy reduced slope. Axial loads (200N, 400N), anterior tibial draw (134N), and combined loads were applied to the tibia while mounted on a free moving and

rotating X-Y-table. Throughout testing, 3D motion tracking captured anterior tibial translation (ATT) and internal tibial rotation (ITR). Change of forces on the reconstructed ACL-graft (via an attached load-cell) were recorded.

Results: ATT was significantly decreased after slope reduction in the ACL-deficient knee by 4.3 mm \pm 3.6 (p < 0.001) at 200N and 6.2mm \pm 4.3 (p < 0.001) at 400N of axial load. An increase of ITR of 2.3° \pm 2.8 (p < 0.001) at 200N and by 4.0° \pm 4.1 (p < 0.001) at 400N was observed after the osteotomy. In the ACL-reconstructed knee, ACL-graft forces decreased after slope reduction osteotomy by a mean of 14.7N \pm 9.8 (p < 0.001) at 200N and 33.8N \pm 16.3 (p < 0.001) at 400N axial load, which equaled a relative decrease by a mean of 17.0% (SD \pm 9.8%), and 33.1% (SD \pm 18.1%), respectively. ATT and ITR were not significantly changed

FM68-FM78: SPINE

FM68

Augmented reality navigated pedicle screw placement – a cadaveric study

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Introduction: Augmented reality (AR) is an emerging technology with great potential for surgical navigation. Through the possibility of in-situ holographic projection of otherwise hidden 3-dimensional anatomical information into the surgical field, AR can overcome many limitations of conventional navigational tools based on 2D displays. This study investigated the feasibility and accuracy of one of the first marker-less holographic navigation developments for lumbar screw placement.

Methods: Lumbar computer tomography scans (CT) of two cadaver specimens and their reconstructed 3D models were used for pedicle screw trajectory planification. Afterwards, the planned trajectories and the 3D models were uploaded to an AR head mounted device. A randomization was performed to assign the navigated technique and the free-hand technique to either the left or right of each vertebra from L1 to L5. The intraoperatively accessible bone surface of each vertebra was captured by a pointing device and used for registration of the planning hologram. The holographic projection was used to navigate placement of k-wires as a simulation of pedicle screw trajectories. A postoperative CT was performed to assess accuracy of both techniques.

Results: A total of 18 k-wires were placed (8 navigated, 10 free-hand) by two experienced surgeons. In two vertebra, AR navigation was aborted, because the registration of the preoperative plan with the intraoperative anatomy was imprecise due to a technical failure. The previously planned entry point differed not significantly by a mean of 4.74 \pm 2.37 mm in the free-hand technique and 5.99 \pm 3.60 mm in the AR-navigated technique (p = 0.39). The previously defined angle of trajectory differed by a mean of 11.21° \pm 7.64° in the free-hand technique and 5.88° \pm 3.69° in the AR-navigated technique (p = 0.09).

Conclusion: This pilot study demonstrates improved angular precision in one of the first AR-navigated pedicle screw placement studies worldwide.

Technical shortcomings of the used technology need to be eliminated for potential clinical applications.

FM69

Does the O-arm based navigation in spinal fusion increase accuracy of screw placement? Our experience with 1122 consecutive pedicular screws.

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Introduction: Surgical treatment of lumbosacral degenerative disease has markedly grown over the last 20 years. Safety and efficiency are key elements in spinal surgery. In this respect, a plethora of image-guided and navigational systems have been developed. These technologies have a substantial and their usefulness is still debated. The aim of this study was to assess the safety in pedicular screw insertion using the O-arm system with Stealth Station® Navigation and to compare our results with the literature.

Methods: We conducted a mono-centric retrospective study including 216 patients for a total number of 223 spinal fusions while using the O-arm navigation system from March 2016 to July 2018. Of the 223 procedures, 11 were traumatic cases and 212 were fusion for degenerative

in the ACL-reconstructed knee. Testing of a tibial anterior drawing force in the ACL-deficient knee led to a significantly increased ATT by 2.7mm \pm 3.6 (p < 0.001) after the osteotomy. The ACL-reconstructed knee did not show a significant change (n.s.) in ATT after the osteotomy. However, ACL-graft forces detected a significant increase by 13.0N \pm 8.3 (p < 0.001) after the osteotomy with a tibial anterior drawer force, whereas the additional axial loading reduced this difference due to the osteotomy (5.3N \pm 12.6 (n.s.)).

Conclusion: Slope-reducing osteotomy decreased anterior tibial translation in the ACL-deficient and ACL-reconstructed knee under axial load, while internal rotation increased in the ACL-deficient status.

disease. The vast majority of fusion concerned the lumbar level. Surgery were performed by 3 senior surgeons. Assistance was carried out by a total of 8 senior residents who participated in screw insertion. In all cases a standard open posterior approach was used. Mean age at surgery was 65,5 years. The position of each screw was analyzed retrospectively by an independent observer using the Rampersaud classification. Radiation exposure (RE) of patients as well as complications within 30 postoperative days were reported.

Results: In a 29 months interval 1122 screws were inserted during the 223 surgeries. 11 screws (0,98%) required intraoperative repositioning. 2.4% of the screws (27/1122) showed a malposition type C. There were no severely misplaced screws and no revision surgery was needed due to screw malposition. In a terms of complications five patients underwent an early revision surgery due to compressive hematoma and one patient showing signs of Brown-Sequard syndrome.

The average effective dose to patient was 12 mSv.

Conclusion: The O-arm system provides excellent accuracy in screw placement. Our results were similar to those reported in the literature. The routinely performed control CT scan has led to a higher RE of the patient (similar to that of an abdominal CT) when compared with standard fluoroscopy. We consider this difference as acceptable since improved safety by preventing revision surgery due to screw misplacement. Still, concern about reducing radiation should move us towards the use of newer generation of O-arm system with low dose mode.

FM70

Augmented Reality-Assisted Rod Bending in Spinal Surgery

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Introduction: In complex deformity cases, surgeons may be confronted with difficulties in shaping and reducing rods into pedicle screw heads, which may result in forceful reduction maneuvers, potential screw loosening or pull-out, and longer surgery time. This study sought to evaluate the benefit of holographic rods as assistive equipment for manual rod bending.

Methods: A custom-written application for an augmented reality (AR) system (HoloLens, Microsoft Cooperation, WA, USA) was designed with the aim of assisting spine surgeons with rod bending. After application startup a custom-made pointing device equipped with a commercially available fiducial marker (Clear Guide Medical, MD, USA) is employed to capture the 3D positions of the screw heads. Once all screws have been captured, a centripetal Catmull–Rom spline is generated. The resulting hologram can be moved and rotated freely, and employed as a template for bending the implant. The application indicates the precise length of the required rod.

As a test fixture, we made use of a pelvic-/lumbar spine model (Sawbones, WA, USA) with pedicle screws (M.U.S.T., Medacta, Switzerland) inserted bilaterally at six levels (L2-5, S1, iliacal). Rod bending (4-mm alloy rod) was performed manually with and without the AR-technology, six times in a randomized fashion on both sides of the spine model by three fellowship-trained spine surgeons. An independent observer recorded the time for bending and inserting the rod, the number of rod-bending maneuvers, and the accuracy of the rod length.

Results: The total time spent on bending and inserting the rod was significantly shorter with AR compared to without (374 \pm 79 vs. 465 \pm 121 s, p = 0.01195). The rod length was significantly more often correct with AR (15/18 vs. 4/18, p < 0.001). In addition, fewer rebending maneuvers

were needed with AR; although, this difference was not significant (7/18 vs. 10/18 $p > 0.05$).

Conclusion: In daily surgical routines, precise rod shaping is required for the appropriate alignment of pedicle screw-rod constructs. Despite the negative biomechanical consequences of rod reduction, it is often used and required if rod bending is not accurate.

With this novel augmented reality application, the time for bending and inserting the rod is decreased by 20% as compared with the conventional method (374 vs. 465 s).

AR-assisted rod bending has the potential to reduce surgery time and increase the accuracy of manual rod bending.

FM71

Imaging in patients with cervical spine pain after trauma – Sensitivity and specificity of X-Ray, CT and MRI

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Introduction: The NEXUS- Criteria are well accepted to guide decision making towards radiographic workup in patients with neck pain after trauma. There is some evidence that plain x-ray may provide false security to rule out an injury. However, there is no consensus whether x-ray, CT, or MRI is superior to confirm or rule out c-spine injuries.

Methods: We reviewed 4110 consecutive patients with traumatic neck pain admitted to our emergency department (ED). The available imaging as well as the modality of imaging obtained during the presentation in ED was reviewed and documented. Thereafter, radiographic findings by the radiologist were compared to those from the spine surgeon. In case of disagreement, two orthopedic surgeons specialized in spine surgery blinded to the former report independently reviewed the images to find a consensus - injury or no injury.

Results: In 540 patients primary plain x-ray was performed. An injury was detected in ten patients (2%). In 390 patients additional CT/MRI was conducted. The analysis of these images revealed 32 injuries to the c-spine were missed on initial plain films leading to a 24% sensitivity of x-ray. There were no false positive injuries diagnosed on conventional x-ray as compared to CT or MRI resulting in a specificity of 100%.

In 2193 patients, primary CT scan was performed. Seven percent (164 patients) had an injury of the c-spine. Ninety patients received additional MRI scans (4%) revealing 10 additional injuries - five required immediate surgical therapy. One initially suspected injury on CT could not be confirmed in MRI. Thus resulting in a sensitivity of 94% and specificity of 99.9%.

Sixty-three patients underwent MRI without previous X-Ray or CT to assess possible c-spine injuries. Three injuries were found. A total of 160 patients had MRI with additional CT/x-ray. Thirty-four injuries were detected with no missed injury and no false positive report as compared to the other two imaging modalities.

Conclusion: We present the largest cohort of patients with neck pain after trauma admitted to the ED. We found that x-ray examinations have a poor sensitivity to find injuries to the c-spine, missing nearly 7 out of 10 injuries in this series. While CT scan has a very good sensitivity and is routinely performed, there are still relevant injuries missed using only the CT. In our retrospective analysis, the MRI was the best diagnostic modality with a sensitivity and specificity of 100% to detect c-spine injury following trauma.

FM72

The Core Yellow Flags Index (CYFI) for the baseline assessment of psychological status in patients undergoing spine surgery

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Introduction: Depression, anxiety, catastrophising thoughts, and fear-avoidance beliefs are some of the so-called "yellow flags" that predict a poor outcome in back patients. Many surgeons have difficulty assessing or detecting yellow flags and they rarely formally screen for them. This may be due to the complexity of existing instruments and time constraints during the consultation. We aimed to develop a brief assessment tool that would allow for the rapid and systematic evaluation of core flags in clinical practice.

Methods: Large sets of existing data from 4 questionnaires (ZUNG depression (N = 399); Hospital Anxiety and Depression Scale (Anxiety-subscale) (N = 308); Pain Catastrophising (N = 766); Fear Avoidance Beliefs (N = 736)) were analysed to identify the single item in each that best represented the full scale score. The 4 items were coined the "Core Yellow Flags Index" (CYFI). 1'768 patients completed CYFI and a Core Outcome Measures Index (COMI) preoperatively, and a COMI 3 and 12mo later (FU). Reliability was assessed in 30 patients who completed CYFI twice, 6±7days apart.

Results: The individual flag items were correlated with their corresponding full-length questionnaires: 0.71 (depression), 0.81 (catastrophising), 0.77 (anxiety), 0.83 (fear avoidance beliefs). The test-retest reliability was 0.6-0.8 for each of the 4 items and 0.83 for the set, considered good. Cronbach's α for the 4 items was 0.79. Structural equation modelling revealed that CYFI explained a unique, significant proportion of the variance in COMI at 3 months' FU ($\beta = 0.23$, $p < 0.001$) and also at 12 months FU ($\beta = 0.20$, $p < 0.001$). The fit of the model was good (RMSEA = 0.06, CFI = 0.96, $\chi^2(18) = 59.56$, $\chi^2/df = 3.31$).

Discussion: The 4-item CYFI proved to be a simple, practicable, reliable and valid tool for routinely assessing key psychological attributes in spine surgery patient. It made a significant and clinically relevant contribution to the prediction of patient outcome after surgery. CYFI's items were similar to those in the "STarTBack screening tool", used in primary care to evaluate the risk of back pain chronicity, which further substantiates its validity. The brevity of CYFI makes it a useful addition to the brief COMI in the self-assessment of baseline status before surgery. Its widespread use may assist in improving the accuracy of individual outcome predictions in predictive analytical models derived using spine registry data.

* FM73

Validation of the Mirza invasiveness index for spinal surgery in patients with lumbar spinal disorders registered in the Spine Tango registry of EUROSPINE

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Introduction: The complexity of spine surgery affects the extent of blood loss, duration of the procedure and complication rate. Being able to quantify the invasiveness of an operation is important in the decision making process, to weigh up the risks of surgery. It is also valuable for comparing outcomes and complication rates across studies and in benchmarking activities. In 2008 Mirza et al. published an invasiveness index for spinal surgery. This study aims to evaluate the external validity of that index in data from the Spine Tango registry of EUROSPINE.

Methods: A cross-sectional analysis was performed with data acquired from the Spine Tango registry from 2000 to 2017. The study group included 23580 patients. The Mirza invasiveness index was calculated using the detailed surgical information documented on the Spine Tango forms as the sum of 6 possible interventions on each vertebral level: anterior/posterior decompression, anterior/posterior fusion, anterior/posterior stabilization. The correlation between the Mirza invasiveness index and blood-loss, operative time and complications was evaluated using a multiple regression analysis adjusting for possible confounders (age, gender, BMI, ASA score, number of previous surgeries).

Results: The mean (\pm SD) Mirza index was 6.1 ± 5.6 (range 0-42). An increase of 1 point in the Mirza index was associated with an increase in blood-loss of 30ml (95% CI 29.5-30.6; $p < 0.0005$) and an increase in operative time of 8 minutes (95% CI 8.29-8.57; $p < 0.0005$). The multiple regression models showed an R-sq of 35% with blood-loss as the dependent variable and an R-sq of 42% with operative time as the dependent variable. The mean Mirza index was significantly higher ($p < 0.001$) in the group with surgical complications (6.71 ± 6.32) compared to the group without surgical complications (6.03 ± 5.51). The mean Mirza index was significantly higher ($p < 0.001$) in the group with general medical complications (6.68 ± 7.84) compared to the group without general medical complications (6.03 ± 5.51).

Conclusion: The Mirza invasiveness index showed good construct validity in the Spine Tango data. The Mirza index is simple to calculate with the information recorded on the Spine Tango forms. It can be used to adjust for the surgical case-mix in comparing rates of complications or outcomes in different studies or comparing hospitals or surgeons in the registry.

FM74

Extreme long-term outcome of operatively versus conservatively treated patients with adolescent idiopathic scoliosis

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Introduction: Extreme long-term outcome of patients with adolescent idiopathic scoliosis (AIS) is largely underreported. We report results of conservative and surgical treatment of AIS 29 years and later.

Methods: Patients with AIS and a follow up of at least 41 years in the surgical group (and 29 years in the conservative group) were included. Patients were treated surgically if the primary curve was $\geq 45^\circ$ in adolescence or conservatively if $<45^\circ$ / surgery was denied by the patient. From a cohort of conservatively treated patients, a subgroup was selected to be matched to the surgical group regarding age, gender, comorbidities and curve severity. A comparison between both groups for the primary outcome of the subjective spine value (0-100%) was performed using the Chi-squared and Wilcoxon rank sum tests. The Sign test of matched pairs was used for comparisons within the surgical group.

Results: The median age of patients (n = 16) at initial presentation was 14 (interquartile range 2) years. There were 12 females (75%). The median follow up was 46 (12) years. There were no differences between the surgical (n = 8) and conservative (n = 8) group for age, gender, comorbidities, follow up, and minimal difference of the initial severity of the primary curve at the thoraco-lumbar region (Cobb angles of 48° (16°) versus (40° (19°); p = 0.172). There were two revisions (25%) in the surgical group (partial hardware removal after 2 years and extension of the instrumentation after 35 years). There was a significant pre- to post-operative reduction of the severity of the primary curve (Cobb angle -21° (16°); p = 0.012) and secondary curve (-20° (19°); p = 0.043). There were no clinical differences in the subjective spine value (70 (30) vs 90 (30) points, p = 0.136) and Oswestry Disability Index between groups. However, the severity of the primary curve at final follow up was lower in the surgical group (38° (3°) vs 61° (33°); p = 0.006). In the course of around three centuries, the severity of the primary curve progressed by a median of 9° (9° ; p = 0.027) in the surgical group and 18° (31° ; p = 0.012) in the conservative group.

Conclusion: Surgical treatment of AIS reduces the progression of curve evolution over 40 years, even if not significantly influencing the subjective satisfaction of the patient if compared to moderate AIS that is treated conservatively.

* FM75

Disproportion of vertebral bodies and its impact on lumbar disc herniation

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Introduction: The radiographic correlation of disproportional lumbar vertebral bodies and bilateral spondylolysis and degenerative changes of the disc has been described previously. Nevertheless, its clinical relevance has never been evaluated. The aim of this study was to analyze whether disproportion of vertebral bodies is a risk factor for disc herniation.

Materials: 72 patients (m:34 f: 38; mean age: 49yrs; range, 16-85 yrs) who underwent lumbar microdiscectomy due to symptomatic disc herniation between January 2013 and June 2018 could be included.

In every patient Magnet Resonance Images (MRI) of 3 motion segments (1 pathologic and 2 healthy) were analyzed for a.-p. diameter of the caudal endplate of the upper compared to the cranial endplate of the lower vertebral body. Disproportion of the motion segment was defined as shortening of $>10\%$ of the a.-p. diameter of the cranial endplate of the lower compared to the caudal endplate of the upper vertebral body.

Results: In total n = 216 motion segments were analyzed. The level of disc herniation was L5/S1 in 48.6%, L4/5 in 37.5% and L3/4 and L2/3 in 6.9% respectively. In total 26 disproportional motion segments were found (12.04%) (L5/S1: 18.06%; L4/5: 12.5%; L3/4: 5.56%). There was a significant difference between disc herniations in disproportional and normal motion segments (p <0.01). Multiregression analysis revealed that disproportion of the motion segment triples the risk for disc herniation compared to normal (Odds Ratio: 3.04).

Conclusion: Disproportion of the motion segment is a risk factor for disc herniation and triples the risk for its occurrence.

* FM76

Surgery-induced Spreading of Tumor Cells into the Circulatory System during Cement Augmentation in Metastatic Spinal Disease - A Pilot Study

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Introduction: With an increasing survival of cancer patients suffering from metastatic spinal disease (MSD), surgical procedures such as cement augmentation/vertebroplasty (VP) and balloon kyphoplasty (BKP)] have become more widespread. Surgery-induced spreading of tumor cells remains a major concern of VP/BKP in cancer patients. We aimed to evaluate the effect of cement augmentation on iatrogenic dissemination of tumour cells and investigated the dynamic patterns of these circulating tumour cells (CTCs) in patients' blood during the procedure.

Materials and Methods: We prospectively recruited eleven consecutive patients suffering from either breast (n = 7), prostate (n = 3) or colon (n = 1) cancer with spinal metastases undergoing VP (n = 1) or BKP (n = 10) at our institution from 2017-2018. One patient was excluded from the study due to clotted blood samples, leaving 10 patients for analyses. In all patients, intra-operative transpedicular biopsies were obtained for histopathological confirmation of the primary tumour. Mean age was 66.1 (SD:10.6) years with male:female = 3:8. Blood samples were collected from either a central (n = 6) or peripheral (n = 5) venous catheter before starting the surgery and at 1, 5, 10 and 20 minutes after cement application. The samples were analyzed with the RT-PCR-ADNA test (Qiagen), which is a qualitative immunomagnetic-cell-selection-system. It includes a highly sensitive RT-PCR for detecting breast, prostate and colon cancer-specific mRNA markers.

Results: Histopathologically, 9/10 tumours were confirmed; 1/10 was negative. In 5/9 patients with positive histopathologic proof, mRNA-markers for the individual tumour entity were detected in the blood circulation at all 4 time points. In all 9/9 cases, these specific mRNA-markers were detected in the circulation only at 5 and 10 minutes after cement application. In the histopathologically negative case, no mRNA-markers could be detected at any time point.

Conclusion: We observed surgery-induced spreading of tumour cells into the circulatory system during cement augmentation in MSD. In all patients, CTCs were detected at 5 and 10 minutes after cement application. Hence, we conjecture that the optimal time for blood sampling for detecting CTCs would be between 5 and 10 minutes after cement application. We have paved the path for future studies which investigate cell viability and prophylactic strategies to prevent from surgery-induced spreading of tumour cells during cement augmentation.

FM77

Treating fragility fractures of the posterior pelvis - do we need to take a broader view?

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Abstract

Introduction: A classification system to treat fragility fractures of the pelvis (FFP) based on fracture type has been proposed in the literature. Conservative treatment is the method of choice for Type I and II fractures. For Type III and IV fractures, treatment recommendations are largely based on theory and tend to favor surgery. However, our institution's experience treating these fractures differs from these recommendations.

Methods: The aim of this retrospective cohort study was to compare outcomes according to treatment course and to assess if other factors should be considered in the treatment algorithm. Of the 145 patients with fragility fractures of the pelvis hospitalized at our institution, 77 with posterior pelvic ring fractures were included in the study. The treatment course, patient demographics, and clinical factors potentially influencing treatment outcomes were analyzed.

Results: 26 patients (Group 1) were posteriorly stabilized using minimally invasive lumbopelvic fixation, 18 patients (Group 2) failed conservative treatment and subsequently underwent surgical stabilization, and 33 patients (Group 3) were successfully treated conservatively. Conservative treatment succeeded in 62% of Type II, 33% of Type III and

33% of Type VI fractures. Moreover, 52% of conservatively treated patients had either Type III or IV fractures. Although the median age of patients in Group 3 was higher, no other risk factors were significantly different among the groups.

Conclusion: Decisions about treatment course for patients with fragility fractures of the posterior pelvis should not be based on fracture type alone. Further evidence-based research is needed to complement the existing guidelines.

Key words: Fragility fracture of the pelvis, sacrum fracture, osteoporosis, geriatric patient

* FM78

A severe case of Pyoderma Gangraenosum after transforaminal lumbar interbody fusion (TLIF), Case Report and Literature Review

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Introduction: Rare cases of auto-immune disorders have been known to lead to severe wound healing disorders after surgical intervention. We present a well-documented case after spondylodesis, as well as photographic development of an extensive musculocutaneous soft tissue defect.

Methods: An inpatient case of severe pyoderma gangraenosum following spine surgery was reviewed, with collection of thorough patient history, inpatient digital data and complete case photo documentation. This was cross analyzed with a literature review concerning pyoderma gangraenosum, and pathergic reactions in spine surgery.

Results: A 55-year-old patient was consulted in the orthopaedic outpatient clinic in 2018 for back pain associated with radiculopathic pain in his legs due to L4/5 spondylolisthesis. Transforaminal lumbar interbody fusion was performed.

In the first week of postoperative care a hematoma was revised. Due to intraoperative pus a microbiologic sampling was obtained, and antibiotic treatment initiated. Inflammatory markers continued to rise, under assumption of possible necrotizing fasciitis serial revisions were performed. The initial biopsy showed neutrophilic proliferation, an underlying infectious disease was deemed likely, which would later prove misleading. Furthermore, the patient developed systemic abscess-like pus filled lesions. Aggressive wound debridement led to a massive soft tissue defect, without progress in wound healing. Patient deterioration required intensive care. Three weeks in all the bacterial cultures proved negative. The clinical situation imposed upon a possible autoimmune response, and corticosteroids were added to the therapeutic regime. The patient rapidly improved, wound healing progressed. In later revision a full skin thickness biopsy confirmed the possibility of dermal hematologic neoplasia manifestation, with correlation to an autoimmune response.

Discharge was at 3 months post primary intervention, after several complications counting renal insufficiency, anemia, massive transfusions, ARDS, secondary implant infection and needed overlap plastic.

Conclusion: Auto-immune triggered pathergy is rare in the surgical field and the consequences are grave, which demands earlier diagnosis for proper management. Thorough data and photo documentation is rarely encountered due delay in diagnosis. Negative microbiological samplings prove a leading hint in differential diagnosis, whereas a suggestive histology of infection is not reliable.

FM79-FM97: BASIC RESEARCH

* FM79

Automated CT-MR image fusion for the preoperative planning of orthopedic surgeries

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Introduction: CT-MR image fusion is required in preoperative planning of complex cases, in which information from both image modalities is crucial. Applications of this technique include tumor resection planning and corrective osteotomy planning, when soft tissue needs to be considered. However, available semi-automatic fusion techniques are not sufficiently accurate due to poor resolution of clinical MR images. Consequently, time-consuming manual alignment between the images is required (gold standard; GS). Fully automatic fusion algorithms have been validated in neuro- and spinal-surgery, but their accuracy on clinical MR images for upper extremities has not been yet studied. The goal of this study was the evaluation of an automated image fusion method applied to CT and MR images of the forearm. The method was compared against a semi-automatic technique and the GS.

Materials and Methods: 40 patients were included in this retrospective study. Inclusion criteria were presence of a CT scan (1 mm slice thickness; 120 kV), a MR scan (Sagittal T2, 2 mm slice thickness) of the distal radius, and no presence of previous osseous pathology. Image fusion according to the GS method was achieved by manual segmentation of the cortical bone layer of the radius bones in CT and MRI, using commercial segmentation software (Mimics Medical V.19.0). Subsequently, the extracted 3D models were manually aligned using dedicated preoperative planning software. Similarly, landmark-based semi-automatic image fusion was achieved by image registration using 4 corresponding bony landmarks, manually placed on both image modalities. Automated image fusion was performed through a multimodal registration algorithm using normalized mutual information metric. Accuracy evaluation was obtained by root mean square error assessment of the aligned bone models between the cortical layer of the distal joint surfaces of the CT and MR radius, among the different methods.

Results: Automatic image fusion was 3% less accurate than the GS (0.02 ± 0.01 mm, range: 0.04 – 0.14 mm), but 93% more accurate than the semi-automatic landmark-based method (0.34 ± 0.17 mm, range: 0.16 – 0.66 mm). The GS and semi-automatic method required 30 and 20 min of additional manual work, respectively.

Conclusion: Automatic image-fusion can generate results comparable in accuracy to the GS and significantly better than the landmark-based method, with considerably faster registration times than all tested fusion methods.

* FM80

3D-printed clamps as a novel technique to fixate spine specimens for biomechanical testing

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Introduction: To record accurate data in biomechanical testing of the spine, firm specimen fixation in the testing machine is crucial. The standard to achieve this goal is potting, an approach that uses the embedment of the specimen in a solidifying material like polymethylmethacrylate (PMMA), Wood's metal or dental stone. Insertion of screws, pins or other connecting elements is often performed to improve anchoring strength. Since potting includes disadvantages like heating of specimen, no simple access to embedded anatomical structures and difficult geometrical orientation of the specimens, we developed an alternative, more customizable fixating technique using a 3D-printed clamping system. The aim of this study was to compare the fixation rigidity of the novel clamping technique to PMMA potting with and without screw insertion.

Methods: Sixteen thoracic and lumbar functional spine units of bovine, porcine, ovine and human cadavers (4 each) were consecutively fixed with the above mentioned techniques and loaded in all six degrees of freedom (flexion-extension, lateral bending and axial rotation: ± 7.5 Nm; anteroposterior and lateral shear: ± 150 N; axial compression-decompression: 1500 N / - 150 N). After 5 preconditioning cycles, the combined relative movement between the cranial and caudal vertebral body and

their corresponding fixtures were recorded over the period of 5 loading cycles using a 3D-tracking system. Statistical data analysis was done using the Wilcoxon signed-rank test.

Results: Simple potting showed significant more relative movement in all loading directions compared to the 3D-printed clamps and potting with screws ($p < 0.05$). The 3D-printed clamps showed superior rigidity in comparison to potting with screws in lateral shear loading ($p < 0.001$). During testing, two vertebral bodies slipped out of simple potting and had to be repotted. Three cases of vertebral body fractures were observed during testing of screw augmented potting.

Conclusion: Regarding fixation strength, the novel 3D-printed clamping system proved to be a valid alternative to potting with screw insertion, while providing the expected advantages and showed no failures during these experiments. It must be stated, that for all fixation methods tested, the recorded data show non-negligible movement of the vertebral bodies in the fixtures. We conclude that direct measurement of vertebral body movement is crucial to eliminate this inaccuracy in biomechanical testing.

FM81

Augmented Reality Enhanced in-situ Visualization for Ultrasound Guided Interventions

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Introduction: Operator-dependency is the drawback of ultrasound (US) for diagnostic and therapeutic applications. Sonographic images are currently displayed on monitors and their understanding needs competence of spatial orientation. Direct overlay of sonographic images on the according anatomy is now possible with augmented reality (AR) technologies. The purpose of this study was to assess the performance of US-guided needle placement with and without AR in-situ US viewing, in dependence of the expertise of the operator.

Material and Methods: Three untrained operators and two experienced radiologists performed 100 US-guided punctures with and without AR in-situ US. The punctures were performed in a leg phantom with soft tissue lesions and a vessel phantom. Time to puncture and number of needle passes were compared.

Results: AR in-situ US resulted in significantly reduced time (22 vs. 30s) and number of needle passes (1.25 versus 1.57) compared to the conventional US technique. The initial gap in performance of untrained operators vs experienced radiologists with the conventional method (time: mean = 20 vs 37s; needle passes: mean = 1.05 vs 1.92) was reduced to a non-significant difference (time: mean = 37 vs 20s; needle passes: mean = 1.9 vs. 1.1).

Conclusion: AR in-situ US could be a potential breakthrough in US imaging by the concept of simplifying spatial orientation of the operator, thus reducing the experience-based differences in performance of US-guided interventions.

* FM82

The technique of augmented reality guided periacetabular osteotomy –feasibility experiments

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Introduction: The Ganz' periacetabular osteotomy (PAO) is a demanding surgical procedure that consists of four osteotomies, namely the supra-acetabular (saOT), the pubis (pOT), the ischium (iOT) and the retro-acetabular OT (raOT). The PAO is typically carried out in a free-hand (FH) fashion making planning and reproducibility of these osteotomies challenging and insufficiently reproducible. We therefore performed a feasibility study to test whether Augmented Reality (AR) guidance of surgical instruments would increase accuracy of PAO osteotomies.

Methods: A 3D osteotomy-plan for a PAO was created. 30 plastic pelvises were scanned with computer tomography to build a virtual model, equipped with virtual osteotomy guides. This virtual bone/guide model was then displayed to the operator with an AR head mounted device. A plastic femur was attached to the acetabular socket to simulate the hip joint and tissue coverage was imitated using foam rubber. One senior

surgeon performed 15 FH and 15 AR-guided PAO's through a modified smith-peterson approach. The distance and angulation between the planned and the performed osteotomy planes were compared.

Results: AR-guided osteotomies were able to avoid catastrophic failures (violence of posterior column/ acetabular joint surface).

The mean distance between the planned and the performed saOT was 1.20 mm for the FH vs. 1.49 mm in the AR PAO, for the pOT 2.13 mm in the FH vs. 3.49 mm in the AR PAO, for the iOT 2.38 mm in the FH vs. 2.67 mm in the AR PAO, and for the raOT 2.04 mm in the FH vs. 1.80 mm in the AR performed PAO ($p = ns$). Except for the AR performed raOT that showed a significantly better correlation with the plan than in FH PAO (7.80° vs. 11.69° , $p = 0.0027$), no angles were statistically different between FH and AR PAO's.

Conclusion: Our study shows that it is feasible to guide surgical instruments along virtual paths provided by an AR headset to perform complex surgical tasks requiring spatial orientation, such as Ganz' PAO. The minimal amelioration of accuracy between AR-guided and FH osteotomies is assumed to be much more pronounced with less experienced surgeon and subject of further studies. Feasibility studies in cadaveric and later in-vivo are needed prior to broader clinical application.

* FM83

Intraoperative irradiation doses related to imaging devices in paediatric orthopaedics and traumatology

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Introduction: The radiation-induced cancer due to the imaging devices concern the growing child. Intraoperative irradiation doses are not well-documented in children. New technologies such as the 3D imaging combined with navigation will be more and more used in children. A phantom study has demonstrated that one 3D O-arm[®] acquisition was equivalent to four minutes of 2D C-arm exposure. The goal of the study is to evaluate the intraoperative doses received by our patients with a C-arm in our current practice, as well as the risk of exposure-induced cancer death (REID) caused by the irradiation of the imaging device.

Methods: From April 2017 to October 2018, in two University Hospitals, 2 countries, we prospectively recruited all consecutive children who needed one of the following surgery: scoliosis, bony osteotomy, growth modulation, long bone fracture requiring an intramedullary elastic nailing. We collected demographic and operative data, with dose reports including duration and doses. The main outcome was the effective dose (E) in millisievert (mSv), calculated with the PCXMC software, and the secondary outcome was the REID in %.

Results: 205 patients operated with C-arm were included. Overall E was ranged from 4.3×10^{-4} to 1.59 mSv. The most irradiated region was the spine (0.03 to 1.59 mSv), then the hip (0.05 to 0.61 mSv). The overall REID was between 2.8×10^{-7} and 0.02 %. For information, one patient operated with 3D device received 1.70 mSv.

Conclusion: Effective doses with C-arm may reach in some circumstances almost the same level than doses received with the O-arm[®]. Some pelvic and hip osteotomies may benefit from using a 3D device with navigation. Nevertheless, more studies are necessary to evaluate 3D irradiation.

FM84

Biomechanical Characteristics of Fascia Lata Graft for Superior Capsule Reconstruction with and without Polyester Patch Augmentation

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Introduction: Superior capsule reconstruction (SCR) was developed to restore superior glenohumeral stability and function to shoulder joints with irreparable rotator cuff tears. Previous biomechanical studies have investigated the effects of SCR using dermal graft or freeze-dried fascia lata allograft. The objective of the current study was to investigate the effect of SCR using fresh-frozen fascia lata graft, which closely resembles the fresh fascia lata autograft used clinically, on shoulder biomechanics in irreparable rotator cuff tendon tear.

Methods: Three types of grafts for superior capsule reconstruction were made from fascia lata: (1) thin graft (2 layers of fascia lata; average graft

thickness: 2.7 mm [medial], 3.0 mm [lateral]); (2) thin graft augmented with a polyester patch (polyester patch between 2 layers of fascia lata; average thickness: 4.4 mm [medial], 4.1 mm [lateral]); (3) thick graft (double layer of fascia lata augmented with intermuscular septum; average thickness: 8.6 mm [medial], 8.9 mm [lateral]). Specimens underwent cyclic loading from 5 to 50 N for 30 cycles, followed by tensile testing to failure. Linear stiffness, extension, hysteresis, stiffness, yield load, ultimate load, energy to yield load, and energy to ultimate load were compared among the three graft types by using repeated-measures analysis of variance followed by Tukey's post hoc test.

Results: Under cyclic loading, there were no statistically significant differences among the three types of graft in regard to extension, hysteresis, and linear stiffness. The graft comprising thin fascia lata augmented with polyester patch augmentation had the greatest linear stiffness among the three graft types. Linear stiffness and ultimate load for thin fascia lata augmented with polyester patch (85.0 ± 4.4 N/mm, 1144 ± 61 N) were significantly greater than for thin fascia lata alone (51.4 ± 5.6 N/mm, 435 ± 59 N) ($P = 0.007$, $P = 0.01$). Neither linear stiffness, hysteresis, extension, load, nor energy differed between thick fascia lata and thin fascia lata augmented with a polyester patch ($P = 0.08$ to 0.97).

Conclusion: Polyester patch augmentations significantly increased the ultimate load and linear stiffness of thin fascia lata graft. Polyester patch augmentation may decrease the graft tear rate and improve superior glenohumeral stability after superior capsule reconstruction, even with thin fascia lata graft.

FM85

An In Vitro Model for the Treatment of Intervertebral Disc Degeneration Using Nasal Chondrocytes

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Introduction: Intervertebral disc (IVD) degeneration is the most common cause of specific low back pain. Human nasal chondrocytes (hNCs) were identified as a possible alternative cell source for the treatment of intervertebral disc (IVD) degeneration due to their ability to survive and produce extracellular matrix in an IVD environment. They were shown to possess high proliferation capacity and are capable to adapt to heterotopic transplantation sites. This study aims to investigate the interaction of hNCs with human nucleus pulposus cells (hNPs) in a 3D in vitro co-culture model.

Methods: In vitro nucleus pulposus micro-tissue was fabricated by pooling eight hNPs micro-aggregates (25'000 cells per micro-aggregate, cultured for two weeks) together. GFP-labelled hNCs were then added to the hNP micro-tissue either as single cell suspension (200'000 cells per micro-tissue) or as 16 micro-aggregates (12'500 per micro-aggregate, cultured for two days). Monoculture hNPs and co-culture hNPs-hNCs were cultivated for two weeks. Preliminary analysis was conducted upon macroscopic investigations during co-culture time.

Results: Macroscopic investigations showed that: (i) control hNPs micro-aggregates in monoculture did not fuse into a stable construct, (ii) hNPs micro-aggregates in co-culture with hNCs suspension or with hNCs micro-aggregates merged to create one accumulative mass (indicating positive interactions between the two cell types), (iii) metabolic activities was high and similar in the two co-culture groups (indicating new matrix formation).

Discussion & Conclusions: Preliminary results indicate that the experimental approach to investigate the interaction of hNCs with hNPs is feasible. Visual evaluation suggests that co-culture of hNCs and hNPs has an advantageous effect on matrix production. Histological and biochemical analysis will be performed to validate and quantify the impact of hNC cells on the viability, proliferation and extracellular matrix production of hNPs and vis-versa.

* FM86

One-way Street Disc Degeneration? An Investigation of Hydrogel and Fibroblast Growth Factor 18 (FGF-18) for Intervertebral Disc Regeneration

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Introduction: The intervertebral disc (IVD) has a limited self-healing capacity. The healthy nucleus pulposus (NP) is rich in Collagen 2 (COL 2) and water binding proteoglycans like Aggrecan (ACAN). During disc degeneration, Collagen 1 (COL 1) is increasing in the NP tissue which leads to a more fibrous and resistant tissue. This degenerative process is still a one-way street: Treatment strategies focusing on IVD regeneration are still missing. Therefore, we investigated a fibrinogen-hyaluronic acid hydrogel (FBG:HA, RegenoGel), and the fibroblast growth factor 18 (FGF-18), which has been subject of clinical studies promoting cell differentiation and proliferation in cartilage tissue. The aims of the present work were to investigate the regenerative effect of (1) FBG:HA hydrogel, and (2) FGF-18 on human and bovine NP cells in vitro.

Methods: Healthy bovine NP cells (n = 4, age 8-12 month) and human mildly degenerated NP cells (n = 4, age 30-55 years, Pfirrmann grade 2-3) were cultured for 14 days in the FBG:HA hydrogel (RegenoGel™, provided by ProCore, Israel). Cells were stimulated by adding FGF-18 (1, 10, and 100 ng/ml) in the culture medium. At day 7 and day 14, gene expression was measured by real-time-PCR; Glycosaminoglycan (GAG) content in the gel and medium was evaluated by DMMB assay, and histology was performed by cryosection followed by safranin-o/fast green staining.

Results: Aim (1): Both bovine and human NP cells, encapsulated in the FBG:HA hydrogel, showed a donor dependent up-regulation in gene expression for the anabolic markers COL 2 (24-fold p < 0.01 in human NP cells) and ACAN (13-fold, ns). Furthermore, an increase in GAG content within the hydrogels over the time (p < 0.001) was detected. Aim (2): No significant differences in gene expression and GAG production were observed upon addition of FGF-18. Nevertheless, histological samples revealed an increase in proteoglycan content in a dose dependent manner. This was more evident in bovine NP cells compared to the human NP cells.

Conclusion: Analysis showed that the Fibrin-HA hydrogel supported cell phenotype and function in mildly degenerated human disc cells. By adding FGF-18, we could not see a significant improvement of this effect at the tested experimental conditions. More pronounced matrix synthesis may be observed in longer term studies. The hydrogel might be a promising treatment option and could also be loaded with other drugs, with or without FGF-18.

FM87

Nasal chondrocytes are potential autologous cell-transplant candidates for treating degenerative disc disease

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Introduction: This project aims to determine whether nasal chondrocytes can be considered as an autologous cell source for cell therapy of disc degeneration by comparing them to MSCs and articular chondrocytes, two cells sources used in phase two clinical trials at the moment.

Methods: Cells are cultured in in vitro micro-mass culture conditions mimicking facets of a degenerated intervertebral disc, such as hypoxia, low glucose, inflammation, and acidity. The production of the extra cellular matrix is evaluated using immunohistochemistry, quantitative real time PCR, and biochemical analysis.

Results: Our data demonstrate MSCs, ACs, and NCs have a similar GAG and Collagen 2 production in response to in vitro conditions simulating singular facets of the IVD environment and the addition of TGFβ1. However, NCs synthesis more of these ECM components than MSCs or ACs when cultured in the same conditions without the addition of the growth factor. Furthermore, growth factor primed NCs maintain an exceeding production of GAG and Collagen 2 compared to both growth factor primed MSCs and ACs in harsher conditions, which combine different characteristics of the degenerated IVD environment. Interestingly, the indifference of ECM production of NCs in response to inflammation factors cannot be linked to the absence of gene expression of the respective receptors. Moreover, NCs as the only cell sources display gene expression of the transcription factor FoxF1, a marker for nucleus pulposus cells.

Discussion & Conclusions: In summary, NCs are more similar to nucleus pulposus cells than MSCs and ACs, as they can better produce ECM in an in vitro IVD environment and express the nucleus pulposus marker FoxF1. These findings encourage the assessment that employing NCs in a cell therapy treatment of degenerated disc disease could promote new matrix production in the disc, which could inhibit or delay further disc height loss if not even lead to disc height gain.

* FM88

Individualized prediction of pedicle screw fixation strength – an experimentally validated finite element study

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Introduction: Pedicle screws are used for the treatment of a wide variety of spinal pathologies. Screw loosening occurring after spinal instrumentation is a frequently arising issue and is prevalent in patients with low bone quality. Although a sufficient pedicle screw fixation in bone is required for treatment success, it has not been predictable computationally so far individually. The goal of this work was to develop an automated tool able to predict patient-specific screw pull-out strength through finite element simulations.

Methods: In vitro pull-out tests were performed on 20 instrumented lumbar vertebrae of bovine and porcine origin. For this purpose, an experimental setup was developed which allowed accurate positioning of the vertebra in the testing machine and hence precise screw extraction along its longitudinal axis. The results from the biomechanical tests were used to validate the finite element model. The model was automatically created from clinical CT images of the animal vertebra acquired before and after screw insertion. Further, heterogeneous bone density distribution was emulated with information obtained from CT scans.

Results: Experimental and simulation pull-out strengths were strongly correlated ($\rho = 0.82$, $p < 0.0001$) and we were able to predict the pull-out force with 20% mean error. Both the experimental and the simulated screw fixation strength were associated to great extent with pull-out stiffness ($\rho_{\text{Experiment}} = 0.65$, $\rho_{\text{Experiment}} < 0.01$; $\rho_{\text{Simulation}} = 0.96$, $\rho_{\text{Simulation}} < 0.0001$) and strain energy ($\rho_{\text{Experiment}} = 0.81$, $\rho_{\text{Experiment}} < 0.0001$; $\rho_{\text{Simulation}} = 0.96$, $\rho_{\text{Simulation}} < 0.0001$). Also screw size ($\rho_{\text{Experiment}} = 0.66$, $\rho_{\text{Experiment}} < 0.01$; $\rho_{\text{Simulation}} = 0.74$, $\rho_{\text{Simulation}} < 0.01$) and mean vertebral density ($\rho_{\text{Experiment}} = 0.86$, $\rho_{\text{Experiment}} = 1.00 \cdot 10^{-6}$; $\rho_{\text{Simulation}} = 0.81$, $\rho_{\text{Simulation}} < 0.0001$) were positively correlated to pull-out forces.

Conclusion: Overall, the analysis of automatically created finite element models were able to successfully predict pull-out strength of pedicle screws from vertebral bone by consideration of heterogeneous bone mechanical properties determined from CT scans. Once fully validated, this algorithm might allow to plan each pedicle screw position automatically to be surrounded by best bone quality and achieve highest possible fixation strength.

* FM89

Assessing the Clinical Applicability of Intratendinous Genipin Injections: Mechanical Augmentation and Spatial Distribution in an Ex Vivo Degenerative Tendon Model

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Background: Tendinopathy is a common musculoskeletal disorder and current treatment options show limited success. Genipin is an effective collagen crosslinker with low cytotoxicity and a promising therapeutic strategy for stabilizing an intratendinous lesion. This study examined the mechanical effect and delivery of intratendinous genipin injection in healthy and degenerated tendons.

Methods: Bovine superficial digital flexor tendons were randomized into four groups: Healthy control (N = 25), healthy genipin (N = 25), degenerated control (N = 45) and degenerated genipin (N = 45). Degeneration was induced by Collagenase D injection. After 24h, degenerated tendons were subsequently injected with either 0.2ml of 80 mm genipin or buffer only. 24h post-treatment, samples were cyclically loaded for 500 cycles and then ramp loaded to failure. Fluorescence and absorption assays were performed to analyze genipin crosslink distribution and estimate tissue concentration after injection.

Results: Compared to controls, genipin treatment increased force at failure by 19% in degenerated tendons (median control 530 N vs. 633 N; $p = 0.0078$). No significant differences in mechanical properties were observed in healthy tendons, while degenerated tendons showed a significant difference in failure stress (+23%, $p = 0.049$), stiffness (+27%, $p = 0.037$), work to failure (+42%, $p = 0.009$), and cyclic stress relaxation (-11%, $p < 0.001$) after genipin injection. Fluorescence and absorption were significantly higher in genipin treated tendons compared to control groups. A higher degree of crosslinking (+45%, $p < 0.001$) and a more

localized distribution were observed in the treated healthy compared to degenerated tendons, with higher genipin tissue concentrations in healthy (7.9 mM) than in degenerated tissue (2.3 mM).

Conclusion: Using an ex-vivo tendinopathy model, intratendinous genipin injections recovered mechanical strength to the level of healthy tendons. Measured by genipin tissue distribution, injection is an effective method for local delivery with acceptable potential for off-target cytotoxicity. This study provides a proof of concept for the use of intratendinous genipin injection in the treatment of tendinopathy. The results demonstrate that a degenerated tendon can be mechanically augmented by a clinically viable method of local genipin delivery. This warrants further in vivo studies towards the development of a clinically applicable treatment based on genipin.

FM90

Transplantation of autologous mesenchymal stem cells halts fatty atrophy of detached rotator cuff muscle after tendon repair: result from a large animal model

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Introduction: We investigated whether the injection of autologous mesenchymal stem cells (MSC) in ruptured rotator cuff muscle halts muscle-to-fat conversion subsequent to tendon repair by promoting growth and regeneration of muscle fibers in a sheep model that more closely reflects the requirements of a therapeutic approach in human than previously studied models in rodents.

Methods: Infraspinatus muscles of the right shoulder of Swiss Alpine sheep (n = 14) were released by osteotomy and reattached sixteen weeks later with (T-MSC, n = 8) or without (T, n = 6) treatment through electropulsing and injection of microtissues of 0.9 Mio fluorescently-labelled MSCs in a demarcated area to allow recovery for six weeks. Muscle volume and composition was followed with MRI- and CT-based imaging. Fiber type, fat and extracellular matrix composition, and the expression of myogenic (myogenin), adipogenic (PPARG), and regeneration (tenascin-C) markers were estimated in biopsies from the MSC-injected, media-injected and non-injected areas of infraspinatus muscles six weeks after reattachment.

Results: 16 weeks after tendon release, the infraspinatus volume was reduced in group T-MSC (130.3 vs. 166.2 mL) and T (136.7 vs. 187.7 mL), and fat fraction was correspondingly elevated to 49% and 54%. Muscle-to-fat conversion did proceed in group T but not group T-MSC during recovery from repair, as indicated by different changes in fat-free mass (-4.8% vs. 29.2% p = 0.018) and fat fraction (+1.6% vs. +11.2%; p = 0.009). Histological measures in the non-injected areas confirmed the muscle-sparing effect of MSC-treatment by a lower area percentage of fat in group T-MSC compared to T (8.5% vs. 19.6%, p = 0.018). The area percentage of extracellular matrix was elevated in the repaired muscle respective to its contralateral control for group T (25.5% vs. 16.6%; p = 0.042) but not for group T-MSC (8.5% vs. 2.0%; p = 0.868). PPARG expression was two-fold lowered in media- and MSC-injected areas. MSC-injected areas demonstrated a 59% enhanced expression of the extracellular protein tenascin-C and held myotubes in vicinity of fluorescence-positive granulomas.

Conclusion: The administration of a relatively small dose of autologous MSCs (corresponding to ~5% of the total muscle volume) halted the progression of fatty atrophy after tendon repair in a large animal model. The effect was explained by the preservation of fat-free mass, which was associated with interstitial, but not myogenic, reactions.

FM91

Improved suture pullout through genipin-coated sutures in degenerated human biceps tendons with limited changes in cell viability

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Introduction: Suture-tendon interface often appears to be the critical limitation for a successful tendon-to-tendon or tendon-to-bone repair. Genipin, a naturally occurring chemical crosslinker emerged as a promising agent for arresting tear progression in injured tendons and genipin-

coated sutures showed beneficial effects on suture pullout forces in degenerated animal tendons. The scope of the present study was to investigate if genipin-coated sutures can improve suture pullout force in degenerated human shoulder tendons. Moreover, we evaluated cytotoxicity in the surrounding tissue after genipin-coated suturing.

Material and methods: 30 freshly harvested, degenerated human long biceps tendons were allocated to two groups, control (n = 15) and genipin (n = 15). According to the testing group either an untreated or genipin-coated suture was inserted at a distance of 1 cm from the tendon edge. 24 hours after suturing a mechanical test protocol composed of repeated cyclic testing followed by a ramp-to-failure test was performed. Mechanical performance was compared using Mann-Whitney U-testing. For a visual control of cell viability, specimens with genipin-coated and control sutures were analyzed as stained histological sections using combined fluorescent/light microscopy.

Results: In human biceps tendons treated with a genipin-coated suture maximum pullout force was greater (median, 29 N [range, 12 - 96 N] versus 16 N [range, 7 - 78 N]; p = 0.028) with corresponding increases in energy (median, 265 mJ [range, 83 - 1055 mJ] versus 117 mJ [17 - 688 mJ]; p = 0.017). Cyclic (median, 1.8 N/m [range, 1.1 - 5.9 N/m] versus 2.1 N/m [range, 1.2 - 7.6 N/m]; p = 0.571) and ultimate elongation (median, 9.1 N/mm [range, 2.9 - 15.5 N/mm] vs. 7.3 N/mm [1.5 - 14.9 N/mm]; p = 0.169) of the tendon-suture construct was not altered by the genipin-coated suture. Visual qualitative investigation of cell viability in the tissue surrounding the suture channel revealed that while there is a minimal cytotoxic effect of genipin on the tenocytes, the mechanical stress induced by the suturing also has a negative effect on cell viability.

Conclusion: Genipin-coated sutures resulted in a significant increase of suture pullout force compared to sham treatment. Our findings suggest that cytotoxicity of genipin-coated sutures is limited to a defined radius around the suture. We conclude that genipin-coated suture for human shoulder tendon repair is both a biomechanically and biologically viable approach.

FM92

Superior Capsule Reconstruction Using Fresh-frozen Fascia Lata Graft for Irreparable Supraspinatus and Infraspinatus Tendon Tears: A Cadaveric Biomechanical Study

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Background: Superior capsule reconstruction (SCR) was developed to restore superior glenohumeral stability and function to shoulder joints with irreparable rotator cuff tears. Previous biomechanical studies have investigated the effects of SCR using dermal graft or freeze-dried fascia lata allograft. The objective of the current study was to investigate the effect of SCR using fresh-frozen fascia lata graft, which closely resembles the fresh fascia lata autograft used clinically, on shoulder biomechanics in irreparable rotator cuff tendon tear.

Methods: Eight fresh-frozen cadaveric shoulders were tested by using a custom system. Subacromial peak contact pressure, superior glenohumeral translation, and glenohumeral range of motion were compared under three conditions: (1) intact shoulder; (2) simulated irreparable rotator cuff (supraspinatus and infraspinatus) tear; and (3) SCR using fresh-frozen fascia lata graft. SCR was performed according to the technique for SCR using fascia lata autograft.

Results: Compared with the intact condition, creation of the irreparable rotator cuff tear increased superior translation and subacromial peak contact pressure at 0° (P < 0.01) and 30° (P < 0.001) of glenohumeral abduction. SCR using fresh-frozen fascia lata graft decreased superior translation and subacromial peak contact pressure to the intact level (P < 0.01 for both). SCR using fresh-frozen fascia lata graft did not decrease internal (P = 0.15 to 0.99), external (P = 0.90 to 0.99), or total (P = 0.35 to 0.98) rotation at 0°, 30°, or 60° of glenohumeral abduction, compared with the irreparable supraspinatus and infraspinatus tendon tear condition.

Conclusion: SCR using fresh-frozen fascia lata graft completely restored superior stability of the glenohumeral joint without any restriction of glenohumeral range of motion after surgery. Therefore, SCR using fascia lata autograft improves shoulder function in most of irreparable rotator cuff tears.

FM93

Genetic Lineage Tracing of targeted tendon cells after full detachment and repair of the supraspinatus tendon

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Background: Current treatments of supraspinatus injury do not restore a functional enthesis leading to high failure rates after surgery. To date the understanding of the basic biological mechanisms underlying tendon to bone healing is poor. The goal of this study is to identify cellular mediators of supraspinatus enthesis healing using inducible Cre lines that target specific cell populations.

Methods: A full supraspinatus tendon detachment and repair was carried out in adult mouse (contralateral shoulder served as uninjured control). To assess function, mice were gaited before and at d3, 7 and 14 post-injury. For postoperative pain assessment, the mouse grimace scale was used prior and 3h, 6h, 24h and 48h post-injury. For lineage tracing, inducible Cre lines were used: ScxCreERT2 (tenocytes), Sox9CreERT2 (cartilage/fibrocartilage cells), Axin2CreERT2 (Wnt-responsive stem-cells), α SMACreERT2 (epitenon cells) (n = 4/group). To label cells, tamoxifen was given daily for 3 days prior to surgery. Biomechanical testing and micro-CT was performed at d28. Statistics were done using a LME (gait), a one-way ANOVA with Tukey's post hoc test (MCS) and paired T-Test (biomechanics). Significance was set at p < 0.05.

Results: Gait analysis showed a significant decrease in stride length and paw area at timepoint d3 compared to pre-operative data. Evaluation of mouse grimace scale showed a significant increase in the score at 3h after surgery followed by a significant decrease towards baseline at 24h. No significant differences were detected between preoperative baseline and scores after 24h respectively 48h.

Histological analysis showed that all repairs healed with extensive scar formation and loss of enthesis architecture. While few Sox9lin and Scxlin cells were found, there was an increase of α SMAlin and Axin2lin cells within the scar. The biomechanical testing showed that the enthesis/scar area is significantly increased after repair, while the maximal force and stiffness is significantly decreased.

Conclusion: Animals experienced the most pain at 3h post-injury. The tendon repair resulted in a massive hypercellular scar formation and disrupted architecture. An increase of α SMAlin and Axin2lin cells was observed. The repair showed inferior function in comparison to the original enthesis.

FM94

Early deconditioning of oxidative pathways precedes lipid accumulation in rotator cuff muscle after tendon release

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Introduction: The cellular pathways which initiate fat accumulation with rotator cuff disease are poorly understood. We hypothesized that an early fiber type-related dysfunction of oxidative pathways precedes lipid accumulation in rotator cuff muscle after tendon release and would be mitigated by the pharmacological stimulation of beta oxidation by L-carnitine.

Methods: Female Swiss Alpine sheep were subjected to unilateral release of the infraspinatus tendon and left unrepaired for up to sixteen weeks (n = 12), or for two weeks without (n = 6) or with oral administration of L-carnitine (n = 3). Biopsies were collected from infraspinatus muscle before, two, six and sixteen weeks after tendon release, and used to characterize cellular composition and the concentrations of the entire collection of gene transcripts, metabolites and lipid species, as well as mitochondrial proteins. Volume and fat content of infraspinatus muscle were radiologically assessed.

Results: From 12173 detected transcripts in infraspinatus muscle, only the concentration of 26 was affected two weeks after tendon release, all being lowered and mainly associated with mitochondria (5) and myofibrils (16). Concomitantly, protein levels of marker proteins of mitochondrial respiration complex I-IV were 28-52% reduced, and a slow-to-fast shift of muscle fiber type composition, and a 9%-loss in muscle volume

was identified; preceding increases in fat and connective tissue six and sixteen weeks after tendon release when atrophy came to a halt.

The down-regulation of the slow oxidative gene program after tendon release was related to a reduced concentration of high-energy phosphates (ATP, ADP) and plasma membrane constituents, and the activation of alanine, aspartate and glutamine metabolism. Oral administration of L-carnitine mitigated atrophy of the detached infraspinatus muscle two weeks after tendon release (-4.4% vs. -9.2%) and increased the saturation levels and carbon chain length of lipid species, rather than normalising mitochondrial respiration related molecular species.

Conclusion: Staged deteriorations of the slow oxidative and fast fiber population underlie atrophy and fat accumulation in released sheep infraspinatus muscle and offer as explanation for clinically observed differences in the condition of a torn rotator cuff muscle. In our model atrophy and aberrant lipid metabolism were related to mitochondrial dysfunction, which was not terminated by oral activation of beta oxidation.

* FM95

A mechano-sensitive role for macrophages in tendon healing

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Introduction: The host response to implanted synthetic patches has been determined as central for a successful clinical outcome. Immune cells, such as Macrophages are the first to interact with implanted biomaterials, turning their initial response, specifically their polarization into either pro-inflammatory (M1) or anti-inflammatory (M2) phenotype, crucial for tissue healing. Therefore, in the present study we determined the impact of the topographical cues and mechanical load of bio-implantable materials, used for the stabilization of surgical repairs of torn tendons, on macrophage activation.

Methods: Naïve (M0) macrophages and primary human tendon fibroblasts (hTFs) were cultured on aligned or random oriented polycaprolactone nanofiber substrates separately and in direct co-culture and conditioned by either static load (1% strain) or dynamic loading (7% strain) for 24h in a custom made bioreactor. Following, macrophage polarization was assessed by analyzing the surface markers CCR7 (M1-marker) and MRC1 (M2-marker) on the gene expression level and further validated by flow cytometry. The macrophage conditioned medium was used to stimulate hTFs in static culture to analyze their inflammatory response to the secreted factors.

Results: Our results indicate that disorganized topographies alone promote the polarization of M0 macrophages towards a pro-inflammatory phenotype (M1-like, CCR7+, n = 9, p < 0.001), which was further increased by dynamic mechanical loading. Interestingly, in direct co-culture this effect was inverted indicating a trend for a polarization towards a pro-resolving phenotype (M2-like, MRC1+). Quantification of the NF κ B pathway activation in hTFs stimulated with factors secreted by mechanically loaded macrophages revealed significantly elevated inflammatory activation compared to those exposed to media conditioned by statically loaded macrophages.

Conclusion: This study indicates that the macrophages response to biomaterial topography and mechanical deformation of biomaterials appears to be more dramatic than that of the hTFs, suggesting a central role for macrophages as mechano-sensitive cells in tendon healing. Notably, mechanical loading in direct co-culture with tendon fibroblasts promotes the phenotypic switch towards the M2 phenotype beneficial for tissue remodeling. The here presented findings allow conclusions for the design of 'immuno-modulatory' biomaterials promoting positive biological and clinical outcomes.

* FM96

The immunomodulatory effect of controlled BMP-2 release

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Introduction: Macrophages, highly plastic cells able to respond to multiple external stimuli, have shown to be a key regulator in driving early bone regeneration by various ossification mechanisms. Surprisingly, little is known about the effect of bone morphogenetic protein-2 (BMP-2), a

potent clinically used osteoinductive agent, on this apex early bone regeneration regulatory cells. Therefore, in this work, we aimed to investigate the immunomodulatory effect of BMP-2 on macrophages *in vivo* and *in vitro*.

Materials and methods: Oligo[(polyethylene glycol) fumarate] bis[2-(methacryloyloxy) ethyl] containing poly (lactic-co-glycolic acid) microspheres, an osteoconductive phosphorylated composite hydrogel, was employed. Three composite implants with differential BMP-2 release were created: BMP-2 encapsulated in microspheres (OPF-BP-Msp, mainly sustained release), BMP-2 encapsulated in microspheres and adsorbed on the phosphorylated hydrogel (OPF-BP-Cmb, combined sustained and burst release), and BMP-2 adsorbed on the phosphorylated hydrogel (OPF-BP-Ads, mainly burst release). The *in vivo* immunomodulatory effect of differential BMP-2 release was investigated after 1 week of subcutaneous implantation in a rat model using histology and immunohistochemistry. *In vitro*, using a human monocyte leukemia cell-line, the effect of BMP-2 on macrophage phenotype was investigated with flow cytometry.

Results: Whereas a low general infiltration of lymphocytes, neutrophils and plasma cells was observed, a high infiltration of macrophages was seen in all composite implants. The unloaded control showed significantly ($p < 0.03$) more macrophage infiltration ($50.3 \pm 11.0\%$) compared to the low dose sustained release implants OPF-BP-Cmb ($23.6 \pm 15.4\%$) and OPF-BP-Mps ($31.7 \pm 15.4\%$). No difference in macrophage infiltration was seen between the control and OPF-BP-Ads. OPF-Ads showed a significantly ($p = 0.02$) higher infiltration of macrophages ($46.8 \pm 13.5\%$) compared to OPF-Cmb. Furthermore, a dose response effect of BMP-2 on macrophage polarization towards the M1 phenotype was observed *in vitro*.

Conclusion: This study shows that BMP-2 plays a role in immunomodulation of macrophages *in vivo* and *in vitro*. Ongoing histological and biochemical analysis *in vivo* and *in vitro* might give further insight into its mechanism and effect on bone formation.

* FM97

Mechanophenotyping of bone cancer cells

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FM98-FM117: SHOULDER / ELBOW / HAND

FM98

Scapula Morphology. Chicken and Egg Debate?

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Background: Several shoulder pathologies, such as rotator cuff lesions, gleno-humeral arthritis or posterior instability, are believed to be associated with variations in native scapular morphology, mostly represented by the CSA. The latter concept is mainly based on retrospective non-comparative studies. The shape of the scapula reflects changes which have been brought about by more unusual or specialized functional demands. In unilateral overhead athletes, greater muscle strength on the dominant arm is known to stimulate bone adaptations, including scapular lateralization with internal rotation, anterior tilt, and reduced subacromial space. The hypothesis of this study was that variations in scapular morphology (CSA) reflect bone adaptation to repetitive stress or activity.

Methods: The authors prospectively evaluated true antero-posterior radiographs of 19 competitive tennis players aged 40.4 ± 10.0 years (range, 22.0 – 61.0). The cohort comprised 17 men (89%) and 2 women (11%) who had been trained at a competitive level for over 10 years. A priori sample size calculation suggested that a minimum of 8 patients was required to confirm if a difference in CSA of $3.5^\circ \pm 2.5^\circ$ between dominant and non-dominant arms is statistically significant, with a power of 90%. The inter-observer agreement for CSA measurements was high (intra-class correlation coefficient, 0.88; CI, 0.76 – 0.94).

Results: Dominant shoulders had a CSA of $36.9^\circ \pm 3.9^\circ$ (median, 36.0° ; range, $30.0^\circ - 43.5^\circ$) while non-dominant shoulders had a CSA of $34.6^\circ \pm 3.3^\circ$ (median, 34.5° ; range, $29.4^\circ - 41.0^\circ$). The CSA was greater in dominant than non-dominant shoulders by $2.3^\circ \pm 2.3^\circ$ (median, 2.6° ; range, $-2.9^\circ - 5.2^\circ$; $p < 0.005$).

Conclusions: Unilateral overhead sports may lead to bone adaptation and increase the CSA on the dominant shoulder compared to the non-

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Introduction: Although rare among the general population, bone malignancies have a high rate of incidence among children and adolescents and are associated with high mortality rates. Osteosarcoma is the most frequent primary cancer of bone and shows a high tendency to metastasize in lungs. Despite the frequent use of osteosarcoma-derived cell lines in basic biomechanical research and for the evaluation of cell response to new biomaterials, the mechanical phenotype and the differences between osteosarcoma cells and other tumors remain largely undescribed.

Methods: In the present work we combine the best established semi-highthroughput and highthroughput techniques, including compressive indentation, tensile testing and free-floating deformability, for the biomechanical phenotyping of two low metastatic osteosarcoma cell lines (SaOs-2 and HuO9) with those of the experimentally-derived highly metastatic variants (SaOs-2-LM5 and HuO9-M132, respectively). We further complement the biophysical data with morphological and cell contractility data.

Results: Our results expose the need of multiparametric biomechanical analysis to uncover the relationship between the biophysical phenotype of cancer cells and their malignancy potential. We observed a marginally reduced stiffness in free-floating highly metastatic cells, but an inverse trend when probed in adhered state through tension. Furthermore, we found a consistent and significant decrease in cellular contractility and focal adhesion count in the highly metastatic osteosarcoma cell lines. While these results confirm some of the data available in literature, they also contradict some of the findings reported for other tumor types. As, unlike most neoplasms, bone malignancies are softer than the organ where they originate, these discrepancies might be explained by this fundamental difference.

Conclusion: Our results expose that the definition of “cell mechano-phenotype” depends heavily on the means by which this property is measured and the framework according to which it is analyzed. Therefore a consistent link between the biophysical properties of cells and malignancy can only be identified within the context of the probing method.

dominant side. Even if this study does not question the whole CSA philosophy, it seems premature to state that scapular morphology is responsible for most shoulder pathologies. On the contrary, activities or underlying pathologies could be responsible for bone remodeling creating lateral extension of the acromion. Further high level prospective studies seem mandatory.

FM99

Pseudoparalysis needs to be distinguished from pseudoparesis: A matched-pair analysis of patients with massive rotator cuff tears

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Introduction: Massive rotator cuff tears (mRCT) can be associated with pseudoparalysis (PP). The general definition of PP is loss of active anterior elevation (AAE) above 90° . However, it has been suggested that this arbitrary cutoff needs to be refined. It was the purpose to determine significant factors associated with PP and whether there are significant differences in patients with AAE $<90^\circ$ (pseudoparesis) compared with AAE $<45^\circ$ (pseudoparalysis).

Methods: In this retrospective study, 50 patients with mRCT (≥ 2 tendons) and AAE $<90^\circ$ (PP-group) were age- and gender-matched to a cohort of 50 patients with mRCT and AAE $>90^\circ$ (NPP-group). Subgroup analysis of the PP-group included comparison of patients with pseudoparesis (AAE $<90^\circ$) with those with pseudoparalysis (AAE $<45^\circ$). Measurements on plain radiographs included the critical shoulder angle (CSA), posterior acromial tilt, anterior and posterior acromial coverage (AAC; PAC), and posterior acromial height (PAH). Measurements on MRI included fatty infiltration (FI) according to Goutallier, anterior (subscapularis) and posterior (infraspinatus and teres minor) tear extension and global tear extension (anterior + posterior tear extension).

Results: Univariate analyses showed significant differences between the PP- and NPP-group in terms of CSA (38.2° vs. 36.2° ; $p = 0.001$),

PAH (22 vs. 17mm; $p < 0.001$), FI and tear extension of the anterior, posterior and global rotator cuff ($p < 0.001$). Multivariate analysis showed that FI of the subscapularis (odds ratio (OR) 16.4; $p < 0.001$) followed by FI of the teres minor (OR 4.4; $p < 0.001$) and the infraspinatus (OR 2.6; $p < 0.001$) had the most significant association with PP. Comparison of pseudoparetic ($n = 26$) with pseudoparalytic patients ($n = 24$) showed significant differences of FI and tear extension of the anterior and posterior rotator cuff ($p < 0.001$).

Conclusions: This study confirms that the quality of the subscapularis but also of the infraspinatus and teres minor have probably the strongest association with loss of AAE $> 90^\circ$. It further shows that pseudoparalysis (AAE $< 45^\circ$) needs to be distinguished from pseudoparesis (AAE $< 90^\circ$), which are not only clinically, but also structurally significantly different from each other.

FM100

Surgical Management of Chronic High-Grade Acromioclavicular Dislocations – A Systematic Review

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Introduction: A large variety of techniques have been described for the treatment of chronic acromioclavicular (AC) joint instability. However, to date, no gold standard technique exists. In this study we aim to systematically review the clinical results of the three main categories of AC joint reconstruction for high grade chronic instability (Rockwood III to VI).

Methods: An extensive literature search was performed according to PRISMA guidelines, identifying all relevant studies. Inclusion criteria was clinical studies involving patients with AC joint instability (Rockwood III to VI) of at least 6 weeks that were managed with surgical reconstruction of the AC joint and/or coracoclavicular ligaments. Studies were included if the minimum follow-up was at least 1 year. Depending on the surgical technique performed, patients were divided into one of three groups; Group 1: Non-biologic fixation between the coracoid and clavicle, such as suture loops and synthetic ligaments, Group 2: Biologic reconstruction of coracoclavicular ligaments, such as allograft or autograft ligament reconstruction, and Group 3: Ligament or tendon transfer, such as a Weaver-Dunn or Dewar type procedure. Patient demographics, clinical functional outcome scores, radiographic outcome and complications were compared.

Results: Two independent investigators reviewed a total of 960 articles. Twenty-seven studies met the inclusion criteria, which comprised of 590 patients that were divided into one of the three groups. The complication rates were similar between the 3 groups, non-biologic (15%), biologic (15%) and ligament or tendon transfer (17%), with failure rates of 8%, 7% and 5%, respectively. In terms of functional results, the mean Constant score was 87.2 for non-biologic ($n = 89$), 92.4 for biologic ($n = 86$) and 87.4 for ligament of tendon transfer ($n = 49$).

Conclusion: Comparing the results of three different AC joint reconstruction methods, all techniques showed similar complication rates. In the only available Level II studies, AC joint reconstruction with a tendon graft showed superior results. However, further level I or II studies are required to draw valid conclusion.

FM101

Low-profile Single Tightrope Stabilization for Acute Acromioclavicular Dislocations

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Introduction: A common complication after arthroscopically assisted tightrope stabilization of acute acromioclavicular (AC) joint dislocations is implant-related soft tissue irritation, which is reported as up to 25%. In order to reduce the soft tissue irritation, the low-profile tight rope was developed. We report on the first clinical and radiological results of patients treated with this technique.

Methods: A total of 38 patients with acute AC-joint dislocations Rockwood IIIb or V (2 female/36 male, age \bar{x} 39 (19 – 63) years) have been included in this study so far. The surgical technique was standardized and included a stabilization of the AC-joint with a single low-profile tight-rope and an additional acromioclavicular cerclage. For clinical evaluation the Subjective Shoulder Value (SSV), Constant Score (CS), Taft Score (TF) and Acromioclavicular Joint Instability Score (ACJI) were collected. To assess the radiological outcome loaded panoramic view radiographs

and bilateral Alexander view radiographs were taken, where the coracoclavicular (CC) distance and its difference between the sides as well as the horizontal instability were measured.

Results: Preoperative mean CC difference was 9.1 mm (± 3.3 mm). Directly after surgery the CC difference was -0.9 mm. After 3 months it was 1.3 mm ($N = 29$), 3.7 mm after 6 months ($N = 22$) and 3.0 mm ($N = 11$) after 1 year. 27% had a partial dynamic posterior translation in the Alexander view and 36% a complete translation after one year. On average patients scored 89.3% ($\pm 3.7\%$) in SSV, 94.6 (± 4.4) points in CS, 10 (± 1.3) points in TF and 79 (± 8.8) points in ACJI. In 2 patients a sintering of the implant to the level of the superior corticalis could be observed. One patient complained of irritation caused by the proximal tight rope button. No revision surgeries due to implant irritation were necessary so far.

Conclusion: Initial clinical and radiological results of the low-profile tight-rope stabilization technique are satisfactory. Regarding implant-related soft tissue irritations this technique appears beneficial.

FM102

Abduction-external-rotation-immobilization vs. Arthroscopic stabilization after primary traumatic anterior shoulder dislocation

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Background: Surgical stabilization and immobilization in external rotation after first time anterior shoulder dislocation is still under debate. The aim of this study is to evaluate the early clinical outcome of immobilization in abduction-/external-rotation including recurrence rates versus arthroscopy primary stabilization after primary anterior traumatic shoulder dislocation in a prospective randomized multicentre trial by the German society for shoulder and elbow surgery (DVSE).

Methods: 117 patients (9 female, 108 male) were included in this study. Within the operative group (group I: $n = 54$) an arthroscopy primary stabilization procedure was performed. The second group (group II: $n = 63$) has been treated conservatively using a 3- week immobilization using an abduction (30°)/external rotation (60°) brace. Follow-up evaluation was performed 1, 3, 6 weeks as well as 6, 12, 24 months post-operatively respectively post-reduction. Active and passive range of motion, instability testing and Constant Score, Rowe Score, WOSI and SSV were included to evaluate the objective and subjective shoulder functionality. Currently 74 patients completed the 24 months follow-up (group I: 37, group II: 37). By the time of the ICSES all patients will reach the final follow-up.

Results: In the latest follow-up after 24 months no significant differences were found between both groups regarding the active and passive range of motion ($p > 0.05$). In addition, the Constant Score, Rowe Score, WOSI and SSV did not differ significantly between the two groups ($p > 0.05$). The recurrence rate of group II was 18.9% and 2.9% in group I. Due to non-compliance, immobilization therapies had to be discontinued in 6 cases (9.5%) in group II within the first 3 weeks.

Conclusions: Both groups present comparable results in clinical outcome. However, these preliminary data suggest a higher rate of persistent instability after abduction-/ external-rotation-immobilization compared to arthroscopic shoulder stabilization.

FM103

Muscle Degeneration Induced by Sequential Release and Denervation of the Rotator Cuff Tendon in Sheep

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Introduction: Tenotomy predominantly induces fatty infiltration and denervation induces mostly muscle atrophy. Simultaneous tenotomy and neurectomy combine their negative effects. It was the purpose of this study to analyze the effect of sequential tendon release followed by denervation compared to denervation followed by tendon release of the infraspinatus tendon and muscle in a sheep rotator cuff model.

Methods: Twelve Swiss alpine sheep were used for this study. In the tenotomy/neurectomy (= T/N group, $n = 6$) the infraspinatus tendon release was performed first, followed by the transection of the suprascapular nerve 8 weeks later. In the neurectomy/tenotomy group (= N/T group, $n = 6$) the neurectomy was performed first followed by the tenotomy 8

weeks later. All sheep were sacrificed after 16 weeks. For ethical reasons the data of 6 sheep which served as the control group in a prior study from our institution were also used as the control group for this study. Magnetic resonance imaging (MRI) was performed before the first surgery (baseline) after 8 and 16 weeks. The MRI data were used to assess muscle volume, fat fraction, tendon retraction.

Results: The mean amount of intramuscular fat after 16 weeks was with $52\% \pm 12$ in the T/N group higher than in the N/T group ($37\% \pm 7$, $p = 0.002$). At 8 weeks postoperatively the mean infraspinatus muscle volume had decreased significantly more in the N/T group ($52\% \pm 7\%$ of the original volume) compared to the T/N group ($73\% \pm 2\%$, $p = 0.001$) and the control group ($78\% \pm 11\%$). After 16 weeks the muscle volume of the N/T ($51\% \pm 8\%$) and T/N group ($49\% \pm 3\%$) showed no differences ($p = 0.732$). After 16 weeks the retraction of the T/N group was $7.3\text{cm} \pm 0.3\text{cm}$ and $6.7\text{cm} \pm 0.2$ in the N/T group ($p = 0.631$).

Conclusion: Sequential tenotomy followed by neurectomy leads to more fatty infiltration than sequential neurectomy followed by tenotomy. Neurectomy causes a faster loss of infraspinatus muscle volume compared to tenotomy. The tendon retraction is not influenced by the different sequential damages.

FM104

Clinical and radiological results after an arthroscopic posterior bone block for recurrent posterior shoulder instability: mean follow-up of 7.4 years.

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Introduction: Posterior shoulder instability is a rare condition and the treatment is a challenging problem. Even though arthroscopic capsulolabral reconstruction is an effective, reliable treatment with satisfactory results, a high failure rate with recurrence of the instability is reported in the literature. Therefore, the purpose of this study is to examine the clinical and radiographical long-term outcomes associated with an arthroscopic posterior bone graft procedure.

Materials and methods: We retrospectively analyzed 19 shoulders of 18 patients (2 female, 16 male) where an arthroscopic posterior bone block procedure was performed. The preoperatively patient reported outcome measure scores were assessed prospectively and compared to the clinical examination and clinical outcome scores at latest follow-up. Furthermore, shoulder range of motion was monitored and patients were examined for apprehension and recurrent instability. Evolution of osteoarthritis was analyzed by radiographs and nonunion, osteolysis and graft position were examined in CT scans. Statistical analysis was performed with univariate t-tests.

Results: Mean follow-up was 7.3 years (SD 1.7) and mean age of the evaluated patients was 33.9 years (SD 12.7). 5 patients (26%) had previous arthroscopic capsulolabral reconstruction. All measured outcome scores improved significantly: Walch-Duplay improved from 32.4 (SD 31) to 78.9 (SD 21.9; $p < 0.001$), Rowe from 36.8 (SD 23.1) to 79.2 (SD 23.7; $p < 0.001$), Constant score from 62.7 (SD 18.2) to 80.4 (SD 18; $p = 0.005$), ASES from 56.9 (SD 17.7) to 80.7 (SD 18.2; $p = 0.003$). The pain level measured with VAS decreased from 5.6 (2.5) to 2.3 (SD 2.3; $p < 0.001$). The SSV improved from 58.2 (SD 20.3) to 76.3 (SD 24.1; $p = 0.002$). Mean satisfaction with the performed procedure at latest follow-up was 8.4 (SD 2.1). Four patients (21%) reported of remaining apprehension and 1 patient (5%) was revised for recurrent posterior instability with a second arthroscopic posterior bone block 1 year after index surgery. 7 shoulders (37%) were reoperated for screw removal which was performed arthroscopically in a mean time of 7 months (SD 12.7). In radiographs, osteoarthritic changes evolved during the follow-up period. No conversion into total shoulder arthroplasty was observed.

Conclusion: We conclude that the arthroscopic posterior bone block is a safe procedure in the treatment of posterior shoulder instability with reliable longtime clinical results.

FM105

What is the Optimal Tension of SuturePatch in Superior Capsule Reconstruction for Irreparable Tears of the Supraspinatus and Infraspinatus Tendons?

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Introduction: Postoperative graft tear is correlated with poor clinical outcome after superior capsule reconstruction (SCR) for irreparable rotator cuff tears. The objective of this study was to investigate the optimal tension of the SuturePatch (Arthrex, Naples, FL), which has been developed to reinforce SCR.

Methods: Eight fresh-frozen cadaveric shoulders were tested by using a custom shoulder-testing system. Superior glenohumeral translation, subacromial peak contact pressure, and glenohumeral range of motion (ROM) were compared among 4 conditions: 1) intact; 2) irreparable supraspinatus and infraspinatus tears; 3) SCR using a thin fascia lata graft and SuturePatch augmentation performed at 20° glenohumeral abduction; and 4) SCR using the same graft with SuturePatch augmentation performed at 30° glenohumeral abduction.

Results: Increased superior glenohumeral translation and subacromial peak contact pressure after creation of an irreparable supraspinatus and infraspinatus tendon tear significantly decreased after SCR with SuturePatch augmentation performed at both 20° and 30° glenohumeral abduction. Superior glenohumeral translation and subacromial peak contact pressure did not differ between 20° and 30° glenohumeral abductions. Internal rotation ($P = 0.39$ to 0.99), external rotation ($P = 0.61$ to 0.99), or total rotational range of motion ($P = 0.51$ to 0.99) were comparable between the irreparable supraspinatus and infraspinatus tendon tear condition and SCR with SuturePatch augmentation at both 20° and 30° glenohumeral abduction.

Conclusions: SCR with SuturePatch augmentation restored superior glenohumeral stability and maintained glenohumeral range of motion. When the SuturePatch is used to augment the graft of SCR, 30° or 45° of shoulder abduction may provide the optimal tension for graft attachment to the glenoid medially and greater tuberosity laterally.

FM106

Conservative treatment of distal biceps tendon ruptures in young and active patients yields good clinical results and high patient satisfaction

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Introduction: Surgical treatment of distal biceps tendon ruptures has been recommended in an active population to avoid loss of supination strength and endurance. It has been the standard care despite complication rates as high as 40% and reoperation rate of 18%. The impairment after nonoperative treatment is still a debate. The aim of this study was to show clinical and functional outcome in active patients with nonoperative treatment of complete distal biceps tendon ruptures.

Methods: Ten male patients with an average age of 50 years (26-59 years) were reviewed 8.5 month (6-16 month) after conservative treatment of a complete tear of the distal biceps tendon. Occupation, duration of work incapacity, hand dominance, pain score, range of motion, strength and Disability of the Arm Shoulder and Hand (DASH) – Score and the Mayo Elbow Performance Score (MEPS) were determined. Supination torque was measured in 30° and 90° of pronation with the elbow at 90° of flexion using a static torque sensor. Flexion strength was measured with an IsoForce measuring device. The values were compared to the uninjured side.

Results: Six patients were manual and 4 were office workers. The average duration of work incapacity was 5 days (0-25 days), 5 patients did not have to stop their activity despite heavy labor. The dominant side was involved in 3 patients. Supination torque of the injured arm averaged 8.34 Nm in 30° pronation and 10.26 Nm in 90° pronation, corresponding to a loss of 20.9% and 30.6% compared to the uninjured side. Flexion strength was 14% lower on the injured side. The average MEPS was 98.3 points (100 = normal elbow), the mean DASH-Score was 3.16 points out of 100 (0 = no disability). 3 patients were slightly disturbed by the cosmetics of the biceps.

Conclusion: Nonoperative treatment of complete distal biceps tendon ruptures yields good clinical results and a high patient satisfaction in a young active population. The loss of supination torque leads to no relevant disability in daily life. Therefore the risk to suffer a major complication or reoperation outweighs the gain in supination torque.

FM107

Dynamic anterior shoulder stabilization using the long head of the biceps tendon: a biomechanical study

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Background: A new concept of dynamic anterior shoulder stabilization (DAS) combining Bankart repair with the additional sling effect of the long head of the biceps (LHB) tendon to treat anterior glenohumeral instability has recently been introduced. Purpose: to biomechanically investigate the stabilizing effect of the DAS technique in comparison to standard Bankart repair in different defect models.

Methods: 24 fresh frozen cadaver shoulders (average \pm SD: age 60.1 \pm 8.6 years) were mounted in a shoulder-testing system allowing 6 degrees of freedom. Glenohumeral translation was tested in 60° abduction and 60° external rotation (ABER position) while forces of 20 N, 30 N and 40 N were applied. The translation was measured using a 3D-digitizer and the total translation and the relative translation in relation to the native starting position were determined. Maximal external and internal rotation after application of 1.5 Nm torque to the humerus were measured. All specimens went through for 4 different conditions (Intact, defect, isolated Bankart repair, DAS) and were randomized to 3 different defect groups (Isolated Bankart lesion; 10% anterior glenoid defect; 20 20% anterior glenoid defect).

Results: Both surgical techniques resulted in decreased anterior glenohumeral translation in comparison to the defect conditions in all defect groups. In comparison with isolated Bankart repair DAS showed significant less relative anterior translation in 10 23 % glenoid defects (30 N: 2.6 \pm 3.4 mm vs. 5.3 \pm 4.2 mm; $p = 0.044$) and in 20 % glenoid defects (40 N: 2.1 \pm 6.6 mm vs. 6.0 \pm 5.7 mm; $p = 0.035$). However, in 20 % defects DAS led to a relevant posterior and inferior shift of the humeral head in ABER position and to a relevant increase of inferior glenohumeral translation. Both surgical techniques did not limit the rotational range of motion.

Conclusion: In the context of minor glenoid bone defects the DAS technique demonstrates superior results in comparison to isolated Bankart repair.

FM108

Arthroscopic augmentation with an absorbable synthetic scaffold in critical cuff repairs

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Praxis Shouldercare

Introduction: In the presence of a failed rotator cuff (RC) repair or a massive tear with compromised tissue quality patch augmentation becomes a logical adjunct from a mechanical and biological point of view. We hypothesize that augmentation of the repair with a novel bio-absorbable scaffold might improve healing rates with few complications and reasonable added costs.

Methods: A consecutive series of 70 patients was prospectively included since 3/14. The case series includes 47 revision cases (typically medial failures) and 23 primary repairs in massive tears. The operation is technically demanding but reproducible and includes 12 steps (video). The cuff is repaired with a standard suture bridge construct using 1 medial and 2 lateral anchors ; no additional anchors are needed for patch fixation. The proposed scaffold (BioFiber, Wright) consists of biosynthetic fibers woven into a lattice structure and fully absorbing in the Krebs cycle over 18 months.

Results: Until now 30 patients have completed 24 mo FU including Constant Score (CS), Subjective Shoulder Value (SSV) and a native MRI. The CS rose from 44 to 85 points, the SSV from 40 to 80%. MR scans showed an intact repair in 20 cases (67%, Sugaya Type II-III). In this series of 70, one shoulder was revised for infection, another for inflammatory reaction. One patient received a reversed prosthesis and 2 more were arthroscopically revised because of a symptomatic gap formation at the posterior edge of the patch. Reversal of pseudoparesis in massive tears was achieved in 10 cases. The added costs of patch augmentation was about 600 Euros, added operation time less than 30'. Patch integration has been observed at repeat arthroscopy.

Conclusion: We report a learnable technique for patch augmentation in the revision setting and for massive RC tears. Implant costs are reasonable; the material has been successfully used in abdominal wall hernias and cosmetic breast surgery. So far only few orthopaedic results have

been reported. The scaffold is made from fully absorbable synthetic fibres containing no DNA residues. It has good mechanical (maintaining 60% of strenght at 3 mo) and biological properties. Our preliminary results suggest an improved outcome and possibly higher healing rates in critical situations.

FM109

Frozen shoulder - A true burden for the Swiss Health Care System

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Introduction: Frozen shoulder (FS), also known as adhesive capsulitis, is a poorly understood pathological entity that characterizes a painful and stiff shoulder. This often very debilitating disease can occur either after shoulder trauma, shoulder surgery or idiopathically with no known origin. Although FS is self-limiting in most cases, the typically protracted course of the disease leads to prolonged incapacity to work and considerable direct and indirect costs. Since we are of the opinion that the socio-economic effects of FS are strongly underestimated in Switzerland, we have conducted this study on the basis of the comprehensive database of the Swiss National Accident Insurance Fund (SUVA).

Methods: ICD-10 codes of shoulder injuries (S4* and M84.3*) with and without additional code of adhesive capsulitis (M75.0) were used for data extraction. Long-term disability was defined as absence from work >90 days and very long-term cases were defined as patients with >360 days absence from work. Health and treatment costs as well as total insurance costs were measured in a 5-year follow-up.

Results: At an incidence of 5% among all patients registered for shoulder injuries, a total of 22,228 post-traumatic shoulder freeze disorders were identified and further analyzed over 8 years. Patients suffering from FS after a shoulder injury showed significantly longer absenteeism with 30.8% long-term and 9.7% very long-term cases, compared with 9.4% and 1.3%, respectively, in the non-FS cohort. While the total cost of an injured shoulder without FS development was approximately CHF 8,000, the cost of cases with posttraumatic and postoperative FS was calculated at CHF 34,000 per case, resulting in an additional total cost of CHF 78 million per year for all FS patients.

Conclusion: The development of an FS after a shoulder injury is associated with a massively longer incapacity to work (3.3-7.5 times) and causes enormous costs for the Swiss healthcare system every year. The available figures do not include the even more frequent idiopathic FS cases.

* FM110

Stand-alone Coracoclavicular Suture Repair of Acute Neer Type IIB/V Distal Clavicle Fractures

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Background: Treatment of displaced lateral clavicle fractures remains challenging, especially when encountering concomitant coracoclavicular instability with a small lateral fragment which does not allow for sufficient screw purchase. Available techniques usually require prominent hardware or bear the risk of button migration. This study presents long-term results of a novel suture technique for the treatment of Neer type IIB/V distal clavicle fractures.

Methods: Nine-teen patients were treated for distal clavicle fractures (11 left, 8 right) with either rupture or bony avulsion of the coracoclavicular ligaments between January 2006 and June 2018. Both the preoperative and last available postoperative radiographs were reviewed. The short-term follow-up was favourable in all patients. Moreover, twelve patients were additionally amenable to a telephone survey at a mean follow-up period of 5.6 years (range 0.7 – 11.9 years).

Results: The majority of patients (n = 11) showed a bony avulsion of the coracoclavicular ligaments. The mean coracoclavicular distance was 21 mm at diagnosis. During the telephone survey, all patients reported a very satisfactory outcome with subjective shoulder values averaging 92 % vs. 97 % on the contralateral side. ASES scores showed a mean value of 96 % vs. 99 % at the uninjured side. All but two patients had sufficient radiological follow-up of longer than three months or showed well-advanced fracture healing at an earlier stage. One patient developed an asymptomatic non-union, that remained untreated. Another patient un-

derwent arthroscopic resection of the acromioclavicular joint due to post-traumatic osteoarthritis 1 ½ years after index surgery. The restored coracoclavicular distance remained stable over time and averaged 11 mm at last follow-up with an average side difference of 1 mm.

Conclusion: The stand-alone suture repair of acute Neer type IIB/V distal clavicular fractures is a less invasive fixation technique without prominent hardware that allows for a well-controlled anatomic reduction and stable fixation of difficult-to-treat comminuted fractures. Both radiographic and patient-reported long-term results are very satisfactory.

FM111

The accuracy of joint aspiration for the diagnosis of septic shoulder arthritis

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Background: Shoulder joint aspirations are frequently performed to rule out septic arthritis. In case of punctio sicca, physicians often augment the aspiration liquid by injecting a saline solution.

Methods: We performed shoulder joint aspirations by fluoroscopy assistance and analyzed the value of an additional saline irrigation in patients undergoing revision shoulder surgery. Multiple deep intraoperative tissue samples served as the microbiological gold standard.

Results: We performed 119 aspirations occurring between 180 to 0 days before revision surgery. Among them, we could directly sample intra-articular liquid in 71 cases; after saline injection in 44 episodes; and 4 cases remained "punctio sicca" despite injected saline. According to intraoperative samples, 31 shoulders were infected, but only 15 (15/31; 48%) yielded pathogens in the aspiration. Moreover, none of the 44 saline-enforced irrigations revealed bacteria, but eight of them (8/44; 18%) confirmed infection in intraoperative samples. Overall, sensitivity, specificity, positive and negative predictive values of a pre-surgical aspiration was 42%, 98%, 87%, and 78%.

Conclusion: When surgical revision is planned, a pre-surgical shoulder joint aspiration is not reliable to sufficiently exclude shoulder joint infection and irrigation after unsuccessful primary aspiration is futile.

Level of Evidence: Level III, retrospective cohort study.

FM112

Failed repair of torn human rotator cuff muscle is associated with deteriorations of muscle fiber type distribution and mitochondrial composition

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Introduction: Tears of rotator cuff tendons affect approximately one in five individuals above the age of sixty years. Arthroscopic tendon to bone repair is the preferred treatment for symptomatic tears of rotator cuff tendons which are refractory to conservative treatment. Such repairs, however, may fail to heal or re-tear within months after reattachment. We hypothesized that failure of healing or re-tearing of a supraspinatus repair is associated with specific degenerative changes in the molecular and cellular composition of the supraspinatus muscle prior to repair.

Methods: 95 consecutive patients (61 male, 34 female) who underwent arthroscopic repair of an isolated or combined tear of the supraspinatus tendon consented to participate in this independent ethics committee approved, prospective study (registered as NCT02123784 at ClinicalTrials.gov). Supraspinatus tendon integrity was assessed preoperatively and three and twelve months postoperatively using magnetic resonance imaging. Intraoperatively, a supraspinatus muscle biopsy (~10 mg) was harvested in a standardized fashion. The distribution of slow, fast and hybrid type muscle fibers was determined immunohistologically; levels of marker proteins of mitochondrial respiration were quantified using western blotting. Differences in muscle features between successfully and non-successfully repaired musculotendinous units were assessed statistically with univariate and multivariate ANOVAs. Significance was declared at a p-value of 5%.

Results: Nineteen of the ninety-five tendon to bone repairs failed; in the analyzed seventy-four patients a subset of sixteen failed. In the nineteen failed tendon to bone repairs the percentage of hybrid type fibers was nearly tripled (5.3% vs. 1.9%, $p = 0.009$) and the levels of the combined

mitochondrial proteins were 50% higher ($p = 0.031$) than in the successful bone repairs. The mitochondrial effect could be localized to increased levels of the respiratory complex II marker succinate dehydrogenase A.

Conclusion: Perturbations of muscle fiber type composition and mitochondrial protein expression in ruptured supraspinatus muscle may provide biomarkers to identify musculotendinous units who are at risk for a not successful healing after tendon repair. The finding indicates that aspects of rotator cuff disease share commonalities with age-related myopathies.

FM113

Capitate resurfacing and PRC: a surgical option for radio- and midcarpal arthrosis? Series of 20 cases

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Introduction: Therapy after failure of conservative treatment for symptomatic lunare facet and head of the capitate arthrosis is challenging. Until now the commonly proposed surgical option was complete wrist arthrodesis. A resurfacing of the capitate head with a "Resurfacing Capitate Pyrocarbon Implant" (RCPI) combined with a proximal row carpectomy (PRC) is an alternative surgical approach that preserves wrist motion. The aim of this study is to evaluate the short term clinical and patient rated outcomes of our 20 patients.

Patients and Methods: From September 2010 to October 2018, 20 patients underwent PRC in combination with RCPI for the following reasons: 5 SNAC wrist III°, 5 SCAC wrist, 3 SLAC wrist III°, 2 Kienboeck disease III°, 3 radiocapital arthrosis after PRC, 1 malunion of the radius with destruction of the articular surface and 1 patient with radio- and midcarpal arthrosis due to rheumatoid arthritis. The patients were evaluated preoperatively and at 6, 12 and 18 weeks postoperatively. Primary outcome is Quick Disabilities of the Arm, Shoulder and Hand Score (quickDASH), secondary outcomes are the numeric rating scale (NRS), conventional wrist x-rays, active wrist range of motion and grip strength.

Results: There were 13 male and 7 female patients with a mean age of 55.7 years (range 30 to 72 years). The quickDASH score improved statistically significant from 63.6 to 9.6. Radiographic evaluation showed a shallow radiolucent line around the implant in 18 patients without dislocation or displacement assuming a stable implant. In two patients progressing sintering of the implant was observed. One of those patients was converted to an Amdandys implant, the other refused further surgery. Radial styloidectomy was performed in 3 patients for impingement of the remaining carpus and the radius. Bony impression of the lunare facet was observed in one asymptomatic patient. In comparison to preoperative wrist range of motion, stable flexion/extension of 32/36° and radial/ulnar deviation of 25/11° were measured. The NRS improved statistically significant from 8 to 1. Grip strength improved from 17 to 21 kg

Conclusion: PRC combined with RCPI is a valuable surgical option to improve pain and daily function while preserving limited wrist motion. This intervention may postpone further salvage procedure. Thus, long term data is missing.

FM114

The effects of the surgical repair of an ulnar styloid fracture on the instability of the distal radio-ulnar joint and comparison of different surgical techniques In a biomechanical, cadaveric model

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Introduction: The cases in which a fixation of an Ulnar styloid fractures (USF) is indicated is not conclusively defined. However, 10% of these fractures are addressed surgically. No biomechanical studies have compared the different techniques or showed the superiority of one over the others. Our biomechanical, cadaveric study aims to access the influence of an ORIF of a USF including the fovea to the pronosupination and the DP-translation of the distal radioulnar joint (DRUJ). And to compare four different techniques.

Methods: 9 forearm specimens (1 male; mean age 64) were mounted on a costum jig, preserving the interosseous membrane, extensor carpi ulnaris, pronator quadratus, and TFCC. The positional change of the DRUJ was recorded via MicroScribe. 1Nm was applied for Pronosupination. DP-translation was measured in neutral, full pronation and 90° supination applying 15 N. Six different, sequential conditions were tested in the same specimen: intact, USF including the fovea and 4 repair techniques (2 K-wire, tension band wiring (TBW), headless compression screw (HCS), suture anchor).

Results: The pronosupination was increased significantly after the foveal fracture from average 202.5° to 219.4° ($p < 0.001$) and the DP-Translation in neutral from average 8.1mm to 10.5 mm ($p < 0.001$). Only the K-wire fixation (215.1°; $p = 0.118$) and the TBW (to 212.2°; $p = 0.657$) restored the rotation to no significant difference. However, the DP-translation in neutral could be reduced significantly in all 4 techniques (range: 7.2-8.9mm; K-wire $p = 0.006$; the other techniques $p < 0.001$) and with TBW and anchor suture in supination as well. In neutral the last two techniques reduced the translation even below the intact condition.

Conclusion: Our study shows that the increase in DP-translation in neutral could be reduced significantly with all four techniques (with TBW and anchor suture even below the intact condition). However, there were some significant differences between them: in supination TBW and suture anchor could restore the stability, so that these two techniques seem to be superior in reducing the DP-translational instability. The increased rotational instability of the DRUJ after the fracture could be restored with the K-wires fixation and the TBW alone. So, from a biomechanical point of view, we conclude, that the TBW is superior to the other (tested) techniques, restoring the appropriated stability in all planes.

* FM115

First to second metacarpal shaft fusion with iliac crest bone graft: a treatment option after failed trapeziometacarpal arthroplasty and failed revision of trapeziectomy. Report of two cases.

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Introduction: A first to second metacarpal shaft fusion with a bone graft is described in the literature for the treatment of thenar paralysis after poliomyelitis. To our knowledge, this technique has not been considered as a treatment option for failed trapeziometacarpal arthroplasty.

Methods: We report two cases with failed trapeziometacarpal arthroplasty. In the first case, a 51 year old woman experienced persistent pain 5 years after trapeziometacarpal arthroplasty with the abductor pollicis longus tendon of the right hand. After discussion of therapeutic options, she decided on an arthrodesis, so we performed an intermetacarpal shaft fusion with iliac crest bone graft.

Another 51 year old woman with Ehlers-Danlos syndrome type 2 who coincidentally had an arthrodesis of the trapeziometacarpal joint of the opposite hand later on, had persistent pain and instability after a trapeziectomy of the right hand with use of a Mini TightRope® suspension instead of her own tendon tissue. An arthrodesis of the first and second metacarpal base was performed, which had to be revised due to dislocation of the arthrodesis after a fall. We used the intermetacarpal shaft fusion with iliac crest bone graft as salvage procedure.

Results: No pseudarthrosis occurred. Both patients were satisfied with the results of the intervention and were almost pain free. Our first patient reported weakness in the operated side with difficulty opening jars and bottles. Also, after the primary surgery multiple sclerosis was diagnosed and she was uncertain if some of the weakness was due to her neurological condition. Grip strength (measured by Jamar dynamometer) and pinch strength were diminished in comparison to the opposite hand (16.5 vs. 23 kg and 5 vs. 6.5 kg respectively). Opposition according to Kapandji was 9 vs. 10.

Our second patient had comparative grip and pinch strength after surgery of right versus left hand of 18 vs. 13 kg and 5.5 vs. 4.5 kg respectively. According to Kapandji, opposition of right versus left hand was 7 vs. 10.

Conclusion: Intermetacarpal shaft fusion with bone graft can be seen as an additional option in the menu of revision surgeries after failed trapeziometacarpal arthroplasty, especially if instability is an issue.

FM116

The role of the remaining parts of the distal radio-ulnar ligaments after an ulnar styloid fracture including the fovea, for the stability of the distal radio-ulnar joint

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Introduction: Clinical studies suggest that untreated ulnar styloid fractures (USF) do not affect patient outcomes. The remaining soft tissues after the USF, may maintain a sufficient residual stability. Controversies exist about basal USF that include the fovea. These have a risk of causing distal radio-ulnar joint (DRUJ) instability, because they may include the insertion of the deep portion of the distal radio-ulnar ligaments (DRUL). Some evidence exist, that even in these fractures some stabilizers are left. This study investigates the importance of the remaining soft tissues attachment in such fractures, for the stability of the DRUJ.

Methods: Soft tissue was removed from 17 forearm specimens (mean age 64.5), preserving the interosseous membrane, ECU, pronator quadratus, and TFCC. The positional change of the DRUJ was recorded via MicroScribe. 1Nm was applied for Pronosupination. DP-translation was measured in neutral, full pronation and 90° supination applying 15 N. After testing the specimen with an reproduced USF including the fovea, the remaining parts of the DRUL were transected. In 8 specimens starting with the dorsal and in 9 specimens starting with the palmar side. Differences were compared using ANOVA and Tukey post hoc tests.

Results: After testing, the correct placement of the fracture was confirmed. Forearm movement tended to increase as an additional lesion was added. No matter which part of the remaining soft tissues was transected first, the pronosupination only increased significantly compared to the foveal fracture (mean: 205.8°) after the dissection of both the palmar and the dorsal remaining soft tissue (mean 217.0°; dorsal first: $p = 0.010$; palmar first: $p = 0.031$). Also the DP-translation changed significantly after the transection of both parts of the remaining soft tissue, no matter in which order it was realized. Increasing in neutral (dorsal first: $p = 0.019$; palmar first: $p = 0.018$) and supination (dorsal first: $p = 0.012$; palmar first: $p < 0.001$). However, if we look at the percentage of this increase, the dorsal tear is responsible for a bigger amount, no matter if it was performed first or second.

Conclusion: Our results shows that in a USF including the fovea, there are still soft tissues attaching to the ulnar head, giving a residual stability to the DRUJ. Cutting these structures leads to a significant increase in pronosupination and DP-translation. The dorsal portions seems to have a more important role in the DP-stability.

FM117

The Carpal Instability Non Dissociative after Intra-articular Radius Fractures

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Introduction: CIND (carpal instability non-dissociative) is characterized by dysfunction of the entire proximal carpal row, manifested at either the radiocarpal joint, the midcarpal joint or both AND a lack of a dissociation within the proximal carpal row (in difference to CID). While cases were noted following extra-articular distal radius fractures (DRF), no report in the literature has yet described adaptive CIND after intra-articular DRF. We presented this rare pathology and discussed our management and outcomes

Material and methods: The clinical records of 10 patients following intra-articular fractures or radiocarpal dislocations were reviewed. Management and treatment outcomes were studied. The aim of this study is to present this rare pathology and collect data about whose characteristics.

Results: 10 patients with 6 intraarticular fractures and 4 with radiocarpal fracture dislocations were collected. The initial treatment consisted in 5 cases of an ORIF, in 3 cases of Closed Reduction (CR) and percutaneous fixation and in 2 cases of a CR and casting. In all cases the radiological raised suspicion of CIND, was confirmed by an arthroscopic exclusion of intrinsic intercarpal ligament lesions. In 8 cases the whole

proximal palmar row adopted a flexed position with radiocarpal subluxation, while the midcarpal joint exhibited a hyper-extended position. The other two cases revealed a CIND with dorsal rotation of the whole proximal row and palmar subluxation and a flexion deformity in the midcarpal joint after a malunion of a DRF. 5 cases required a Radio-Scapho-lunate fusion while 3 cases open reduction, K-wire carpal transfixation and capsular ligament repair was done. 2 patients had no subjective discomfort and didn't need any further treatment.

FM118-FM137: KNEE / HIP

FM118

Bone wax can lead to foreign body reaction and local osteolysis

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Introduction: Bone wax is a hemostatic agent, widely used to prevent bleeding from bony surfaces. Absorbable and non-absorbable types of bone wax can be differentiated. Despite its effectiveness in hemostatic control, non-absorbable types especially are associated with foreign body granuloma. We observed focal osteolysis after femoroacetabular impingement (FAI) surgery with application of non-absorbable bone wax, consisting of paraffin and bees wax. Thus, we asked if a persistent foreign body reaction might lead to osteolysis and if there is progression of osteolysis over time.

Methods: We identified 571 patients between 01/2002 and 12/2006 that underwent offset correction at FAI surgery with application of bone wax at our orthopedic department. 146 patients had to be excluded due to previous operation or trauma. Out of those remaining 425 patients, we retrospectively observed six hips in five patients with persistent pain and clearly visible osteolysis on the x-rays in the area of the offset correction, which were included in the final study group. The mean age of the patients at offset correction was 29 ± 9 years (20-48 years). Histopathological examination of samples taken at later revision surgery at our hospital was performed. Additionally, we measured the relative area of the osteolysis (area of osteolysis/ area of femoral head in %) in the x-ray follow-up over a mean time of 8.6 ± 2.5 years (5-13 years) and compared the first with the last quotient.

Results: Histologically we found remaining wax as a foreign material with attached multinucleated giant cells and abundant mononuclear cells, distinctive for foreign body granuloma. We measured an increase in size of the osteolysis for all six hips. The mean initial quotient was 5.5% ± 2.7% (2.3%–10.7%), the mean quotient at the latest followup was 11.2% ± 3.9% (7.1%–17.3%). Comparing the values, the mean increase of the area of osteolysis compared to the initial area of osteolysis was 124.6% ± 74.1% (61.4% – 281%), which means the osteolysis has more than doubled.

Conclusion: Bone wax (consisting of paraffin and bees wax) can remain as a foreign body. It then provokes long lasting foreign body granuloma with inflammatory and phagocytic reaction, resulting in osteolysis. There is progression of osteolysis over time. The usage of bonewax should therefore occur in knowledge of the possible risks. Based on our findings, we have abandoned the use of bone wax during femoroacetabular impingement surgery.

* FM119

Posterior tibial plateau fractures and the impact of trauma mechanism

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Background: Posterior involvement in tibial plateau fractures (TPF) can have significant impact on functional outcome. The surgical decision making when to apply posterior approaches and the benefit of posterior internal fixation remains up for debate. Previous studies have had insufficient power to assess the benefit of utilizing posterior internal fixation methods. Furthermore, recent studies suggest that the trauma mechanism should be evaluated preoperatively to decide on surgical strategies. The main goal of this study was to evaluate the outcome in TPF with posterior involvement and to assess whether the trauma mechanism, assessed on preoperative imaging, has any effect on postoperative outcome.

Discussion: CIND after intra-articular DRF is a rare entity. The malalignment of the proximal carpal row is secondary to the mal-position of non-reduced articular fragments and/or associated extrinsic radiocarpal capsulo-ligamentous lesion. Depending on rotation of the proximal carpal row, the midcarpal joint develops a compensatory deformity in the opposite direction. Additional management with either open reduction of the malalignment or limited radiocarpal fusion is often needed.

Methods: An international retrospective multicenter study was conducted in four European level 1 trauma centers. Between January 2014 and December 2016, all consecutive operatively treated TPF with posterior involvement according to the revised three column classification (rTCC) were evaluated. Demographic and treatment related variables were assessed. Based on preoperative imaging, the trauma mechanism was determined as either 'valgus' or 'varus' and 'flexion' or 'extension'. All included patients were sent questionnaires including the Knee injury and Osteoarthritis Outcome Score to evaluate functional outcome.

Results: A total of 121 patients were included in the study. Eighty patients (66.1%) responded to the questionnaires with a median follow-up of 30.9 months (IQR 22.5 – 39.5). Fifty-five patients sustained a three column fracture, 57 a two column fracture and 9 patients a single posterior column fracture. Trauma mechanism was mostly a valgus deforming force (64.5%). Furthermore, extension and flexion trauma were more evenly divided (46.3% and 53.7%). Varus trauma was associated with worse outcome on the KOOS 'symptoms' subscale (p = 0.018). Furthermore, the combination of flexion and varus trauma was associated with significantly lower outcome scores on all subscales (p = 0.012, p = 0.040, p = 0.004, p = 0.009 and p = 0.006). Moreover, the presence of a medial column fracture was also associated with lower outcome scores.

Conclusion: Posterior tibial plateau fractures are associated with moderate to poor outcome. Varus deforming force has a significant impact on functional outcome, even more so combined with flexion of the knee. Assessing injury mechanism in relation to fracture morphology is important in the understanding of TPF.

FM120

Conventional fluoroscopy-guided percutaneous placement of iliosacral screws in the era of intraoperative 3D imaging and navigation: Inappropriate or still a valid option?

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Introduction: The percutaneous placement of iliosacral screws (ISS) is an established technique for the fixation of posterior pelvic ring injuries. The anatomy of the sacrum is complex and the landmarks may be difficult to identify with conventional fluoroscopy, particular in osteoporotic bone or in the presence of interfering bowel gas. Malpositioning of ISS is a complication with potential injury to adjacent neurovascular structures. Thus, computer navigated screw insertion has gained increasing popularity. It was the aim of this study to evaluate the quality of conventional fluoroscopy-guided percutaneous placement of ISS.

Methods: In 2017, the surgical procedure was standardized following a step by step technique using conventional intraoperative fluoroscopy. All procedures between 01/2017 and 12/2018 were included. All patients underwent computed tomography (CT) for fracture analysis and preoperative planning. Surgery was performed percutaneously in supine position. Following the standardized procedure, a postoperative CT was performed to confirm proper screw position. The screw position was defined to be either correct or with tangential involvement or true hit of the neuroforamina or spinal canal, or with anterior or superior bone perforation. Postoperative complications and revision surgeries were recorded as well.

Results: Median age was 78 years (range 16-91 years). In total, 50 ISS were inserted in 26 patients, 32 ISS into S1 and 18 into S2, respectively. In a 16 year old patient, 2x6.5 cannulated screws were used, all other patients received 7.3 cannulated screws. One planned procedure had to be aborted before skin incision due to insufficient visualization of the radiological landmarks. Regarding S1, malposition was observed for 2 ISS (6%), of these, 1 (3%) with tangential involvement of the spinal canal and 1 (3%) anterior bone penetration. For S2, tangential involvement of the spinal canal was seen for 3 (17%) ISS. Screw malposition did not cause

any neurovascular complications. Early migration resulted in screw exchange in 1 case (2%) and another 2 ISS had to be removed prematurely due to symptomatic loosening (4%).

Conclusions: Following a standardized step by step surgical technique, conventional ISS placement is reliable and safe. Due to the smaller dimensions, ISS malposition was more frequently observed in S2 than in S1. However, only tangential involvement of the spinal canal occurred and no neurovascular complications were seen.

* FM121

An Astonishing Finding: The 1-Year Mortality Rate After Operatively Treated Acetabular Fractures in the Elderly is Lower Compared to Proximal Femoral Fractures

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Introduction: The high 1-year mortality rate in the geriatric population after surgical treatment for proximal femoral fractures is well known. While the incidence of these fractures decreases, the number of acetabular fractures in the elderly increases dramatically. However, the mortality rate of geriatric acetabular fractures has never been compared to proximal femoral fractures. The difficulty and complexity of surgical fixation, as well as the impossibility of full weight-bearing lead to the hypothesis, that one-year mortality after geriatric acetabular fractures should be higher compared to proximal femoral fractures. The aims of this study were: (1) to analyze epidemiologic data for both fracture patterns in geriatric patients, (2) to evaluate one-year mortality after operative treatment in both groups, (3) to determine negative predictive factors for one-year mortality in both groups.

Methods: Retrospective comparative study, 394 consecutive patients (2012-2017), Level 1 Trauma Center, 104 acetabular fractures, 290 proximal femoral fractures. Exclusion criteria were age <60, non-operative treatment. (1) Data concerning demographics, mechanisms of injury, perioperative course and comorbidities in form of ASA score and Charlson Comorbidity index were compared. (2) All patients were contacted, and the mortality of both groups was evaluated through Kaplan-Meier survivorship analysis. (3) Cox proportional-hazard modeling was conducted for all epidemiologic parameters, in order to identify negative predictive factors for one-year mortality.

Results: (1) There was no statistical difference between the groups regarding age, gender, BMI and the most common mechanism of injury. Also, no differences in important systemic diseases could be observed. ASA score and Charlson Comorbidity index were both significantly lower in the acetabular fracture group, while the mean intraoperative blood loss was higher. (2) One-year mortality was significantly lower in acetabular fractures, also after matching with the most common ASA score and Charlson Comorbidity index. (3) A postoperative paralytic ileus was identified as a negative predictive factor for acetabular fractures, meanwhile delirium, age at surgery, comorbidity index and renal insufficiency were found for proximal femoral fractures.

Conclusion: Despite the complexity of operative treatment for acetabular fractures in the elderly, one-year mortality seems to be lower than after proximal femoral fractures.

* FM122

Basi-cervical femoral neck fractures: Arthroplasty provides greater survivorship compared to osteo-synthesis in patients with multiple comorbidities

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Introduction Femoral neck fractures (FNFs) are associated with a high mortality in the following years. These fractures are normally treated surgically with open reduction and internal fixation (ORIF) or with arthroplasty. After a basi-cervical FNF both arthroplasty and ORIF are considered suitable options. The invasiveness of arthroplasty and the risk of pain persistence and activity limitations after ORIF can both prejudice patients' survivorship, especially in older patients with comorbidities. Baseline patients characteristics can play a key role in the choice of treatment, which could affect patient response, not only in terms of function recovery, but also in terms of survivorship.

Methods All patients that underwent surgery for FNFs at the author Institution from January 2010 to January 2018 were retrospectively identified. Patients with basi-cervical FNFs, older than 60 years, with at least 1 year of follow-up, and information on survivorship were selected. The influence of treatment approach was evaluated in terms of survivorship rate, survivorship curves, complications, and hospitalization length. Age and ASA score were used to create sub-classes of patients and analyses were performed for every sub-class.

Results A total of 226 patients were included, 154 undergone hip arthroplasty and 72 ORIF. After a mean follow-up of 4.9 ± 2.4 years, 74 out of 154 patients in the arthroplasty group (48%) and 33 out of 72 patients in the ORIF group (45%) were dead with non-significant difference between groups. The overall survivorship curves of the two treatment groups showed no significant difference. Overall hospitalization length was 13.5 ± 8.9 days, with non-significant difference between the two treatment groups. There were 130 overall complications, 97 in the arthroplasty group and 33 in the ORIF group (OR: 2.1; $p = 0.02$). In the ASA3/4-subgroup, the survivorship curves show a lower mortality in the arthroplasty group ($p = 0.008$).

Conclusion Arthroplasty and ORIF are both valuable procedures for the treatment of basi-cervical FNFs, but a high mortality rate should be forecasted. Arthroplasty seemed to improve chances of patients' survivorship in the ASA3/4-subgroup in this series. Thus, besides fractures displacement, the choice of treatment approach should consider the presence of comorbidities, and further high-level studies should investigate the best treatment approach for specific patients affected by FNFs.

FM123

Cement Augmentation Prevents Mechanical Complications in Unstable Ptertrochanteric Fractures Treated with PFN-A

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Introduction: The proximal femoral nail is in general considered a safe and reliable implant for operative treatment of trochanteric fractures. However, mechanical complications, such as secondary varus collaps and cut-out, remain a serious issue. It has been suggested that cement augmentation might minimize the risk of these complications. This study aims to identify risk factors related to mechanical complications in both patients with stable and unstable ptertrochanteric fractures. We aimed to elucidate the impact on cement augmentation to reduce mechanical complications.

Methods: This was a retrospective chart review of all consecutive patients with trochanteric fractures treated in a level one trauma center in Switzerland with PFN-A between January 2012 and June 2017 with a minimal follow-up of 3 months. Patients were divided in two groups according to fracture type into stable (AO/OTA A1-A2.1) and unstable (AO/OTA A2.2-A3) fractures. Risk factor analysis was performed in each group to identify factors related to the outcome of interest: unstable retention, defined as at least 10° of secondary loss of CCD angle, cut-out or cut-through of the blade, lateral migration of the blade more than 10 mm, or implant failure within the follow-up period. Risk factors included cement augmentation or not, type of fracture according to the AO/OTA classification, adequacy of reduction, tip-apex distance (TAD), position of blade within the femoral head, the nail-shaft position and CCD angle postoperatively.

Results: A total of 80 patients with a stable and 80 patients with an unstable fracture were included. The overall mean age was 81 years (± 10.2) and 22.5% of the patients were male. Unstable retention occurred in 7 patients (8.75%) with a stable fracture and in 13 patients (16.25%) with an unstable fracture. All unstable retentions within the unstable fracture group occurred among patients who did not receive cement augmentation ($p = 0.049$). In the group with the stable fractures, unstable retention occurred in 1 patient with cement augmentation and in 6 patients without cement augmentation ($p = 0.54$). Other risk factors associated with unstable retention were the position of the blade within the femoral head, the TAD, adequacy of reduction and the nail-shaft position.

Conclusion: Patients with an unstable ptertrochanteric fracture might benefit from cement augmentation. There appears to be no benefit of augmentation in patients with a stable fracture.

FM124

Femoral nerve palsy following Girdlestone resection arthroplasty: An anatomical study

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Introduction: Failed hip arthroplasty patients unsuitable for reimplantation may be offered Girdlestone resection arthroplasty (GRA). We discovered paralysis of the quadriceps muscle group (QS) in a patient with bilateral GRA due to periprosthetic infection. Paralysis recovered after reimplantation of a total hip. The purpose of this study was to investigate the anatomy of the femoral nerve (F) with special emphasis on the nerve entry points into the different component of the QS in a GRA situation.

Methods: Eight cadaveric hemipelvis were investigated. The F was dissected and its course was traced distally. After GRA through the direct anterior approach, an axial stress to the lower extremity was applied and the relative movement of the femur was recorded. The F and its entry points into the different components of the QS were assessed before and after the GRA was performed.

Results: The F divides into a medial and lateral division supplying the different components of the QS. GRA led to a shift of the femur in 1. vertical (3.8 cm), 2. lateral (2.5cm), 3. dorsal (1.8 cm) and 4. external (36.5 degree) directions. This caused tearing of the F branches to the QS. Migration of the F entry point was recorded 5.3 mm for vastus medialis, 5.4mm for medial part of the vastus intermedius, 16.3 mm for lateral part of the vastus intermedius, 23.1mm for rectus femoris, 30.8mm for tensor vastus intermedius and 28.8mm for vastus lateralis muscle.

Conclusion: Migration of the femur after GRA alters the anatomical course of the F with its entry points into the QS. Tearing mainly occurs to the lateral division of the F that supplies the vastus lateralis, tensor vastus intermedius, lateral parts of the vastus intermedius and rectus femoris. Partial F palsy might be an additional reason for poor functional result following GRA.

FM125

Rotational Subtrochanteric Femoral Osteotomies for Patients with Femoroacetabular Impingement due to low Femoral Torsion

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Introduction: Patients with femoro-acetabular impingement (FAI) can present with high and low femoral torsion. The causal therapy for patients with low femoral torsion is a rotational femoral osteotomy to increase femoral torsion. So far, no clinical results of patients undergoing rotational femoral osteotomies have been investigated.

Aims: To assess (1) hip pain, ROM and function, (2) subsequent surgeries, complications and (3) PROMs in patients undergoing rotational femoral osteotomies for symptomatic anterior intra- and extraarticular subspine FAI.

Methods: This is a retrospective case series involving 18 patients (23 hips, 2014-2018) that underwent rotational femoral osteotomies for anterior intra- and extraarticular subspine FAI. The mean age of the patients was 25 ± 6 years (58% male) with a minimum 1-year followup (mean 2 ± 1, range 1-5 years).

All patients underwent MR arthrography and CT of the pelvis.

Surgical indication was a positive anterior impingement test, limited internal rotation in 90° of flexion (mean 9° ± 11) and in extension (mean 22° ± 11), anterosuperior chondrolabral damage in MR arthrography and CT - based measurement of abnormal low femoral torsion (mean 5° ± 3).

Results: (1) The positive anterior impingement test decreased from preoperatively 100% to 9% (p < 0.001). Internal rotation in 90° of flexion and in extension increased significantly (p < 0.001) from preoperative 10° ± 8 (0 – 30) to 31° ± 10 (15 – 50) and from 24° ± 11 (0 – 45 to 36° ± 10 (20 – 50). The mean Merle d'Aubigné and Postel score increased from 14 ± 2 (8 – 15) points to 17 ± 1 (13 – 18, p < 0.001) points.

(2) At followup, all hips were preserved and none of them had a total hip arthroplasty. One hip (4%) underwent revision osteosynthesis, that was performed for delayed healing of the femoral osteotomy. Implant removal was performed in 10 hips (43%).

(3) PROMs were satisfactory at 1-year followup.

Conclusion: Corrective rotational femoral osteotomies combined with a SHD for cam resection and/or labral refixation for the treatment of anterior intra- and extraarticular subspine impingement improve hip pain and function in most of the patients at short term followup.

FM126

The impact of mal-angulated femoral rotational osteotomies on mechanical leg axis

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Introduction: Subtrochanteric or supracondylar femoral rotational osteotomies are established surgical treatments for femoral rotational deformities. An unintended change of the mechanical leg axis is an identified problem. So far no attention has been drawn to the impact of mal-angulated osteotomies on mechanical leg axis. Goal of the present study was to assess the effect on the mechanical leg axis in case of angular deviation of the osteotomy plain from correct preoperative planning, using a computer simulation approach.

Methods: 3D models of a patient leg with 42° femoral anteversion (Model 1) and a patient with 6° femoral retroversion (Model 2) were generated from computed tomography data. Subtrochanteric and supracondylar rotational osteotomies were executed in the surgical planning software CASPA (Balgrist CARD AG, Zurich, Switzerland), with correctly placed osteotomies, perpendicular to the femoral mechanical axis. Mal-angulated osteotomies in sagittal and frontal plain (±5°, ±10°, ±15°, ±20°, ±30°) followed by different degrees of rotation (5°, 10°, 15°, 20°, 30°) were simulated and its effect on the mechanical axis measured.

Results: 20 correct and 400 mal-angulated osteotomies have been simulated. Correct placed osteotomies showed mean deviations from preoperative mechanical axis of 0.05° ± 0.06° in Model 1 and of -0.25° ± 0.26° in Model 2. Mal-angulation of ± 30° with 30° rotation showed maximum deviation from preoperative mechanical axis in subtrochanteric osteotomies (4.02° ± 0.39°), likewise maximum deviation in supracondylar osteotomies were seen with mal-angulation of ± 30° and 30° rotation (12.37° ± 0.78°). Overall, unintended angulated osteotomies in sagittal plain showed higher deviations of the mechanical axis (up to 12.37° ± 0.78° in supracondylar osteotomies), than angulation failure in frontal plain (up to 3.98° ± 1.89° in supracondylar osteotomies).

Conclusion: Mal-angulation of femoral rotational osteotomies showed relevant change of mechanical leg axis. This effect was more marked for the supracondylar site. Deviation of femoral osteotomy in the sagittal plain had higher impact on the mechanical leg axis than deviation in the frontal plain. Navigation aids may be considered for femoral rotational osteotomies, especially when supracondylar and with high degree of correction.

FM127

The Precice intramedullary limb lengthening system: A review of 9 consecutive cases

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Introduction: There is rising popularity of the use of intramedullary limb lengthening systems with the Precice limb lengthening nail as the currently newest device. The intramedullary limb lengthening method reduces complications which are associated with external fixators such as soft tissue infections, joint stiffness and patients acceptance. The Precice nail consists of a magnet technology with a remote controller which enables non-invasive bone lengthening.

Method: The lengthening of 7 femoral bones was undertaken in 6 patients. Diagnosis was short stature (bilateral femoral lengthening of 8cm) in one case, femoral deficiency in one case, hemihypotrophy in 3 cases and posttraumatic limb length discrepancy in one patient. 2 tibias were lengthened, one in fibular hemimelia and the other one in hemihypotrophy. Surgical technique included a minimal invasive corticotomy followed by a 7 day latency period. In two cases frontal or torsional plane deformities were corrected during implantation of the nail. Patients were instantly mobilized under partial weight bearing and knee range of motion maintained by a defined physiotherapy protocol. The femora were lengthened one third of a mm 3x per day, the tibia 2 times. Radiographic and clinical review was performed every 1-2 weeks. When three of four cortices were seen in the radiographs patients full weight bearing was allowed.

Results: The average bone lengthening was 5.6 cm in the femur and 4 cm in the tibia. The aim of the treatment was achieved in every single patient. There was one major complication in a tibial lengthening patient with a compartment syndrom which needed urgent surgical revision but showed full reconvalescence in further course. The lengthening was not

disturbed. An implant related problem was not observed. Pain was minimal, the patients were mostly only restricted by the partial weight bearing on crutches. In the proximal femur lengthenings, we found a mild varus deformity, when the ostotomy site was too proximal. A slightly more distally performed osteotomy prevented this problem in the consecutive cases. There were no complications of infection, poor bone regenerate or premature consolidation.

Conclusion: The Precice nail is a new device offering accurate control of the lengthening process and rehabilitation. Overall the patient acceptance is very high and the results favourable. Nevertheless possible complications should be considered and anticipated.

FM128

Early anterior cruciate ligament reconstruction within 3 weeks does not increase stiffness and complications compared to delayed reconstruction: a meta-analysis of RCTs

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Introduction: Historically, according to findings from retrospective large series, it was advocated that when ACL reconstruction is performed within 3 weeks, there is a higher risk of post-operative arthrofibrosis and consequent knee stiffness and ROM limitation should be expected. However, possible benefits or complications of delaying surgery remain unclear due to heterogeneous and conflictual trials.

Methods: A systematic literature search was performed on PubMed, Web of Science, Cochrane library and the grey literature, focusing only on high level evidence from RCTs. According to previous literature, 2 analyses with different cut-off of time injury-to-surgery to distinguish early and delayed reconstruction were performed: 3 weeks and 10 weeks. Influence of timing was analysed through meta-analyses in terms of PROMs, risk of complications, ROM limitation, risk of re-tears, and residual laxity. Risk of bias and quality of evidence were assessed following the Cochrane guidelines.

Results: Eight studies (5 in the “3 weeks cut-off” analysis and 3 in the “10 weeks cut-off” analysis) were included. No differences were found in terms of PROMs, risk of complications, ROM limitation, risk of re-tears, and residual laxity between earlier and delayed surgeries, both in the “3 weeks cut-off” analysis or in the “10 weeks” analysis ($p > 0.05$). The level of evidence was moderate-to-low for the outcomes of the “3 weeks cut-off” analysis and low-to-very low for the outcomes of the “10 weeks” analysis.

Conclusion: This meta-analysis of RCTs shows that timing of surgery after ACL tears has no influence on the final functional outcome, on the risk of re-tear, and on residual instability. Thus, RCTs do not confirm the previously reported benefits of postponing surgeries, suggesting that ACL reconstruction can be performed safely in the acute setting.

FM129

Biomechanical Comparison Between Anterolateral Ligament Reconstruction and Modified Lemaire Lateral Extraarticular Tenodesis in the ACL-Reconstructed Knee

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Introduction: In an anterior cruciate ligament (ACL) and anterolateral ligament (ALL) deficient knee, isolated ACL reconstruction does not restore the normal kinematics of the knee compared to a combined ACL+ALL reconstruction. This higher knee stability after combined ACL+ALL reconstruction protects the ACL graft and meniscus repair. However the choice between lateral extraarticular tenodesis (LET) and anatomic ALLR for the anterolateral reconstruction remains a source of debate in literature. The aim of the study was to evaluate the knee kinematics after ACL+ALL reconstruction and to compare biomechanical properties of two anterolateral procedures: anatomic ALL reconstruction and modified Lemaire LET.

Methods: Six non paired human fresh-frozen cadaveric knees were tested with a 6 degrees of freedom robotic system (KUKA Robotics). Internal rotation and anterior translation of the knee were recorded from 0° to 90° of flexion after applying a 5-N·m internal rotation torque and a 134-N anterior load, respectively. A full kinematics assessment was performed in each following conditions: intact knee, after section of the ACL, after section of the ACL and ALL, after isolated ACL reconstruction and

after combined ACL and ALL reconstruction using either a modified Lemaire LET or an anatomic ALL reconstruction. These different states were compared using a Tukey paired comparison test.

Results: Knee kinematics was significantly different after ACL and ALL transection in comparison with both intact and ACL-deficient knee. After isolated ACL reconstruction, anterior translation and internal rotation remained significantly increased compared to intact knee ($+2.33 \pm 1.44$ mm and $+1.98 \pm 1.06^\circ$, respectively; $p < 0.01$). On the other hand, the addition of an anatomic ALL reconstruction or a modified Lemaire LET to the ACL reconstruction allowed to restore anterior translation and internal rotation to values similar to the intact knee. Finally, the two anterolateral procedures had not significantly different values in both tests. This difference was 0.67 ± 1.46 mm for anterior translation ($p = 0.79$) and $0.11 \pm 1.11^\circ$ for internal rotation ($p = 0.99$).

Conclusion: In ACL+ALL-deficient knees, isolated ACL reconstruction presented a persistent significant rotatory and anterior laxity in comparison with the intact knee. This difference could be abolished with the addition of an anatomic ALL reconstruction or a modified Lemaire LET. None of these procedures was better than the other.

* FM130

Introducing the lateral femoral condyle index as a risk factor for acl injury

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Introduction: The asymmetry of the medial and lateral knee compartments contributes significantly to femorotibial biomechanics and pivoting, and it is reported to be a relevant risk factor for an anterior cruciate ligament (ACL) injury.

Methods: A retrospective case-control study of 60 patients was conducted. Three age- and gender-matched cohorts (each $n = 20$) were analyzed: ACL re-ruptures, primary ACL ruptures and a control group consisting of isolated meniscal tears or patients with anterior knee pain without signs of trochlear dysplasia. The lateral femoral condyle index (LFCI) as a novel MRI measurement was developed to quantify femoral sphericity. In addition, previously known MRI risk factors associated with ACL injury were analyzed. Differences between groups were compared, cut-off values were defined and diagnostic performance of the risk factors was assessed. The risk factors were subsequently analyzed using multiple logistic regression.

Results: The LFCI was significantly smaller in the ACL re-ruptures (median, 0.67; range, 0.59–0.75) and in the primary ACL ruptures (0.67; range, 0.60–0.75) than in the control group (0.76; range, 0.6–0.81; $p < 0.01$). The LFCI yielded the highest AUC: 0.82 (0.7–0.9). A cut-off of 0.70 yielded a sensitivity of 78% and a specificity of 80% to predict an ACL rupture or re-rupture (OR, 13.79; 95% CI, 3.67–51.75). In combination with lateral tibial height (cut-off 3.8 mm) and lateral tibial slope (cut-off 2.9°), the diagnostic performance was improved. The AUC was 0.86 (95% CI, 0.75–0.94), with a sensitivity of 90% and a specificity of 70% (OR: 21.00; 95% CI: 5.10 to 85.80).

Conclusion: A decreased LFCI is associated with an ACL rupture and re-rupture. The lateral femoral condyle index, lateral tibial height and lateral tibial slope are the most predictive risk factors for an ACL injury. These findings might aid clinicians in identifying patients at risk for an ACL injury and inform the patient after reconstruction for a higher risk of re-rupture.

* FM131

The modified outside-in suture technique for large bucket handle meniscal tears. A prospective cohort study with detailed radiological and clinical outcome: 74 consecutive cases

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Introduction: Few large studies exist on bucket-handle meniscal tear (BHMT) repair. They focus on the classic all-inside and inside-out techniques and report failure rates between 10 and 30%. The modified outside-in suture (MOIS) technique was described more recently (Ahn JH, KSSTA, 2006). It uses a semi-lunar shaped hook to stitch the meniscus vertically and maintain more circumferential collagenous fibers. It could therefore offer a stronger way to stabilize the meniscus tear.

Purpose: To prospectively evaluate the radiological and clinical outcomes of the MOIS technique for BHMT on a large sample.

Method: Between 2015 and 2018, all patients presenting with complete vertical tear extending from the posterior to the middle or anterior one-third portion of the meniscus were eligible. Patients with a BHMT affecting the white/white zone or resulting in non-reducible fragments were excluded (n = 21). We did not exclude patients who received partial meniscectomy in the avascular zone before repairing the BHMT, nor did we exclude double BHMTs. The primary outcome was an assessment of meniscal healing at 6 months by CT arthrography (CTA) using Henning's criteria. CTA was replaced by arthroscopic evaluation (12%) when second surgery needed or by an MRI (9%) if the patient refused arthrography for personal convenience. KOOS and IKDC scores were collected as a secondary outcome at 6 and 12 months. Results: 74 consecutive BHMTs (73 knees) were included. Sex ratio 2.4, BMI 24.6±4.7 Kg/m², age 28.7±8.6 years. No loss of follow-up. Medial meniscus (73%) more frequently affected. Most cases (78%) were large BHMTs extending from the posterior to the anterior one-third, the remaining (22%) involving only the posterior two-thirds. Complete healing of the tear was achieved in 72%. The persistence of partial tear involving less than 50% of the thickness was observed 16%, always observed at the posterior horn, never required revision and resulted at one year in similar KOOS and IKDC scores than complete healed group. Failure of the suture was observed 12%. 40% were symptomatic required a revision either for one third a redo suture or a partial meniscectomy for two third.

Conclusion: The MOIS technique offers a promising approach to BHMTs. Failure rate was limited at 12% and revision for meniscectomy was required only for 4%. Persistence of a partial tear was observed at the posterior horn in almost one fifth of the sutures with no impact on clinical outcome at 1 year.

* FM132

Estimation of Femoral Projection on Plain AP Pelvis Views Using the Trochanteric Contour: A novel method to correct for underestimation of femoral offset

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Introduction: Accurate reconstruction of femoral offset is mandatory for a good functional outcome in THR. Templating on AP pelvic x-rays can be inaccurate as the femoral offset is often underestimated due to inadequate projection. We hypothesize that the double contour created by the postero-medial aspect of the greater trochanter is predictive for the angle between the femoral neck and the projection plane (i.e. film), and that the measured offset is adequate if the two contours are superimposed.

Our aims were (1) to correlate the width of the trochanteric double contour with the projection-related underestimation of the femoral offset. (2) To define a criterion based on the double contour to determine the suitability of a given x-ray for preoperative templating and to calculate a correction factor for the projected offset.

Patients and Methods: 86 skeletally mature patients (29 ♂, 34±16 years; 57 ♀ 31±16y) with plain pelvic AP-views and CT scans of the lower limbs performed for various reasons were included. On the x-rays, we measured the apparent femoral offset, apparent femoral head diameter and the width of the trochanteric double contour. The true femoral offset and true femoral head diameter were obtained from CT scans. The x-ray values were calibrated by comparing the femoral head size on the x-ray and in the CT scan. The femoral offset error (ratio of calibrated x-ray femoral offset to true femoral offset) was correlated with the width of the double contour.

Results: The average femoral offset was 45±5 mm and 40±4mm in males and females respectively, femoral antetorsion was 13±8° and 22±14°. The double contour width correlated with the projection related offset error (R = 0.55, p <0.0001) at femoral neck level, (R = 0.36, p <0.001) at piriformis fossa level. In the sub-group of patients with an antetorsion between 6° and 20°, these correlations were R = 0.77 and 0.73, p <0.01. Finally, all x-rays showing a double contour width at piriformis fossa level below 4 mm had a projection related error lower than 10%.

Conclusion: X-rays with a double contour width of less than 4mm may be considered adequate for templating (projection related error <10%). Additionally, the double contour width is useful for estimating femoral projection angle and hence for estimating true femoral offset. However, this method appears less reliable in patients with high (>20°) or low (<6°) femoral antetorsion.

FM133

Gait pattern in adolescents with recurrent patellar instability: The effect of trochleoplasty

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Background: The gait pattern of patients with patellar instability differs from a healthy extensor moments, as a sign of quadriceps avoidance.

Purpose: To investigate the influence of a trochleoplasty on the gait pattern of patients with patellar instability and compare the postoperative gait to a healthy control group.

Methods: A bilateral dislocation group (6 patients) and a unilateral dislocation group (14 patients) were treated with bilateral and unilateral trochleoplasty respectively. Kinematics/kinetics of the knee, ankle, and hip were captured using 3d-gait analysis (VICON, 12 cameras, 200Hz, Plug-in-Gait, two force plates). The mean of six trials was computed. The gait cycles were compared pre- to postoperatively for each group. The postoperative gait cycles of the two groups were compared to each other and the gait cycle of a healthy population (54 knees).

Results: The bilateral dislocation group postoperatively increased knee flexion angles and knee extensor moments during the whole stance phase, whereas knee flexion angles and knee extensor moments did not differ pre- to postoperatively in the unilateral dislocation group. Compared to the healthy population, postoperative knee flexion angles and knee extensor moments of the bilateral dislocation group did not differ to the control, whereas those of the unilateral dislocation group still were lower.

Conclusion: In adolescents with bilateral recurrent patellar dislocations, trochleoplasty of both knees increases knee flexion angles and knee extensor moments comparable to normal gait. In unilateral symptomatic patients, normal walking could not be achieved with a unilateral trochleoplasty.

FM134

Recurrent patellar dislocations: MPFL reconstruction provides better functional outcomes vs other medial soft tissue surgical techniques – A meta-analysis

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Introduction: After the recurrent lateral patellar dislocations, the laxity of medial patellofemoral soft tissue is addressed surgically. Treatments addressing medial soft tissues stretching and rupture without the use of a graft have been preferred by many surgeons due to the low invasiveness. However, some concerns about their effectiveness in preventing recurrences and providing a good functional outcome exist, and MPFL reconstruction was purposed as a necessary treatment. MPFL reconstruction provides good results in terms of recurrence and functional outcomes and, despite a minor risk of complications, is now advocated to be better than the less invasive medial patellofemoral soft tissue surgery in the treatment of LPD.

Methods: PubMed, Cochrane library, Web of Science, and grey literature databases were searched to find all the relevant records. Study selection, data extraction and risk of bias assessment processes, were performed following the Cochrane and PRISMA guidelines. Different techniques were compared in terms of redislocations and complications rates, Kujala, Lysholm, IKDC, and Tegner scores at the short-term (<3 years) and long-term (>3years) follow-ups through meta-analyses.

Results: Six studies involving 319 knees were included in the quantitative synthesis. The analyses of redislocations and complications rates showed no significant differences between treatments, whereas significant differences favoring MPFL reconstruction were documented in the Kujala and Lysholm scores at both short-term (8.6 p <0.001; 10.9 p <0.001) and long-term follow-ups (6.3 p = 0.02; 13.5 p <0.001). No significant differences were found in the analyses of the IKDC and Tegner scores (p >0.05). The level of evidence was very low for the redislocations and complications rates and low for the functional outcomes.

Conclusion: MPFL reconstruction and medial patellofemoral soft tissue surgery procedures were both effective in restoring the medial restraining forces preventing redislocation. Nonetheless, MPFL reconstruction provided better functional outcomes both at short-term and long-term follow-ups thus supporting MPFL reconstruction as the best treatment for recurrent patellar dislocation.

* FM135

High failure rate 10.8 years after Green's quadricepsplasty for recurrent dislocation of the patella

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Introduction: In adolescent patients with recurrent patellar dislocation, the Green's quadricepsplasty stabilizes the patella in a combination of a lateral release, a transfer of the medial head of the quadriceps onto the lateral part of the patella and an imbrication of the medial patellar retinaculum and joint capsule. This study aimed to evaluate the long-term performance, considering re-dislocations and functional outcomes. We hypothesized a high failure rate in the long-term.

Methods: 26 knees in 23 patients (mean age 14.2 years; 4-22 years, 18 females) with recurrent patellofemoral dislocation underwent Green's quadricepsplasty with a mean follow up 10.8 years (6-24 years). Clinical assessment was carried out with an IKDC-score and a self-assessment for each knee separately. The radiologic evaluation included measurement of the patella height, the grade of trochlear dysplasia and the sulcus angle.

Results: In 12 of 26 cases (46.2%) the patella did not re-dislocate after Green's quadricepsplasty. In 11 of 26 cases (42.3%), the patients described the function of their knees as normal or nearly normal according to IKDC after the surgical treatment without any re-dislocation. In 14 of 26 cases (53.8%), the patella re-dislocated. 7 of these 14 cases underwent a revision operation. Re-dislocations occurred after a mean interval of 21 months after the index procedure. In only 2 of 26 cases (7.7%) the patients returned to sports.

Conclusion: Green's procedure to stabilize patellofemoral instabilities results in a high failure rate on the long-term and low subjective assessments. We do not recommend performing this technique.

* FM136

Clinical and biomechanical evaluation of one stage treatment of a simultaneous ipsilateral patellar tendon and ACL tear combined with a tibial plateau fracture: a case study

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Introduction: Simultaneous ipsilateral patellar tendon (PT) and anterior cruciate ligament (ACL) tear is a rare injury. A systematic review in 2018 identified 28 cases in 17 published reports in the English literature. Associated meniscal and ligamentous injuries are common but frequently initially missed. In contrast, to date there is no report of associated fractures. Moreover, there are no established treatment algorithms: open and arthroscopic, and one or two stage approaches have been described.

Methods: We report on a 40-year-old female Caucasian patient presenting with a ski injury resulting in simultaneous ipsilateral patellar tendon and ACL tear combined with a tibia plateau fracture and a medial and lateral meniscus lesion. The diagnostic procedures included X-ray and CT. The ACL rupture and meniscal tears were only diagnosed intraoperatively. ORIF of the tibia as well as one-stage primary reconstruction of the PT and ACL and suturing of the menisci was conducted. The rehabilitation included a combined PT and ACL-reconstruction scheme.

FM138-FM151: INFECTIONS / TUMOURS

FM138

Open- versus closed-plan operating room design – a risk factor for surgical infections?

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Introduction: Surgical site infection (SSI) is a complication that can cause a significant burden for patients and the health care system. Identified risk factors are categorized to modifiable (e.g. smoking, etc) and

Results: The final follow-up was 2 years postoperatively: the IKDC Score was 89.7, the Lysholm Score 94, and the ROM 145-5-0°, the return to daily activities was uncomplicated. Lower extremity kinematic, kinetic and muscle activity data was collected. At 60°/s, knee flexor strength was 5.1% higher and knee extensor strength and work were 7.3% and 8.4% lower, respectively. The injured knee presented a 5.7° extension deficit during terminal stance and a 15.6° higher flexion throughout swing. These altered joint kinematics went along with large side to side difference in hip and knee joint moments during midstance and terminal stance. During weight acceptance, vastus medialis and hamstring muscles showed greater relative activity in the injured than the uninjured side.

Conclusion:

This case adds to the existing knowledge regarding the treatment of simultaneous PT and ACL rupture and emphasizes the need for extensive diagnostic procedures to capture and diagnose possible concomitant injuries. It demonstrates the possibility of excellent early and midterm results with a one stage approach and suitable rehabilitation scheme. Biomechanical measurements could further help evaluate the outcome of the treatments and implications for the development of potential secondary damage.

FM137

Patellofemoral instability in trochleodysplastic knee joints and the quantitative influence of bony, ligamentous and dynamic stabilizers- a finite element simulation

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Introduction: Patellofemoral instability is a disabling condition. Our current understanding of the quantitative influence of different anatomical variations (trochlear groove, tibial tuberosity-trochlear groove distance (TTTG), quadriceps force and the medial patellofemoral ligament (MPFL)) on patellar stability is currently limited. In the present study we developed a simulation pipeline for rapid finite-element- (FE)-simulation of the patellofemoral joint with patient specific geometries using preoperative MRI images.

Method: A uniformly meshed template geometry is morphed onto the patient specific pointcloud representing the borders of the respective volumetric segmentation. This allows the definition of one set of model constraints merely by changing patient specific geometric representation. In this model geometries can be deformed - for instance to simulate surgical deepening of the trochlear groove - and evaluated again in the same model. Forces were varied i.e. quadriceps force, vastus medialis force. Ligament influences were altered i.e. simulated MPFL tear as well as simulated MPFL reconstruction by different grafts (Gracilis, Semitendinosus). The insertion of the patellar ligament was moved to influence TTTG.

Results: Initial results indicate that the current modeling approach is feasible and sensitive to the manipulation of these surgical parameters. The force necessary to lateralize the patella by 10 mm was calculated in different flexion angles. Force values were increased after simulated MPFL reconstruction as well as increased by higher quadriceps force. Patellar tracking is altered by reduction of the TTTG.

Conclusion: Model based preoperative simulation of patient specific anatomy with simulated surgical alteration can provide quantitative understanding of patellar stability in a given individual, and may provide useful guidance for pre-operative planning

non-modifiable (e.g. demographic characteristics, etc). Although unknown so far, one modifiable potential risk factor could be the architecture of the operating rooms (ORs), namely all-open plan versus single room closed plan ORs. This was the research question of this observational cohort study.

Methods: Patients undergoing a broad spectrum of orthopedic surgeries in 2016 (all open-plan OR) and 2017 (closed-plan OR) were monitored in a university hospital setting. Surgeries performed in the transition phase from the open-plan to the closed-plan ORs were excluded to avoid bias. The primary outcome was early SSI within 30-90 days of surgery. Further, ASA (american society of anesthesiologists) classification and

body mass index (BMI) were monitored as surrogates for the most important interfering risk factors for SSI. A logistic regression analysis adjusted for potential confounders.

Results: Overall, the incidence of SSI was 0.6% (n = 45) in 7746 included surgical cases with a mean age of 52 [standard deviation (SD) 19] years and 3'838 (50%) females. There were similar incidences of SSI in the closed-plan OR (0.7% [n = 27]) and all-open-plan OR (0.5% [n = 18]) (odds ratio = 1.34 [95% confidence interval] 0.72 - 2.49, p = 0.351; adjusting for age, gender, ASA classification, and BMI). Age and gender were not identified as risk factors for SSI. However, the risk of SSI increased significantly by 92% with each increase in one ASA category (odds ratio = 1.92 [95% CI 1.16 - 3.18], p = 0.011) and increased borderline significantly by 5% with each increase in one kg/m² BMI (odds ratio = 1.05 [95% CI 1.00–1.11], p = 0.053).

Conclusion: The overall incidence of early infections (0.6%) after a broad spectrum of orthopaedic surgeries was independent of whether surgeries were performed in an all-open-plan or single room closed-plan OR setting. Increase of ASA category and possibly BMI, however, were identified as independent risk factors for SSI.

FM139

Treatment of prosthetic-joint infections: the role of the surgeon

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Introduction: There is a constant increase of total joint arthroplasties to improve the quality of life of an aging population. Prosthetic-joint infections are rare, with an incidence of 1-2%, but they represent serious complications in terms of morbidity and mortality. Different therapeutic options exist, but the role of the surgeon's experience has never been investigated. The aim of this retrospective study is to assess the infection eradication success rate depending on the involvement of a septic surgeon.

Methods: Patients having a prosthetic-joint infection at Lausanne University Hospital (Switzerland) between 2006 and 2018 were included. The success rate depending on type of surgeon (septic vs non-septic) and type of surgical procedure was analyzed.

Results: 444 patients (61% hips, 37% knees) were identified with a median age of 70 years. The overall success rate was 83% for septic surgeons compared to 61% for non-septic surgeons (p < 0.05). The effect of the surgeon was predominant in debridement with retention of the prosthesis where the experience could improve the success rate from 43% (non-septic) to 75% (septic) (p < 0.05).

Conclusion: The involvement of a septic surgeon is associated with a significantly higher success rate, suggesting surgical experience is an important factor in treating prosthetic-joint infections.

FM140

Long-term Implant Stability after Prosthetic Joint Infection Successfully Treated with Debridement and Retention: A Case-Control Study.

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Introduction: Periprosthetic joint infection (PJI) is a serious complication of arthroplasty surgery. Curative surgical strategy preserving a functional joint includes debridement and implant retention (DAIR), provided that published criteria are fulfilled. The aim of the present study was to compare long-term total hip arthroplasty (THA) survival results of DAIR-treated patients with THAs not treated with DAIR.

Methods: The study design was a 1:3 matched case-control study. Patients were identified from our prospectively THA database (1984-2016). The denominator was a THA for all variables, except for patient characteristics. Cases were defined as retained THAs after DAIR for PJIs, controls defined as THAs without DAIR procedure. Groups were matched for the age at the time-point of surgery (<55 y, 55-65 y, 65-75 y, >75 y), sex, type of surgery (primary implantation or revision) and the stem type. Follow-up examinations were scheduled at 4 months, 1 y, 2 y and 5 y, and all 5 y thereafter. At each follow-up, an AP pelvic view radiograph and a false-profile view was obtained. All radiographs were analysed in a randomized fashion, and blinded to whether image derived from a case or a control. Loosening was defined as circumferential osteolysis/debonding in every Gruen zone and/or subsidence of >5 mm and/or fracture of the cement mantle.

Results: 57 cases and 171 controls were included in the study. One of the control patients was lost to follow-up. The mean follow-up in cases and controls were 6.8 (SD 5.7) y and 7.7 (SD 5.5) y, and 7.6 (SD 6.0) y and 8.0 (SD 5.5) y, respectively, in alive patients. DAIR was successful in 93%. The proportion of THAs revised due to aseptic loosening was 7% in cases and 3.5% in controls (p = 0.27). There was no significant difference in the cumulative incidence for death (adjusted for stem revision). After 10 y, stem revision for any reason was 17.4% (SD 7.1%) in cases and 5.6% (SD 2.2%) in controls. Stem revision for aseptic loosening was 10% (SD 6.1%) and 4.6% (SD 2.1%), respectively. 225 of 228 hips were eligible for radiological analysis. Four (7.1%) cases and 8 (4.7%) controls were radiologically loose (p = 0.49), 3 and 4 of them, respectively, were revised during follow-up.

Conclusion: Long-term results after DAIR procedure revealed stable implant results in our cohort. Comparisons with controls demonstrated a non-significant mean difference of 5.4% revisions for aseptic loosening in DAIR cases.

* FM141

Is there a benefit for systematic cerclage wire exchange after extended trochanteric osteotomy in the setting of a two-stage procedure for periprosthetic joint infection? A prospective case-series.

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Introduction: Periprosthetic joint infection is one of the most feared complication in joint arthroplasty. When performing a two-stage revision, removal of a well-fixed stem can necessitate an extended trochanteric osteotomy (ETO). The ETO is classically closed with multiple metallic cables or wires before inserting an antibiotic loaded spacer. During the second operation the spacer is removed and repeated extensive debridement is performed. As the metallic wires are considered to be potentially contaminated they should be exchanged. Their systemic exchange however leads to an extended operative time, larger surgical approach as well as increased risk of neurological and vascular lesions. The aim of this study is to evaluate the risk and benefit of cerclage wire exchange in the setting of a two-stage procedure.

Method: We prospectively included all patients treated at our institution with a two-stage procedure for PJI of the hip and in which an ETO was necessary. During the second stage, we systematically exchanged the most proximal cerclage wire, which was sent for separate sonication and microbiology. Standard microbiological work up with at least three tissue biopsies, sonication of the spacer and perioperative complication were recorded.

Results: We included ten patients (4 female) with a mean age of 67 years (range 43-80). Microbiology came back positive for one wire (10%), the germ was nonetheless different from that of the primary infection. For all other patients, wires as well as standard microbiology work up came back negative. We did not encounter any specific complication during cerclage wire exchange.

Conclusion: Our results do not support the benefit of systematic wire exchange at the time of stem reimplantation. The reported rate of infection after revision arthroplasty is reported around 8% and can partly be explained by the extended operative time. A higher case load is needed to further confirm these results.

FM142

Limb-Preserving Treatment Concept of Acute and Chronic Infection of Tumor Mega-Prostheses with debridement, retaining of components, and local high-dose antibiotic therapy: A Case Serie of five Patients.

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LUKS Luzern

Background: A prosthetic infection represents a devastating complication. Tumor prostheses can usually not be easily removed without endangering the limb. A prosthetic preservation approach may be chosen despite an increased risk of infection recurrence

Questions/Purposes: The aim of this case series is to document a prosthesis-preserving approach by using locally high-dose as well as systemic antibiotic therapy.

Methods: Five patients with a tumor prosthesis infection between May 2017 and October 2018 are included in our case series. Three of them suffered an acute and two a chronic infection (2 elbow; 3 knees with 1° implantation between 1985 and 2009). All patients showed clinical signs

of infection locally, three had a consecutive systemic inflammation response. In all cases, a thorough debridement of the infected tissue with microbiological sampling was performed. In three cases the modular parts of the prosthesis were changed. The inlay was changed in all these cases. In addition, once the femoral and once the femoral and the tibial prosthesis components were changed. The implanted stems could be preserved in all cases. Three patients needed a second look. In four cases we applied also a high dosed local antibiotic therapy. All patients were initially treated empirically with antibiotics. After receiving the microbiological samples, a specific antibiotic therapy for at least 3 months was established. We performed a close aftercare to monitor wound healing.

Results: The average follow-up was performed over 7 months after the last Operation (range: 3 to 12 month). Bacterial growth was detected in all intraoperatively assimilated samples. Three patients show an unproblematic healing, even after discontinuing antibiotic therapy. Another patient is free of infection after 5 months with continued therapy. The fifth patient has re-developed secretion after 11 weeks and suppressive therapy was initiated to render the wound dry.

Conclusions: A prosthesis-preserving approach with locally high-dose as well as systemic antibiotic therapy shows good short-term results in this small case series, with retaining of the prosthetic components. However, larger, controlled and randomized trials are needed to assess the long-term success rates.

Level of Evidence: Level IV

* FM143

Long-term survival at 5 years after above the knee amputation due to vascular insufficiency: Predictors for mortality

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Introduction: Due to an ever aging population and the increasing prevalence of diabetes and vascular insufficiency the number of lower limb amputations is increasing. The aim of this retrospective study is to evaluate the survival rate of Gritti-Stokes and mid-thigh amputations with a minimum 5 years follow-up and to identify factors that may influence it.

Patients and methods: From September 2007 to December 31, 2013, 100 patients were treated with an above knee amputation with a mean age of 69.9 years. Indication for surgery was necrosis in 87% of cases with 47 patients suffering on the right side, 52 on the left and 1 bilateral. We analysed different factors with a potential impact on long-term survival: sex (62 men), amputation type (60 Gritti-Stokes and 40 mid-thigh), presence of in-hospital complications (22 patients), cardiac history (40 patients), arterial hypertension (71 patients), smokers (41 patients), insulin-dependent type II diabetes (27 patients), chronic renal failure (29 patients), level of dependence (EMS / Home), professional activity (74 retired patients) and the presence of a prosthesis after the amputation (42 patients).

Results: 77 patients died during the follow-up period, 22 survived and 1 was lost. The survival rate is 75% at one year and just less than 50% at 3 years. An association or trend in survival rate was found with the following factors: amputation level ($p = 0.06$), cardiac history ($p = 0.09$), high blood pressure ($p = 0.02$), type II diabetes ($p = 0.002$), chronic renal failure ($p = 0.12$), level of dependence (EMS / Home) ($p = 0.001$), professional activity ($p = 0.002$) and the postoperative equipment ($p = 0.003$). No associations for gender ($p = 0.51$), smokers ($p = 0.19$) and in-hospital complications ($p = 0.40$) were found with the survival rate.

Conclusions: Above knee amputation is an intervention associated with a high mortality rate. Amputation according to Gritti-Stokes shows better results than higher femoral amputations. The interest of this study is also to be able to inform patients and their family objectively of the long-term mortality after a major amputation of lower limb. Medical care in specialized centers is essential for proper follow-up and adequate stump care and prosthesis training increasing thus the hope for a return to home as quickly as possible.

FM144

First-in-human implantation of a new prosthesis for trans-femoral amputated patients.

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Introduction Patients with trans-femoral amputations use lower limb prosthesis whose attachment is realized by a stump-fitting socket to

which the artificial limb is fixed. However, the performance of this fixation method is often reported as unsatisfactory. Some patients have complained about the restricted hip motion, pain, soft tissue irritation and break down, as well as the lack of appropriate control of the prosthetic limb. An alternative solution for trans-femoral amputated patient is attaching the artificial limb directly to the femur via a percutaneous implant with a risk of infections and implant loosening. To overcome this issue a new concept of device that combines the advantages of the trans-femoral fixation and the through-knee amputation was created and implanted.

Methods The new implant is composed by an intramedullary nail with a terminal base plate allowing weight-bearing with a more physiological pressure distribution and better prosthesis fixation and control. This phase-I study will evaluate the results of the implantation this innovative device in 5 previously trans-femoral amputated patients. This will be carried out by evaluating the clinical, radiological and ergonomic outcome and health-related quality of life. Moreover safety will be monitored with a follow-up of 2 years.

Results The first patient has been successfully treated without peri-operative complications during a 107-minute long surgery with a multi-disciplinary approach. After 3 months, the results are promising with an improvement of all the clinical scores, a good integration of the implant, and a significant increase of patient's quality of life. This was achieved without adverse events or safety concerns. A second patient has been enrolled and will be treated in March.

Conclusion The first-in-human implantation of the new device showed interesting results in terms of functional outcome and patients satisfaction, without safety concerns after 3 months from surgery. This innovative implant could represent an affordable solution for the orthopaedic surgeon in order to improve the quality of life of trans-femoral amputated patients.

FM145

Distribution patterns of foot and ankle tumors

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Introduction: Bone and soft tissue masses of the foot and ankle are not particularly rare but true neoplasia has to be strictly differentiated from pseudotumorous lesions. Diagnosis is often delayed as diagnostic errors are more common than in other regions. Awareness for this localization of musculoskeletal tumors is not very high and neoplasia is often not considered. The purpose of this study is to provide detailed information on the incidence and distribution patterns of foot and ankle tumors of a university tumor institute and propose a simple definition to facilitate comparison of future investigations.

Methods: As part of a retrospective, single-centre study, the data of patients that were treated for foot and ankle tumors between June 1997 and December 2015 in a musculoskeletal tumor centre were analyzed regarding epidemiologic information, entity and localization. Included were all cases with a true tumor of the foot and ankle. Exclusion criteria were incomplete information on the patient or entity (e.g. histopathological diagnosis) and all pseudotumorous lesions.

Results: Out of 7487 musculoskeletal tumors, 413 cases (5,52%) of tumors of the foot and ankle in 409 patients were included (215 male and 198 female patients). The average age of the affected patients was $36 \pm 18y$ (min.3y, max.92y). Two hundred sixty-six tumors involved the bone (64%), among them 231 (87%) benign and 35 (13%) malignant. There were 147 soft tissue tumors (36%), 104 (71%) were benign, 43 (29%) malignant. The most common benign osseous tumor lesions included simple bone cysts, enchondroma and osteochondroma. By far the most common malignant bone tumor was chondrosarcoma. Common benign soft tissue tumors included pigmented villonodular synovitis, superficial fibromatosis and schwannoma whereas the most common malignant members were synovial sarcoma and myxofibrosarcoma. Regarding anatomical localization, the hindfoot was affected most often.

Conclusions: Knowledge of incidence and distribution patterns of foot and ankle tumors will help to correctly assess unclear masses and initiate the right steps in further diagnostics and treatment. Unawareness can lead to delayed diagnosis and inadequate treatment with serious consequences for the affected patient.

FM146

Rotation plasty for failed tumor reconstruction with megaprosthesis or allograftDr. Kourosh Modaresi¹; Dr. Charles-Edouard Dumont; Prof. Dr. Ulrich Exner¹ Orthopädische Chirurgie Zürich, Klinik Pyramide am See

Introduction: Rotation plasty, initially described in 1930 (1), is a salvage procedure for large segmental defects of the leg when foot/ankle function is preserved to replace function of the knee and allow for terminal weight bearing. The procedure is generally well accepted and superior to amputation. Few reports have been published about conversion of failed „megaprotheses“ or allograft after tumor resection due to infection or loosening

Methods: 6 patients have been treated with conversion of failed reconstructions (4 due to infection, 2 to loosening) to rotation plasty at ages 16 to 51 years, 2 to 14 years after the initial reconstruction. f/u after conversion to rotation plasty is 1 to 16 years.

Types of rotation plasty: Foot to femur 1, foot to proximal tibia 1, tibia to femur 4.

Results: 1 patient died of systemic disease 2 years after rotation plasty. 1 patient needed revision for pseudarthrosis. At present the five patients surviving have excellent function being highly satisfied after poor experience with the failed reconstructions.

Discussion/Conclusion Rotation plasty as salvage of failed primary tumor reconstruction should be considered in rare cases, also in those with large bone defect, but intact vessels/nerves. Although the outcome is visually unusual it has advantages, making it a therapeutic alternative to potential above-knee amputation. (2)

(1) Borggreve J., Die Rotationsplastik nach Borggreve; Unfall Chir (1930) 28:175–178.

(2) Canavese F et al, Rotationplasty as a salvage of failed primary limb reconstruction: up to date review and case report. J Pediatr Orthop B. 2014 May;23 (3):247-53.

FM147

Radiation dose deviations by titanium versus CF/PEEK implants in long bonesDr. Christoph Laux¹; Dr. Christina Villefort¹; Stefanie Ehrbar²; Dr. Lotte Wilke²; Prof. Dr. Matthias Guckenberger²; Dr. Daniel Andreas Müller¹¹ Universitätsklinik Balgrist; ² UniversitätsSpital Zürich

Introduction: Metallic implants show dose modulating effects in radiotherapy and complicate its CT-based planning. During radiation therapy, dose deviations induced by metallic implants 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 and the diagnosis of local recurrences is doubtful. This experimental study investigates the dosimetric impact of titanium and radiolucent carbon fibre/polyether ether ketone (CF/PEEK) implants during planning and administration of adjuvant radiation therapy in long bones.

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 %). This effect, however, was even greater at the implant-bone interface and diminished in the bone core. The radiation dose was not significantly affected by the amount of surrounding soft tissues. A significant imaging artefact reduction with improved planning feasibility 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 the radiation dose to an osseous target volume. In radiotherapy, the use of CF/PEEK implants appears to be particularly beneficial for intramedullary nails.

FM148

Assessment of articular degeneration after subchondral cementation and joint preservation of giant cell tumors at the kneeCyrill Wechsler¹; Dr. Sandro Hodel¹; Dr. Christoph Laux¹; Christoph Stern²; PD Dr. Andrea Roskopf¹; Dr. Daniel Andreas Müller¹¹ Balgrist; ² Universitätsklinik Balgrist

Purpose: To quantify degeneration and clinical outcome after curettage and cementation in subchondral localization of giant cell tumor (GCT) at the knee.

Methods: Retrospective analysis of 14 patients (7 male, 7 female) who underwent subchondral curettage and cementation for a biopsy-proven GCT at the knee between 08/2002 and 08/2017 with a mean age of 33 years (range: 18 to 51) and a mean follow-up of 44.4 months (range 8.5 to 132 months). Whole-Organ Magnetic Resonance Imaging Score (WORMS), Kellgren-Lawrence (KL) and Musculoskeletal Tumor Society Score (MSTS) were assessed.

Results: Radiological degeneration progressed from preoperative to the latest follow-up: WORMS from 4 to 7 (p = 0.21) and KL remained 0 (p = 0.18) but yielded no significance. Progressive degeneration (WORMS) was associated with proximity to the articular cartilage (mean 1.2 mm; range 0 to 12mm) (p = 0.03) but not with tumor volume (mean 62.4 cm³; range 17 to 122) (p = 0.10). Most common degenerative findings were cartilage lesions (n = 11), synovitis (n = 5) and osteophytes (n = 4). Mean MSTS score increased from 23.0 (preoperative) to 28 at latest follow-up (p < 0.01).

7 local recurrences were treated with 6 revision surgeries. Cement spacer removal and defect filling with cancellous autograft was performed in 7 patients. Conversion to a total knee arthroplasty was performed in one patient for local tumor control.

Conclusions: Cementation of GCT is associated with slight degeneration at medium-term follow-up, especially in direct proximity to the articular cartilage of the knee. This helps the treating surgeon in decision-making for joint preservation surgery in this young cohort. Removal of the cement and autograft reconstruction may be beneficial in the long-term.

FM149

Myxoid liposarcoma – single institution results of 15 patientsProf. Dr. G. Ulrich Exner¹; Dr. Alexander Metzdorf²; Dr. Helmut Kranzbühler³; PD Dr. Michael O. Kurrer⁴¹ Orthopädie Zentrum Zürich; ² Ospedale Italiano Moncucco; ³ Radioonkologie Stadtspital Triemli; ⁴ Gemeinschaftspraxis für Pathologie

Introduction: Myxoid liposarcoma (MLS) is a malignant tumour composed of primitive non-lipogenic cells and small signet-ring cell lipoblasts in a prominent myxoid stroma. Metastatic disease is typically extrapulmonary 1. With 28 Gy low dose radiotherapy only one local recurrence in 23 patients occurred with disease free survival of 71% 2.

Methods: 15 patients were treated 2008 - 17 with tumor volumes 90 to 630cc. All patients had neo-adjuvant 50Gy or adjuvant 64Gy radiotherapy.

Results: One patient presented metastases at 9 months (multiple soft tissue and bone lesions); he died 3 y later without recurrence at the primary site. Another patient presented lung metastases at 8 months after resection of the primary tumor which were resected 10 months later together with a new lesion in the same leg distant to the primary site (possibly being a metastasis rather than local recurrence). A third patient developed a second solitary MLS of the opposite leg 4 years after initial treatment. All other patients are diseasefree at minimum f/u of 2 years. Discussion In a series of 33 patients 1 with similar f/u 9 patients (27%) developed metastases, 7 of them within less than 13 months after diagnosis. All metastases were first extrapulmonary and only 2 showed pulmonary metastases later on; It was suggested to use total body MRI instead of CT for surveillance. Local recurrence was not observed; however 11 had contaminated margins at initial 'whoops' surgery. This could be an explanation for the higher metastasis rate than in our series of patients.

Conclusions: Because of the short interval until development of 'soft tissue metastases' the question has to be raised, whether they indeed are metastases or de novo multilocular new tumors. For surveillance total body MRI might be superior to CT; however the consequences still have to be established. Lowering the radiation dose may be an aspect to be considered. The interval for the development of metastases is important for the surveillance strategy. 3. Gorelik et al. Early detection of metastases

ses using whole-body MRI for initial staging and routine follow-up of myxoid liposarcoma. *Skeletal Radiology* published online Dec 23, 2017. Salduz et al. Neoadjuvant radiotherapy for myxoid liposarcomas: Oncologic outcomes and histopathologic correlations. *Acta Orthopaedica et Traumatologica Turcica* 2017 (51):355-3613. Ezuddin et al. Local recurrence of soft-tissue sarcoma: issues in imaging surveillance strategy. *Skeletal Radiol* 2018 (47):1641-165

FM150

Mid- to longterm results in extracorporeal irradiation and reimplantation of tibial, sarcoma-bearing bone segments following resection

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Introduction: Diaphyseal tibial sarcomas are rare and commonly treated with a wide resection combined with endoprostheses, allografts with or without vascularised fibulae, segmental transport, or with the induced membrane technique. Reconstruction with extracorporeal irradiated autograft at this site is a rarely applied technique and will be analysed in this study.

Methods: Eight patients with primary malignant sarcomas received local treatment by means of a wide resection and reimplantation of an extracorporeally irradiated autograft. The median age at the time of diagnosis was 23 years. The extracorporeally irradiated graft was combined with an ipsilateral vascularised fibula when a full thickness segment of the tibia had to be resected and no cortex could be preserved (n = 5). Oncological as well as functional results such as the Musculoskeletal Tumor Society score were recorded. The median clinical and radiological follow-up was 72 months.

Results: All patients had clear margins after wide resection, and were free of disease without evidence for local recurrence at the time of the last follow up. Full weight-bearing was allowed at the time of radiological consolidation of the irradiated grafts, which was achieved after a median of 5 months. The functional results were good and excellent in 7 of 8 patients. There were postoperative complications in 3 patients.

Conclusion: We conclude that ECI grafting, also in combination with vascularised ipsilateral fibulae, is a suitable method for the treatment of localised and resectable tibial sarcomas.

P001–P120: POSTERS

P001

EBV associated Leiomyosarcoma in an immunosuppressed patient at an atypical location – a rare case report

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Soft tissue sarcomas are very rare tumors representing less than 1% of all forms of cancers. Leiomyosarcomas are a rare subgroup and constitute about 6% of soft tissue sarcomas. We present the case of a 66-year-old female with a painful tumor in the distal left humerus. The patient was immunosuppressed due to chronic renal transplant failure. After the radiological diagnostic work-up was completed (X-ray, CT, MRI), histopathological biopsy results showed a leiomyosarcoma associated with Epstein Barr Virus (EBV). A total “en-bloc” resection of the tumor and internal, double plate fixation of the shortened distal humerus was performed. Postoperatively adjuvant radiotherapy was applied. The postoperative course was uneventful. No recurrence was found over a 2-year follow-up period. Range of motion (ROM) was regained with 110/20/0° of flexion/extension and full pro-/supination. This case highlights the necessity for awareness of cancer development in immunosuppressed patients and adds valuable knowledge to the sparse available literature on the treatment of upper extremity leiomyosarcomas.

Key words: Leiomyosarcoma; immunosuppression; Epstein barr virus; EBV

P002

The role of anchor and suture removal in rotator cuffs infections

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FM151

Biopsy or no biopsy? – MRI-based decision support to discriminate subfascial lipoma from well-differentiated liposarcoma

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Introduction: Imaging is insufficient for certain differentiation between lipoma and well-differentiated liposarcoma (WDL). Many lesions remain indeterminate and patients are referred to biopsy. Aim of this study was to provide MRI based quantitative decision support when to biopsy initially indeterminate subfascial lipomatous tumours.

Methods: MRI of 26 histopathologically proven subfascial well-differentiated liposarcomas (WDLs) and 68 lipomas were retrospectively reviewed. Exclusion criteria were mass-like non-lipomatous soft tissue components, suprafascial and intraabdominal location. Ratios derived from region of interest based signal intensity (SI) measurements of tumour and adjacent fat on inversion recovery fat saturated (STIR) images were calculated (= mean SI tumour/mean SI adjacent-fat).

Univariate regression analyses were applied and a p-value <0.01 deemed significant. The discriminatory ability was assessed by ROC curve analyses. Interreader agreement was evaluated by calculation of intraclass correlation coefficients (ICC). Tumour size, location, septation and patient demographics were noted.

Results: STIR-SI ratios performed well discriminating lipoma from WDL (p <0.001, AUC = 0.88, cut-off = 1.18, 92% specificity, 74% sensitivity). Interreader agreement was excellent (ICC = 0.93). ALT/WDLs were significantly larger than lipomas (p <0.001, AUC = 0.86, cut-off = 11 cm, 92% specificity, 69% sensitivity). Combination of a STIR-SI ratio <1.4 and size <11 cm as decision support would have spared 65% of Lipoma patients from biopsy or excision with histopathological workup (combined specificity = 100%, sensitivity = 65%). Qualitative imaging parameters and patient demographics did not differ significantly (each p >0.053).

Conclusion: The combination of STIR-SI ratio and maximum diameter allows the discrimination between lipoma and WDL, potentially reducing the number of invasive diagnostics in initially indeterminate lipomatous lesions.

Introduction: To investigate the benefit of surgical implant (anchor and/or suture) removal and prolonged antibiotic therapy in acute and chronic infections of rotator cuff repair.

Methods: Single-centre cohort and case-control study (Cox regression) with emphasis on the role of surgical anchor and suture removal in infected rotator cuff repairs (RCI). Outcome variables are remission of infection and post-infectious re-operations due to failed tendon healing (mechanical sequels). Minimal active follow-up was six months.

Results: We identified 53 RCIs (18 early infections; 35 chronic; 43 males; median age 54 years; 5 diabetic patients) which were surgically treated. Twenty-six repairs (49%) were intact upon revision surgery (debridement); 9 partially and 18 totally re-ruptured. Total anchor removal was performed in 11 cases, and total suture removal in 25 cases. The median number of surgical revisions was 1 (range, 1-3 procedures) and the median duration of post-surgical antibiotic therapy 75 days. During a median active follow-up of two years, eight infections (8/53; 15%) clinically recurred. Among 38 patients with persistent pain, 26 (26/38; 68%) needed a revision surgery not related to persistent infection. By multivariate analysis, anchor removal neither influenced remission (hazard ratio [HR] 0.9, 95%CI 0.4-2.1), nor the need for revision surgery due to mechanical sequels (HR 0.6, 0.2-1.8). The corresponding results for suture removal were HR 1.3, 0.7-2.5 and HR 0.7, 0.3-1.7, respectively. Likewise, the numbers of revision surgery (HR 1.3, 0.7-2.5) and antibiotics beyond six weeks failed to influence remission (HR 0.8, 0.3-2.4).

Conclusion: In our RCI cohort, the removal of anchors or sutures, repeated revision surgery or an antibiotic therapy beyond six weeks, failed to improve remission or to reduce sequels.

P003

Does the osseous configuration of the shoulder joint predispose to shoulder instability?

Dr. Kerstin Büttler; PD Dr. Arno Frigg; Dr. Holger Grehn

Introduction: The stability of the shoulder depends on three factors: the bony morphology, the glenohumeral ligaments and the muscular balance. The influence of the osseous configuration on the shoulder stability has been controversially discussed in literature. Different measuring methods were used to measure parameters of the glenoid and the humeral head. The aim of this study was to investigate if there is a correlation between the bony configuration of the shoulder joint and shoulder instability, using a 3D-viewer and therefore being able to adjust the axis of the MR images to the measuring axis.

Methods: 31 patients with a shoulder dislocation were included and 37 patients without a shoulder dislocation. MR images were conducted of the shoulder and the elbow without moving the patient. Glenoid version, inclination of the glenoid, anterior-posterior and superior-inferior diameter of the glenoid, concavity of the glenoid, humeral torsion, anterior-posterior, medio-lateral and superior-inferior diameter of the humeral head, acromionindex as well as the index "lower" glenoid ap/Humerus ap were measured using 3D reconstruction.

Results: Among the 37 patients with a shoulder dislocation, 87.1% had an anterior shoulder dislocation. The statistical analysis of the patients with anterior instability with the control group showed a statistically significant difference in the index "lower" glenoid ap/Humerus ap. Patients with anterior instability had an index of 0.58, the control group 0.60 ($p = 0.04$). No statistically significant difference was found concerning the diameter of the humeral head or the glenoid, the inclination of the glenoid, the concavity of the glenoid or the acromion index, neither regarding all types of instability together, nor regarding only the anterior instability.

Conclusion: The static osseous stabilizers of the shoulder alone are less relevant for the shoulder stability as expected. The shoulder joint is a muscular guided and stabilized joint. Thus, divergent static glenohumeral structures can be compensated and stabilized dynamically. Only the index of the anterior-posterior glenoid diameter "lower" to the anterior-posterior diameter of the humeral head was found to be statistically different in our study. In our opinion, it is important for future studies to determine the proportion of the glenoid to the humeral head in an index, because the proportion of the glenoid to the humeral head is crucial for the static stability of the shoulder.

P004

The use of a partially resorbable mesh to augment the insertion site of a functional muscle flap in reconstruction of active elbow flexion

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Introduction: Extensive soft tissue trauma often requires reconstruction with a muscle flap. When active elbow flexion is lost due to traumatic destruction of elbow flexors, a functional latissimus dorsi flap is an established method to restore elbow function. However, when attaching the distal end of the muscle flap there is a risk of insufficient fixation at the insertion site due to the weak properties of the muscle tissue. We present a method to strengthen the insertion site of the flap by using a partially resorbable mesh (Vypro®).

Material and methods: We report on a patient who sustained an open subluxation of the elbow joint with a large soft tissue defect Gustilo-Anderson grade IIIa with complete loss of active elbow flexion. To restore active range of motion we performed a functional latissimus dorsi transfer. The distal end of the flap was attached to the radial tuberosity with bone anchors. To augment the insertion site and increase the pull-out strength of the sutures on the distal end of the flap we attached a circumferential Vypro® mesh.

Results: The patient achieved excellent results for strength of elbow flexion and range of motion with mesh stabilization of the distal insertion. No adverse effects of the mesh occurred.

Conclusion: When a strong attachment of a muscle flap to tendon or bone is needed in functional restoration, mesh augmentation might be a viable option.

P005

Does an abduction brace carry weight of the arm after supraspinatus repair?

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Introduction: Abduction braces are used with the intention to relieve tension on the supraspinatus thereby protecting an operative repair. It is not known, however, whether patients wearing a brace do deposit the weight of the arm on the brace effectively or actively stabilize the arm despite the brace. It is further unknown what position of the arm is most effective to relax the shoulder and considered most comfortable.

Methods: Twenty-two patients who had undergone an arthroscopic supraspinatus repair were postoperatively fitted with a standard abduction brace, equipped with a torque sensor to indirectly measure the weight of the arm on the brace on the first and second post-operative day. Most comfortable arm position, tear size and degenerative muscular changes using MRI were assessed.

Results: Most patients (15vs.5) preferred a low angle of abduction with the brace in the scapular rather than the true frontal plane irrespective of tear location or size. While loads applied to the brace were slightly higher at high abduction angles (70° and 90°) under regional anesthesia (day1), they were significantly higher at low abduction angles (30° and 50°) with the arm fully awake (day2).

Conclusion: The most comfortable brace position - which is at low angles of abduction (30-50 degrees) in the scapular plane - is associated with the highest load transfer to the brace in the unanesthetized arm. We therefore conclude that if an abduction brace is used, it should be fitted in the scapular plane with an abduction angle between 30 and 50 degrees.

P006

Outcome after long locking plate osteosynthesis of complex humeral shaft fractures.

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Introduction: Humeral shaft fractures account for up to 5% of all fractures, but complex form of those fractures (type AO B or higher) are relatively rare. Recent trend towards a minimally invasive plate osteosynthesis (MIPO) potentially offers the same union rate as open reduction and internal fixation (ORIF) but less complications. The aim of our study is to show that, according to our experience, the treatment of complex humeral fractures via open reduction and internal fixation with a long pre-contoured plate (long PHILOS) is a viable option with low morbidity of the open approach, few complications, high union rate and good clinical outcome.

Methods: We performed a retrospective study of complex humeral shaft fractures treated in our institution between June/2011 and December/2017. We could identify and include 27 consecutive patients treated with a long PHILOS plate (7 male, 20 female; average age: 65 years) that had complete records to at least 1 year follow-up. Complications and fracture healing were evaluated, as well as clinical outcome and quality of life (DASH score and EQ-5) at last follow-up.

Results: Average postoperative follow-up was 20.5 (SD ± 11) months. Radiological examination could positively confirm fracture healing on average at 12.7 (SD ± 3) months. Average DASH score was 35 (SD ± 15.83). The EQ-5 Mobility score was 1.58 (SD ± 0.81), EQ-5 Self-Care 1.23 (SD ± 0.59), and EQ-5 VAS 86 (SD ± 9.17). Complications included one secondary fracture dislocation, two postoperative radial nerve palsies, and two implant failures (18.5%).

Conclusion: ORIF with long PHILOS plate is a safe and effective option for the treatment of complex humeral shaft fractures, offering good functional recovery and low complication rate. Compared to closed operative treatment options (MIPO, nailing) ORIF and long PHILOS plate had no increased morbidity attributed to relatively long open surgical approach. In our series, radial nerve palsy could not be completely avoided, which accentuates the importance of precise surgical technique.

P007

Inter-Epicondylar Distance and Radial Head Diameter as indirect Markers for Length Adjustment in distal Biceps Tendon Allo-/Autograft Reconstruction

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Introduction: Early musculotendinous retraction, shortening and fibrosis after distal biceps tendon tears makes a primary reconstruction often difficult or even impossible. Interposition by an allograft seems to be a good solution, however there is no consensus how to adjust the correct tendon length intraoperatively. The aim of this study was to find a reference value for intraoperative tendon length adjustment.

Methods: Three-dimensional surface models of healthy distal biceps tendons were created based on 85 MRI scans. The tendon length was measured as the external tendon part from the point of muscle fibre termination to the insertion on the bicipital tuberosity. Inter-epicondylar distance (IED) and radial head diameter (RHD) was calculated on antero-posterior radiographs. Correlations were done between the calculated tendon length and IED, RHD and patient's height (PH).

Results: Mean length of the external part of the distal biceps tendon was 69mm (female 64mm, male 71mm). The tendon length was on average 1.1 times of the IED, 3 times of the RHD and 0.4 times of PH (in cm). Herewith, the tendon length could be predicted within +/-0.5cm/1cm deviation in 49%/84% by IED, 55%/82% by RHD, 47%/80 by PH and 45%/82% by mean tendon length. Intra- and inter-reader reliability of IED and RHD was excellent ($R^2 = 0.938-0.981$).

Conclusions: The distal biceps tendon length can be predicted within 1cm with an accuracy of up to 84% by IED with an excellent intra- and inter-reader reliability. IED could be a helpful reference value for intra-operative tendon length adjustment in distal biceps allograft surgery.

P008

Innervation of the acromioclavicular joint by the suprascapular nerve

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Introduction: The suprascapular nerve is largely responsible for the majority of the sensory innervation of the acromioclavicular joint (ACJ). In this anatomical study we describe, in detail, the anatomy of the sensory innervation of the ACJ by the branches of the suprascapular nerve.

Methods: Twenty-seven shoulders from 17 cadaveric specimens were carefully dissected to identify the course of the suprascapular nerve, with the main focus being on the sensory innervation of the ACJ. Nine specific measurements of the ACJ sensory nerves were made of each shoulder in relation to distinct anatomical landmarks to determine the mean location and course of these nerves.

Results: In all 27 shoulders (100%) a sensory branch to the ACJ with a proximal origin from the suprascapular nerve could be depicted ("first sensory branch"). The mean length of this branch was 4.3 cm (range, 3.3 – 5.3 cm). In 14 shoulders (52%) a further sensory branch of the suprascapular nerve innervating the posterior ACJ capsule could be identified ("second sensory branch").

Discussion: A detailed anatomical description of the sensory innervation of the ACJ from suprascapular nerve branches was performed, which can potentially aid in the development of more focused anesthetic blockades and ACJ denervation procedures.

P009

Midshaft clavicle fractures: surgery provides better results compared with non-operative treatment. A meta-analysis.

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Introduction: Midshaft clavicle fractures (MCFs) are one of the most common injuries in adults, representing 2-5% of all fractures. Either non-operative or surgical treatments can be used for this kind of fractures, but there is still no consensus about which method provides better results. Nonsurgical treatment was usually preferred in the past, with expectation of good outcomes and fracture union. Nonetheless, more recent studies suggested that the nonunion rate was greater than previously expected with nonsurgical treatment and, consequentially, surgical treatment has become more and more used.

Methods: A systematic research of the literature was performed, following the PRISMA guidelines, on PubMed, Web of Science, and Cochrane library databases. The risk of bias was evaluated using the Cochrane collaboration "Risk of bias" tool and the quality of evidence was graded according to GRADE guidelines. RCTs investigating differences between surgery and non-operative treatment for displaced MCFs were included. The primary outcome was the nonunion rate. Other outcomes analyzed were: time to union and to return to activities, Constant score, DASH index, patients' satisfaction, secondary operations, and complications.

Results: Out of 832 records found, 14 RCTs with 1546 patients were included. A significantly lower risk ratio for nonunion of 10% ($p < 0.001$) favoring surgery was found. Time to union was 5.1 weeks shorter with

surgery ($p = 0.007$). The complication rate was higher in the surgical group (31.3% vs 20.5%, $p < 0.001$). The shoulder function at short-term follow-up was significantly better in the surgical group (DASH index mean difference = 4.0 points), while no statistical difference was found both in the Constant score and in the DASH index at mid-term follow-up ($p = 0.41$ and 0.80 , respectively). At long-term follow-up, both shoulder functional scores were significantly better in the surgery group: the overall Constant score mean difference was 5.3 points ($p < 0.001$) and DASH index mean difference was 4.3 points ($p = 0.04$).

Conclusions: Surgical treatment of MCFs significantly reduces the non-union rate and shortens the time to union compared to the non-operative approach and, despite a slight higher incidence of complications, leads to better shoulder functional scores both at short and long-term follow-ups. Further studies should address the clinical significance of the documented improvement.

P010

Intraoperative estimation of Popeye deformity appearance by electrical stimulation of the musculocutaneous nerve

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Background: Although the need for tenodesis after a tenotomy of the long head of biceps brachii muscle is controversial, some of in particular younger patients require tenodesis in order to reduce the probability of Popeye deformity occurrence. In addition to the cosmetically unfavorable appearance, Popeye deformity is also associated with poor functional outcome and more pain. The aim of this study was to investigate a new technique to intraoperatively estimate the risk of Popeye deformity development with electrical stimulation of the biceps brachii muscle.

Methods: Electrical stimulation of the musculocutaneous nerve was applied to assess the risk of Popeye deformity after biceps tendinopathy has been affirmed. Simultaneously to the maximal motor response, the contraction of the biceps tendon inside the joint, following the rhythm of the stimulator, was visible. Biceps tenotomy was then performed. The contraction of the long proximal biceps tendon was arthroscopically documented. The risk of a possible postoperative Popeye deformity was estimated by the surgeon based on the movement amplitude of the long biceps tendon.

Results: 12 consecutive patients (5 females, 7 males, mean age 53 years, SD 9.5, 9/12 dominant shoulders) underwent either biceps tenotomy ($n = 7$) or biceps tenodesis ($n = 5$). After a mean follow-up period of 20 months (SD 3.4), no Popeye deformity has been documented in any of the 7 patients with biceps tenotomy. In 3 out of 5 patients where biceps deformity has been anticipated intraoperatively, Popeye sign was observed postoperative. The Constant Shoulder Score improved by an average of 12 points (SD 7.2) with an average Constant Shoulder Score of 93 (SD 7.9) after 20 months. Both the preoperative pain level (Visual Analogue Scale = VAS, mean 4.6, SD 2.3) and the preoperative Subjective Shoulder Value (SSV, mean 64%, SD 16.6) showed a significant improvement ($pVAS = 0.002$, $pSSV = 0.008$) (VAS 1.4, SD 1.6 respectively SSV 83%, SD 12.9). No damage of musculocutaneous nerve was observed.

Conclusion: The intraoperative use of biceps brachii muscle stimulation device is a valuable, safe and patient specific technique to help the surgeon estimate the need for biceps tenodesis.

P011

"Coverage index and integrity of medial hinge": two new radiological risk factors for secondary dislocation of humeral head fractures

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Introduction: Most of proximal humeral head fractures can be treated conservatively. However, further fragment dislocation may change initial decision-making. We describe two new simple radiological parameters representing risk factors for secondary fracture dislocation: "coverage index" and integrity of the medial hinge.

Methods: Radiological measurements were performed on AP and Neer's view. "Coverage index" was defined as the ratio between the radius of the humeral head and the distance between the rotational center of the head and the axis of the shaft. The ratio was estimated on AP and Neer views. "Medial hinge" was considered intact, if the medial cortices were in line on AP-view. "Cranial migration of the shaft into the head was

termed “telescoping” and medial migration of the metaphysis relative to the humeral head was termed “medialization”.

For demographics descriptive ANOVA Statistics were used. Further statistical evaluation was performed using t-test, Firth logistic regression and Tobit models.

Results: Radiographs of 198 patients (199 fractures) were evaluated. Average patient age was 69 years (range 26-99). According to Neer's classification, there were 24 one-part fractures (12%) and 175 cases with more complex fractures (2, 3 and 4-part: 132;42;1).

66 fractures (33%) showed significant secondary dislocation of more than 5 mm.

Disruption of the medial hinge presented with an odds ratio for secondary dislocation 38.5 ($p < 0.01$). There was a strong inverse relationship the “fracture coverage” and dislocation rate on the AP ($r = -0.733$) as well on the Neer's view ($r = -0.481$).

In addition, two distinctively different patterns of fracture dislocation were observed:

Medialization of the shaft with valgus displacement of the head in 22 out of 66 cases (33%) and telescoping of the diaphysis with Varus displacement of the head in 44 cases (66%).

Conclusion: In our patients group, 33% of patients showed a secondary dislocation of >5 mm. A low “fracture coverage index” on either AP- or Neer's view as well as a disrupted medial hinge are negative prognostic factors for secondary fracture dislocation. Two distinct dislocation pattern are seen, leading either to medial migration of the shaft with valgus displacement of the head or to cranial migration of the shaft and Varus displacement of the head.

P012

Mid- to long-term results of the arthroscopic autologous iliac crest bone grafting technique for anatomic glenoid reconstruction

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Open bone-grafting procedures have evolved into an established treatment option for recurrent anterior shoulder instability with substantial osseous glenoid defects and yield good results during long-term follow-up. Innovation of arthroscopic surgery further enabled the development of all-arthroscopic approaches with good initial outcomes. The aim of this study was to evaluate the clinical and radiologic mid- to long-term results of anatomic glenoid reconstruction using an arthroscopic, autologous tricortical iliac crest bone-grafting technique.

14 patients [11/13m, mean age 31.1 years (range: 17-49)] underwent arthroscopic anatomic glenoid reconstruction of substantial osseous defects in cases of recurrent anteroinferior glenohumeral instability. The patients were prospectively evaluated by clinical [range of motion, subscapularis tests, Subjective Shoulder Value (SSV), Constant Score (CS), Rowe Score (RS), Walch Duplay Score (WD), Western Ontario Shoulder Instability Index (WOSI)] and radiological [x-ray (true a.p., Bernageau and axillary views) and computed tomography (CT) with 3-dimensional (3D) reconstruction] examination.

After a follow-up period of 77.3 (range: 54-110) months, all patients showed an unrestricted range-of-motion with negative subscapularis tests. The SSV averaged 87 (range: 65-100)%, CS 94 (range: 83-100) points, RS 89 (range: 30-100) points, WD 84 (range: 25-100) points and WOSI 70 (range: 47-87)%. One patient underwent an arthroscopic capsular plication 8 months postoperatively due to a persistent feeling of instability without a recurrent shoulder dislocation. At the time of final follow-up, the apprehension sign was positive in two patients. One patient suffered a first traumatic postoperative re-dislocation followed by further dislocations. Progression of dislocation arthropathy was observed in 4 cases ($n = 2$ grade I, $n = 2$ grade II according to Samilson & Prieto). CT imaging showed a consolidated autograft and the glenoid index increased from a mean of 0.77 (range 0.67-0.84) preoperatively to 1.01 (range 0.81-1.19) at the time of follow-up examination.

Arthroscopic reconstruction of anteroinferior glenoid defects using an autologous iliac crest bone grafting technique yields stable clinical and radiologic results over a mid- to long-term follow-up period. The integrity of the subscapularis muscle is preserved and successful reconstruction of the pear-shaped glenoid anatomy is achieved.

P013

Effect of Prednisolone for prevention of muscle degeneration after infraspinatus tendon release in sheep

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Introduction: Fatty infiltration is one of the main factors which determine irreparability of rotator cuff tears. Recent observations would be compatible with an inflammatory mechanism initiated by tendon release which leads to active destructing and degeneration of the muscle cells. It was the aim of this study to explore if the suggested inflammatory muscle degeneration and fatty infiltration can be blocked by prednisolone treatment in a sheep model.

Methods: The infraspinatus tendon was released in 6 alpine sheep. Directly after the procedure, the sheep were injected daily with intramuscular prednisolone (Prednisolut[®]) in a dose of 0.5mg/kg body weight. All sheep underwent repair of the retracted musculotendinous unit after 16 weeks and were sacrificed after 22 weeks. Due to ethical reasons the data of 6 sheep from a prior study of our institution were used as the control group. These sheep were treated with the identical study protocol with exception of the prednisolone treatment. Fatty infiltration, muscle volume and myotendinous retraction were measured on MRI preoperatively, after 6 weeks, and before ISP repair (= 16 weeks) and at scarification (= 22 weeks).

Results: The progression of fatty infiltration after tendon repair in the prednisolone group (mean, 53% \pm 6 at 16 weeks and mean 54% \pm 11 at 22 weeks) was significantly lower ($p = 0.024$) compared to the control group (49% \pm 5 at 16 weeks and 61% \pm 7 after 22 weeks). The muscle volume decreased to a mean of 80% \pm 5% after 22 weeks in the prednisolone group, and to a mean of 69% \pm 8 at 22 weeks in the control group ($p = 0.089$). The prednisolone group showed no muscle volume loss after tendon repair (80% \pm 7 at 16 weeks and 81% \pm 5 at 22 weeks), whereas the control group showed a significantly higher ($p = 0.034$) loss of muscle volume after tendon repair (78% \pm 8 at 16 weeks and 69% \pm 8 at 22 weeks). No differences were seen in the distances of retraction of the greater tuberosity bone chip which corresponds for the tendon retraction (7cm \pm 0.9 prednisolone group, 7cm \pm 0.5 control group, $p = 0.709$).

Conclusion: Intramuscular prednisolone treatment after tendon release causes less progression of fatty infiltration and less muscle volume loss after tendon repair in sheep. Myotendinous retraction is not influenced by i.m. prednisolone treatment in sheep.

P014

The Impact of Clavicular Length Restoration in the Treatment of Non-unions of Clavicular Midshaft and

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Objectives: Multiple techniques and plate positioning options are available for the treatment of clavicular non-unions. In cases of segmental bone loss and clavicular shortening of more than 20 mm, there is an ongoing debate whether autologous cortical bone grafts should be applied for restoration of clavicular length in order to improve shoulder function and outcomes. Our aim was to evaluate the impact of plating and cortical bone grafting in clavicular non-unions on length restoration and its functional outcome

Methods: In a ambidirectional, bicenter study all patients treated with plate osteosynthesis and iliac bone grafting after non-unions of the clavicle were identified in the hospital information system. Patients with a minimal follow-up of 2 years were invited for a clinical examination and functional outcome scores (Constant Score [CS], Simple Shoulder Test [SST] and Subjective Shoulder Value [SSV]). Clavicle length restoration was determined by both navigation ultrasound and radiographic measurements compared to the healthy contralateral side.

Results: Since 2005, a total of 46 patients met the inclusion criteria in both clinics. Twenty-five patients (54%) (mean age 57.8 years, 52% female) were available for a median follow-up of 6 years (2 to 13 years). Median functional outcomes were high with CS = 82 (range 38-95), SST = 12 (range 3-12), SSV = 95 (range 60-100), and also the patient satisfaction (88% had $> = 8$ on a NRS 0-10). Four patients suffered from a refracture after removal of osteosynthesis material. One case was not revised resulting in a clavicle shortening of 32mm. No other patient re-

vealed a shortening of >20 mm. Radiographic and ultrasound measurements showed a moderate correlation (Intraclass Correlation Coefficient = 0.602)

Conclusions: Treatment of clavicle non-unions with plate osteosynthesis and iliac bone grafting offers safe stabilization and adequate length restoration with good functional outcome and a high degree of patient satisfaction.

key words: clavicle non-union, iliac bone crest, plate osteosynthesis, navigation ultrasound

P015

Effect of Biceps Rerouting Technique to Restore Glenohumeral Joint Stability for Massive Rotator Cuff Tears

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Introduction: Recently superior capsule reconstruction (SCR) with tensor fascia lata (TFL) was proposed to treatment for massive rotator cuff tears. However, SCR with TFL has several limitations such as long operation time and complications related to donor site morbidity. So we reported novel technique so called a Biceps Rerouting technique (BR) to avoid this complications. The purpose of this study is to evaluate the biomechanical effect of Biceps Rerouting (BR) on glenohumeral stability at massive rotator cuff tears in the shoulder joint

Methods: A total of 8 cadaveric shoulders were used for testing in 5 conditions: (1) intact shoulder; (2) massive cuff tear (MCT); (3) partial repair (PR); (4) biceps rerouting (BR); and (5) BR with side to side repair (BRSS). Superior humeral translation, subacromial contact pressure and total rotational range of motion were measured at 40°, 20°, and then 0° of glenohumeral (GH) abduction with 0°, 30°, 60°, 90° external rotation at each testing condition. Repeated measures analysis of variance with a Tukey post hoc test was used for statistical comparison.

Results: Superior humeral translation was significantly decreased in BR and BRSS compared to MCT and PR in 0° GH abduction with ER 30°, 60° and 90° (P < 0.001) and in 20° GH abduction with ER 60° and 90° (P < 0.001). BR and BRSS significantly decreased subacromial contact pressure compared to MCT and PR at 0° GH abduction with ER 30°, 60° and 90° (P < 0.001). There was no statistically significant decrease in total rotational range of motion following BR at any abduction angle.

Conclusion: BR significantly decreased superior humeral translation and subacromial contact pressure in cadaveric specimens compared to partial repair at small angle of GH abduction. In conclusion, BR restored stability of shoulder in specimens with massive rotator cuff tear. We believe BR is a feasible alternative in the treatment option for massive rotator cuff tears.

P016

Development of a prediction model for the occurrence of shoulder stiffness within 6 months after arthroscopic rotator cuff repair

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Introduction: Arthroscopic rotator cuff repair (ARCR) is a cost-effective procedure associated with rapid recovery of shoulder function and quality of life in most patients. Some patients however experience local complications or do not recover well. Shoulder stiffness which occurs in about 10% of patients within 6 months after ARCR is associated with major limitation in the functional integrity of affected persons in everyday activities. The objective of this project was to develop a predictive model for the risk of occurrence of shoulder stiffness.

Methods: Consecutive primary ARCRs documented in a local clinical registry between 10-2013 and 12-2017 were included. We reviewed patient charts retrospectively to identify patients who experienced shoulder stiffness postoperatively until the final clinical follow-up (6 months). Twenty four prognostic factor candidates were considered including patient-related factors (n = 4), disease-related factors (n = 6), rotator cuff integrity factors (n = 7) and operative details (n = 7). In a first development step, we used full-case data and logistic regression to develop a predictive model for shoulder stiffness. Predictive accuracy of factors included in the model was assessed by the area under the receiver operating characteristics curve (AUC).

Results: We reviewed 1363 ARCR cases (1330 patient CRF) of which 8.2% had shoulder stiffness; full data for all factors were documented in

1000 ARCRs including 87 shoulder stiffness records (8.7%). In final multivariable prognostic model an increased risk of stiffness was associated with partial tears and pre-operation steroid infiltration; the risk was lowered in males, patients with overweight, high baseline passive shoulder flexion (Flex) and abduction (Abd), infraspinatus (ISP) tears, sign of tendon degeneration, and acromioplasty. The AUC was 0.68. Predicted risk of shoulder stiffness ranged from 1.5% to 46%. The highest risk was estimated in a 30-year-old women with no overweight, prior steroid infiltration on a partial tear, baseline Flex and Abd of 170° and 90°, respectively, and no acromioplasty.

Conclusion: A prognostic model for postoperative shoulder stiffness was developed for ARCR patients, offering personalized health information to support future decision process for surgery and rehabilitation. Further model validation is required. This offers new possibilities towards the routine use of outcome predictors and risk calculators in shoulder orthopedic surgery.

P017

Sternoclavicular steroid injections and their role in decision-making for surgery

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Introduction: Sternoclavicular joint (SCJ) injections are standard first-line treatment for painful non-infectious pathologies of the SCJ after failed conservative treatment. Short-term effectiveness of corticosteroid injections of SCJ has been proven and therefore clinical use is well justified. However, long-term effects and the role of SCJ injections in decision-making for surgery are not yet sufficiently elaborated.

Methods: All patients, who received CT-guided SC steroid injection between January 2012 and January 2017 were retrospectively analyzed. Pain response immediately after SCJ injection was routinely prospectively documented in our clinical database. Furthermore questionnaires, including ASES-Score were sent to the patients. 34 patients with 49 SCJ injections replied the questionnaire (89%) with a median follow-up of 50 months after first SCJ Injection. 10 patients underwent subsequent surgery. Spearman-Test was performed to investigate the Influence of short-term effect on outcome after surgery. The effect of SCJ injection on subgroups was compared with Mann-Whitney analysis. Pain on the VAS is depicted as mean±SD.

Results: Directly after SCJ injection, pain decreased from VAS 5.1±2.4 to VAS 3.5±3 (p < 0.001). When comparing effectiveness of SCJ injections for instability (VAS 6.3±2.1 to VAS 5.1±3.1, p = 0.09, n = 9) and for degenerative joint disease (VAS 5.1±2.4 to VAS 3.5±3 p < 0.001, n = 38), the effect was less in patients with an unstable SCJ.

When analyzing patients with multiple injections, pain reduction seemed to decrease in efficiency with repetition even though statistical significance was not reached. The final ASES-Score was much lower, and therefore outcome was worse, in patients with multiple injections than in those who were satisfied after the first injection (p = 0.01). In the 7 patients who underwent surgery for degenerative changes there was a very strong correlation of pain relief after last infiltration to the definitive outcome (ASES-Score at final follow-up) r = 0.86, p = 0.012.

Conclusions: Sternoclavicular injections are a very useful tool in the context of degenerative sternoclavicular joint disorders; interestingly however, if local injections are repeated, there is a decreasing effect with subsequent SCJ injections. The amount of pain reduction after the last is, in case the affect is not long lasting, at least a strong indicator for the future success of an operative treatment of the sternoclavicular joint.

P018

Effects of SuturePatch Augmentation in Superior Capsule Reconstruction for Irreparable Supraspinatus and Infraspinatus Tendon Tears: A biomechanical study

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Introduction: Superior capsule reconstruction (SCR) was developed to restore superior glenohumeral stability and function to shoulder joints

with irreparable rotator cuff tears. However, thin grafts provide poor stability and the graft may be abraded by the acromion, resulting in poor clinical outcome.

Hypothesis: Superior glenohumeral stability is improved after SCR with a thin fascia lata graft augmented with a SuturePatch (Arthrex, Inc., Naples, Florida).

Study Design: Controlled laboratory study.

Methods: Eight fresh-frozen cadaveric shoulders were tested using a custom shoulder-testing system. Subacromial peak contact pressure, superior glenohumeral translation, and glenohumeral range of motion were compared under four conditions: (1) intact shoulder; (2) simulated irreparable rotator cuff (supraspinatus and infraspinatus) tear; (3) SCR using a thin fascia lata graft (double layer; average thickness, 2.7 mm [medial], 3.0 mm [lateral]); (4) SCR using a thin fascia lata graft augmented with a SuturePatch between the fascia lata layers.

Results: Creation of the rotator cuff tear significantly increased superior translation and subacromial peak contact pressure at 0° ($P < .001$) and 30° of glenohumeral abduction ($P < .001$). SCR using a thin fascia lata graft with or without SuturePatch augmentation significantly decreased superior translation and subacromial peak contact pressure at 0° and 30° of glenohumeral abduction compared with before SCR ($P < .05$). Superior translation after SCR without SuturePatch augmentation was significantly larger than that in the intact condition ($P < .001$), whereas that after SCR with SuturePatch augmentation was comparable to that in the intact condition ($P = .14$ to $.98$). SCR using a thin fascia lata graft either with or without SuturePatch augmentation did not significantly decrease internal, external, and total rotation compared with before SCR ($P = .19$ to $.99$).

Conclusion: SCR using a thin fascia lata graft partially restored superior glenohumeral stability. However, when a thin fascia lata graft augmented with a SuturePatch was used, superior stability was completely restored without restriction of the glenohumeral rotational range of motion.

P019

Pin fixation of fractures of the hook of hamate with small diameter is a feasible option

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Introduction: The necessity for internal fixation of hook of hamate fractures is still discussed. To prevent pseudarthrosis with ongoing pain, weakness and potential degenerative changes of flexor tendons, closed reduction and screw fixation can be performed. We report about a young woman who sustained a hook of hamate fracture, but the available headless compression screws exceeded the hook diameter.

Methods: The 23 year old woman suffered a mangling injury of her left arm by a quad bike. Beside a severe soft tissue injury, a forearm fracture and several non-displaced carpal injuries, a hook of hamate fracture was diagnosed (type 1 III according to Milch classification). CRIF was planned to prevent pseudarthrosis. The carpal tunnel view was used for pin positioning. Because of a small hook diameter the osteosynthesis was performed with an OrthoSorb® pin 1.3 mm instead of a headless compression screw following a postoperative immobilization in a forearm cast for initially six weeks.

Results: Six weeks postoperative the CT scan showed advanced bone healing. Wrist immobilization was prolonged for eight weeks. After three months slight tenderness on the palmar aspect was still present. The clinical examination six months postoperatively showed no tenderness, a negative Pull-Test and a painfree patient, therefore no further CT scan was necessary.

Conclusion: CRIF of hook of hamate fractures with a resorbable pin is a feasible option, especially in cases where the available headless compression screws exceed the diameter of the hook of hamate. Because compression forces of a resorbable pin are limited, prolonged postoperative immobilization must be accepted.

P020

Flexor Digitorum Profundus (FDP) hemi-tendon translocation for loss of substance of the extensor apparatus in zone 1 and/or 2 of the long fingers. An anatomical study.

Dr Natalia Papastergiou; Dr Sebastien Durand

Introduction: Extensor apparatus injuries are very common traumas and loss of substance in zone I and/or II of the long finger is difficult to treat. Surgical treatment options include tendon grafting, extensor tendi-

noplasty, tenodesis and distal interphalangeal joint (DIP) arthrodesis. We have looked at a new approach and present the anatomical bases of the FDP hemi-tendon translocation.

Material and method: Ring, middle and index finger of five fresh cadaveric specimens were included in this study.

Volar groove in the FDP tendon is identified in zone 1 of the flexor sheath and the tendon is gently pared into radial and ulnar bundles. The selected hemi-tendon is proximally sectioned and led on the dorsal aspect of the finger through a transosseous tunnel at the distal phalanx. Digital Caliper with readability of 0.01mm is used for quantitative evaluation.

Results: The distance between the distal pulp and the proximal stump of the hemi-tendon at the proximal edge of A1 pulley is 101.24mm (range 95.8 - 105.32mm). The distance between the distal pulp and the proximal stump of the hemi-tendon after translocation through the transosseous tunnel is 89.4mm (range 85.8 - 95.5 mm) and distance between the DIP joint and the anterior 2mm drill hole of the transosseous tunnel is 7.6mm (range 6.8 – 8.5 mm).

Conclusion: The technical feasibility of this procedure is demonstrated. The main advantage of this procedure is that a distal suture is not required and secure proximal fixation allows immediate active mobilization. The larger cross sectional area of the hemi FDP allows longitudinal splitting to achieve biomimicry of the extensor apparatus.

P021

Surgical Management of Multiple Myeloma with Symptomatic Involvement of the Spine

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Introduction: Multiple myeloma (MM) is the most frequent primary malignancy of the spine resulting in osteolytic lesions which may lead to spinal instability, pathologic fractures, and spinal cord compression (SCC) implying a high risk of neurological impairment and subsequent reduction in patients' quality of life. We aimed to investigate the clinical presentation, surgical indications and outcomes, complications, survival and its influencing factors in surgically treated MM patients with symptomatic involvement of the spine (SIS).

Methods: Out of 350 MM patients treated at our institution over a period of twelve years (2006-2018), we identified 24 patients who were surgically treated for SIS. A retrospective analysis of prospectively-collected data on demographics, clinical presentation, comorbidities, surgical indications and outcomes was done and we investigated the factors predisposing to postoperative complications and survival.

Results: The median follow-up duration was 85 months; median overall survival (OS) was 50 months. Clinical presentation at admission included pain (88%), sensory and/or motor deficit (67%) and bowel/bladder dysfunction (25%). Symptomatic pathological fractures were seen in 33%. Predominant surgical indications were rapid neurological deterioration±SCC, followed by mechanical instability. There were 21% patients with surgical-related complications (<3 months). Surgical-site infections occurred in 17%, without any obvious factors predisposing to infective complications. Neurological deterioration, especially in the presence of motor deficit and/or bowel/bladder dysfunction, significantly reduced OS.

Conclusions: Sudden onset neurological deterioration had predominantly led to surgery. We have achieved good short and long term pain reduction. Surgery is a valuable option for MM patients with SIS who present with rapid neurological deterioration±SCC and/or mechanical instability.

P022

The long and short of it: outcome assessment using the SRS-instrument in patients with adult spinal deformity

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Introduction: Designed for patients with adolescent idiopathic scoliosis, the SRS-22 is also widely used as an outcome instrument in patients with adult spinal deformity (ASD), although its validity in ASD has not been adequately evaluated. A recent confirmatory factor analyses of its 20 non-management items in ASD patients revealed some consistently

weak item-loadings. It was suggested that 4 items (3,14,15,17) be removed, to provide an improved, shorter version of the instrument. This study aims to evaluate the responsiveness of that version.

Methods: The analysis involved the data of 214 patients with ASD (45±20 years; 168 F, 46 M; 58 degenerative, 156 idiopathic; 130 surgical, 84 conservative) who had completed the following questionnaires within the European Spine Study Group's (ESSG) multicentre prospective study: the SRS-22 and the Core Outcome Measures Index (COMI) upon inclusion and at 12 mo follow-up (FU); and a transition question indicating how the back problem had changed relative to 1 year ago. The latter used a Likert-scale (-7 to +7) and was the external criterion for treatment success in a Receiver Operating Characteristics (ROC) curve analysis, with $\geq +4$ (i.e., at least "moderately better") being a "good" outcome.

Results: The SRS 16-item and SRS 20-item scores showed similarly strong correlations with the COMI scores ($r = -0.79$ and $r = 0.78$, respectively), indicating construct validity for both. The correlations between "change in the back problem" and SRS change scores (baseline to 12mo FU) were $r = 0.57$ for the 16-item SRS and $r = 0.55$ for the 20-item SRS. The standardized response means (change score/SD) for patients with a "good" outcome were 1.13 and 1.11 for the 16-item and 20-item instruments, respectively ($=$ large effect sizes); the areas under the ROC curve were 0.85 and 0.83 respectively (16 v 20, $p = 0.053$). The 16-item version discriminated slightly better between good and poor outcomes for the SRS sub-domains.

Conclusion: With the "change in back problem" serving as external criterion, the 16-item instrument showed as good if not better external responsiveness compared with the 20-item. The 16-item instrument seems to be well able to detect important change in adult spinal deformity. Since it is shorter, more responsive, and has already been shown to have better structural validity than the 20-item version, we recommend its use in future studies of patients with ASD. Together with the 2 management items, this should form a new SRS-18 instrument.

P023

What do patients consider to be an acceptable level of symptoms to live with after surgery for adult spinal deformity?

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Introduction: A new approach to the interpretation of treatment success comprises the reporting of the percentage of patients whose symptoms have reduced to an acceptable level, i.e., who have reached a satisfactory symptom state. We sought to evaluate the acceptable level of symptoms in patients after operative and non-operative treatment for adult spinal deformity (ASD), as measured by different outcome instruments.

Methods: This was a cross-sectional analysis of 12-mo outcome data from the database of an international observational study of patients with ASD (European Spine Study Group; ESSG). The following questionnaires were completed at 12 months' follow-up: Oswestry Disability Index; Pain NRS; SRS-22 (from which the total score and the sub-domain scores for pain, function, self-image, and mental health were calculated for the brief 16-item set); and symptom-specific well-being (SSWB) "if you had to spend the rest of your life with the symptoms you have now, how would you feel about it?" (5-point response scale from "very satisfied" to "very dissatisfied", dichotomised for use as external criterion in receiver operating characteristics (ROC) analysis to determine cut-off scores). Being at least "somewhat satisfied" with the current state was considered an acceptable state.

Results: The data from 556 patients was available for analysis. 45% reported being in an "acceptable symptom state". The SRS scores corresponding to this state ranged from >3.0 to >3.8 depending on the specific SRS domain; for ODI the value was ≤ 22 and for pain ≤ 3 . The ROC areas under the curve (AUC) were all relatively high (AUC 0.70-0.85), suggesting the questionnaire scores discriminated well between patients in an acceptable state or not.

Conclusion: Many spine interventions can improve the patient's complaints but rarely do they totally eliminate them. Reporting the percentage of patients achieving a score equivalent to the "acceptable state" may represent a more stringent target for denoting surgical success in the treatment of degenerative spinal disorders.

P024

Osteoblastoma in third cervical vertebra: Case report

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Introduction: Osteoblastoma is a benign tumor, representing 1 to 5% of the primary bone tumors. The incidence of osteoblastoma involving the spine reaches 36%, from which even 40% affect the cervical segment, more commonly the posterior elements. Young male people are the most affected. The diagnosis is frequently late, as it usually courses with chronic cervical pain as the only symptom. However, when there is mass effect on nerve roots or the spinal cord, neurological manifestations such as radiculopathy or myelopathy do occur as well. The most sensitive radiographic examination used in osteoblastoma's evaluation is the bone scan. The treatment goal is complete surgical resection, which allows the complete regression of complaints and decrease the likelihood of recurrences.

Methods: Here we report a case of a 16 years old Brazilian patient who presented since 2 months with left cervical pain as single symptom, without irradiation and non-responsive to medications such as non-steroidal anti-inflammatory drugs. In further investigation, a spine computed tomography revealed destruction of the posterior C3 arch and tissue invasion. The patient underwent a decompressive surgery with a tricortical iliac crest graft between C2 and C4 and arthrodesis with anterior cervical plaque from C2 to C4. Seven days later, a side mass screw was placed at the right side of C2, C3 and C4 through posterior access.

Results: The histopathological examination was suggestive of osteoblastoma. After surgical excision, the patient had total resolution of the symptoms and no sequels. At the three-year follow-up, the patient was asymptomatic, had no restrictions on daily activities, and to date there has been no evidence of recurrence.

Conclusion: During investigation of chronic spine pain cases in young patients, it is essential to consider osteoblastoma as differential diagnosis, aiming an early and complete surgical resection to avoid progression of bone destruction and neurological deficits as well as resolve the symptoms and prevent recurrences.

P025

Factors associated with having an indication for surgery in lumbar spinal stenosis

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Introduction: The outcome of surgery for spinal stenosis can be very variable, suggesting patient selection could be improved. The aim of this study was to evaluate, in a comprehensive multivariable model, the baseline characteristics that distinguish patients considered to have an indication for surgery from those with no such indication.

Methods: Data were extracted from the database of the Lumbar Spinal Stenosis Outcomes Study (LSOS), a multicentre, prospective observational study of patients with spinal stenosis and neurogenic claudication being treated surgically or conservatively. A total of 556 full observations were identified for inclusion; 280 (50.4%) females, mean age 72.8 (8.5) y. A logistic forward stepwise regression model was built with this sample to predict "having an indication of surgery", as documented by the referring clinician, using a range of baseline variables (demographic, clinical history, neurological, radiological, patient self-ratings for pain, disability, HRQL, psychological status) and controlling for study site fixed-effects.

Results: A total of 415 (73%) patients had an indication for surgery and 142 (27%) did not. The predictors of "indication for surgery" with the lowest p values ($p < 0.01$) in the multivariable model included: worse score on the "back trouble thermometer", lower psychological distress (SCL-K-9), higher Roland Morris score, grade C or D morphological spinal stenosis grade (rootlet to cerebrospinal fluid ratio on axial MRI; Schizas grade), and less disc degeneration (Pfirrmann grade). Other significant predictors ($p < 0.05$) included non-Swiss nationality, symptoms getting worse in the last 3 months, no PT in the last 3 mo, and numbness of the foot. Model discrimination was good (AUC 87.2%, 95% CI 84.1-90.3%) and the model was well calibrated.

Discussion: The most important variables shown to be associated with having an indication for surgery were a combination of severe/worsening

symptoms and disability, less psychological distress, and radiological evidence of severe stenosis without accompanying disc degeneration. We suggest that these should be combined into an algorithm for further investigation as potential "appropriate use criteria" to assist with decision-making in lumbar spinal stenosis. Our ongoing studies will examine whether patients with a higher probability of having a surgical indication based on these criteria actually go on to have a significantly better outcome after surgery.

P026

Spino-pelvic alignment after short segment transforaminal lumbar interbody fusion (TLIF) - Is correction possible and worthwhile?

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Introduction: Sagittal alignment is governed by radiological parameters such as pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS) and lumbar lordosis (LL). Matching LL and PI, and a low Global Alignment and Proportion (GAP) Score influence both clinical outcome and the risk of revision in long fusion. The influence of short transforaminal lumbar interbody fusion (TLIF) on the sagittal profile is equivocal. This retrospective study aimed to evaluate the magnitude of the change in segmental and regional lordosis in short segment TLIF, and its effect on spino-pelvic alignment and clinical outcome.

Methods: We identified 196 patients who had undergone TLIF (≤ 3 segments) for degenerative spinal disorders in 2012. PI, PT, SS, LL, L4-S1 lordosis, fused segments lordosis (FSL) and remaining unfused segments lordosis (RSL) were measured on standing lumbar spine radiographs pre- and 6-weeks postoperatively. Based on these measurements, spino-pelvic alignment (PI-LL) and L-GAP-Score were assessed. Patients were categorized as balanced, unbalanced, or uncompensated (PI-LL) and proportioned, moderately or severely disproportioned (L-GAP). The Core Outcome Measures Index (COMI) was used to assess patient-rated outcome pre-, and 2- and 5- years post-operatively.

Results: TLIF was performed in 1 segment in 140, 2 segments in 50 and 3 segments in 6 patients. 106 patients had degenerative spondylolisthesis, 32 isthmic spondylolisthesis, and 58 osteochondrosis. PT, SS, LL, L4-S1 showed no significant differences, pre- to postoperatively. FSL was increased from 21.9° pre- to 23.4° postoperatively (1.3°/fused segment) ($p < .01$); however, the proportion of patients in the PI-LL and L-GAP-Score categories showed no significant differences. The increase in FSL and the decrease in RSL showed a significant correlation ($R = -0.285$, $p < .01$).

The COMI improved significantly from 7.2 at baseline to 2.8 5-years' postoperatively ($p < .01$). Patients were more likely to achieve the minimal clinically important change in COMI score at 5 years' postoperatively with FSL >3 than with FSL $<3^\circ$ ($p = .03$).

Conclusion: Short segment TLIF can increase lordosis within fused segments, and reduce compensatory mechanisms in the unfused lumbar spine. A good clinical outcome is achieved for the majority of patients at 5-years' follow-up independent of spino-pelvic alignment. An increase of lordosis in the fused segments of more than 3 degrees appears to be associated with better clinical outcome.

P027

Preoperative Planning of Spinal Alignment by Statistical and Musculoskeletal Modeling

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Introduction: Statistical shape models (SSMs) have been widely used to create 3D model of anatomical structures such as bones and organs, yet their potential to predict abstract global musculoskeletal properties has not been investigated. As spinal sagittal alignment plays a crucial role in spine related pathologies and often the optimal or healthy alignment remains unknown, we aimed at adopting the SSM method to predict sagittal spinal alignment based on the configuration of sacrum and pelvis. The predicted alignment was then evaluated using computational models in order to assess biomechanical quality metrics.

Methods: The 2D SSM to predict sagittal alignment of the spine was trained with 50 annotated lateral EOS images. The primary annotations localized the femoral heads (FH) (4 points on the right and left acetabula) and the sacrum (boundaries of the endplate). Additionally, for training of

the SSM, each vertebra's upper and lower endplates from C1 to L5 were annotated. From these the midpoints of each vertebra were derived, defining the spinal curvature. The trained SSM was then employed to predict a healthy sagittal alignment from positions of FH and sacrum. To compare the loads of the altered (predicted) alignment with original loading, two personalized musculoskeletal models were created with OpenSim (simtk.org) based on a validated template model, and a linear forward bending motion from upright standing to 30° lumbar flexion was simulated.

Results: The alignment predicted by the SSM presents more pronounced lumbar lordosis and thoracic kyphosis. Sagittal balance determined by the sagittal vertical axis (SVA) was reestablished. The comparison of the joints loads between the different alignment models showed lower compression forces for the SSM predicted alignment at all levels throughout the whole motion. Shear forces at L3/4 and L4/5 were comparable. In flexed postures shear was reduced in upper levels, whereas L5/S1 shear forces were slightly higher in predicted alignment.

Conclusion: We showed the first application of a 2D SSM to predict sagittal spinal alignment. The ability of an SSM predicted alignment to reduce joints loads at lumbar segments was further demonstrated. The prediction of an optimal spinal alignment and its analysis using biomechanical models has the potential to change preoperative planning in spinal surgery.

P028

Radiographic long-term results of Trauma-XLIF in thoracolumbar fractures

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Introduction: Fractures of the thoracolumbar junction are the most common injuries of the spine. Posterior stabilisation is a well-recognized treatment option to restore sagittal alignment, even though significant postoperative loss of reduction is documented. Posterior stabilisation combined with minimal invasive extreme lateral interbody fusion (XLIF) was hypothesized to prevent postoperative kyphotic deformity and induce anterior fusion.

Methods: We retrospectively analyzed all patients with traumatic thoracolumbar (Th11 – L2) fractures (AO A3, A4, B2) treated since 2011 with mono- or bisegmental posterior fixation and monosegmental extreme lateral interbody fusion. Follow up was at least four months. Monosegmental kyphotic angulation was measured independently by two different orthopaedic surgeons comparing preoperative sagittal computer tomography in supine position with postoperative and last follow-up lateral X-ray in upright standing position.

Results: 30 patients were treated (19 type A, 11 type B fractures), whereas only four initially monosegmental. There was a significant age difference according to fracture type (mean age type A = 41 vs. type B = 53 years). Fusion rate of 97% was achieved. One pseudarthrosis needed revision surgery.

Comparing preoperative monosegmental kyphosis in supine position with postoperative kyphosis in upright position showed a significant improvement in kyphosis regardless of fracture type (A 15.99° -->7.43°, B 15.68° -->8.05°).

Our results showed a fracture-independent significant loss of reduction and increase in monosegmental kyphosis (A 7.43° -->10.63°, B 8.05° -->11.23°) over a mean follow-up of 26 months (range 4 – 74 month). However, there was a significant segmental correction (mean 5.03°) and long-term preservation of sagittal profile comparing preoperative (supine position) to last follow-up (upright position) images.

Conclusion: Radiographic analysis showed that posterior stabilisation combined with minimal invasive lateral interbody fusion (XLIF) achieve a high fusion rate and minimal loss of reduction. This might be relevant in this rather young collective in order to prevent kyphotic deformity.

P029

L4/L5 Nerve Root Compression After Vertical Sacral Fracture: An Indication for the Pararectus Approach?

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Objective: Compression of the L4 and/or L5 nerve roots after vertical sacrum fracture may occur as a direct trauma consequence or postoperatively, as a result of the anteriorly dislocated fracture fragments. In this case series we show the decompression of the L4 and/or L5 nerve root via the intrapelvic, extraperitoneal Pararectus approach.

Methods: A retrospective analysis of a total of four patient cases with a mean age of 35 years (range: 18 - 49 years) and a follow-up period of 7 - 27 months was performed. All patients had a transforaminal longitudinal sacral fracture, which caused a radiculopathy. All patients underwent neurolysis via Pararectus approach. The extension of this approach, which we have established for the osteosynthesis of acetabular fractures, allows a direct visualization of the nerve roots in their course over the sacral ala.

Results: In all cases, dislocated osseous fragments of the sacrum that resulted in L4 and/or L5 nerve root compression could be successfully removed via the Pararectus approach. In one patient, L4/L5 nerve root compression occurred as a direct trauma consequence. After decompression, this patient completely recovered from the neurological deficit (dorsiflexion of the great toe M2/5 improved postoperative to M5/5). In the other three patients, the L4 and/or L5 radiculopathy appeared after spinopelvic stabilization. In two of the three patients, a slight improvement in neurological deficits was observed after L4/L5 nerve root decompression. Two patients improved with persisting neurological deficits (Patient 2: Dorsiflexion of the foot and great toe M0/5 improved to M3/5; Patient 3: dorsiflexion of the foot still M0/5, dorsiflexion of the great toe M0/5 improved to M3/5). The remaining patient showed no changes of the symptoms (dorsiflexion of the foot and great toe M0/5).

Conclusion: The fracture fragments of the sacrum caused a radiculopathy of the nerve roots L4 and/or L5. The Pararectus approach allows neurolysis via direct visualization of the nerve roots as they pass over the sacrum, and is a suitable alternative to other anterior approaches, such as the first window of the ilioinguinal approach, for this indication.

P030

Patient-specific template-guided versus free-hand lumbar pedicle screw implantation – a randomized controlled trial

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Introduction: Pedicle screw misplacement is biomechanically disadvantageous and carries the risk of neurovascular sequelae. Patient-specific template-guided pedicle screw placement has the highest yet reported accuracy in cadaveric and early clinical studies. However, a randomized controlled trial eliminating potential biases is lacking. We aimed to compare patient-specific template-guided (TG) versus free-hand (FH) lumbar pedicle screw implantation in a randomized controlled trial to illuminate aspects of accuracy and safety.

Methods: Patients scheduled for lumbar fusion surgery were randomized to either the TG or FH pedicle screw insertion group. An immediate postoperative computer tomography (CT) was performed to assess accuracy of pedicle screws by grading perforations rate using a 2 mm increment grading scale. Time of surgical exposure and blood loss, time of screw insertion and overall surgery, as well as intraoperative radiation dose and complications were recorded and compared.

Results: 24 patients (9 male, 15 female) with a mean age of 64 years underwent either FH (n = 13) or TG (n = 11) pedicle screw insertion with a mean follow-up of 13.4 months. A total of 108 screws (FH-screws/TG-screws = 62/46) were implanted. There was no significant difference in surgical exposure time (31.6 ± 8.7 min versus 40.7 ± 12.1 min; p = 0.062), screw insertion time (27.0 ± 11.0 min versus 33.6 ± 13.6 min; p = 0.234), overall surgical time (157.7 ± 32.7 min versus 177.8 ± 36.4 min; p = 0.168) and blood loss (353.8 ± 187.6 ml versus 518.2 ± 355.2 ml; p = 0.161) between the FH and the TG group, respectively. Radiation exposure was significantly less in the TG group (230.8 ± 132.7 cGy) vs the FH group (67.8 ± 31.0 cGy) (p = 0.001). There were 4 pedicle screw perforations (6% in the FH group and 2 (4%) in the TG group (p = 1.000)). All perforations were less than 2 mm and had no clinical consequences. Clinically relevant complications were 1 postoperative pedicle fracture in the FH group (p = 1.000), 2 infections in the FH group and 1 infection in the TG group (p = 1.000).

Conclusion: Patient-specific template-guided pedicle screw insertion provides a similar accuracy, but less intraoperative radiation exposure than the FH technique. However, for the lumbar region it requires more surgical time and blood loss by tendency. Other screw trajectories such as cortical bone trajectory might amplify the potential benefits of patient-specific guides, but need further evaluation.

P031

Stand-alone Anterior Lumbar Interbody Fusion (ALIF) for grade I isthmic spondylolisthesis

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Introduction: The surgical treatment of isthmic spondylolisthesis (ISP) remains controversial. For low grade ISP the majority of the literature suggests a posterior approach, decompression and pedicle screw instrumentation, with or without interbody fusion (TLIF, PLIF). Usually anterior interbody fusion (ALIF), is always combined with posterior instrumentation for the treatment of ISP. There is only limited literature about stand-alone ALIF for ISP. The aim of this study is to retrospectively analyze the clinical and radiological outcome of a large cases series treated with ALIF stand alone in our institution.

Methods: All cases with grade I ISP treated with ALIF between 10/2012 and 12/2016 were analyzed regarding demographic data, affected level, bone graft used and postoperative pain (VAS). The latest available follow up imaging was used to detect bony fusion. Any revision and complications were recorded.

Results: 125 Grade I ISP cases (71 f, 54 m) were treated with ALIF stand alone (115 in L5/S1; 10 in L4/5). In 92 patients (103 levels) the cage was filled with matrix graft product (rhBMP-2), 32 patients (32 levels) received iliac crest autograft and one case DBM. Follow up was 10.3 months. The overall fusion rate was 92.7%. There was no association between the graft used and the fusion rate (p = 0.287). Despite the high fusion rate, during the follow up period, 39 of the patients (31%) complained for persistent back pain. The use of BMP graft was associated with an increased rate of postoperative pain (30/85 = 35.3%) compared with autologous graft (6/31 = 19.4%), but the difference did not reach a statistical significance (p = 0.117). In total 12 patients a revision surgery with additional posterior stabilisation was performed (reoperation rate of 10.3%). All 12 Patients were suffering from mechanical backpain, 2 of them with confirmed non union in the 6 month postop CT Scan. In 4 Cases the posterior stabilisation was performed due to fracture of the inferior endplate. There was no case of retrograde ejaculation in our series.

Conclusion: A stand-alone ALIF is an effective treatment for a Grade I ISP. In the vast majority fusion is achieved without additional posterior stabilisation. Our study confirms that the postoperative pain is not statistically correlated with bony fusion. The additional risks, complications and costs, associated with additional posterior instrumentation the treatment of Grad I ISP is in our opinion an unnecessary surgical procedure.

P032

From medical images to patient specific biomechanical analysis – a machine learning based pipeline

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Introduction: Computational methods are widely used in spinal research and proved their potential for clinical decision making and surgical planning. Finite element (FE) approaches are a valuable tool to simulate and assess relationships between structure and function in the spine, as well as investigating surgical techniques by accounting for bone-implant interaction. The application of machine learning (ML) techniques on the other hand currently focuses on the localization of structures, segmentation, and computer-aided diagnosis. As a novel approach, we present a ML based pipeline addressing automatic FE model generation from medical imaging data and execution of patient-specific simulations of lumbar functional spine units (FSU).

Methods: The open-source NiftyNet package is employed to segment the lumbar spine based on training of a validated network with a large database of clinical CTs. The training dataset is comprised by L1: 71, L2: 100, L3: 138, L4: 110, L5: 77. In parallel, a 3D statistically deformable model was trained with the same dataset. The resulting patient-specific anatomical models are processed by a custom-built FE model generator for the creation of personalized FSU FE models. The deformable model allows to automatically detect endplates, ligament attachment sites, and localize facet joints.

Results: The resulting modelling pipeline was evaluated by leave-one-out experiment, comparing the errors between automatically registered and manually segmented vertebrae. The resulting RMS errors lie between 0.5 and 2.6 mm, and is comparable to those obtained by manual

segmentation. Different vertebral structure like the pedicle and spinous process regions are more challenging to fit, thus resulting in a higher RMS error in these regions as compared to the vertebral body. The modeling and simulation pipeline is able to automatically create models of lumbar FSUs and simulate flexion, extension, lateral bending, and axial rotation by applying a combined load at the upper vertebral endplate.

Conclusions: The proposed pipeline is the first example of combining ML techniques with simulation environments. This approach automatizes the preparation of patient-specific numerical models decreasing the preparation time by more than 70% and bears a high potential for clinical application in surgical planning. The pipeline is undergoing rigorous validation by comparing outputs of automatically vs. manually generated FSU FE models.

P033

Patient-specific disc loads as predictor for adjacent segment disease in lumbar spinal fusion

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Introduction: Adjacent segment disease is the most important, yet insufficiently controllable, long-term complication associated with lumbar spinal fusion. We hypothesized that intervertebral loading is differently altered in patients with and without adjacent segment disease (ASD) after spine surgery. If so, patient-specific disc loads could predict occurrence of adjacent segment disease and approaches for their alteration could be developed.

Methods: Ten patients who underwent revision surgery for ASD after L4/5 spinal fusion between 01/2014 and 12/2017 at our institution were identified and compared to a control group of 12 asymptomatic patients with a minimum of 4 years follow up after L4/5 spinal fusion. Landmarks on pre-op and follow-up lateral radiographs were annotated, and normalized alignment specific musculoskeletal models automatically created using a custom-built modelling pipeline. Lumbar intervertebral shear forces in unfused lumbar segments were computed for two postures: upright standing [U] and 30° upper body forward flexion [F]. Differences in loads between the pre and post-op condition were computed for each subject and compared between groups.

Results: Mean shear force in the ASD group increased after L4/5 fusion in upright and flexed posture at all levels except L3/4, which experienced a reduction of -26N in the flexed posture. In contrast, mean shear force in the control group were lowered at levels L2/3, L3/4, and L5/S1 ([U]: -6N, -12N, -40N / [F]: -23N, -53N, -90N, respectively). A marginal average increase of shear could be observed at level L1/2. Differences in force changes between ASD and control group achieved only statistical significance at the lowermost lumbar level (L5/S1).

Conclusion: Patient-specific biomechanical calculation of disc load changes after spine surgery revealed higher loads for patients with ASD. Moreover, such changes in ASD patients were most pronounced at the immediate adjacent levels and diminished towards more distant levels, reflecting the levels with highest risk of ASD. This first report of patient-specific disc load calculation with predictive merits for ASD could initiate a paradigm change in spine surgery planning and patient education.

P034

From broken spine to broken heart: Takotsubo cardiomyopathy during conservative management of spine fractures

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Introduction: Takotsubo Stress Syndrome is a rare transient ventricular dysfunction resulting in cardiogenic shock, which stimulates a sympathetic response and mimics an acute myocardial infarction.

Case: A 79 years old man presented retrosternal pain with cardiogenic shock during a non-operative management of spine fractures. No previous history of cardiac problems were reported and no present emotional or physical stress event was mentioned by the patient. The patient was managed according to acute myocardial infarction guidelines and was transferred for cardiac cauterization, where he was diagnosed with Takotsubo Stress Syndrome. After supportive management for 10 days the patient was discharged to rehabilitation center for further management of spine fractures.

Discussion: Although the exact etiology and pathophysiology is not yet clarified, Takotsubo Stress Syndrome is often documented in postmenopausal women under an emotional or physical stress factor. Usually presented symptoms include substernal pain, electrocardiographic as well as cardiac biomarker changes. Diagnosis is solidified with angiography and management includes supportive measures of heart failure. Cases in orthopedic literature for Takotsubo Stress Syndrome are scarce. This is the first case, documented during a non-operative management of spine fractures and adds in the growing literature of atypical circumstances.

Conclusion: This article raise awareness of Takotsubo Stress Syndrome in the differential diagnosis of acute myocardial syndrome during non-operative management of spine fractures.

Keywords: Takotsubo Stress Syndrome, non-operative Takotsubo stress cardiomyopathy, postoperative Takotsubo stress cardiomyopathy case report.

P035

Refractory autoimmune hemolytic anemia secondary to metal-on-metal total hip replacement

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Introduction: Wear of bearing surfaces and corrosion of non-moving components of total hip replacements (THR) can result in increased local and systemic metal concentrations. Metal particles may cause systemic toxicity. Secondary neurologic, cardiac, endocrine and autoimmune diseases have been described. These problems are mainly associated with large-head (≥ 36 mm) metal-on-metal (LH-MoM) bearing surfaces, and with wear caused by failure of taper connections. In the present report, we describe a case of refractory autoimmune hemolytic anemia (AHA) secondary to bilateral LH-MoM THR.

Methods: Report of the clinical features of a case.

Results: Bilateral LH-MoM THR had been performed elsewhere 11 years ago in a 36 years old woman because of osteoarthritis secondary to residual hip dysplasia. In the following year, she developed autoimmune hemolytic anemia. Despite treatment with high dose of glucocorticoids, splenectomy and with rituximab, AHA persisted, with persistent elevation of serum LDH and reticulocyte count, and with decreased haptoglobin levels. Following development of bilateral hematogenic periprosthetic joint infection with *S. aureus*, both prosthesis were explanted. Postoperatively, the hemolysis parameters rapidly normalized and the glucocorticoid treatment could be stopped, for the first time since the diagnosis of AHA. After adequate antibiotic treatment, reconstruction was performed bilaterally using uncemented cups and stems, with a ceramic-on-polyethylene bearing. At 2 years postoperatively, no recurrence of AHA nor of infection was observed. Of note, elevated chromium (3.6 µg/l) and cobalt (22.3 µg/l) serum levels had been measured years earlier, but no action had been taken. Shortly after explantation, chromium nearly normalized and cobalt levels decreased to 6.2 µg/l.

Conclusion: Considering the striking association between the evolution of AHA and the presence of LH-MoM THR, and healing of AHA after explantation of both prosthesis, metal immunization/intoxication must be postulated as being causative. This complication has been described only once so far. Even if AHA is a very rare complication, it is life threatening. Patient with LH-MoM THR should be monitored regularly, including determination of cobalt and chromium blood levels.

References:

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P036

Unrecognized chondrosarcoma as a cause of total hip arthroplasty failure. A case series and review of the literature.

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Introduction: According to the Swedish registry, total hip replacements (THR) were performed with 95% of excellent outcomes at 10 years follow-up. The most common THR indications were osteoarthritis and avascular necrosis, whereas symptomatic aseptic loosening was by far the primary indication to revision surgery. X-Ray are cost-efficient and most often sufficient to support surgical indication. Bone tumors and especially

chondroid tumors are nonetheless difficult to specify on radiographs. Therefore the threshold to CT /MRI should be low. Chondrosarcoma (CS) is the most frequent bone sarcoma in adults, and proximal femur is the most common location. If THR is performed in the setting of unrecognized CS, it will surely lead to early relapse and poor or even fatal outcome. We report three cases of unrecognized high grade CS in the setting of primary or revision THR and review the literature on this rare clinical presentation.

Method: A systematic review on articles related to THR and bone tumors, published between 1980 and 2018 was performed on Pubmed, Embase, Medline Ovid SP and Web of Science, using the guidelines set in the PRISMA.

Results: Case series: three patients were referred to our sarcoma center after failure of THR due to unrecognized high-grade CS. All three cases presented with advanced staged disease, leading to a rapid fatal outcome. Looking at preoperative work-up, we could not identify radiological signs of either osteoarthritis, avascular necrosis of the femoral head, or aseptic loosening of the stem to support indication to primary or revision THR.

Literature review: 58 papers were identified of which 12 met the inclusion criteria on the subject. They confirmed that primary or revision THR failure due to unrecognized CS is extremely rare, with only few case reports available in the review. Altogether, 13 cases of CS in the setting of THR were described in 11 papers. Outcome was generally unfavorable.

Conclusions: Before proceeding to THR primary or revision, diagnosis must be ascertained. Atypical presentation of a common pathology, like osteoarthritis, avascular necrosis or aseptic loosening of a THR, should raise suspicion for another cause for symptoms, and additional work-up be performed. As our cases dramatically demonstrate, unrecognized or inadequately managed bone or soft tissue sarcoma may lead to poor or even fatal outcome. In doubtful cases, a second opinion should be asked in a multidisciplinary reference center.

P037

Metal wear in metal-on-metal total hip arthroplasty is not always caused by the bearing: a case report.

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Introduction: Local adverse reaction to metal debris and systemic toxicity of metal ions are common causes of failure after metal-on-metal (MoM) total hip arthroplasty (THA). We report a case with an uncommon mechanical complication with massive metal wear.

Methods: A 81-year-old man underwent MoM THA 20 years ago. Only 2 years later, the cup was revised, due to delamination of the titanium mesh, with reconstruction with a reinforcement ring and a cemented metal-polyethylen sandwich cup and a 28 mm metal head. During further follow-up, the treating orthopaedic surgeon documented a migration of the cup, but no additional revision was performed. Finally, the patient was referred due to progressive leg shortening. The cup had migrated cranially and was dislocated, causing an extraarticular impingement. The blood levels of Cr, Co and Ti were increased.

Results: Transfemoral revision THA was performed. Massive metallosis was present, with solid tumours and viscous fluid. The neck of the stem had a deep posterior notch due to impingement with the metallic inlay. Retrospectively, this could also be identified on the preoperative CT-scan. Reconstruction was performed with acetabular porous tantalum augments, an anti-protrusion ring, a cemented polyethylene cup and an uncemented modular stem. Histology showed massive proliferation of macrophages, due to phagocytosis of metal particles, and necrosis within the solid tumours. Now 6 months postoperatively, the patient showed an unproblematic recovery. Ti blood levels however remain high.

Discussion: In this case, massive metallosis after MoM THA had an uncommon cause, which might easily be overlooked and thus probably also is underreported. The harder CoCr alloy of the bearing can easily notch into the softer Ti alloy of the stem. In case of cup malposition, component impingement has to be looked for, but was missed preoperatively in this case. A precise analysis of the components with CT-scan could detect critical material defects and might be essential for accurate planning of any revision. Phagocytosis of metal particles by macrophages lead to voluminous tissue reactions, even if the total amount of metal is small. Histology is crucial in revision to identify the reason of failure, both in septic and in aseptic situations. The determination of metal ion blood levels is recommended too, because it can indicate metal wear and as increased levels might also cause systemic toxicity, which has to be identified properly.

P038

Reconstruction of Femoral Head Impaction Injuries using Osteochondral Shell Autografts Harvested from the Head-Neck Junction – Minimal 4-year Follow-up

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Background: Femoral head impaction defects are observed in variable extent, as a result to traumatic hip dislocation e.g. caused by traffic accidents or seen in professional athletes, with compression of the articular cartilage and the subchondral bone into the femoral head, leading to irregular articular surfaces predisposing to osteoarthritis and influencing the outcome.

Objectives: This study reports the outcome after a minimum follow up (FU) of four years in a consecutive series treated with transfer of osteochondral shell autografts in hips (TOSAH) from the head-neck junction into the defect using surgical hip dislocation.

Design and Methods: Between 06/2007 and 03/2014 twelve patients (mean age: 35yrs, range: 18-53; median Injury Severity Score: 13, range: 9-14) sustained a traumatic posterior hip dislocation in combination with acetabular and/or Pipkin fractures and were inter alia treated using TOSAH using surgical hip dislocation. Conversion to total hip replacement (THR) during FU was noted as failure. Patients were clinically (e.g. merle 'aubigne score) and radiographically assessed for occurrence of osteoarthritis (OA), avascular necrosis (AVN) and/or heterotopic ossifications (HO).

Results: In four patients, conversion to THR was performed at eleven, twelve, 28 and 44 months postoperatively. Seven of eight patients (mean age: 34yrs, range 18-53) with preserved hips passed a FU of 4 years (mean FU: 5.7yrs, range 4.3-8.0yrs) and presented with a mean Merle-d'Aubigné Score of 16 points (range: 14-18). One patient showed progression of OA at latest FU. No AVN but HO (Brooker grade 1 in two, Brooker grade 2 in one) was found. One patient (1 hip) moved overseas and was lost to follow up.

Conclusion: The presented technique used as a salvage procedure for severely injured hip joints showed the potential to delay conversion to THR and to preserve the hip joint at midterm with satisfying clinical and radiological outcome.

P039

Joint compression forces in abnormal version of acetabulum or femur in different joint positions- a 3D finite element study

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Introduction: Impingement surgery aims to restore impingement-free range of motion (ROM). The role of the femoral torsion in femoroacetabular impingement is gaining on interest, but has not yet been fully understood. In this study we focus on the ROM and cartilage load in a finite element model with a compensatory condition of acetabular retroversion and increased femoral anteversion.

Methods: MRI scans of a healthy subject were used to obtain two different finite element models simulating load scenarios during stance phase: 1. a healthy model (HM) and 2. a model with combined acetabular retroversion (-10°) and increased femoral anteversion (+20°) (AR-FAM). Motion data and joint reaction forces (JRF) measured in our gait lab were integrated. Localization and magnitude of hip JRF were determined, as well as ROM and forces of the hip abductors for both constellations.

Results: ROM of hip flexion was 113° and 114°, whereas internal rotation was 32° and 46° for the HM and AR-FAM, respectively. Muscle moment arms were shortened from an average of 3.5cm to 2.9cm (17.0%) with increase to 20° femoral anteversion. Average muscle forces of the hip abductors were increased from 146 N (HM) to 172 N (AR-FAM, 18.2%), and the resultant JRF was raised from 317 to 395 %body weight (24.6%). Average pressure was increased by 25.6% between HM and AR-FAM (1.1 to 1.3 MPa). Localization of the pressure was not markedly changed in the two models.

Conclusion: In a morphological condition when increased femoral anteversion compensates for acetabular retroversion achieving a physiological ROM, the joint reaction forces during normal gait show substantial alteration in this FE model. Individualized impingement surgery should not

only normalizes impingement free ROM, but also needs to optimize joint load.

P040

Dupuytren-like fibromatosis of the acetabular labrum: a case report

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Introduction: Dupuytren's disease is a fibro-proliferative disorder known to affect the palm of the hand. Other known superficial fibromatoses are Garrod's knuckle pads, plantar fibromatosis of Ledderhose, and Peyronie's penile fibromatosis. In frozen shoulder, joint capsulitis shows similar histological alterations to those in Dupuytren's disease. Such alterations never have been described to occur in the hip joint.

Case report: A 23 year old female patient presented with a 2-year history of progressive right hip pain, without prior history of trauma. She complained of a constant pain in the groin, episodes of pseudo-blockades, and joint stiffness with ambulation. Clinical examination revealed reduced flexion and internal rotation as well as significant pain during FADIR-testing. Standard radiographs did not show residual hip dysplasia nor signs of femoro-acetabular impingement.

Further investigation by MRI scan showed hypertrophic synovia at the antero-lateral femoral head-neck junction. The patient underwent surgical dislocation of the hip through a trochanteric slide approach with excision of a lobulated mass measuring 30x15x8 mm originating from the antero-superior acetabular labrum. Macroscopically, the articular cartilage and hip joint capsule were found to be normal. Postoperatively, the patient reported significant relieve of pain and functional recovery. MRI scan at 10 months showed no evidence of recurrence.

Histopathological workup: Multinodular proliferation of benign fibroblasts as well as myofibroblast proliferation was seen. The histological appearances were found to be similar to those in Dupuytren's disease of the hand, with no inflammation and no synovial involvement.

Conclusion: The described tumoral lesion of the acetabular labrum seems to belong to the group of Dupuytren's fibromatosis. Due to its localization inside the hip joint it is diagnosed as Dupuytren-like fibromatosis. MRI is the method of choice for diagnosis and complete excision of the tumor including adjacent parts of the acetabular labrum may result in excellent outcome, without recurrence.

P041

It's worth cleaning – The sole examination of the female taper identified the cause of a trunnion failure 16 years after total hip arthroplasty

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Introduction: Adverse reaction to metal debris (ARMD) is a well-known issue of total hip replacements (THR) with metal-on-metal (MoM) pairings. This however mainly affects large-head MoM THR, whereas small diameter (28-32 mm) MoM pairings are associated with low long-term revision rates. The pairing however does not necessarily cause failure. This report documents a failure due to trunnionosis of a correctly oriented small-diameter MoM THR. Identification of the cause was possible through sole analysis of the female taper, as the stem had not been revised. This technique is routinely not available. But this case illustrates the importance of cleaning the taper when seating the head in THR.

Methods: Case presentation, complemented with results from advanced analysis of the retrievals. A 65 year old male patient had been revised 16 years after THR with 28 mm MoM pairing, due to local ARMD. As both the cup and the stem were well integrated and oriented, and considering body weight of 120 kg, revision solely of the inlay and the head was performed, through an anterior approach. A semi-fluid necrotic tumor of ~1000 ml was evacuated. Despite distinct wear of the male taper, the stem was left in place and reconstruction performed with a head with inner skirt. The follow-up of actually 2 years was unproblematic. While the cup and the outer surface of the head were accessible to direct analysis by a coordinate measuring machine, the female taper had to be analyzed indirectly by measuring an imprint.

Results: Histology showed acellular necrosis, as typically associated with metal wear particles. Wear on the surface of the cup and of the head was within expected ranges. The analysis of the female taper identified 2 particles within the taper connection, which can reasonably only be

bone fragments, that probably caused failure. The defect on the softer male taper titanium alloy was more important than the one identifiable on the firmer CoCr counterpart.

Conclusion: Failure due to ARMD after MoM THR is not necessarily caused by the pairing, but can be due to trunnionosis. When the stem is not retrieved, analysis of the taper requires indirect measurements using an imprint of the female taper, a technique commonly not available. Observations made in this case underscore the importance of optimal technique, especially cleaning, when seating the head on the taper when performing THR to avoid failures due to trunnionosis.

P042

Myositis ossificans of the thigh reducing hip flexion after THA

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Introduction: Myositis ossificans is a benign but frequently overlooked disease. It is characterized by non-tumoral heterotopic ossifications of muscular tissue. In most cases it represents late sequelae of trauma and thus, is most common in young active males. Its spontaneous evolution is generally favorable and no surgical treatment is needed.

Methods: We present a case of myositis ossificans of the right adductor magnus muscle interfering with hip flexion after total hip arthroplasty. A 70-year-old male patient with a history of bilateral total hip arthroplasty (2012 left hip; 2013 right hip) presented in our outpatient clinic with pain free but severe restriction of the range of motion of his right hip impeding normal sitting position. Physical examination showed a tumoral mass inside the adductor muscles. Hip motion was found to be restricted to 40° of flexion. Radiography showed a radiopaque mass originating from the postero-medial mid-diaphyseal region of the femur towards the ischial tuberosity. CT scan and MRI revealed a large ossification inside the adductor magnus and partially the adductor longus muscles.

Because of the important functional impairment the ossifications were partially removed through a Ludloff approach and the adductor muscles detached from its origin at the ischial tuberosity resulting in 85° of hip flexion intraoperatively. Postoperative regimen included administration of Indocid 75mg/day for a four weeks period as well as a physical rehabilitation program using a continuous passive motion apparatus (Arthrotec). Six months postoperatively the patient maintained 75° of hip flexion, sitting position was normalized and radiographically no local reappearance of ossifications was observed.

Conclusion: Myositis ossificans is a non-tumoral heterotopic ossification of muscular tissue, mainly of post-traumatic etiology. It is a self-limited pathology with a possibility of spontaneous regression. Thus, surgical intervention is rarely indicated. In our patient hip flexion was severely reduced to 40° due to the ossifications localized mainly inside the adductor magnus muscle. Anatomically, the main muscle mass of the adductor magnus is localized posteriorly to the center of rotation of the hip joint, which explains mechanically the very limited hip flexion in this patient.

P043

Results of osteosynthesis versus acute total hip arthroplasty for acetabular fractures in the elderly

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Introduction: There is a significant increase of acetabular fractures in the elderly in recent years. If surgery is chosen the standard treatment for displaced acetabular fractures is open reduction and internal fixation (ORIF). The place of total hip arthroplasty (THA) as an acute treatment for acetabular fracture in the elderly is not well defined. The aim of this study is to compare outcomes between ORIF and ORIF combined with acute THA for acetabular fracture in the elderly.

Methods: From 2007 to 2018, 189 patients were treated surgically for an acetabular fracture in our institution. Fifty-one patients were older than 65 years and were retrospectively reviewed. Twenty-five were treated with ORIF, and 26 with ORIF and acute THA. We analysed the outcome focusing on intraoperative as well as early/late complications, operating time, blood loss, functional outcome with the Harris Hip Score (HHS), revision rate and length of hospital stay.

Results: The mean age for the ORIF group was 75.4 years (66-92); the mean age for the THA group was 78.2 years (66-88). Charlson comorbidity index were similar (1.7 vs 1.8). Mean blood loss for ORIF was 690 mL (250-1800) versus 962 mL (400-1700) for THA group. Mean surgery time was 135 minutes (54-305) for ORIF group versus 186 minutes (106-

250) for the THA group. Mean Harris Hip score (HHS) for ORIF was 68.25 (24-92) versus 74.5 (51-89) in THA group with a mean follow up time of respectively 12.9 and 14.4 months. Twenty-four percent of ORIF group had an early complication versus 23 % for THA. Three patients (12 %) of the ORIF group were converted to THA (1 arthrosis, 1 necrosis, 1 intra-articular screw) with mean HHS of 88.5 after conversion (HHS before of 53.5). The other revision in the ORIF group concerns an infection. Revision rate for THA was 11.5 % (2 infections and 1 instability). Mean length of post-operative hospital stay was 15 days for the ORIF group versus 13 days for THA group.

Conclusion: Although surgical time and perioperative bleeding are more elevated in THA group, it seems to be an efficient procedure with equivalent complications and revision rate, and better outcome. Acute THA combined with ORIF for acetabular fractures in the elderly seems to be a safe procedure in selected patients, based on surgeon experience, articular destruction, pre-existent arthrosis and patient comorbidities. After THA combined with ORIF, full weight bearing is possible, which is an important factor for this old population.

P044

Results of open reduction internal fixation versus percutaneous iliosacral screw fixation for unstable posterior pelvic ring disruptions: retrospective study of 36 patients

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Introduction: Surgical stabilization of posterior pelvic ring fractures can be achieved by closed reduction and percutaneous fixation (CRPF) or open reduction and internal fixation technique (ORIF). The aim of the present study is to compare the clinical results of both methods in the treatment of sacroiliac fractures.

Material and methods: Medical records of thirty-six patients consecutively operated for unstable posterior pelvic ring disruptions were retrospectively reviewed. We compared 14 patients treated by ORIF versus 22 patients stabilized by using CRPF under fluoroscopic C-Arm or O-Arm guidance between 2007-2017 in a trauma level one center. The Majeed and Pohlemann scores were used to evaluate the functional outcomes. Complications like blood loss, infection rate, neurologic injury, the operation time and the length of hospital stay were analyzed.

Results: 22 patients (mean age, 40.4 ± 16.6) were treated with CRPF and 14 patients (mean age, 43 ± 20) by ORIF technique. The gender distribution is similar with respectively 14.28 % of women and 85.7 % of men in the ORIF group versus 18.18 % of women and 81.8% of men in the CRPF group. The mean Majeed pelvic score is 79.14 ± 20.55 for the CRPF compared with 71.30 ± 19.89 for the ORIF technique. The percentage of good to excellent results with the Majeed score is 71.3 % for the CRPF compared to 46 % for the ORIF technique. The mean total Pohlemann score is 7.28 ± 2.12 for CRPF compared to 6.76 ± 2.04 for the ORIF procedure. The mean operation time (CRPF, 141.8 minutes ± 73.94 versus ORIF, 148.78 ± 69.73) and length of hospitalization (CRPF, 25.5 days ± 17.75 versus ORIF, 30 ± 14.41) are similar in both groups. Percutaneous fixation reduces surgical blood loss by half with a mean of 614 cc ± 384.66 cc compared to 300 cc ± 194.45 for the open technique. There was 1 case (7.1 %) of infection in the ORIF and none in CRPF technique (p = 0.214). The CRPF procedure has 4 neurological lesions (18.18 %) versus 2 (14.2 %) for the ORIF technique (p = 0.714).

Conclusion: Percutaneous iliosacral fixation of unstable posterior pelvic fractures has gained in popularity over the years. Comparatively to the open technique, this method has better functional outcomes with lower rates of bleeding and infection. However, we did not find lower neurologic injury rate with the percutaneous fixation.

P045

Predicting postoperative complications in patients with acetabular fractures

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Introduction: Acetabular fractures are treated operatively even in patients with significant comorbidities by open reduction and internal fixation in order to achieve early and acceptable reduction. However, the decision to treat operatively is occasionally deferred or foregone in patients perceived to be unfit for surgery. To date, no predictive scoring

system has been developed to objectively evaluate patient risk for post-operative complications in this population. The previously validated Estimation of Physiologic Ability and Surgical Stress (E-PASS) score has been shown to predict outcome in a variety of fractures. This score which incorporates both patient and surgical factors may be used to quantify risk for surgical decision-making in acetabular fracture management.

Methods: A retrospective review of electronic patient records was performed for all patients with acetabular fractures surgically treated between January 2013 and June 2018 in a Level 1 Trauma Centre. Patients with multiple operations or injuries and those with malignancies were excluded. Data collected included: age, date of birth, weight, and presence of pulmonary disease, heart disease, or diabetes mellitus, the surgical approach used, blood loss, operation time, American Society for Anesthesiologists (ASA) score, mortality to date, and complication types. E-PASS scores were determined for all patients. This is comprised of a preoperative risk score (PRS), a surgical stress score (SSS), and a comprehensive risk score (CRS). Complications were graded according to the Clavien-Dindo Classification.

Results: Of 212 patients, 106 patients were excluded because they did not fulfil study criteria or due to incomplete data. Of these, complications were reported in 37 (34.9%) patients and 3 (2.8%) died. Hospital post-operative morbidity and mortality rates increased significantly with the PRS and CRS. The SSS did not correlate significantly with frequency of complications.

Conclusion: These results suggest that E-PASS is useful in characterizing patient risk profile for postoperative complications in surgically treated acetabular fractures. Regarding the constituent score parameters, the presence of non-controllable patient factors such as comorbidities has a greater influence on adverse outcomes compared with controllable factors such as surgical stress. This has important implications for clinical decision making in this complex patient group.

P046

Delamination of the hydroxyapatite coating from the stem 14 months after total hip arthroplasty

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Introduction: Hydroxyapatite (HA) coating has become very popular in uncemented total hip arthroplasty (THA), as it might help accelerate integration of the implant by the surrounding bone. But the interface between such a coating and the underlying metal represents a potential rupture point. We present a case where it could be documented that the HA coating separated from the stem and this contributed to early failure after THA.

Case report and methods: Uncemented THA with an HA coated stem had been performed in a 68 years old patient to treat a femoral neck fracture. A minor trauma 14 months postoperatively induced a comminuted periprosthetic fracture of the proximal femur, which required revision of the loose stem. The stem could be recovered without any instrumentation. Recovery and rehabilitation up to now 1 year postoperatively are uneventful.

Radiologic studies are presented. The structure of the implants surface was photo documented. Tissue specimens sampled during debridement of the medullary cavity of the proximal femur have been examined by uCT. The crystallographic phases of the HA coating and of adhering bone residues were determined by x-ray diffraction (XRD) methods.

Results: The thin and dense line parallel to the medial edge of the implant seen in conventional radiographies could be identified by uCT to be the HA coating of the stem with a thickness of 60 – 100 µm. It had been well integrated by bone, but showed a separation from the implant. Where bone growth had occurred the HA had resorbed in large parts, while still being present, but fragmented, under adhering bone trabecula. Local polishing of the roughened surface of the stem was also identified.

Discussion & Conclusions: Analysis of the retrievals confirmed good bone ongrowth on the HA layer, but the coating had separated entirely from the underlying stem. Partial polishing of the rough surface of the stem indicates separation of the HA coating long before the trauma. Such early failure of the HA coating on the metal of the stem is a poor result for a permanent implant. XRD revealed no alteration of the HA crystalline structure. Closer investigation showed a directional bone growth pattern, possibly induced by the HA crystal direction. Remaining HA was identified between the trabecular bone was fragmented and unstable. This case indicates the risk and the chances of HA coatings on THA and further investigations are needed.

P047

Coronal alignment parameters vary widely in non-osteoarthritic knees – a study performed on 3DCT

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Introduction: The postoperative coronal alignment is a key factor for a good clinical outcome in total knee arthroplasty (TKA). At the same time, the optimal alignment has been under debate in recent years. Some surgeons promote TKA alignment concepts where the alignment goal is defined according to the native alignment of the patient. Such approaches require a profound knowledge about the variability of the native alignment, which seems to be missing. Only few studies assess the variability of the native alignment and the few only used radiographs. The purpose of this study was therefore to assess the variability of the coronal alignment in native knees using 3D reconstructed CT scans.

Methods: The hospital registry was searched for patients older than 16 and younger than 45 years, who received a CT according to the Imperial Knee Protocol. Patients with prosthesis, osteoarthritis, fractures or injury of the collateral ligaments were excluded. Finally, 308 non-osteoarthritic knees of 160 patients remained (102 males and 58 females, mean age \pm standard deviation (SD) 30 \pm 7 years). The following angles were measured using a validated software (KneePLAN 3D, Symbios, Yverdon les Bains, Switzerland): hip-knee-ankle angle (HKA, angle formed by the lines connecting the centers of the femoral head, the knee and the talus), femoral mechanical angle (FMA, angle between the mechanical axis of the femur and the tangent to the distal femoral condyles) and tibial mechanical angle (TMA, angle between the mechanical axis of the tibia and the tangent to the tibial plateau). Since a neutrally aligned limb is the current gold standard for TKA, it was further assessed how variable FMA and TMA were in neutrally aligned limbs (HKA 180 \pm 3).

Results: The overall mean HKA \pm SD was 179.7 \pm 2.9 varus. Values ranged from 172.6 $^\circ$ varus to 187.1 $^\circ$ valgus. The overall mean FMA \pm SD was 93.4 \pm 2.0 and values ranged from 87.9 $^\circ$ varus to 100 $^\circ$ valgus. The overall mean TMA \pm SD was 87.2 \pm 2.4 with a range from 81.3 $^\circ$ varus to 94.6 $^\circ$ valgus. A neutrally aligned limb was found in 76% of the population. The FMA of these limbs ranged from 88 $^\circ$ varus to 100 $^\circ$ valgus and the TMA from 81 $^\circ$ varus to 92 $^\circ$ valgus. A neutrally aligned limb with a neutrally aligned tibia and femur (90 \pm 3) was found in 19% of the population.

Conclusion: All coronal alignment parameters varied widely in a young non-osteoarthritic population. The variability of FMA and TMA remains high even when the overall alignment is limited to neutral.

P048

Meniscus sizing using three-dimensional models of the ipsilateral tibia plateau based on CT scans - a new sizing approach

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Background: Meniscus allograft transplantation seems to be a reliable option for postmeniscectomy syndrome in young patients. Selection of a meniscus allograft with a similar three-dimensional (3D) size is essential for an optimal distribution of joint pressure and good clinical results. Direct meniscus sizing by MRI scan is not possible in total meniscectomy and indirect sizing by conventional radiography (RX) often inaccurate.

Purpose: The purpose of this study was to develop a new indirect sizing method, based on the three-dimensional shape of the ipsilateral tibia plateau, which is independent of the meniscus condition and could be performed fully automatized. Further, we analyzed the accuracy of the method compared to the currently used RX and MRI based sizing methods.

Methods: Fifty healthy knee joints with available RX, MRI and computer tomography (CT) scan were used. 3D surface models of the menisci were created by segmentation in MRI scan and 3D bone models of the tibia plateau by semi-automatic segmentation of the corresponding CT scan. For the further analysis, we created 3D bone models of the proximal 10 mm of the entire tibia plateau and of the half tibia plateau with and without the intercondylar area in a standardized fashion. For each meniscus, the best fitting “allograft” couple out of all other 49 menisci were assessed 1) by the surface distance of the 3D meniscus (3D-MRI), 2) by the surface distance of the 3D tibia plateau (3D-CT) and 3) by width/length measured in x-ray (2D-RX).

Differences between the gold standard (3D-MRI) and the other sizing methods were assessed by mean (MeSD) / maximum surface distance (MaSD), as well as meniscal width, length and height.

Results: 3D-CT sizing using the half tibia plateau without the intercondylar area was better than the other 3D-CT sizing methods ($p < 0.001$). Neither sizing by 3D-CT technique, nor by 2D-RX of the ipsilateral tibia plateau could select the best possible allograft in each case (Differences to 3D-MRI of MeSD 0.18-0.35 mm, MaSD 1.25-1.99mm, $p < 0.001$). 3D-CT sizing was significantly better for medial, but not better for lateral meniscus than 2D-RX sizing.

Conclusion: Automatized, indirect meniscus sizing using the 3D bone models of the tibia plateau is feasible and more precise than the previously described 2D-RX method. This method might become the gold-standard after total meniscectomy if 2D-MRI sizing is not possible. However, further technical improvement is needed.

P049

Three-dimensional meniscus allograft sizing - a retrospective study of 280 healthy menisci

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Introduction: Even in the 21st century, meniscus allograft sizing is done only by width and length of the meniscus in 2D MRI scan of the contralateral side, or even only in conventional radiographs of the ipsilateral side. Although it is recognized that length, width and height do not correlate and a similar 3D shape of the allograft is crucial for good results, 3D meniscus sizing has still not yet been tried.

The purpose of this study was to evaluate a new 3D meniscus sizing method to increase the accuracy of the 3D allograft shape and to reduce outliers, compared to the currently used radiographic and MRI sizing methods.

Methods: 280 3D meniscus surface models were generated out of 50 bilateral and 40 unilateral knee joint MRI scans. All together served as an imaginary meniscus allograft tissue bank. Meniscus sizing and allograft selection was done for all 50 bilateral knee joints by 1) the closest mean surface distance (MeSD) (3D-MRI sizing of the contralateral meniscus), 2) the smallest meniscal width/length difference measured in MRI (2D-MRI sizing of the contralateral meniscus) and 3) in x-ray as proposed by Pollard (2D-RX sizing of the ipsilateral tibia plateau). 3D shape (MeSD and maximum surface distance (MaSD)), as well as meniscal width, length and height were then compared between the selected and original meniscus. And all three sizing methods among each other.

Results: Allograft selection by MeSD (3D-MRI) was in all measurement parameters superior. Especially the 3D shape was significantly improved ($p < 0.001$), while mean differences in meniscal width, length and height were only slightly, but not significant better ($p = n.s.$). Further, outliers over 5 mm in width and length could be reduced by 2.8 times for medial and by 1.3 times for lateral meniscus.

Conclusion: 3D MRI sizing by MeSD of the contralateral meniscus can significantly improve meniscus allograft selection, compared to sizing only by width and length in radiography or MRI. Sizing by conventional radiography seems not to be very reliable with up to 48% outliers over 5 mm.

P050

Highly variable coronal tibial and femoral alignment in osteoarthritic knees – a systematic review

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Purpose: There is a lack of knowledge about coronal alignment variability in osteoarthritic knees. Therefore, the purpose of this article was to systematically review the current literature and collect data about the lower limb alignment including hip-knee-ankle angle (HKA), femoral mechanical angle (FMA), tibial mechanical angle (TMA) and the joint line convergence angle (JLCA) in osteoarthritic knees.

Methods: A systematic review was performed using the electronic databases MEDLINE (PubMed), EMBASE and Google Scholar. The following keywords were used: (morphology OR geometr* OR anatomy OR alignment OR phenotypes), (coronal OR neutral OR varus OR valgus), (knee OR lower limb OR femur OR tibia) and (osteoarthritis OR arthritis). Out of 110 full text articles retrieved 15 studies were included. Demographic information included author's names, year of publication, imaging modality, sample size and patient demographics (i.e. sex, age, etc.). Descriptive statistics, such as means, ranges, and measures of variance (e.g. standard deviations, 95% confidence intervals (CI)) for all angles (HKA, FMA, TMA, JLCA) are presented.

Results: Thirteen studies reported mean overall HKA angles ranging from 163.5°±2.3° to 179.9°±4.8°. The mean HKA angles in females were between 164.1°±7.2° and 178.8°±4.8°, and between 163.4°±5.5° and 177.4°±3.9° in males. The highest reported HKA angles were 27.7° varus and 22.0° valgus. Seven studies reported mean FMA angles. Mean values ranged from 92.7°±2.7° valgus to 88.6°±2° varus. The reported mean FMAs for male were 87.9°±0.5 to 90.7°±3° and for female 89.91°±2.8° to 92.9°±3.1°. Six studies reported mean TMA values. TMA ranged from 81.7°±3.9° varus to 87.7°±4.1° varus. Only three studies reported mean JLCA angles, which ranged from -4.3° to -6.4°±3.8°.

Conclusion: Osteoarthritic knees showed a huge variation in overall coronal limb alignment as well as in femoral and tibial coronal alignment. Current total knee arthroplasty (TKA) alignment philosophies and pre-operative planning do not sufficiently consider this variation, which might be one reason for unhappy knees after TKA.

P051

Native non-osteoarthritic knees have a highly variable patellofemoral alignment – a systematic review

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Purpose: There is still a lack of knowledge regarding the variability of patellofemoral alignment in healthy, non-osteoarthritic knees without patellofemoral instability. We therefore conducted a systematic review of the current literature to evaluate the variability of native patellofemoral alignment.

Methods: The patellofemoral alignment of the knee was defined by the following parameters: sulcus angle (SA), femoral trochlear depth (FTD), patellar tilt angle (PTA), lateral patellofemoral angle (LPFA), lateral femoral trochlear inclination (LFTI) and tibial tubercle – trochlear groove distance (TT-TG). The electronic databases MEDLINE and EMBASE were searched from database inception to search date (January 11, 2019) and screened for relevant studies. The PRISMA guidelines were followed. Inclusion criteria were studies that report the patellofemoral alignment of the native, non-osteoarthritic knee without patellofemoral instability.

Results: A total of 15 studies met the inclusion criteria. Twelve studies performed the measurements on MRI, three studies used CT and two studies used X-ray in addition to MRI. The reported mean SA (°) values ranged from 118.7 ± 7 to 168 ± NA. The mean FTD (mm) ranged from 3.4 ± 1.1 to 7.1 ± 1.8. The reported mean PTA (°) values ranged from 0.7 ± 4.99 to 17.05 ± 4.3. The reported mean LPFA (°) values ranged from 6.26 ± 4.1 to 11.1 ± 4.0. The reported mean LFTI (°) values ranged from 16.3 ± 2.8 to 22.1 ± 1.9.

Conclusion: The broad variability of native patellofemoral alignment shown in this systematic review suggests the necessity for a more anatomic and individualized approach in knee surgery.

P052

Blackburne-Peel or modified Insall-Salvati ratio after total knee arthroplasty – is there a clinical relevance?

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Introduction: Alterations in patellar height and posterior tibial slope (PTS) are frequently measured radiographic parameters associated with postoperative impairments after total knee arthroplasty (TKA). Few studies correlate the clinical outcome of TKA with the radiological indices. We hypothesised that both the modified Insall-Salvati ratio (mISR) and the Blackburne-Peel ratio (BPR) would correlate with the clinical outcome after TKA.

Methods: A total of 282 computer navigated primary LCS-TKAs, implanted in our institution from 2008 to 2012, were included. Data (ROM, FJS-12, WOMAC and revision surgery) were collected independently and prospectively. Patellar height (mISR, BPR), joint line position and PTS were measured on pre- and postoperative radiographs. Bivariate and multiple regression analyses were performed.

Results: Mean mISR (1.5 to 1.4) and BPR (0.8 to 0.6) decreased from preoperatively to one year follow-up. Mean joint line shift in a cranial direction was 2mm after TKA implantation. Analysis of dichotomous variables (presence of PB and PPB or not) only showed significantly lower flexion in patients with PPB (p < 0.001). However multiple regression revealed that BPR was a significant positive independent predictor for FJS-

12 (p = 0.016) and flexion (p < 0.001) at one year follow-up. Postoperative PTS (p < 0.01) and initial patella height (p < 0.001) were both predictive for BPR at follow-up, while the joint line height was not.

Conclusion: The BPR is a useful and capable radiographic parameter to predict patient outcomes one year after primary navigated TKA. Lowering the BPR should be avoided, as this may lead to significant restrictions in terms of ROM and patient reported outcome measures.

P053

Surgical access to proximal tibio-fibular joint problems

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Introduction: Access to the tibio-fibular joint is limited due to the surrounding soft tissue coverage and vicinity of the peroneal nerve. In lateral tibia plateau fractures, trans-fibular approaches to address the comminuted poster-lateral joint surface have been described 1) 2) – however there is no description of approaches to treat pathologies of the proximal tibio-fibular joint.

Objectives: We present the approach used in 2 cases to treat articular neoplasms of the proximal tibio-fibular joint.

Patients:

Case 1: Female patient (50y), with chondromatosis of the proximal tibio-fibular joint. A first attempt elsewhere by partial resection from posterior failed and the patient suffered from persistent pain. Full exposure of the joint by a subcapital osteotomy with proximal reflexion of the fibular head and the lateral collateral ligament after release of the common fibular nerve (CFN) allowed complete resection of the chondromatosis. The fibular head was then arthrodesed to the tibia with 2 screws, while the subcapital osteotomy was left without osteosynthesis. The arthrodesis healed uneventfully as well as the subcapital osteotomy within 10 weeks, painfree jogging was possible 12 weeks after the procedure.

Case 2: Male patient (50y), with osteo-chondroma of the proximal fibula at the level of the tibio-fibular joint. A similar approach after exposure of the CFN was performed, with full resection of the osteo-chondroma and arthrodesis of the joint. The arthrodesis with 2 screws as well as the osteotomy united within 8 weeks, providing painfree unlimited function of the knee joint.

Results: There were no complications during the procedure or in the postoperative follow-up period. The tibio-fibular arthrodesis healed uneventfully, the patients were painfree with unrestricted function after 8 and 10 weeks, respectively. There were no problems encountered from the common fibular nerve (CFN) after full exposure of the nerve during surgical exposure.

Conclusion: This appearingly rather detouring approach allowed full visualization of the proximal tibio-fibular joint to treat the underlying pathology. Healing of the subcapital fibula osteotomy in our cases did not need special attention and the approach led to high patient satisfaction after short rehabilitation.

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P054

Open Knee Extensor Mechanism Ruptures: A Less Invasive Technique

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Introduction: Acute traumatic patellar and quadriceps tendon lacera-
tions may occur with a transverse anterior knee wound, going straight
down to the tendon. To expose the entire patella for transosseous tunnel
repair, the surgeon has to extend the wound longitudinally over the pa-
tella, creating a skin flap that may present healing issues and induce
anterior knee pain due to the scar tissue in the prepatellar bursa. Based
on a clinical case, we present a less invasive technique that avoids the
need to extend the traumatic wound, thus potentially decreasing skin
healing complications and anterior knee pain occurrence as well as op-
erating time.

Methods: We present the case of a 23 year-old patient, transferred with
a deep, transverse anterior knee wound made by a snowboard. Physical
examination showed a complete patellar tendon section. He was taken
to the operating theater for wound exploration and repair of the patellar
tendon. In order to avoid longitudinal extension of the traumatic wound
to expose the patella for transosseous tunnel repair, the following tech-
nique was applied: The technique is based on the use of a 2.4 mm

straight passing needle, used in anterior cruciate ligament reconstruction, that is used as a drill and a suture passer at the same time, making it possible to drill the transosseous tunnels in the patella without having to expose its entire surface. The sutures are passed through the patellar tunnels using only the traumatic wound and the knots are tied through a small incision at the opposite pole of the patella. No skin flaps need to be raised and the patellar bursa is left untouched.

Results: With a standard postoperative rehabilitation protocole, the use of this technique allowed full recovery of range of motion at three months and muscle strength at six months postoperative. There is no anterior knee pain and the cosmetic result is better, since only the traumatic wound was used to repair the patellar tendon. There were no wound healing issues and no wound adhesion with the underlying tissues. In our experience, the technique is no more difficult than the standard technique and there is practically no learning curve, making it ideal in open ruptures with a transverse wound.

Conclusions: We propose this technique in cases of open acute patellar or quadriceps tendon ruptures. It allows for a decrease in surgical trauma, can potentially decrease skin healing complications, anterior knee pain and accelerate rehabilitation.

P055

Chronic patellar tendon rupture on a native knee: reconstruction with an Achilles tendon allograft with a calcaneal block. A case report.

Hafize Heutschi-Öztürk

Introduction: Chronic ruptures of the patellar tendon have important consequences on the daily life of patients, considering the lack of the extension function and thus the difficulty to walk. Several techniques have been described for the reconstruction, with allo- or autograft and yet no consensus has been reached for the solution that works best. We describe the case of a reconstruction with an Achilles tendon allograft for a chronic rupture that happened two years ago.

Case report: A 60-year-old man consulted for a chronic rupture of his left patellar tendon after a fall with direct reception on the knee. He has been admitted in another hospital where they recommended surgery that the patient refused. In the meantime he was hospitalised several times in a psychiatric hospital for alcoholic withdrawals in a context of personality disorder. Finally, he decided to support a surgical intervention because of his difficulty to walk while having to remind constantly to keep the knee in extension.

During the physical examination we were able to palpate the femoral condyles as well as the intercondylar spaces through a gap while the patient was flexing. The patella was mobilized and it was possible to lower it. The patient was able to walk slowly with the knee kept in extension.

After discussing the case with colleagues, we decided for the reconstruction with an Achilles tendon allograft with the calcaneal block. The latter has been inserted in a cavity previously prepared under the tibial tuberosity and fixed with a 3.5 mm screw. Then, after having estimated the optimal height of the patella, we introduced a cerclage through it distally to the tibial tuberosity. We then fixed the graft on the quadriceps tendon and around the patella with Orthocord suture in such a way to cover the patella.

For postoperative care, we prescribed a knee extension brace for walking and authorized the early progressive mobilization during physiotherapy. At 3 months followup, the patient was able to flex at 90° with a total extension and the quadriceps muscle strength estimated at 4.

Conclusion: Chronic patellar tendon ruptures remains controversial. It is essential to consider every option depending on the knee being native or not, and the different types of grafts. If an allograft does not convince some surgeons, in particular due to the risks of infection and its availability, it still is an excellent option with a good cover of important tendon defects.

P056

A SPECT/CT study of the in-vivo bone load of native patella after primary total knee prosthesis: which are the differences between native pain-free patella from overstuffed patellae needing secondary patellar resurfacing?

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Introduction: The question to resurface the patella at the time of primary implantation of total knee arthroplasty (TKA) is still open. Aim of this

study was to investigate which parameters correlate with the need for secondary patellar resurfacing after TKA.

Methods: 76 patients who underwent primary TKA (cruciate retaining or posterior stabilized) without patellar resurfacing because of primary osteoarthritis were retrospectively analyzed. Group N included 40 pain-free patients at 1- and 2-years postoperative controls. Group SR included 36 patients who developed patellar overstuffing that resolved after secondary patellar resurfacing. Both groups were comparable with regard to age, gender and knee side.

All patients underwent pre- and postoperative standard knee x-rays, orthoradiograms and 1.5 years postoperative SPECT/CT.

The following data were collected: pre- and postoperative leg axis and Caton-Dechamp index (CD-index), three-dimensional position of the TKA components and sizes of TKA components.

The patellar bone load was evaluated on SPECT/CT images. According to a previously validated scheme, the patella was divided into 8 quadrants and the mean bone trace uptake (BTU) was calculated.

All data were compared between groups with parametric and non-parametric tests and within groups with the Pearson's correlation.

Results: Both groups showed corrected aligned TKA components and neutral postoperative leg axis (Group N: 1.03 varus ± 3.08; Group RS: 0.53 varus ± 0.96) which did not differ significantly. Despite pre- and postoperative CD-Index of both groups were within the normal range, group SR showed a significant higher postoperative CD-Index (Group N: 0.74 ± 0.16; Group RS: 0.86 ± 0.16). The patellar bone load was significantly higher in three of four not articular quadrants in group SR (superolateral, superomedial and inferomedial).

The Pearson's correlation showed significant correlations between almost every patellar quadrant and the femoral size in group N and with the femoral and tibial size in group SR.

Almost all quadrants of group SR correlated with the postoperative CD-Index (Not articular: inferolateral, superolateral, inferomedial; articular: inferomedial, inferolateral).

Conclusions: A significant higher bone load on the not articular half of the patella seems to be related to the need of secondary patellar resurfacing. The corrected alignment of the TKA components and postoperative leg axis could have limited the correlations with the SPECT/CT data.

P057

Short-Term Outcomes of Extensor Mechanism Allograft Reconstruction in Multi-Operated Knees

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Introduction: Extensor mechanism insufficiency (EMI) in patients with history of multiple knee surgeries is a devastating complication. Treatment usually involves surgery. Studies have reported poor outcomes after direct repair, even for acute ruptures. Thus, the 2 most popular management techniques are EM reconstruction or arthrodesis. However, no technique yields superior outcomes. The aim of our study is to describe the results of EM reconstructions with complete allografts.

Methods: We prospectively followed 2 patients with TKA and history of multiple surgeries ending up in prosthetic infection and EMI. All patients were treated with fresh-frozen allografts that were composed of the quadriceps tendon, the patella, the patellar tendon and the tibial tubercle. The senior author performed all surgeries according to the technique described by Bonin. However, he used screws instead of cerclage wires to secure the graft on the proximal tibia. A medial gastrocnemius flap was done in 1 case to cover the tibial tubercle due to poor skin conditions. Recorded outcomes measures included: clinical exam, x-rays, KSS and SF-12.

Results: FU time was 12±4.2m. Age at surgery was 73±14.1yo. At the most recent FU: Grafts didn't show any signs of lengthening and tibial tubercle healed properly. Patellar height was 0.9±0.1 (Caton-Deschamps). Quadriceps strength was M4. Knee flexion was 107.5°±3.5. Extension lag was 10°. All patients could walk with full weight bearing using 2 crutches. Knee and function KSS values increased from 41.5±0.7 and 0 (preoperative) to 76.5±7.8 and 35.0±21.2 (at FU), respectively. PCS and MCS SF-12 increased from 17.4 and 37 (preoperative) to 38.1±7.4 and 60.3±0.9 (at FU), respectively.

Conclusion: Short-term outcomes of EM reconstruction with complete allografts in patients with lower level of activity are good. All Patients recovered their full level of activity. All the grafts are still functional and the remaining extension lag did not interfere with patient daily activities. Reported KSS values are higher than those of similar patients treated in our hospital by arthrodesis (knee and function KSS values were 51±7.1 and 30±7.1, respectively). Soft tissue coverage with a medial gastrocnemius

flap is an option in patients with poor soft-tissues. Although it isn't possible to draw any conclusions from this study because of its small number of patients, the results of such procedures are encouraging and this technique deserves to be studied in more detail

P058

Determining factors for sports participation 2 to 3.5 years after anterior cruciate ligament reconstruction

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Objectives: Return to sports after anterior cruciate ligament reconstruction (ACL-R) shows satisfactory results, whereas two to three years post-operatively, sports activity levels are decreasing. The aim of the study was to assess sports activity levels at a minimum of 2 years after ACL-R and investigate on persisting complains in patients returning to their initial sport (RTP) or that changed their sports activity (RTP).

Methods: All patients that underwent primary/isolated ACL-R between October 2013 and June 2015 with isocinetic strength testing 6 to 9 months postoperatively, were eligible for this study. They were contacted by phone and answered a structured questionnaire upon their current sports activity and persisting complaints.

Results: Fifty-six of 73 of the contacted patients were willing to participate (18 female, 30±8 years) with a medium follow-up of 3 years (range: 1.9 to 3.7). RTS was found 75% (N = 42) and RTP in 23%. One patient did not return to any sporting activity. 21% of the RTS were symptom-free, whereas 33% felt some sort of apprehension, pain (29%) or muscular weakness (10%). The most frequent reason to RTP was apprehension (38%), loss of motivation (31%) and pain (8%). The isocinetic strength testing could not predict either RTS/RTP.

Conclusions: Apprehension and post-operative pain are frequent, and equally found in patients with RTS or RTP at 3 years after surgery. Early strength test results alone at 6 to 9 months seem not to be of any benefit to predict RTP or RTS.

P059

Recurrent Patellar Dislocations: Trochleoplasty Improves the Results of Medial Patellofemoral Ligament Surgery only in Severe Trochlear Dysplasia – A Meta-analysis

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Introduction: Medial patellofemoral ligament (MPFL) surgery combined with trochleoplasty (TP) is often performed to restore the normal patellofemoral biomechanics avoiding recurrent lateral patellar dislocation (LPD) in patients with trochlear dysplasia (TD). However, TP is an invasive and technically demanding procedure and the advantages of combining a TP to MPFL surgery instead of performing MPFL surgery without TP are still controversial.

Methods: This meta-analysis quantitatively synthesizes and compares data about outcomes of the treatment of recurrent LPD with MPFL surgery without or with TP in patients affected by TD. A systematic literature search about the treatment of recurrent LPD in the presence of TD was conducted. The primary outcome was the redislocation rate, analysed for different type of TD. As secondary outcome Kujala, and IKDC score were analysed through a meta-analysis. Furthermore, the complication rate was analysed.

Results: No significant difference was found in the overall redislocation rate between MPFL surgery without and with TP. The redislocation rate after MPFL surgery without TP in patients with type A or B TD and in patients with type C or D TD was significantly different (2.7% vs. 18.6%; $p < 0.001$). In the analysis for every single type of TD the following results were obtained: a redislocation rate of 1.8% in type A, 3.2% in type B, 11.9% in type C, and 7.4% in type D TD. A significant difference in the complication rate favoring MPFL surgery without TP was documented. Both surgical approaches provided a significant improvement with no difference in Kujala and IKDC scores. These results were confirmed when data were analysed including only patients with type B, C, or D TD or without additional bone remodelling procedures.

Conclusion: Isolated MPFL is as effective as combined TP and MPFL surgery in preventing redislocation and improving clinical and functional outcomes in patients with recurrent LPD and knees affected by moderate TD. However, in case of severe TD, the redislocation rate is lower when

TP is performed in combination with MPFL surgery, although with comparable clinical outcomes and a higher risk of postoperative range of motion (ROM) limitation.

P060

Bone bruise characteristics in the pediatric population with anterior cruciate ligament tears

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Introduction: During ACL injury, the external forces responsible for ligament rupture can cause a violent impact between the tibial and femoral articular cartilage, which is transferred to bone, resulting in bone bruise. As such, bone bruise characteristics could be an important aspect to better understand the level of joint derangement. While this has been widely investigated in adults, the literature still lacks information about younger patients, where intrinsic differences in terms of ligamentous laxity may lead to different lesion patterns. Purpose of this study is to investigate bone bruise associated with ACL rupture in the pediatric population, to clarify the possible impact on joint homeostasis.

Methods: MRIs of the knee of patients aged 8 to 16 years with ACL tears have been selected from the Institution database. Inclusion criteria were open or at least partially open physis, time between trauma and MRI less than 90 days and no history of prior injury or surgery. Presence of bone bruise, its localization and size were analyzed by two researchers blinded to radiologist's reports and scored with Whole Organ Magnetic Resonance Imaging Score (WORMS). Moreover, ligaments, cartilaginous, meniscal, or other lesions were documented.

Results: Among the selected 78 patients with ACL tears, 54 had bone bruise for a 69% prevalence. Mean area of bone bruise differed between females, where it was 2.2 ± 1.4 cm² in the femur and 1.5 ± 0.8 cm² in the tibia, and males, who had 3.8 ± 2.8 cm² in the femur and 2.6 ± 1.6 cm² in the tibia ($p = 0.006$ in femur; $p = 0.007$ in tibia). Sub-regions mostly affected were lateral posterior tibia and lateral central femur that were involved in 83% and 80% of the knees with bone bruise, respectively. There were low relationship between age and bone bruise area or WORMS (age-area $r = 0.25$; age-WORMS $r = 0.31$). Other injuries associated with bone bruise were 10 ligamentous lesions (18.0%), 3 cartilaginous lesions (5.5 %); 17 meniscal lesions (31.0%); and 1 patellar fracture (1.8%). Non significance has been seen with patients with ACL tear and no bone bruise.

Conclusion: The prevalence of bone bruise in pediatric patients with ACL tears is high, although slightly lower than what documented in adults. The area and the distribution pattern of bone bruise are similar among different ages. The low presence of cartilaginous lesions with respect to what reported in adults suggests a different impact of this trauma on the knee joint in pediatric patients.

P061

Tibio-Femoral Kinematics of the Healthy Knee during Level and Downhill Walking

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Introduction: Accurate assessment of 3D tibio-femoral kinematics in vivo is essential for a clear understanding of knee joint functionality. Downhill walking (DW) exhibits altered kinematics and kinetics (Lay et al. 2006, McIntosh et al. 2006) and is thought to be more challenging than level walking (LW), especially in terms of anterior-posterior (A-P) translation, in TKA subjects. Therefore, the aim of this study was to analyse and compare healthy knee kinematics during complete cycles of LW and DW.

Methods: 7 subjects (24.7 ± 3.4 years, 22.1 ± 1.7 kg/m²) with healthy knees and a radiologically examined neutral limb alignment ($\pm 3^\circ$) were assessed during 5 to 6 complete cycles of LW and DW (10° slope) using a moving fluoroscope (25Hz) (List et al. 2017). After 2D/3D registration of the fluoroscopic images, tibio-femoral rotations and A-P translations of the nearest point of each femoral condyle relative to the tibial articular surface were calculated.

Results: DW showed an increased range of flexion compared to LW (LW $65.2 \pm 4.8^\circ$; DW $72.7 \pm 3.8^\circ$), while the other rotations and the range of A-P translation showed no task dependency. A significantly larger range of A-P translation was found for the lateral relative to the medial condyle

over the whole gait cycle for both tasks (LW lat 22.8 ± 7.2 mm, med 13.8 ± 1.7 mm; DW lat 22.6 ± 8.9 mm, med 13.2 ± 2.2 mm). However, one subject exhibited a larger range of A-P translation for the medial compared to the lateral condyle for LW and DW. For all subjects, extension of the knee during the swing phase was associated with anterior translation of the lateral condyle.

Conclusion: Overall, this *in vivo* study of healthy knees using a moving fluoroscope, revealed larger ranges of A-P translation for the lateral condyle, indicating a centre of rotation primarily located on the medial side of the knee joint for both LW and DW. These findings are in line with previous studies based on static examinations of the knee (Freeman & Pinskerova 2005). Comparing the two walking tasks, only the range of flexion showed a task dependency. Nevertheless, femoral A-P translation movement patterns were highly subject-specific in both tasks. These results suggest that the evaluation of individual knee kinematic patterns might play a key role in guiding implant selection and surgical processes towards successful joint replacement.

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P062

Back To Work After Total Knee Arthroplasty (TKA): A Work Perspective.

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Background: The amount of primary knee prosthesis has been constantly increasing worldwide for several years, even within the active population. Many studies have shown that around 71 to 83 % of patients after total knee arthroplasty (TKA) get back to work within 3 to 6 months. However, the patients' professional activity may have a role to play regarding the delay before returning to work.

Aim: The aim of our study is mainly to observe whether the delay depends on the patients' professional sector.

Study Design & Methods: We studied the 618 TKAs performed from 2010-14 in our hospital. Were included the patients within the working age (under 65 years old) and that had a professional activity at the time of the surgery. Those who were 1 year from retirement were excluded from the study. The final number of patients included was 110, with a mean age of 57 years old, a mean BMI of $30.8 \text{ kg/m}^2 \pm 5.7$, mainly males (71.8%) and classified ASA2 (72.7%). The different professional activities were classified according to the National Institute of Statistics and Economic Studies: primary, secondary, and tertiary. We observed the percentage of patients who regained their professional activity within 6 months following surgery, and those regaining their duty over 6 months. Within this last category, we studied whether some of them underwent a career transition

Results: During the study period, 50% patients were in the tertiary sector, 38.2% in the secondary sector and 11.8% in the primary sector. During the following 6 months after surgery, all socio-professional sectors included, 53% of patients regained their professional activity and 78% at 2 years. Regarding the secondary sector, 80.5% returned to work after 6 months, knowing that 13.8% of them faced a career transition. None of the primary nor tertiary sector underwent a career transition. However, among the patients not returning to work within the 2 years after surgery, 23% lost their jobs and asked for a disability insurance, whereas the other 77% regained their activity with a 50% work incapacity.

Conclusions: Patients who regain their profession within the first 6 months, maintain their professional career, regardless of their professional sectors. However, patients facing difficulties to return to work may have a less favorable prognosis of maintaining their job, and may need a disability insurance in order to support their condition.

P063

Back to Work After Knee Arthroplasty: Total (TKA) vs Unicompartmental (UKA)

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Background: The amount of patients undergoing knee replacement surgery is increasing worldwide, even throughout the active population, whether it involves total knee arthroplasty (TKA) or unicompartmental knee arthroplasty (UKA). However, the delay before returning to work may differ between these two surgeries.

Aim: The aim of our study is to compare the UKAs and TKAs delay before returning to work, and mainly according to their professional sectors.

Study Design & Methods: 618 TKAs and 302 UKAs were performed from 2010-14 in our hospital. Were included the patients within the working age (under 65 years old) and that had a professional activity at the time of the surgery. Those who were 1 year from retirement were excluded from the study. The final number of patients included were 117 UKAs and 110 TKAs. The different professional activities were classified according to the National Institute of Statistics and Economic Studies: primary, secondary, tertiary. We assessed the percentage of patients regaining their professional activity within 6 months following surgery, and those regaining their duty over 6 to 24 months. Within this last category, we studied whether some of them underwent a career transition, and compared our results between the UKAs and TKAs.

Results: During the study period, the first difference between these two populations involved the main professional sector. Indeed, in the TKAs, 50% are in the tertiary sector, contrarily to the UKAs, where the secondary sector is predominant (47%). The secondary sector is exposed to a career transition whether the patient underwent TKA or UKA, with 33% in the UKA group and 13.8% in the TKA group. No career transition was observed in the primary nor tertiary sector, whether they underwent TKA or UKA. However, the UKA patients tend to return to work within 2 years after surgery (94%), whereas only 78% regained work within the same time period in the TKA group, more of them working only on a 50%-time basis or receiving a disability insurance (5.81%).

Conclusions: In our study, the UKA group is more favorable to return back to their professional activity within a large 2-year period after surgery, in comparison with the TKAs. However, the secondary professional sector is mostly at risk for a career transitioning in both surgeries. Surgeons therefore need to prepare the patient for this eventuality after undergoing the knee replacement.

P065

Gradual correction of at least 3-dimensional deformities with the external fixator Taylor Spatial Frame. A review of 34 cases

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Introduction: Treatment of frequently multidimensional deformities of various etiologies is a challenge in orthopedic surgery. Full restoration of limb alignment including leg length correction is the goal of treatment. The Taylor Spatial Frame (TSF) is a software supported hexapod ring fixator, which allows for gradual and simultaneous multidimensional deformity correction, based on callus distraction according to Ilizarov's principles.

We retrospectively reviewed 34 consecutive cases of at least 3-dimensional gradual deformity corrections in the tibia and femur with the Taylor Spatial Frame regarding etiology and type of deformity, final results and complications.

Methods: All cases of gradual deformity corrections with the Taylor Spatial Frame (TSF) between 2005 and 2018 were reviewed. Only cases with at least 3-dimensional corrections were included. Hence, 12 post-traumatic, 14 congenital and 8 cases of various etiology could be included in this study. There were 12 cases with 4-dimensional and 22 cases with a 3-dimensional deformity correction. Most of the cases included bone lengthening in combination with deformity correction in the frontal, sagittal or torsional plane. We treated 21 male and 13 female patients. Average age was 19 years at the time of surgery.

Results: The mean time in the external fixator was 24 weeks. Finally the aim of correction could be achieved in all patients. Average follow-up was 85 weeks. Complications included temporary nerve lesion of the profound branch of the peroneal, which fully recovered after 4 months, 2 cases of insufficient bone formation at the site of the callus distraction, treated with cancellous bone grafting and plating. One osseous infection occurred and needed surgical debridement but consecutively healed well. Premature consolidation (of the fibula) occurred in 1 case. 30 out of 34 patients suffered from a superficial pin infection, treated with oral antibiotics. At final follow up all patients were satisfied by the result and had no ongoing treatment related problems.

Conclusion: For multidimensional deformities in various etiologies the TSF serves as an ideal tool to fully restore the limb alignment by simultaneous gradual correction and limb lengthening. There might be temporary disadvantages due to the external fixation, nevertheless this is a temporary problem and is equalized by the advantages of the undoubtedly accuracy which is provided by this method.

P066

Résultats after knee arthrodesis with T2 Stryker Nail® in severe bone loss

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Introduction: Knee arthrodesis by intramedullary nailing may be one of the last option for limb salvage after severe bone stock deficiency and/or damage of the extensor mechanism due to an infected total knee arthroplasty (TKA), trauma or tumor. The goal of this procedure is to obtain a complete bony bridge and healing at the fusion site. The aim of our study was to evaluate bony fusion after knee arthrodesis using T2 Stryker nail.

Methods: 15 patients underwent knee arthrodesis with T2 Stryker nail from 2000 to 2017, and were retrospectively reviewed to assess fusion rate, time of fusion, complication rates, including new infections, and ambulatory status. Four patients were lost of sight (27%).

Results: 11 patients were included, with a mean follow-up of 47 months (8-131 months). At their most recent follow-up, 7 patients (64%) were full weight bearing on a fused arthrodesis (4/4 cortical) with a mean time of bone fusion of 25 months (6-95 months), 2 patients (18%) with a 2/4 cortical and 1 patient (9%) with a 1/4 fused cortical. Regarding the last patient (9%), with 0/4 cortical after 14 months, we replaced his T2 nail by a Wichita nail (Stryker).

Conclusion: Arthrodesis with the T2 Stryker nail gives satisfactory results regarding patients with failed TKA, trauma or tumor. Walking with an arthrodesis represents an acceptable option for limb salvage, especially knowing the costs and the energy expenditure than can be brought by an above knee amputation.

P067

Small Patella Syndrome (SPS)

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Introduction: Small Patella Syndrome (SPS) is an autosomal-dominant mutation of the TBX4 Gen 17Q23. Prevalence is >1/1.000.000 with 50 cases been described in literature. Clinically patients present with aplasia or hypoplasia of the patella with additional irregularities of the pelvis (hypoplasia or agenesis of the ischium, irregular ischial ossification at) and/or feet (flat-foot or club-foot deformity, brachydactyly). Cranio-facial anomalies have been described.

SPS is also known as ischiopatella dysplasia, ischio-pubic patella syndrome or Scott-Taor Syndrome, first described in 1970 by Goeminne and Dujardin.

Methods: We report on a 47-year female working as a farmer, who presented herself in our Orthopaedic Referral Clinic, currently suffering from recurrent knee pain and lacking strength in her thighs while working. Since childhood she is aware of "not having knee caps and parts of the pelvic bone".

Clinical examination shows extension limitation (Ex/Flex 0-30-140° -opposite side Ex/Flex 10-0-140°) in active movement, with passive movement bilaterally equal, proper ligament stability, no joint effusion, no positive meniscus signs.

Knee a.p./lat + Patella axial bil.: Aplasia of both Patella, slight OA with minimal varus bil.

Pelvis AP + Hips axial bil: Agenesis of both inferior rami pubis, no osteoarthritis of hip joint, Degenerative changes in pubic symphysis and left SI-Joint

MRI LFT Knee: Aplasia of Patella, Hypertrophy of the synovium in the anteromedial, slight joint effusion and baker cyst, minor osteochondral lesion IV° anteromedial on femoral condyle with bone bruise

MRI RT Knee Aplasia of Patella., Hx of MPFL rupture, Chondromalacia of medial compartment.

Results: The patient presents with an early onset of osteoarthritis. The muscular weakness seems to be explained by changed biomechanics of the force vector when activating the quadriceps. In case of continuous knee pain we discussed steroid infiltration and recommend adjustment of the work environment.

Conclusion: SPS is a rare condition in which aplasia of the patella can be combined with additional hypoplasia or aplasia of pelvis and feet. In patients with SPS symptoms can vary from no symptoms, to recurrent dislocation of the hypoplastic patella, the inability to run fast or ride a bike

to early osteoarthritis. Recent studies indicate a possible association between the TBX4 gene mutation and pulmonary arterial hypertension in children, suggesting screening in young patients with SPS.

P068

Clinical and Patient-Reported Short-Term Results after Customized Individually Made Total Knee Arthroplasty

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Praxis LEONARDO, Hirslanden Klinik Birshof

Introduction: The purpose of this study was to assess the clinical and patient-reported outcome measures of a customized individually made total knee arthroplasty (CIM TKA).

Methods: Since January 2017, we prospectively collected clinical and patient-reported outcome measures from patients scheduled for CIM TKA (iTotal, ConforMIS, Inc., Bedford, MA). All surgeries were done by the senior author. We collected data before the surgery, 4 months and 12 months postoperatively. Outcome measures included the functional Knee Society Score (fKSS), the Knee injury and Osteoarthritis Outcome Score (KOOS), the Forgotten Joint Score (FJS), the EQ-5D-3L and patient satisfaction. We analyzed data with paired t-tests.

Consistent with the indications for TKA, we exclude patients with compromised collateral ligaments or having a varus/valgus deformity >15°.

Results: We analyzed data for 24 prostheses (21 patients, 12 male) with a mean patient age of 66.5 years (standard deviation [SD] 9.4, range 48 to 82 years). Anatomic alignment before the surgery was neutral (n = 4), varus (n = 12) and valgus (n = 8), mean range of motion (ROM) was 108° flexion (SD 15.3, range 70 to 130°).

Complete follow-up data will be available in June 2019. Preliminary results of the first 14 prostheses (11 patients) showed 12 months after the surgery neutral alignment for all patients and a mean ROM of 130° flexion (p <0.001). All scores improved significantly: fKSS from 46 to 99 points (p <0.001), KOOS symptoms from 50 to 83 points (p = 0.001), KOOS pain from 49 to 88 points (p <0.001), KOOS daily living from 58 to 87 points (p <0.001), KOOS sport from 18 to 73 points (p <0.001), KOOS quality of life from 25 to 77 points (p <0.001), FJS from 16 to 69 points (p <0.001) and EQ-5D-3L from 0.579 to 0.877 (p <0.001).

Ten patients (91 %) were very satisfied or satisfied with the result of the surgery. One patient with a bilateral surgery was neutral and unsatisfied, respectively. There were no complications, besides one patient who required an arthrolysis following an arthrofibrosis due to a meanwhile healed complex regional pain syndrome.

Conclusion: The 12 months follow-up data collected on CIM TKA showed very good clinical and patient-reported results including a high patient satisfaction. Those results are at least as good as those reported from off-the-shelf implants. Future studies have to confirm those in long-term.

P069

Revision total knee arthroplasty in a patient with Charcot-Marie-Tooth disease.

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Introduction: Charcot-Marie-Tooth (CMT) disease is a rare hereditary neurodegenerative sensory-motor disorder affecting the peripheral nervous system. Total knee arthroplasty (TKA) in this particular patient cohort can be challenging. Furthermore, little is known about the long-term results and survivorship of TKA in these particular patients.

Case report: We hereby present a case of a seventy-two year old woman with Charcot-Marie-Tooth disease and bilateral distal muscle weakness with unstable and massively loose TKA with major tibial bone loss. The primary TKA surgery was twelve years ago. Postoperatively the radiographs showed a well-positioned and aligned TKA and the short-term evolution showed good functional improvement. However, the patient was referred with symptoms of invalidating pain and instability 12 years after primary surgery while the first symptoms gradually began 8 years after. The radiographic exams showed a massive prosthetic loosening with major bone loss on the femoral and tibial side. During revision surgery, significant metallosis, loosening of the femoral and tibial component and severe osteolysis of the tibial plateau was present. A one-stage revision was performed with a cemented semi-constrained TKA (Zimmer, LCCK), including augmentation of the proximal tibial metaphysis with tantalum support and additional bone graft. The patient recovered well and was able to discharge hospital 5 days after surgery. No

complications were reported. At one year post-operatively, the patient showed a favorable course with an excellent functional outcome.

Conclusion: CMT disease is a rare condition that can mimic diabetic neuropathy and can cause secondary atrophy of the gastro-soleus complex, lower leg muscular imbalance and therefore be a major risk factor for TKA loosening. It is important to be aware of the increased complication risk performing TKA in patients with CMT disease. Revision surgery in such situation can be complex due to massive bone loss and instability due to muscle weakness. Even more, it is crucial to follow up these patients closely in order to detect potential complications early. In our case, the revision to a semi-constrained TKA showed an excellent functional result at 1 year after surgery.

P070

Mobil Bearing 180° Spin after Medial Unicompartmental Knee Arthroplasty – a Report of two Clinical Cases

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Unicompartmental knee arthroplasty (UKA) is a safe and well-established treatment for unicompartmental osteoarthritis (OA). Mobile bearing devices promise less polyethylene wear but include the risk of bearing dislocation. We describe two rare cases with an 180° spin in the transversal plane of the mobile bearing and one secondary dislocation. Primary complaints were swelling, discomfort and a short episode of heavy pain. Both cases ended in revision surgery with conversion to a fixed bearing tibial component with good early postoperative results. Symptoms of a 180° spin of the bearing can be subtle, hence in patients with persisting but minor complaints such as swelling and discomfort a carefully radiographic examination is advisable.

P071

Thirty-Month Follow-up after Combined Osteochondral and Meniscal Allograft Transplantation of a Lateral Tibial Plateau in a Young Patient

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Introduction: Malunion of a tibial plateau fracture is associated with a significant risk for posttraumatic osteoarthritis. This complication can be successfully treated with joint replacement in older patients. However, knee arthroplasty in younger patients is associated with a high risk of implant loosening or surgical revision. Therefore, combined osteochondral allograft (OCA) and meniscal allograft transplantation (MAT) has been reported in literature as an alternative to knee arthroplasty in this group of patients.

Case: A 33-year-old patient sustained a split depression type fracture of the proximal tibia (AO 41B3.1) in his right knee that was treated with open reduction and internal fixation (ORIF). At three months postoperative, the patient reported persisting pain with full weight-bearing and CT-scan showed a large and deep osteochondral defect of the lateral tibial plateau. On the other hand, MRI confirmed intact cartilage of the lateral femoral condyle. At six months postoperative, a combined OCA and MAT of the lateral tibial plateau was performed to prevent early degeneration of the lateral compartment. To get full access to the joint, an osteotomy of the lateral femoral epicondyle was associated with the anterolateral approach.

At thirty-month follow-up, the patient was pain-free in all daily and sports activities. He took no medication. Flexion/Extension of the knee was 130-0-0° and the joint presented no effusion. Tegner and subjective IKDC scores were 7 and 92%, respectively. Additionally, X Ray and MRI of the knee performed two years postoperatively showed a complete osseous integration of the graft and an intact cartilage with a retained position and unaltered structure of the lateral meniscus.

Discussion: Combined OCA and MAT is an extremely rare surgical procedure associated with a reoperation rate of 50%. These reoperations were mostly simple arthroscopic procedures while failures requiring graft removal was reported in 12%-23% of patients. In patients with intact graft, all outcome scores were significantly improved after the surgery. Additionally, 78% of them were either extremely satisfied or satisfied with the operation.

Therefore, the reported case confirm that combined OCA and MAT could be a useful alternative to joint replacement in young patients allowing them to return to a full active life. However, it remains a difficult surgical procedure with a high re-operative rate.

P072

The role of generalized hyperlaxity in anatomical stabilization failures of the ankle: state of the literature and recommendations

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Introduction: The ankle stabilization procedure of Broström-Gould (BG) has become the gold standard in the treatment of post-traumatic lateral instability. It is called an “anatomical” reconstruction because it is close to the basic anatomy. However, a certain number of patients do not respond to this treatment and remain with persistent or recurrent pathological laxity. It has been suggested that generalized hyperlaxity may be an important risk factor for these failures.

We propose a review of the literature and recommendations for treatment of failures following anatomical repair in patients with hyperlaxity.

Methodology: We have reviewed the pertinent literature concerning the different causes of failure after an ankle’s stabilization, and extracted from each article those cases related to situations of hyperlaxity, when they were mentioned. The recommendations for treatment were noted and compared.

Results: Between 1966 and 2018 we identified 38 articles related to this topic (Pubmed research).

The BG procedure can give good clinical results in this patient population, but exposes these patients to between 4 to 6.3 times more recurrences. However, the most recent articles support continuation of the management by the technique of BG but reinforced with a synthetic strip. The graphs (which will illustrate this poster) summarize the clinical results after BG by comparing the hyperlaxity population to those without hyperlaxity.

Conclusions: Generalized hyperlaxity (patients with a Beighton score equal to or greater than 4/9) is more and more incriminated as a central factor in the failure of stabilization of the ankle. It is essential to diagnose hyperlaxity prior to performing any surgery. So far there is no consensus concerning the treatment of instability of the ankle in hyperlax patients. According to the literature there is a tendency in favor of the anatomic stabilization of BG, but reinforced with a synthetic strip in those patients.

P073

The Bosworth-like pilon-fracture: An uncommon case of ankle-fracture dislocation

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Introduction: An ankle-fracture dislocation characterized by the dislocation of the fibula posteriorly to the tibial tubercle is defined as “Bosworth injury”. Recent evidence shows that Bosworth injuries are often missed and that the true prevalence has been underestimated. Associated fractures such as a pilon fracture, medial malleolus fracture and posterior malleolus fractures have rarely been reported. Since closed reduction is often impossible to achieve, Bosworth fracture-dislocation require urgent surgery.

Method: In the current report, we present a rare case of a Bosworth-like pilon-fracture with an associated posterior malleolus fracture and impression of the posteromedial pilon. We present a distinct reduction manoeuvre, which might improve closed reduction rates in Bosworth-like fracture patterns.

Results: A 48-year old male patient was admitted to our emergency department, after he suffered a Weber type C fracture of the fibula with a posterior dislocation of the distal fibula behind the posterolateral tibia and posterior subluxation of the talus, representing a Bosworth-like fracture pattern. After 2 attempts in a peripheral hospital, closed reduction was finally achieved by plantar flexion of the ankle joint, pushing the ankle joint together with the distal fibula posteriorly and then pulling the talus laterally, which permits the fibula to pass behind the postero-lateral part of the tibia and go back in its incisura. After closed reduction, a CT scan revealed an additional fracture of the posterior malleolus together with an impression of the posteromedial pilon, which wasn’t evident on plane radiograph. After the soft tissues had improved sufficiently, operative treatment consisted of open reduction and intern fixation of the posterior malleolus and the pilon as well as stabilization of the syndesmosis.

Conclusion: The Bosworth fracture is an often missed, complex injury of the ankle joint. If encountered, CT scan should be obtained to assess additional fractures and associated soft tissue injuries and further plan operative treatment. In case of an irreducible ankle fracture dislocation, Bosworth-like injuries should be considered as a potential cause. Alt-

though closed reduction is difficult to achieve, success rate might be increased by applying axial traction to the plantar flexed ankle joint and laterally reduce the ankle joint. If closed reduction failed, early open reduction and stable internal fixation is the treatment of choice.

P074

Realignment osteotomy in fibular malunion: mid-term results in 19 consecutive patients

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Introduction: Incidence of fibula fractures continues to increase. The exact incidence of distal fibula malunions after fibular reconstructions is unknown, but up to 33% is described in literature. Most frequent malunions of the fibula are shortening and malrotation, resulting in widening of the ankle mortise, talar instability and it has been demonstrated that substantial fibular displacement may increase contact pressures. Therefore distal fibular malunion is a risk factor for development of posttraumatic ankle osteoarthritis. Objectives of this study were to describe our treatment algorithm and surgical technique in patients with posttraumatic fibula malunions; determine intra- and postoperative complication rates, describe mid-term clinical and radiological outcomes and quality of life.

Methods: 21 consecutive patients (12♂, 9♀, mean age 42 y) with symptomatic fibular malunions were included in this prospective study. The initial injury was Weber B and C fracture in 7 and 14 ankles. Mean time between the injury and reconstructive surgery was 17.5 months. In all patients a z-shaped osteotomy of the fibula was performed to achieve the appropriate length/rotation of the fibula. Fixation was performed using a plate. If necessary, supramalleolar and inframalleolar deformities were corrected by supramalleolar tibial and calcaneal osteotomies. All patients were evaluated pre- and postoperatively (mean follow-up 5.6y). Radiological outcomes were assessed using standardized weight-bearing radiographs and clinical outcomes using VAS, AOFAS and SF-36 score.

Results: No intraoperative complications. In two patients early wound healing problems occurred and resolved with i.v. antibiotics. Healing was observed in all ankles within 10 weeks after surgery. Length and rotation of the fibula was improved in all patients, according to Weber criteria. All patients experienced significant pain relief (VAS: 6.5 ± 1.1 to 1.1 ± 0.9 , $P < 0.001$) and functional improvement (AOFAS: 47.1 ± 14.5 to 85.0 ± 7.5 , $P < 0.001$; ROM: $37^\circ \pm 6^\circ$ to $45^\circ \pm 5^\circ$, $P < 0.001$). The SF-36 score increased significantly in all subgroups. In 11 patients hardware was removed due to a discomfort after a mean time of 11.7m.

Conclusion: A z-shaped osteotomy is an efficient and successful method to restore fibula length and rotation in patients with posttraumatic malunion. Our findings in this series of 19 ankles confirm that this realignment surgery results in significant pain relief and functional improvement.

P075

Subtalar instability: Cadaveric Study

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Introduction: Subtalar joint (ST) instability is often misdiagnosed as simple lateral ankle instability or even totally missed. It is defined as a varus tilt with anterior and medial subluxation of the calcaneus in relation to the talus.

Clinical assessment, range of motion testing and stability of the ST are often not exact due to soft tissue around the hindfoot. The clinical examination of the ST stability must be done with the tibiotalar joint in dorsiflexion "blocking" the talus within the mortise limiting tibiotalar motion. A specific test using internal rotation while doing a varus stress test on the calcaneus, patients with subtalar instability demonstrate a medial shift of the calcaneus and an increased talocalcaneal angle. Congruency of the posterior compartment of the ST joint, determines mobility and guidance of motion. The intrinsic ligaments corresponding to the interosseous talocalcaneal ligament (ITCL), the oblique talocalcaneal ligament (TCO), the anterior cervical ligament (ACL), and the lateral talocalcaneal ligament (LTCL) are derived from the inferior extensor retinaculum. The extrinsic ligaments; fibulocalcaneal ligament (FCL) and the tibio-calcaneal part of the deltoid ligament control sliding, rolling and torsional ST motion. Still

there is no single axis of motion identified, but several axes due to the curvatures of the facettes. Shallower angle of the posterior facet with subtalar instability thought to be a predisposing factor to developing subtalar instability in the anteroposterior plane.

Material and method: One the first cadaver, we selectively cut the deltoid ligament then the intrinsic ligaments. On the second cadaver, we cut the FCL then the intrinsic ligaments. On the third cadaver we cut only the intrinsic ligaments.

The clinical assessments of the increase in motion and instability of the subtalar joint was performed by varus tilting and by anterior and medial subluxation.

Results: Each group of ligaments (medial, lateral and intrinsic) has a different contribution for the axes of rotation. Complete tearing of the ACL, CFL and the ATFL were implicated in inducing ST instability.

Conclusion: Subtalar instability is a complex pathology. More accurate testing with objective assessment of the contribution of each group of ligaments should be performed in future studies.

P076

Bilateral osteochondritis dissecans of talar heads and medial femoral condyles: a case report

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Introduction: Osteochondritis dissecans (OCD) is a rare joint disorder defined as osteonecrosis of subchondral bone [1]. Most affected joints are knee, elbow and ankle [2-7]. Simultaneous affection of several joints is an even less frequent condition, usually affecting both knees [8-10]. In 1985, Smith presented a patient with affection of knee and talar dome [11]. Other known cases are both knees and elbows [12], medial femur condyle and opposite patella [13], both elbows and both patella or both elbows and medial femur condyle [14].

Methods: We report a case of bilateral OCD of the talar head, associated with bilateral OCD's of the medial femoral condyles and a review of literature of simultaneous OCD affection of multiple joints.

Results: A 23-year-old female sustained a diaphyseal fracture of her right tibia. Internal fixation with intramedullary nailing was performed. Radiographs of the lower leg showed the typical image of OCD of the talar head. CT scanner confirmed OCD stage III according to Clanton's classification [15] on the right side and stage II on the left. She reported subtle bilateral midfoot pain some years ago and in addition medially localized bilateral knee pain since the age of twelve years needing bilateral knee revision for OCD one year before her lower leg injury. Analysis of former radiographs of the feet revealed that OCD of the talar heads classified as stage I lesions was visible some seven years ago. So far a similar case is not known in the literature.

Conclusion: In our case, bilateral OCD affecting the talar head was an incidental radiographic finding after a lower leg injury in a patient being treated formerly for bilateral OCD of the femoral condyles. Multiple OCD lesions are rare, but unusual joints, such as the talo-navicular joint can be affected. Stage I lesions are commonly treated non-operatively, while with higher stage lesions arthroscopic or open revision with debridement or fragment refixation, autologous matrix-induced chondrogenesis or arthrodesis can be discussed.

P077

Longitudinal plantar approach for excision of Morton's neuroma.

Long-term results.

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Introduction: Longitudinal plantar approaches are generally considered at risk of wound healing problems, painful scar formation, and delayed full weightbearing. Thus, the aim of our study was to investigate long-term outcomes after a primary Morton's neuroma excision through a longitudinal plantar approach.

Methods: We performed a retrospective study including only patients with primary neuroma excision, with no bilateral neuromas operated at the same time, with no previous or simultaneous surgery of the affected foot. Twenty-four patients (28 feet) were evaluated at a mean 9-year follow-up time (range, 6-14) by a single trained examiner using a specific postoperative evaluation protocol, including AOFAS Forefoot subjective and objective scores.

Results: Good-to-excellent outcomes were reported in 25 cases (89.3%), fair results in 3 patients (10.7%), with only two cases of hypertrophic scar formation and keratosis (7.1%). All the patient except one were able to full weight-bearing with a postoperative shoe from the first day after the operation.

Conclusions: This study showed that a longitudinal approach can lead to long-term good-to-excellent outcomes without any case of recurrence or reoperation and an accurate wound closure and an immediate weightbearing with a postoperative shoe can minimize the rate of complications.

P078

Outcome of ray resection as the definitive treatment in forefoot infection or ischemia - a cohort study

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Introduction: Ray resection represents transmetatarsal amputation of selected rays, while the remaining rays are left in place. It is frequently performed in case of infection or ischemia. However, literature concerning its efficacy and outcomes as a definitive treatment is scarce.

Methods: We reviewed our cohort of patients with transmetatarsal ray resections with a mean follow-up of 36.3 months. Rates of re-ulcerations, transfer ulcers and re-amputations were determined. Statistical analysis to detect risk factors for revision surgery was conducted.

Results: Among 185 patients, 38.4% had revision surgery within a mean of 1.4 years (SD 2.6 years, range 2 days to 12.9 years). 11.9% had major amputations and 26.5% minor amputations. 5.9% had same ray re-ulceration, 21.6% had transfer ulcers, and 1.1% had both. Transfer ulcers were mainly localized in adjacent rays. In group comparison, the occurrence of a postoperative ulcer was significantly associated with revision surgery ($p < .01$).

Conclusion: Transmetatarsal ray resection is a reasonable treatment option in case of forefoot ischemia or infection to prevent major amputation but fails in 11.9% of the patients. Transfer ulcers are common in adjacent rays. New occurrence of postoperative ulcer was the only variable associated with further revisions making ulcer prevention paramount.

P079

No recurrence at long-term follow up after wide excision of M. Ledderhose

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Introduction: Current standard treatment for patients with symptomatic Morbus Ledderhose (plantar fibromatosis) is resection. The recurrence rate after resection and the clinical outcome however are unclear. Aim of this study was to assess the recurrence rate after a wide resection for a M. Ledderhose and to analyze the clinical and radiological long-term outcome.

Method: This retrospective case series included 8 patients, who underwent wide resection of a symptomatic M. Ledderhose at our institution. Mean age at time of surgery was 42 years. Three of the patients were men. We assessed the AOFAS (American Orthopaedic foot and ankle score) and FFI (foot functional index) at last follow up. Further, MRI was acquired preoperative and at last follow-up, analyzing signs of recurrence.

Results: Mean follow up was 7.7 years (2 - 12years). At follow up, mean AOFAS was 82 ± 21 , mean FFI was 22 ± 28 . In the physical exam at follow up, no patient showed signs of recurrence. On follow up MRI, no signs of recurrence were found.

Conclusion: Good clinical outcome without any case of recurrence was found at long-term follow up after wide resection of M. Ledderhose.

P080

Revision after Total Transmetatarsal Amputation

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Introduction: Total transmetatarsal amputation (TMA) is an option for foot salvage in severe foot infection and /or ischemia. Factors associated with failures are largely unknown.

Methods: Single-center group comparisons between revisions and re-missions after TMA.

Results: Among 96 adult different patients with TMA (105 amputations), 42 had a revision surgery (40%); of whom 18 witnessed a minor (17%) and 18 a major proximal re-amputation (14%). In group comparisons, a former infection due to *Staphylococcus aureus* was protective for a lower revision risk (4/26 with revision vs. 22/26 in remission; $p = 0.03$). In contrast, postoperatively persistent soft tissue or bone infections ($p = 0.01$) or delayed wound healings ($p = 0.01$) were associated with revision. The American Society of Anesthesiologists' Score, gender, age, body mass index, diabetes, polyneuropathy, chronic renal failure, dialysis, peripheral arterial disease, smoking, and the antibiotic therapy did not influence revision.

Conclusion: TMA is an option to prevent major amputations, but may be associated with a subsequent revision risk in 40%. Statistically in crude group comparison, persistent post-amputation infection and delayed wound healing were associated with enhanced revision, while former infection due to *Staphylococcus aureus* was protective.

P081

Entrapment of the Superficial Peroneal Nerve Following a Tri-malleolar Fracture: Report of a Case

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Introduction: Although peripheral nerve injuries secondary to long bone fractures are well described, entrapment of the superficial peroneal nerve after a lateral malleolar fracture was rarely described in literature [1, 2]. We report a case of a bony entrapment of the left superficial peroneal nerve following a closed tri-malleolar fracture.

Case report: A 54 year-old male sustained a dislocated tri-malleolar fracture of the left ankle and consulted to the emergency department more than six hours after the traumatism. Due to this late presentation, he underwent an initial closed reduction and cast-immobilization; we chose to perform a delayed open reduction and internal fixation. In the preoperative period, the patients complained of severe pain on the lateral side of the ankle radiating down the dorsal aspect of the foot and that was only partly relieved by opioids and by opening up the cast.

Surgery was performed after the soft tissue swelling subsided, ten days postinjury. Performing the lateral approach, we found that the superficial peroneal nerve had an abnormal posterior position and appeared to cross the fibula at only 6cm proximal to the tip of the malleolus and after dissection it was shown to be trapped between the ends of the fracture. Careful neurolysis was carried out and the nerve spontaneously resumed its natural position in front of the fibula. A new cast was applied at the end of surgery. The postoperative course was uneventful and the pain was moderate and responded well to paracetamol and tramadol.

Discussion: This report illustrates two learning messages. First, even if unusual, the entrapment of the superficial peroneal nerve can occur in association with a dislocated ankle fracture and should be considered in case of unusual pain after reduction, even in the absence of clear neurological deficit. Second, even if a careful dissection represents the mainstay of any surgical approach, surgeons should consider the possibility of an abnormal course of the nerve which will require more attention; clinical suspicion should be raised in case of abnormal pain and, of course in case of neurological deficit.

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- 2 - Mino DE, Hughes EC Jr, Bony entrapment of the superficial peroneal nerve. *Clin Orthop Relat Res.* 1984 May; (185):203-6.

P082

Use of retrograde intramedullary nailing technique in the reduction and fixation of pediatric Monteggia fractures type III - a report of 5 cases

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Introduction: Monteggia fractures are defined as fractures of the proximal third of the ulna with associated dislocation of the radial head. They are very rare in adults and even rare in children reaching an incidence of 0.4% - 2% of all pediatric forearm fractures.

The primary goal of the treatment is the anatomical reduction of the ulnar fracture and with that the indirect anatomic reduction of the radial head. Different modalities for the treatment of Monteggia fractures in children are reported. The most frequent one is non-operative and consists in a manual reduction of the ulnar deformity and immobilization of the elbow in flexion and supination in a long-arm cast. However, due to the typical

plastic deformation of the proximal ulnar fracture anatomical reduction of the deformity may be difficult to achieve by closed manipulation. As a consequence of a residual ulnar deformity subluxation of the radial head can persist and later mechanical impingement with reduced pro- supination may occur.

Methods: Five cases in 6 to 8 years-old children are reported. They all had a plastic deformation of the proximal ulna with dislocation or subluxation of the radial head (all type III according to the classification of Bado). Closed reduction of the ulnar deformity was achieved utilizing retrograde nailing of the ulna using a flexible intramedullary nail. Technically, the curvature of the tip of the nail has to follow the initial deformity until some anchorage in the proximal fragment is present. The reduction was then performed with a 180° turn of the nail. Once the ulna was anatomically reduced no further manipulation for reduction of the dislocated radial head was needed. The elbow was additionally immobilized in a long arm cast for four weeks.

Results: At six months, radiographically all fractures were solidly united in an anatomical position and the radio-humeral joint remained anatomically reduced. Elbow mobility was pain-free and symmetric when compared with the uninjured side.

Conclusion: The described nailing technique of pediatric Monteggia fractures is a minimally invasive and efficient method combining indirect reduction and stabilization of the fracture using only one simple implant.

P083

Transitional Salter type II like avulsion fracture of the apophysis of the iliac crest in an adolescent.

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Introduction: Avulsion fractures of pelvic apophyses occur mostly in adolescent males. The main mechanism is a sudden maximal muscle contraction during sports activities combined with the relative mechanical weakness of the apophyseal growth plate. Regularly, standard radiographs are sufficient for the diagnosis. CT-scan may be needed to define the extent and displacement of such apophyseal lesions. Depending on localization and displacement non- or operative treatment is indicated.

Methods: Report of a case and literature review.

Results: A 17-year-old man presented after a judoka fight competition in our emergency department with immobilizing pain above his left hip joint. Physical examination revealed a hematoma and severe pain at the left iliac crest. Hip flexion and abduction against resistance was painful, while passive mobility of the left hip joint was found to be normal. Standard radiographs and CT-scan imaging showed a partial avulsion fracture of the apophysis of the iliac crest. The anterior superior iliac spine (ASIS) and the posterior half of the iliac crest remained undisturbed. Due to the observed minimal displacement a non-operative treatment was followed with restriction of sports activities for six months.

Conclusion: Apophyseal avulsions are relatively frequent in the pelvic ring of adolescents. The ASIS, anterior inferior iliac spine (AIIS), ischial tuberosity and the symphyseal body are concerned with decreasing frequency.

In our case the apophysis of the iliac crest was closed in its anterior part close to the ASIS and thus remained in place like in a transitional fracture. Posteriorly, the apophysis was avulsed presenting a little displaced fracture towards the remaining and intact posterior part of the crest (comparable with a Salter type II lesion in the epiphyseal area). The displacement was purely lateral. Thus, it must be concluded that parts of the external oblique abdominal and of the gluteus medius muscles remained still attached to the avulsed fragment avoiding its displacement.

The treatment of apophyseal avulsions depend on the localization and the extent of displacement. Displaced injuries of the ASIS and the iliac crest are forgiving and can be treated non-operatively. Displacement of the ischial tuberosity can lead to an oblique sitting position, and displacement of the AIIS to an extra-articular anterior impingement of the hip. Thus, in these regions only little displacement can be tolerated without later functional impairment.

P084

Unusual presentation of cystic echinococcosis: a case report

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Introduction: Alveolar echinococcosis is a rare occurrence in orthopaedics. It is a parasitic infection caused by a tapeworm *Echinococcus multilocularis*, usually found in dogs and foxes. Humans are only incidental hosts, contaminated by ingested food. Bone involvement is often asymptomatic and results from hematogenous spread from the liver. However, exclusive muscular involvement has never been described before.

Case presentation: We report the case of a 48 – year old male who presented with a progressive atraumatic swelling in his medial thigh. An MRI revealed a multicystic, thick-walled encapsulated lesion (25 x 8 x 6.3 cm) in the vastus intermediaris and the adductor magnus. A surgical biopsy was performed and serology confirmed the diagnosis of *Echinococcus multilocularis* infection. The patient was treated with surgical resection and peroperative albendazole treatment. After one year of follow-up, the evolution is good and there is no sign of recidive.

Discussion: Due to its infrequent occurrence, the diagnosis of musculoskeletal echinococcosis is challenging, especially in the differential diagnosis of unusual soft tissue lesions. Depending on the localization, different imaging methods are necessary to assess the diagnosis. They can be used in adjunction with the serologic tests. Treatment is also challenging: in our patient, total resection of the cyst and supportive therapy with albendazole were performed successfully.

P085

Is there a benefit for systematic cerclage wire exchange after extended trochanteric osteotomy in the setting of a two-stage procedure for periprosthetic joint infection? A prospective case-series.

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Introduction: Periprosthetic joint infection is one of the most feared complication in joint arthroplasty. When performing a two-stage revision, removal of a well-fixed stem can necessitate an extended trochanteric osteotomy (ETO). The ETO is classically closed with multiple metallic cables or wires before inserting an antibiotic loaded spacer. During the second operation the spacer is removed and repeated extensive debridement is performed. As the metallic wires are considered to be potentially contaminated they should be exchanged. Their systemic exchange however leads to an extended operative time, larger surgical approach as well as increased risk of neurological and vascular lesions. The aim of this study is to evaluate the risk and benefit of cerclage wire exchange in the setting of a two-stage procedure.

Method: We prospectively included all patients treated at our institution with a two-stage procedure for PJI of the hip and in which an ETO was necessary. During the second stage, we systematically exchanged the most proximal cerclage wire, which was sent for separate sonication and microbiology. Standard microbiological work up with at least three tissue biopsies, sonication of the spacer and perioperative complication were recorded.

Results: We included ten patients (4 female) with a mean age of 67 years (range 43-80). Microbiology came back positive for one wire (10%), the germ was nonetheless different from that of the primary infection. For all other patients, wires as well as standard microbiology work up came back negative. We did not encounter any specific complication during cerclage wire exchange.

Conclusion: Our results do not support the benefit of systematic wire exchange at the time of stem reimplantation. The reported rate of infection after revision arthroplasty is reported around 8% and can partly be explained by the extended operative time. A higher case load is needed to further confirm these results.

P086

Fracture on a septic nonunion after an intramedullary nailing of the proximal femur: two-stage implantation. A case report.

Hafize Heutschi-Öztürk; Thomas Buchegger; Dr Jaad Mahloul

Introduction: Septic nonunion care in the presence of implant requires special attention. These cases may be difficult to diagnose in the event of an acute fracture and cannot be treated easily. We hereby present the case of an acute fracture on a septic nonunion area consecutive to an intramedullary nailing.

Case report: A 59-year-old woman was referred to the emergency department following a fall from her height on her left side. The X-rays showed a fracture of the proximal femur around an intramedullary nail that was implanted 10 years ago. Following the surgery, our colleagues performed a debridement and gave the patient antibiotic therapy for an

infection by coagulase-negative Staphylococci. For this reason, we suspected a chronic infection of the nail; we consequently decided to treat this fracture with a two-stage revision surgery. The first stage after reducing the fracture was to replace the nail by an antibiotic-loaded cemented spacer. Making a cemented spacer adapted to the shape of the Gamma nail was particularly challenging, that is why it was assembled in three parts: the longer part for the femoral shaft, a shorter one in the neck and another one into the most proximal shaft. Preoperatively we noticed a site of nonunion in the line of the acute fracture, and the cultures of the different samplings from both the nonunion and the shaft identified a *Staphylococcus hominis*. The antibiotic therapy began post-operatively and 4 weeks later we could proceed to the second stage: the re-implantation of a long Gamma nail with a revision of the nonunion by allograft. At 6 months followup, the patient was able to walk with two crutches, without any pain and the x-rays showed bone consolidation.

Conclusion: In case of a fracture following an implantation, it is very important to take the patient history into account, particularly with infections. In those situations, implant removal and the decision of its replacement in one or two steps combined with adequate antibiotic therapy is essential. The implant design may be a challenge to consider before making the cemented spacer in order to maximise the treatment's beneficial results.

P087

Pneumococcal pyogenic arthritis of the shoulder with cartilage destruction following two steroid injections: An extremely rare complication in a healthy adult

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Introduction: Pneumococcal pyogenic arthritis after steroid injection for adhesive capsulitis of the shoulder is an extremely rare complication. Typically pneumococcal arthritis affects older patients with underlying medical comorbidities or risk factors. In this report, we describe a case of pneumococcal arthritis of the shoulder with cartilage destruction following two steroid injections in an otherwise healthy adult.

Case Presentation: A 36-year-old man presented in our hospital with left shoulder pain and reduced shoulder motion since six weeks without prior trauma. Clinical examination revealed reduced range of motion for abduction and external rotation without clinical signs of infection. Rotator cuff strength was not impaired. A fluoroscopy-guided glenohumeral steroid injection was performed after clinically diagnosing adhesive capsulitis. At five weeks follow-up the patient reported pain relief, however range of motion did not improve significantly despite physiotherapy. A second steroid injection was scheduled in the radiology department. An irregular subchondral trabecular structure was evident under fluoroscopy, however this remained unnoticed at the time. Twelve days after the second injection an extensive pyogenic arthritis developed. Open debridement was performed at admission and aspirate and biopsies were taken. *Streptococcus pneumoniae* could be isolated. Malignancy was histologically excluded. Bacteremia or concomitant pneumococcal infection were not detected except for an unspecific gingivitis. Despite immediate surgical debridement, antibiotic therapy according to current guidelines and a second look, cartilage destruction could not be averted. Infection was treated successfully but the patient depended on oxycodone/naloxone and remained unable to work. Eight months after pneumococcal arthritis a short stem anatomic total shoulder arthroplasty was performed.

Conclusion: Pneumococcal pyogenic arthritis typically occurs via hematogenous seeding from an extraarticular source. Intraarticular steroid injections have a local immunosuppressive effect that can facilitate bacterial seeding if a known or unknown concomitant pneumococcal infection is present. High suspicion is crucial if fluoroscopy shows an irregular subchondral bone that may indicate subchondral bone infarction secondary to bacterial arthritis and further imaging and joint aspiration for culture may be necessary to establish a diagnosis.

P088

Bone crushing in infected pseudarthroses- An extraordinary way to treat osteomyelitis caused by resistant bacteria

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Introduction: Osteomyelitis with multi-resistant bacteria in non-union following fracture treated with osteosynthesis requires a complete removal of infected sequestrum and dead bone.

For consecutive bone defects it is frequently necessary to bridge with a fixateur externe.

The treatment is not only challenging due to reduced bone stock but also characterised by decreased bioavailability of antibiotics.

Case Report (Methods/Results): We report a two-step-surgery approach in order to preserve the bone stock by using autologous cancellous bone in a bacterial infected non-union for subsequently leg length reconstruction.

The 24-year-old patient was admitted to our department with persistent wound secretion and subsequent osteomyelitis on the right femur 3 years after initial surgery and several revisions and several different antibiotic therapies.

Biopsy revealed Methicillin-resistant (MRSA) and borderline Oxacillin-resistant *Staphylococcus aureus* (BORSA).

First the Iizarov-Ring-Fixateur was removed and a vigorous debridement was performed by refreshing the pseudarthrosis, removing of sequestrum and dead bone. Finally we implanted an AO Fixateur externe. The AO Fixateur externe was removed after ten weeks of antibiotic treatment and an antibiotic-free window of 5 weeks. The bone defect was stabilised by a long Gamma Trochanteric Nail (Stryker, UK). A wide resection of the fragments was performed and the resected fragments were crushed and placed beside the nail to bridge the defect zone. Surprisingly the Biopsies of both bone ends revealed same germs as before. So we established antibiotics for 6 month more and frequent radiographic and clinical controls showed a remodeling of the femur during a period of 3 years and no signs of infection.

Subsequently we restored leg length of 4 cm by implanting a fully implantable motorized lengthening nail (Fitbone, Wittenstein; Ingersheim, Germany) and attain full weight bearing. No further germ could be revealed.

Conclusion: In this case we could use infected dead autologous bone by crushing them and placing beside the nail. Crushed Bone could improve bioavailability of antibiotics when dealing with multi-resistant bacteria in non-union healed fracture side. Furthermore, this approach was able to provide new bone formation in a limb resulting in full weight bearing.

P089

Bone and joint infections in the elderly - where do we stand?

PD Dr. Ilker Uçkay

Introduction: With increasing numbers of elderly patients, arthroplasties, fractures, and diabetic foot infections, the worldwide numbers of osteoarticular infections (OAI) among the elderly is concomitantly expected to rise.

Methods: We performed a literature search linking OAIs to geriatric patients and comparing very old patients (>65 years) with average adults (range, 18-65 y).

Results: Most literature on OAI lacks particularities for the elderly and age is not the primary objective of the overwhelming list of objectives in current research. Only less than a dozen articles specifically address OAIs in the geriatric population. However and fortunately, many papers analysed age as a continuous or categorical variable, which we explored "between the lines". The majority of papers stem from the last decade and was written in English. Age itself was not an independent factor related to particular pathogens, prevention of OAI, nursing care, rehabilitation and outcomes of OAI. Financial aspects, comparison of diverse therapies on quality of life, reimbursement policies, or specific guidelines are missing. In general, elderly patients very probably have more adverse events of antibiotic therapy and undergo more conservative surgery and require more nursing care.

Conclusion: The literature on OAI is very sparse. Future clinical research likely will concern more conservative surgical indications, maybe less invasive techniques, but the reduction of inappropriate antibiotic use.

P090

Rare benign intravascular myopericytoma leading to foot pain in a 51-year-old lady. A case report.

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Introduction: Myopericytomas are rare, slow-growing benign peri- intravascular tumors. These are commonly found within the subcutaneous soft tissues of the lower extremities, represented with similar morphology and typical immunohistochemically profile. In MRI, these enhancing tumors are highly vascularized and well-defined. We are reporting a case involving the foot, focusing on the clinical, histopathologic, and radiologic characteristics.

Methods: Report of a case and literature review.

Results: A 51-year-old lady with increasing pain on the plantar side of the right foot without local alterations but tenderness between 1st and 2nd metatarsals was consulted in June 2018.

The MRI showed a well-circumscribed, hypoechoic mass of 10 x 15 mm at plantar base of the 1st metatarsal with contact to medial part of flexor hallucis brevis tendon, which was compatible with an arteriovenous malformation.

An angiography council rather spoke for a solid tumor with good perfusion. The total surgical excision of a well-circumscribed, easily bleeding mass was performed through a medial extended mid foot approach.

The anatomopathological examination showed a rare benign intravascular myopericytoma, localized in a vein with a typical immunohistochemically pattern.

Conclusion: Myopericytoma is a rare benign, peri- intravascular soft-tissue tumor usually found in the lower extremities. Clinical presentation is unspecific and to rule out other malign tumors a total surgical excision is justified. Diagnostic imaging criteria are defined as a solid, hypervascular marked by intravenous gadolinium-contrast enhancement soft-tissue neof ormation.

An anatomopathological examination including specific immunohistochemically analysis is essential for correct diagnosis. Histological findings are peri- or intravascular myoid-spindle cell proliferation accompanied by numerous blood vessels. Differential histopathological diagnosis shows a big variety.

P091

Percutaneous image-guided cryoablation of sacral chordoma

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Introduction: Chordoma is an uncommon primary malignant bone tumour of the spine. The most common location is the sacrococcygeal area (40-50%) followed by the base of the skull (35-40%) and finally from the vertebral bodies (15-20%). Sacral chordoma is difficult to manage, even with the advance in the surgical techniques, chemotherapy or radiotherapy. The optimal treatment remains unclear. Percutaneous image-guided cryoablation (PCA) is a relatively recent technique where it is applied, by means of cryoprobe, an extreme cold that allows to destroy tumors under Imaging control. According to our knowledge, percutaneous image-guided cryoablation as primary or recurrent treatment of chordomas has not been described in the English literature. The purpose of our retrospective study is to analyze the results of selected patients, treated by percutaneous image-guided cryoablation in sacral chordoma, when surgical treatment was overtaken.

Materials and methods: We retrospectively reviewed our database and identified four patients with sacral chordoma treated with percutaneous image-guided cryoablation. We analyzed feasibility, time to local progression, pain release and finally survival. The mean follow-up was a 42 months (Range 15-65).

Results: All four patients had acceptable pain release. Local recurrence occurred in all four. Time to progression was 14 months (range 5-18). At last follow-up visit, all patients were alive with the disease.

Conclusion: Percutaneous imaging-guided cryoablation is a viable mini invasive method to treat recurrent chordomas, when standard treatment alternatives are not available anymore. More patients are needed to confirm this favorable preliminary evaluation.

P092

Extended Forequarter Resection Including the Chest Wall and Lung with Brachial Free Fillet Flap Coverage

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Purpose: Forequarter amputation may be indicated when a tumor involves the axilla and shoulder joint with the accompanying neurovascular plexus. The treating sarcoma surgeon usually needs to determine

whether parts of the chest wall may need to be resected in addition to achieve an adequate margin. However, if such tumor is not only outside but also within the chest and endangering the heart through compression, then the question remains how much of the chest wall can be reasonably resected.

Method: A 41 year old mother of two teenagers presented with unbearable and progressive pain in the shoulder irradiating down into the hand, and progressive dysesthesias of dig I-III. Imaging showed an intra- and extrathoracic mass of some 20cm, involving the entire plexus and shoulder joint, and was abutting the heart and aorta. Patient's history was remarkable for desmoid fibromatosis in her left shoulder, for which she underwent several surgeries, radiation therapy and systemic therapies over the preceding 13 years. A US-guided biopsy revealed a undifferentiated pleomorphic sarcoma subsequent to radiation. There were no metastases diagnosed.

Results: A 3D-print of the complex anatomy with the tumor was used to plan the surgery. We elected to proceed with an extended forequarter amputation involving 9 complete ribs of the chest. We first prepared a large fascio-cutaneous forearm free flap based on the brachial vessels. After a well designed exposure sparing the ipsilateral mamma, an osteotomy anteriorly through the sternum, as well as posteriorly at the facet joints were performed. The lung was easily dissected from the heart and aorta with its tissues to protect the tumor, except for the internal carotid artery which was end-to end-anastomosed after segmental resection. Reconstruction of the chest wall was carried out using 4 metal ribs, and the defect covered using the pedicled and partly de-epithelialized Epaulette-flap, as well as the free fillet flap from the forearm, anastomosing the brachial vessels onto the exiting heart vessels. Wound healing was uneventful. The patient developed progressive scoliosis, and 4 months postoperatively, one rib was removed and a spondylosis of the thoracic spine was performed. 2.5 years postop, she is free of metastasis.

Conclusion: Resection of the hemi-thorax combined with forequarter amputation may represent an option to render a patient free of disease.

P093

Complete Resection of the Obturator Internus Muscle through Antero-inferior Pelvic Exposure

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Tumor lesions in the deep soft tissues of the pelvis, specifically when located within the obturator internus muscle, are surgically difficult to approach. From the lateral as well as the inferior side, the bony pelvis is an unsurmountable hindrance. From anteriorly, the inferior border of the obturator internus muscle with its pudendal neurovascular bundle within the Alcock canal, is located in the depth of the pelvis in close proximity to the iliac vessels and nerves, as well as the bladder and ureter such that it can not be safely controlled.

Method: We herein report on a 30 year old female patient who was diagnosed with a large pendulum mass through the right foramen obturatorium, mainly located within the obturator internus and externus muscles. A biopsy revealed an extraskeletal Ewing's sarcoma, reason why the patient underwent preoperative chemotherapy, as well as postoperative chemo-radiotherapy. The tumor responded greatly to neoadjuvant chemotherapy, and its size reduced greatly to 50 mm located within the obturator internus muscle.

Results: We performed an abdominal midline incision, extended over the pubic bone along the inferior pubic ramus towards the ischial tuberosity, and from there to the medial thigh. Within the pelvis, the iliac vessels, obturator and femoral nerves were dissected and protected. Outside the pelvis, the origin of the adductors were dissected en bloc while saving the extrapelvic parts of the obturator neurovascular bundle. Then, the superior ramus of the pubic bone was osteotomized, which allowed safe access to the inferior aspect of the obturator internus muscle to be prepared up to the ischial spine. No reconstruction of the pubic ramus was performed. An abdominal protection net was placed to prevent hernias, and a pedicled gracilis flap was used to account for the soft tissue resection. The wound healed uneventfully, and adjuvant therapy was continued three weeks postoperatively. At 1 year follow-up, the patient remains disease free and is not restricted in her daily activities.

Conclusion: Wide exposure of the lower pelvis, specifically along the obturator internus muscle, can be achieved through resection of the superior ramus of the pubic bone.

P094

Aggressive Recurrent Juxtacortical Chondromyxoid Fibroma of the Proximal Thigh Requiring Complete Proximal Femoral Resection

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Purpose: Chondromyxoid fibroma (CMF) is a very rare, benign bone tumor of cartilaginous origin, which has the tendency to locally recur in up to 15% after curettage. The WHO classifies it therefore as intermediate malignancy (local recurrence, no metastasis). Juxtacortical localisation is an extremely rare variant of CMF, whereas malignant behaviour has been noticed but not reported so far.

Method: A 10 year old girl was diagnosed with a juxtacortical CMF of the proximal anterior femur. The tumor's soft tissue mass was 5cm, with cortical penetration of 1cm. To keep the morbidity as low as possible, it was elected to resect the soft tissue part en bloc, and to curet the bony part. The initial postoperative course was uneventful.

Results: Three months post surgery, a 10cm diffuse recurrence was noted, mainly in the soft tissues, as well as within the biopsy tract. The case was internationally reviewed both pathologically and surgically, and another curettage for the confirmed CMF was suggested. The parents postponed this for religious reasons. 10 months postoperatively, the tumor mass was ever increasing, involving now the entire subcutaneous tissues as well as the entire quadriceps muscle origin, with impending fracture of the proximal femur. We elected to resect the proximal femur together with the entire origin of the quadriceps muscle as well as a soft tissue island of 23x11cm. For reconstruction we used a growing prosthesis, and a functional, neurotized latissimus dorsi muscle with a generous skin island. Four months post surgery, the patient is pain free, walks without crutches and is free of tumor.

Conclusion: Although CMF is considered benign or locally of intermediate grade, it may show an aggressive behaviour like a malignant tumor and needs to be treated as such. NextGen sequencing did not detect any genetic abnormalities which may allow to distinguish such more aggressive subtype from benign forms.

P095

Excessive White Drainage after Cerament Filling and Curettage of an Aneurysmal Bone Cyst at the Distal Radius

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Purpose: An aneurysmal bone cyst is a benign neoplasm of the bone. Standard therapy includes curettage of the cyst and bone grafting. Cerament (Bonesupport AB) is a synthetic bone graft substitute consisting of 40% hydroxyapatite, 60% calcium sulfate, and a liquid component. Successful application of Cerament has been published in patients with benign bone tumours with full resolution one year after surgery in the majority. However, redness, swelling and a few cases of white drainage have been reported, resolving after five days postoperatively.

Method: Herein, we report on a twelve-year-old boy who after a fall on the left hand was diagnosed with a fracture in association with a, as far unknown, bone cyst in the distal radius. The fracture was successfully treated conservatively. After MR imaging and a biopsy were performed, an aneurysmal bone cyst was diagnosed. The cyst was curetted and filled with 12 CC Cerament.

Results: Postoperatively, redness, swelling, pain and fever up to 38.4 degree Celsius was noticed. One month after initial surgery, excessive white drainage occurred and persisted over four weeks, which lead to revision surgery. Intraoperatively, solid white nodes were found in the subcutaneous tissue. The Cerament was completely dissolved within the bone by extrusion in the soft tissues, and the cyst was filled with clear liquid and covered with a white/green layer. The histologic analysis of the subcutaneous material found a histiocytic foreign body reaction with giant cells. Two weeks after the revision, the wound was dry and uneventful.

Discussion: The etiology of the described complication is unclear. An allergic reaction is unlikely due to the non-allergic findings in the biopsy. In the biopsy, a foreign body reaction was found. However, it is unclear, if an excessive foreign body reaction of the patient was a cause for the increased reduction of the Cerament, or if the foreign body reaction is a sequelae after extrusion of the Cerament in the soft tissue.

Conclusion: Fast reduction of Cerament leading to effusion and extrusion into soft tissues with foreign body reaction occurred in a twelve year

old patient after filling an aneurysmal bone cyst at the distal radius. Revision surgery with thorough debridement was necessary and resulted in complete resolution.

P096

Solitary Epiphysal Enchondroma of the Proximal Humerus in a 13-Year-Old Boy with short humerus lengthened with the PreciceR nail

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Introduction: Solitary epiphysal enchondromas are rare. Of 761 cases reviewed at the Armed Forces Institute of Pathology only 33 cases were located in the epiphysis with 8 in the humeral head and 2 in the tuberculi. The enchondromas usually involve only parts of the epiphysis, e.g. 1,2,3; . Complete involvement of the epiphysis is reported only in the case of a distal fibula enchondroma¹. A review of the literature upon epiphysal enchondromas published until 2008 is given by 2. The case presented here is of interest because of complete involvement of the epiphysis and the resulting shortening of the arm as well as successful lengthening using the PreciceR nail.

Methods: The 13-year-old boy complained of shortness of his left arm with the the desire for lengthening. The X-Ray surprisingly showed the enlarged ellipsoid shaped humeral epiphysis in varus position and irregular joint surface. The MRI documented a distorted bone structure involving the complete epiphysis and partial closure of the physis. MR-angiography revealed normally appearing vessel formation. Tru-cut needle biopsy confirmed the diagnosis of enchondromatous changes.

Results: As the patient felt strongly disturbed by the shortness of his arm lengthening was performed using the fully inserted magnetic driven PreciceR nail, which had to be exchanged twice to achieve 12cm as telescoping of the nail is limited to 5 cm. At 1 year f/u the patient has equal arm length and full function, no signs of progression of the chondromatous 'malformation'.

Conclusion: This case is of interest as epiphysal enchondromas are extremely rare and complete involvement of the proximal humeral epiphysis to our knowledge has never been described before. Lengthening using a device penetrating the cartilaginous region is debatable; however so far sarcomatous dedifferentiation in epiphysal enchondromas has not been described.

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P097

Lower limb osteotomies for joint realignment in a patient with hereditary multiple exostoses and symptomatic bone deformity: a case report

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Objective: Hereditary multiple exostoses (HME) is an autosomal dominant condition, characterised by the development of multiple osteochondromas. Patients may develop significant bone deformity in their lower limbs. These abnormalities, inequality of lower limb length and angular deformity (varus or valgus) of the knee and ankle joints may predispose the joints to premature degeneration, eventually requiring joint replacement surgery. We report a case of a 54-years old HME-affected male patient, who initially developed pain of his right ankle joint due to valgus malalignment. Seven years later he developed early medial compartment osteoarthritis of the left knee as a result of pronounced varus malalignment of the joint line.

Methods: According to long standing radiographs right tibio-talar angle showed a valgus malalignment of 21° in the frontal plane. Correction was performed with closing varus osteotomy at the supramalleolar level of the distal tibia.

Concerning the left knee, a 24° of varus deformity of the distal femur (mL DFA 108°) and a 19° of valgus deformity of the proximal tibia (mMPTA 106°) were measured, resulting in a overall varus orientation of

the joint line. Operative realignment of the knee joint required double level correction, with combined medial closing wedge osteotomy of the proximal tibia and medial opening wedge osteotomy of the distal femur, inserting the tibial wedge into the femoral osteotomy gap.

Results: After both interventions the patient achieved considerable pain relief. After correction of the valgus malalignment of the right ankle joint a nearly physiologic 4° valgus angle and a recentered mechanical leg axis were obtained. Overall correction of the left knee joint line was achieved as planned, with residual undercorrection of the distal femur (mLDFA 100°) and optimal correction of the proximal tibia (mMPTA 90°). The resulting partially arthritic and deformity dependent varus alignment will be corrected at the time of later knee arthroplasty.

Conclusion: Pronounced bone deformities in HME disease may lead to severe joint malalignments increasing the risk for early osteoarthritis in the biomechanically stressed joint compartment. Apart of symptomatic pain relief, operative correction of malalignment with varus and/or valgus realignment osteotomies may reduce the overload of the affected joint and may in turn delay progression of arthritic degeneration and need for early joint replacement.

P098

Corrective osteotomy in X-linked vitamin D-resistant hypophosphatemic rickets (VDXLR) needs optimal metabolic control to be successful

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Introduction: X-linked vitamin D-resistant hypophosphatemic rickets (VDXLR) - initially described as Phosphatediabetes by Fanconi 1) - causes severe bone metabolism disturbance leading to rickets in childhood and persistent osteomalacia in adults. Metabolic improvement is achieved with oral supplementation of vitamin D (best if using active metabolites such as 1,25 (OH)2D3) and phosphate. Historically, bone healing allegedly was poor until proven different by Fucentese et al. 2). As it is a rare disorder we wish to add one more case treated successfully after failed surgeries due to metabolic neglect.

Patient: Case: Male patient (45y) with VDXLR and a significant femoral varus and antecurvature deformity. During childhood he had repeated corrections using Ilizarov frames, treated at the age of 10 and unlocked intramedullary nails at the age of 20. At the age of 44 years he presented to us with bilateral shepards crook deformities (CCD varus-angle of 82° on the right and 84° on the left side) and with a procurvatum of 2° on the right and 8° on the left side. Imaging studies also revealed nails having perforated the femoral cortex bilaterally – due to the recurrent varus deformity of the proximal femur. The patient needed canes for support. After improving the metabolic situation with active vitamin D metabolites and phosphate – monitored by normalized phosphate hemostasis – staged osteotomies with intramedullary nail fixation achieved axial correction and full painfree weight bearing 12 weeks after the second operation. Primary bone healing occurred on both sides.

Results: There were no complications during the procedures or in the postoperative follow-up period. The osteotomies united uneventfully under adequate medical treatment of the VDXLR. There was a significant improvement with painfree and unrestricted function – 3 months after the last procedure the patient was ambulatory without crutches.

Conclusion: The most important prerequisite for successful operative correction of severe bony deformities in VDXLR is a normal metabolic condition. First line treatment comprises of active vitamin D metabolites and phosphate. Under these circumstances, subsequent corrective osteotomies show uncomplicated bony union.

1) Fanconi G.: Der frühinfantile nephrotische-glykosurische Zwergwuchs mit hypophosphatämischer Rachitis. *Jahr. Kind.* 147: 299-338

2) Fucentese et al.: Metabolic and orthopedic management of VDXLR; *J Child Orthop* (2008) 2: 285-291

P099

High Demand 3D-printed Custom Made Shoulder Prosthesis Reconstruction after Tikhoff-Linberg Resection

Franziska Maduz; Lara Pozzi; Dr. Markus Pisan; Prof. Dr. Bruno Fuchs

Purpose: Extra-articular scapulo-humeral resection is rarely indicated, and is associated with advanced tumor disease around the shoulder. This surgical procedure usually does not allow for high functional expectations because the shoulder joint is completely resected. The function mainly depends on the integrity of the deltoid abduction mechanism, spe-

cifically the axillary nerve and the roof of the acromion which –if not resected for tumor purposes- usually is osteotomized at the scapular spine. However, even if both these structures can be saved, there is usually no good solution to fix the scapular spine (together with the acromion and the deltoid origin), which is mandatory for good shoulder function.

Method: We report on a 55 year old female who presented with a 15cm lump of the anterior shoulder and scapula. Imaging showed the mass originating from the scapula, invading the shoulder joint. A MR-neurography showed the axillary nerve on the tumor, and the scapular spine free of tumor. Biopsy revealed a chondrosarcoma G2. Because the patient wanted to preserve as much function as only possible, we elected to 3D-print a custom-made prosthesis with an integrated plate allowing for osteosynthesis of the scapular spine to the prosthesis, together with the deltoid insertion.

Results: After extra-articular resection of the entire scapula and the proximal humerus, we stimulated again the axillary nerve to ensure its function. First, we inserted the uncemented humeral stem. Then, we freed up the scapular spine such that we could fit the 3D-printed drilling guide to place the optimal angle of the screw holes into the scapular spine. The 3D-printed custom-made prosthesis was then brought into the situs and the plate was then easily fixed using the predrilled holes of the scapular spine. The reverse designed prosthesis was then assembled and the scapular body of the prosthesis brought in. Then, the remainder of the trapezius, the rhomboid, levator, latissimus and teres major muscles were sewed to the prosthesis. The arm was immobilized onto an abduction splint for six weeks, when passive range of motion was started. At 3 months, active ROM was begun. There were no complications, specifically no signs of infection.

Conclusion: 3D-printed custom made prosthesis may represent an option to shoulder reconstruction after Tikhoff-Linberg resection, provided the axillary as well as the deltoid origin can be preserved. The costs need to be carefully weighed against the potent

P100

Low Demand Hanging Bridge Reconstruction after Tikhoff-Linberg Shoulder Resection

Franziska Maduz; Lara Pozzi; Dr. Markus Pisan; Prof. Dr. Bruno Fuchs

Purpose: Extra-articular scapulo-humeral (or, Tikhoff-Linberg) resection is rarely indicated, and is usually associated with advanced tumor disease around the shoulder. This surgical procedure usually does not allow for high functional expectations because the shoulder joint is completely resected. If the axillary nerve or the deltoid origin, or both, are sacrificed, the shoulder has no active function anymore and the main focus is directed towards avoiding traction of the arm on the plexus, which causes severe pain. Several different methods of fixation of the humerus exist, including clavicular turn-down or spacer prosthesis to fix at the acromion etc. Herein, we describe the hanging bridge method to fix the arm secured to the chest at the desired position.

Method: A 66 year old patient was diagnosed with an undifferentiated pleomorphic sarcoma of the scapula, proximal humerus, involved the entire joint as well as the axillary nerve. She also had a disseminated encephalitis and a longstanding colitis ulcerosa, reason why she was not able to undergo preoperative chemotherapy. Because of severe pain and the localized disease status, surgery was indicated. Using an utilitarian incision exposing the shoulder joint both from the front and the back, scapula-humeral resection was performed, with sacrifice of the axillary nerve.

Results: After complete exposure, a first Trevira tube was put over the remainder of the humerus stump in terms of a "Zipfelmütze". A second tube was fixed to the lateral end of the clavicle, and passed around two ribs to fix the other end of the tube at the inferior angle of the scapula, to provide the hanging bridge. Then, the tip of the Zipfelmütze is then passed around the hanging bridge, to adjust the length and to achieve a stable construct. Soft tissue reconstruction then enhances the stability through scar tissue formation.

Conclusion: The hanging bridge reconstruction provides a stable construct of the shoulder after Tikhoff-Linberg resection with no traction pain. Obviously, there is no shoulder function, but normal elbow and hand function can be expected.

P101

Extra-Articular PAO Resection in one Piece with the Proximal Femur and Reconstruction with a Pelvic Prosthesis

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Purpose: Periacetabular resection (PAO) is meanwhile an established surgical method to correct the version of hip congruency. When a small intra-articular malignant bone sarcoma is diagnosed, a PAO may be performed to resect the hip joint extra-articularly. To the best of our knowledge, an extra-articular hip joint resection together with the proximal femur has not been reported to date.

Method: A 29 year-old chemist was diagnosed with synovial chondromatosis of the left proximal femur (15x10x10cm), and an initial resection through an antero-medial approach was performed. 20 months later, a second resection was performed for a 5cm local recurrence, as well as 44 months post initial surgery, with the same tumor extent as initially. All pathological work-ups confirmed the benign nature of the initially diagnosis. 71 months after, a third local recurrence was noticed, a biopsy from the lesser trochanter again did not reveal any signs of malignancy. However, because the lesser trochanter was on imaging clearly eroded by the tumor, we elected to transarticularly resect the proximal femur together with the vessels, which were also replaced. At this step, we unexpectedly noticed that there were intraarticular tumor remnants squeezed between the articular surfaces. Postoperative rehabilitation was uneventful with full functional recovery without limp. 103 months after the index surgery, a fourth local recurrence was noticed intra-articularly. No metastasis were ever noted.

Results: We elected to join the lateral incision with an iliac, dorsally diverted incision to expose the lateral aspect of the pelvis. Medius and minimus were kept on the tumor, and the dorsal column exposed while protecting the sciatic nerve in its entire course. With intrapelvic protection, the PAO osteotomy from outside. The lateral femur, specifically the periprosthetic membrane of the proximal femur prosthesis was exposed to then complete the PAO such that the femur could be luxated in one piece with the extra-articular hip-joint outside the pelvis. After new draping, the prosthesis was disassembled and the tumor removed completely. A modular pelvic LUMIC prosthesis was inserted and assembled with the proximal femur, with reconstruction of the soft tissues. Postoperative course was uneventful without any signs of infection.

Conclusion: Extra-articular resection of the hip joint together with the proximal femur in one piece is technically possible, and allows reconstruction with a modular prosthesis

P102

Is Total Humerus Resection with Prosthetic Reconstruction Safe in a Patient with Pathological Fracture from Dedifferentiated Chondrosarcoma?

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Purpose: Patients with dedifferentiated chondrosarcoma (ddCHS) have a dismal prognosis. Surgery is considered as treatment of choice because no chemotherapy so far was able to show response rates. There is continued debate whether the limb with a pathological fracture on the base of a malignant bone tumor should be amputated because of oncological control, or saved. There is general agreement regarding patients with osteosarcoma and pathological fracture to keep the limb, whereas for patients with ddCHS it is not clear.

Method: A 69 year old man noticed some discomfort in his right hand dominant upper arm for some months. 3 weeks prior to diagnosis, he developed night pain and subsequently he felt a crack. Staging evidenced localized disease. The CT-guided biopsy revealed a ddCHS, and the discussion with the patient then involved the Pro's and Con's of amputation versus limb-saving surgery. Imaging showed that proximally and distally, the tumor was confined to the intramedullary bone, and diaphyseally, the neurovascular bundle as well as specifically the radial nerve were separated by a fine line of fat tissues from the tumor.

Results: A utilitarian incision was used from deltopectoral interval to distal, and from there over the crease of the elbow medially to the forearm. Whereas the brachial muscle was sacrificed, the biceps muscle with the motor branch of the musculocutaneous nerve could be saved to retain flexion. The deltoid diaphyseal insertion was completely involved by the tumor and therefore resected. Both shoulder and elbow joints were resected trans-articularly. Reconstruction was performed using a total humerus prosthesis, with uncemented ulnar stem fixation and using the reverse design for the shoulder part. Postoperative course was uneventful.

Conclusion: Pathological fractures in patients with ddCHS imply a challenging situation from the oncological perspective. While current chemotherapy may not affect survival, surgery is necessary for local control, but may neither affect overall outcome. So if amputation may likely not

render a survival advantage, and if the local situation allows to save neurovascular structures, it may be one option to discuss the situation openly with the patient, thereby avoiding mutilating surgery.

P103

Osteotomy Through the Sacral Ala: The Advantage of Using a 3D-Printed Resection Guide

Dr. Fabian Kalberer; Nina Fuchs; Holger Klein; Prof. Dr. Bruno Fuchs

Purpose: Hemipelvectomies need to be carefully planned because the anatomy offers only little options between adequate tumor resection margin and functional loss. This applies specifically for the dorsal osteotomy through the sacral ala, where the tumor often abuts the sacro-iliac joint (SIJ) laterally, and the sacral foramina on the medial side. Further, the long arm of the SIJ is several cm long and thick, and at the inner table, there runs the L5 nerve root which exits the pelvis through the sciatic notch. Therefore, sacral osteotomy is rather complex and free-hand chisel osteotomy may not be precise enough.

Method: A 14 year-old girl was diagnosed with localized Ewing's sarcoma of the iliac bone, and underwent preoperative chemotherapy. Imaging revealed the extent of the tumor from 6mm above the acetabulum to the SIJ, with however, involvement of the respective joint. After completion of preoperative chemotherapy, there was no soft tissue tumor involvement. Through a large iliac incision starting from the sacral midline over the PIS, it was extended distally and dorsally to the greater trochanter, to release the abductors and expose the outer pelvis and protect the sciatic notch.

Results: Two 15 holes 3D drilling guides were printed based on CT and MRI imaging data such that it perfectly fitted to the dorsal aspect of the sacrum. Both guides had the same footprint, but their drilling bits guides were slightly set apart so that the drill holes were set as closely to each other as possible. The length of the drill holes can be accounted for as well in order to avoid damage of the L5 nerve root. Using the chisel by hand allows to safely complete the osteotomy.

Conclusion: The printing of a 3D guide which incorporates drilling guidance greatly assists to perform the sacral anatomy and to improve the precision of this osteotomy, to remove the tumor completely, and to spare the functional anatomy as much as possible

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Toxic Megacolon with Perforation as a Severe Complication after Sacro-Iliac Hemipelvectomy

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Purpose: Hemipelvectomies are technically demanding and challenge both the surgeon as well as the patient to meet the objectives. Many complications may arise, which requires a respective interdisciplinary institutional set-up and the awareness of treating physicians that the unexpected can be handled in the team. Herein, we report on a patient who developed a toxic megacolon with subsequent perforation.

Method: A 63 year-old man developed a sacro-iliac metastasis of a non-seminomatous germcell tumor 16 years after initial diagnosis and treatment. He underwent chemotherapy according to the TIP protocol and showed a good response, but not complete regression. It was then decided to remove the tumor completely to render the patient disease-free. Imaging showed that the tumor had a 7cm soft tissue lesion over the posterior aspect of the ilium, destroyed the PIS, passed the SI-joint and involved the ipsilateral hemisacrum. A internal hemipelvectomy was performed with an osteotomy starting at the anterior notch through the ilium, as well as involving the ipsilateral hemisacrum with parts of the contralateral sacrum between S2 and S4. A reconstruction with a cage, rods and pedicle screws was followed. The patient received iv antibiotics for 48h. Initial postoperative course was uneventful, with the patient being mobilized on 3 postoperative day (POD).

Results: On POD 5 the patient developed some discomfort and a CT scan showed a distended abdomen. On POD 6, the clostridium difficile antigen and toxin were found. He was treated and monitored accordingly and remained hemodynamically stable until POD15 when he became unstable and free abdominal air was diagnosed. He underwent an explorative laparotomy with hemicolectomy and abscess removal, an ileostoma was done. One day later, a further laparotomy was performed with resection of the duodenum and removal of hematoma was done. With an abdominal VAC. One day later, a third revision was performed with then closure of the fascias, to then another 5 days thereafter, to ultimately close the wound completely. Five weeks after index surgery, the patient was leaving the hospital for rehabilitation.

Conclusion: Perforation of a toxic megacolon is a life threatening complication after internal hemipelvectomy. Whereas transitory bowel paralysis is often the case after these type of surgeries, one needs to be aware of this complication and actively search for it.

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Hyperparathyroidism with 'swiss cheese skeleton' in a 21y old man.

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Introduction: Giant cell tumor (GCT) and brown tumor of hyperparathyroidism (BTH) share similar characteristics containing giant cells and spindle-shaped cells in fibrous matrix, but treatment-wise, both these conditions are totally different.

The observation of extensive multiple skeletal osteolyses caused by primary hyperthyroidism is presented to raise attention to consider metabolic causes of space taking lesions of the bone.

Methods: The 21 year old man experienced a sharp pain while playing squash during a forced rotation of his left knee. MRI showed extensive epimetaphysal multicystic osteolysis of the proximal tibia involving more than 2/3 of the bone cross section with a small impression of the medial plateau. The femur showed extensive metaphysal lesion with similar characteristics involving about 1/2 of the cross section. The imaging with fluid levels in the cystic areas was suggestive of aneurysmal bone cysts. As multiple aneurysmal bone have not been observed by these authors a whole body FDG-PET was ordered. PET/CT showed similarly extensive, highly FDG-avid, lytic bone lesions around the right knee, the proximal humeri as well as multiple other skeletal lesions. Furthermore bilateral nephrocalcinosis was detected and an FDG-active nodule of about 2 cm diameter dorsal to the right thyroid lobe suggestive of a parathyroid adenoma. Biopsy of tibia and femur revealed a heterogeneous proliferation of giant cells compatible with BTH as well as GCT. Serum Parathyroid hormone (PTH) was elevated to 127 pmol/l (normal 1.3-7.6). The adenoma was excised followed by normalization of the PTH.

Results: PET-CT at 10 months showed remineralization and normalization of FDG-activity, X-Ray at 16 months complete sclerosisation of the formerly osteolytic regions.

Discussion: Biopsy could have misled to the diagnosis of a GCT of bone. The PET/CT besides depicting the "swiss cheese pattern" of bone lesions and FDG-activity in the parathyroid led to the diagnosis of hyperparathyroidism.

Conclusion:

We wish to stress to raise following questions before biopsy of bone lesion¹:

- Originating in bone (primary bone tumor) ?
- Metastasis ?
- Metabolic cause (hyperparathyroidism, VitD aberration, other endocrine active tumor eg. phosphaturic) ?
- Hematogenous (chloroma, lymphoma etc) ?
- Infection?

1 Exner G.U., Kurrer M.O., Mamisch-Saupe N., Cannon S.R.: The tactics and technique of musculoskeletal biopsy. EFORT Open Rev 2017;2:51-57

P106

Giant Pendulum WDLs Through Sciatic Notch: Transient Iliac Osteotomy For Complete Tumor Resection

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Purpose: Pendulum tumors around the pelvis are infrequent, occur per definition intra- and extrapelvicly, and pass either through the sciatic notch or the foramen obturatorium. Most often, there is a large discrepancy between the two parts of the tumor such, that the entirety of the mass can be approached from one compartment. However, if both the intra- and extrapelvic parts are so large that this is not possible, the question remains how to approach. Specifically, when the tumor should be removed completely for oncologic purposes.

Method: A 45 year old man noticed some unspecific abdominal pain for years, as well as right gluteal swelling for some months, but when a foot drop occurred, he sought medical attention. A large lipomatous tumor mass of 38cm was found on imaging both intra- and extrapelvicly, communicating through the sciatic notch, and involving all the sacral nerve

roots looped within the tumor mass. Ultrasound-guided tru-cut biopsy revealed a well differentiated liposarcoma, whereas some dedifferentiated parts with this large mass were still possible. To potentially improve the intrapelvic resection margins, preoperative radiotherapy with 50Gy was conducted.

Results: Using a triradiate incision, both intra- and extrapelvic masses were dissected, and to remove the mass in its entirety, we elected to osteotomize the ilium starting from the posterior aspect of the notch, slightly anteriorly tilted. The roof of the notch was separately removed with some 2x3cm, rendering an iliac opening (together with moving the leg) of up to 6cm, thereby allowing to lift the entire tumor in one piece. The sacro-spinal and –tuberal ligaments were preserved, as well as the femoral and obturator nerves, while all the sacral nerve roots were sacrificed. The pelvis was osteosynthesized using three threaded screws.

Conclusion: An intra- and extrapelvic tumor mass -which for oncologic reasons has to be completely removed- is safely approached through an iliac osteotomy, allowing to open up wide enough to mobilize it en bloc. Anatomic reduction is followed by screw osteosynthesis, and no additional morbidity is expected.

P107

Pearls and pitfalls in diagnosis and treatment of foot and ankle tumours: Delayed diagnosis and interdisciplinary treatment of a pleomorphic leiomyosarcoma - a case report

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Introduction: True neoplasia of the musculoskeletal system is rare, soft tissue sarcomas (STS) account for only 1% of all malignancies. Correct diagnosis is often delayed and unplanned resection of STS is not uncommon. This case report demonstrates the prolonged course towards correct diagnosis of a pleomorphic leiomyosarcoma of the ankle and its interdisciplinary therapy.

Case report: A 45-year old male presented with a mostly asymptomatic soft tissue mass on the lateral side of his right ankle joint, he had first noticed five years ago. Magnet resonance imaging showed an inhomogeneous soft tissue mass with a partial pseudocapsular margin. The report suggested a pigmented villonodular synovitis (PVNS) although specific susceptibility weighted imaging had not been performed. A single stage resection was planned. After the case was transferred to the responsible foot & ankle and tumour specialist, due to discrepancies a bi-optical verification was performed first. The histopathology report noted a desmoid tumour not matching the clinical or radiological findings. Another institute's opinion was obtained, where a leiomyosarcoma was diagnosed. Only a third institute, however, was able to grade the mass as moderately differentiated pleomorphic leiomyosarcoma.

After an interdisciplinary musculoskeletal tumour board discussion, the tumour was resected included parts of the joint capsule and the anterior talofibular ligament (ATFL). Until final confirmation of complete resection, negative-pressure wound therapy was applied. Secondary reconstruction of the unstable ankle joint was performed with a gracilis muscle flap and an anterior talofibular ligament reconstruction with an autologous gracilis-tendon. Therefore, the reinforced graft tendon was fixated in a blind drill hole at the insertion site of the original ATFL on the talar neck. At the origin, the tendon then was passed and fixated through a transfibular tunnel. Adjuvant radiotherapy (60 Gray/ 30 sessions) started 6 weeks after discharge.

Conclusion: Due to the unspecific appearance of foot and ankle STS, early diagnosis is often missed. Diagnostic errors resulting in unplanned resections are not uncommon, even amongst experienced radiologists, pathologists and orthopaedic surgeons. Any doctor involved in the diagnostic and therapeutic process of unclear lumps and bumps around the foot and ankle has to take true neoplasia into consideration. If in doubt, early referral to a specialist centre is necessary.

P108

Intraosseus epidermal cyst of the distal phalanx of the thumb: A rare finding

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Introduction: Intraosseus epidermal cyst are rare benign tumours that have been described in skull, toes and fingers.

Case presentation: A 53-year-old woman presents a history of one month of pain and swelling of the distal phalanx of the thumb with no recent trauma associated. No other significant illnesses except a wound

suture at the same location 20 years previous and a similar episode of pain and swelling 5 years previous, with spontaneous resolution of the symptoms. The initial examination shows a swollen distal phalanx, painful to the touch and a dystrophic nail but no restriction in range of motion of the interphalangeal joint. The standard x-rays show an osteolytic lesion of the distal phalanx with cortical thinning and no joint invasion. An MRI was performed to confirm the nature of the tumour.

Results: We chose to perform a surgical curettage of the tumour. The histomorphologic exam performed shows an intraosseous epidermal cyst. We treated the patient with standard wound care, free range of motion and direct pressure avoidance. The outcome was a complete pain relief with no complications associated.

Conclusion: Little is known about the pathogenesis of these tumours. However, a previous trauma with bone infiltration of epidermal tissue has been suggested. A malignant lesion should be suspected in the differential diagnosis. The best surgical treatment option remains curettage with or without bone graft in symptomatic cases.

P109

Complete Anterior Pubic Hemipelvectomy does not Require Reconstruction

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Purpose: Internal hemipelvectomies may often require several hours of surgery and are inherent with a wide set of potentially devastating complications. There are many different types of resections, depending on the anatomic location of the tumor. Reconstruction may add to this complexity, however, it is not always clear when to reconstruct. It is generally believed that if the pelvic ring is disrupted, this renders the pelvis unstable and consequently the function may be impaired. Therefore, for each type of internal pelvic resection, the type of reconstruction may vary and needs to be thoughtfully considered. Herein, we report on the function of a patient with complete anterior pubic hemipelvectomy without reconstruction.

Method: A 34 year old female patient was diagnosed with an adenocarcinoma of the mid-rectum (pT3, pN1b 3/21; Pn0, R0, M0) in March 2016. She underwent local resection followed by radio-chemotherapy (Xeloda; 50.4Gy) followed by Leucovorin 5-FU. On August 09, 2017, a singular metastasis of the inferior right ramus of the right pubic bone was diagnosed and then resected, followed by FOLFOX chemotherapy. On May 25, 2018, a local recurrence at the right pubic bone was diagnosed, which was then treated by IMRT hyperthermia and as well as 5-FU chemotherapy. Unfortunately, despite good response overall, there was disease progression in the adductors as well as in the M.obturator internus outside the radiation field, as well as in the contralateral inferior pubic ramus. It was then decided to remove the entire anterior bony pelvis with accompanying soft tissues for disease control.

Results: Through a Pfannenstiel incision which was extended on each side along the inferior pubic ramus distally and dorsally, the entire pubis was exposed. The adductors on the left side were left on the specimen, and while the urethra was protected, the entire anterior pelvis was removed including the right obturator internus muscle en bloc. A right sided pedicled ALT was used to cover the soft tissue defect. No reconstruction of the anterior pelvis was performed. Wound healing was uneventful, and the patient was mobilized on crutches without pain in the dorsal aspect of the pelvis. Five month postoperative, the patient walks without pain.

Conclusion: The reconstruction of the anterior pelvis after complete resection of the bilateral pubic bones is not mandatory, reducing the risk of potential complications, while offering the patient a normal and pain free gait.

P110

Reconstruction of the Flexor Compartment after Soft Tissue Sarcoma Resection of the Proximal Forearm

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Purpose: Soft tissue sarcomas of the proximal forearm represent great challenges mainly because of the complex local anatomy and its associated potential functional loss after resection. It is often difficult to decide between oncological safety and preservation of function, and the situation has to be thoroughly discussed with the patient. If it is decided on limb-salvage surgery, then the main focus is directed towards the best possible reconstruction options.

Method: A 31 year old patient presented with a 70x38x34mm, partly calcified mass in the proximal flexor compartment of the forearm. Biopsy revealed a sclerosing epithelioid fibrosarcoma, and staging studies showed small indeterminate lung nodules. Induction chemotherapy was followed by preoperative radiation. Together with the patient, we opted for limb-salvage surgery and reconstruction of the flexor function using a free gracilis flap.

Results: The entire forearm was exposed from anteriorly and the ulnar as well as radial neurovascular bundle saved. The flexor muscles and the median nerve were transected to expose the interosseous membrane, which was transected and together with the periosteum freed from ulna and radius to keep on the tumor. In parallel, the gracilis muscle was harvested. Disally, we performed a transfer of the common palmar nerve Dig.IV-V to Dig I-II, then used two cable grafts for the reconstruction of the median nerve, transfer of the brachioradialis tendon onto the FPL, as well as a transposition of the extensor digiti minimi to abductor pollicis brevis to restore opponens function. Finally, the free gracilis muscle flap was transferred and anastomosed end-to-side to the radial artery. The postoperative course was uneventful. At 3 months follow-up, the patient starts using her flexion, but still continues intense ergotherapy training.

Conclusion: Soft tissue sarcoma resections in the forearm need to be carefully balanced between oncological safety and functional reasonability, and need to be carefully individualized together with the patient preoperatively to meet the expectations on both sides. A functional free gracilis muscle transfer is well suited to restore flexor function in the forearm.

P111

Load-induced changes in articular cartilage biomarkers before and after high tibial osteotomy in patients with medial knee osteoarthritis

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Introduction: The capacity of chondrocytes to respond to loading seems to play an important role in the pathomechanics of osteoarthritis. High tibial osteotomy (HTO) is a joint preserving surgery for knee osteoarthritis with the goal of improving the load transfer at the knee during walking. The purpose of this study was to investigate load-induced changes in articular cartilage biomarkers before and after HTO in patients with medial compartment knee osteoarthritis.

Methods: Blood samples were collected in 10 patients (6 male, 4 female; 44.3 ± 8.6 years, 25.8 ± 3.9 kg/m²) 4 weeks before and 6 months after a HTO before (t0) and 0, 0.5, 1.5, 3.5, und 5.5 hours (t1-t5) after a 30-minute treadmill walking exercise. Serum concentrations of cartilage oligomeric matrix protein (COMP), matrixmetalloproteinase (MMP)-3, -1, 9, interleukin- (IL)-6, C-propeptide II (CPII), cleavage of type II collagenases (C2C), proteoglycan 4 (PRG-4) und A disintegrin and metalloproteinase with thrombospondin motifs 4 (ADAMTS)-4 were determined using commercial ELISA Kits. Differences in concentrations were detected using ANOVA for repeated measures with surgery (pre versus post) and time as within subject factors (P <0.05).

Results: Postoperative baseline COMP levels were higher and C2C and CPII levels were lower than preoperative levels (P <0.05). Pre- and post-operatively, COMP, MMP-3, C2C, and CPII increased immediately after the walking exercise by 10 to 70% and PRG-4 decreased by 43% (P <0.05). COMP und MMP-3 decreased by up to 25% below baseline level until 5.5 hours after the walking exercise. IL-6 increased 3.5 and 5.5 hours after the walking exercise by more than 400 and 500%, respectively. PRG-4 and MMP-9 showed clear maxima 3.5 hours after the walking exercise.

Discussion: The immediate and delayed load-induced changes in cartilage biomarkers suggest not only a diffusion of cartilage biomarkers but also (possibly delayed) metabolic processes. The decrease in PRG-4—or lubricin—after exercise indicates greater friction during with exercise of the osteoarthritic joint. The lacking differences in load-induced changes of cartilage biomarkers between pre- and postoperative assessment may be caused by individual load correction of the HTO that may lead to different pre- to postoperative load-induced changes between patients. Corresponding evaluation of the association with kinetic gait data will be conducted in a next step.

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P112

Transfemoral amputation: assessment before and after a new distal weight-bearing implant

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Background: Individuals with a transfemoral amputation may experience limitations in activities of daily living due to reduced mobility and prosthesis-related problems with several hard socket designs. In this context, we proposed a new internal femoral implant that allows for distal weight-bearing. This implant, named MAKAN[®], was developed at the University Hospitals of Geneva with improvement of the gait and the use of the prosthetics satisfaction as goals.

Aim: To assess change in gait quality, mobility, physical function, pain and satisfaction with use in daily life before-and-after MAKAN[®] implantation using validated outcome measurement tools.

Methods: A 64-year-old with a left traumatic amputation underwent clinical gait analysis (CGA) with a traditional hard socket prosthesis including the ischial tuberosity, and 6 months after MAKAN[®] implantation. The CGA was performed with shoes and sticks at different walking speeds. Spatio-temporal parameters, including kinematics of the hip, knee and ankle were calculated and compared. In addition, the patient underwent several tests, including 6-minutes walk test (6-WT), TUG, Tinetti, and Short Physical Performance Battery (SPPB). Patient satisfaction with use of the prosthesis (Satpro) and the level of pain (AVS) were evaluated at each session.

Results: At the second evaluation, CGA was higher on the MAKAN[®] side (0.64 ± 0.03 m/s vs. 0.56 ± 0.04 m/s). We observed also a better ankle and knee kinematic for the sound side. For the left side, we observed a better angle foot progression and hip kinematic. The step width was lower at second CGA (0.13 ± 0.01 m vs. 0.21 ± 0.01 m) and the Tinetti test evolved from 22 to 25 points, reflecting a better equilibrium. The 6-WT improved by 45.5 % (165 to 240 m). The SPPB was 2 points improved (7 to 9). TUG was realized in 18 seconds instead of 23 with traditional hard socket. AVS went from 4 to 2: There was no difference with Satpro.

Discussion and conclusion: The use of the MAKAN[®] prosthesis produced improvements for the patient in terms of gait quality, speed and distance of walking, equilibrium, physical function and level of pain. We did not observe any difference concerning patient satisfaction with use of the MAKAN[®].

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Major Lower Limb Amputation for Vascular disease: Does Diabetes Mellitus Influence Prosthetic Fitting?

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Background: Peripheral arterial disease (sPAD) is one of the main causes of major atraumatic lower extremity amputations (MLEA). Diabetes Mellitus (DM) is a frequent concomitant condition in MLEA. However, the influence of DM on the rate of successful prosthetic fitting in MLEA is unknown.

Aim: Evaluation of DM effect on the rate of successful prosthetic fitting in MLEA, when stratified by age, sex and level of amputation.

Methods: Retrospective survey of systematic data collection including all MLEA, the latter defined as any level of amputation proximal to the foot. The cohort included all patients requiring MLEA for sPAD, with or without DM, between 1993 and 2017 at Geneva University Hospitals. The rate of successful prosthetic fitting in both groups, corrected for age, sex, and level of MLEA was analyzed via logistic regression. Successful prosthetic fitting is defined as any patient with MLEA fitted with definitive ambulation prosthesis at 6 months postoperatively. Unsuccessful is any patient not fit for definitive prosthesis at 6 months because of cognitive and/or functional inability to securely use a prosthesis.

Results: Seven hundred sixty-three MLEA were performed from 1993 to 2017. Baseline characteristics showed a male predominance (67%; n = 509). Diabetic patients (n = 459; 60%) were significantly younger for amputation than non-diabetic patients (70.4 ± 11 vs 74.1 ± 12 years p <0.001). The majority of amputations (57.7 %) were performed below the knee (BKA). The probability of having a BKA was significantly lower in non-diabetic patients as compared to those with DM (OR 0.36 (CI95%

0.27-0.50), p <0.001). The rate of successful prosthetic fitting was 65.3 %. The probability of successful prosthetic fitting was significantly higher in patients with BKA than in those with above knee amputation (OR 4.93 (CI95% 3.39-7.16), p <0.001), and lower in patients older than 65 years (OR 0.52 (CI95% 0.37-0.72), p <0.001). Sex and presence of diabetes did not influence the prosthetic fitting.

Discussion and conclusion: DM patients with peripheral arterial disease were found to have a lower level of amputation and a younger age at the time of amputation when compared to non-DM patients. Despite these objective factors, DM patients showed no difference in terms of prosthetic use. Preservation of the knee joint, and age below 65 years had a positive effect on the rate of prosthetic fitting.

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Assessment of fluid dynamic stimulation effects on cell mineralization in bioprinted scaffolds

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Introduction: Regeneration of bone tissue in critical sized defects is still an issue and, in this context, biological substitutes based on scaffolds loaded with osteogenic cells, can be a promising therapeutic approach. However, the development of clinically relevant cellularized constructs is limited by inadequate construct architecture and oxygenation. Bioprinting allows controlled cell positioning, but static culture of bioprinted structures leads to inhomogeneous extracellular matrix formation and insufficient oxygen transport in internal scaffold regions. Our aim is thus to use perfusion bioreactors to enhance homogeneity of mineral deposition by human mesenchymal stem cells (hMSCs) and oxygen transport in bioprinted constructs.

Methods: Cylindrical porous scaffolds (d = 10 mm, h = 3 mm) were designed with SolidWorks and bioprinted using a hydrogel made of 0.8% (w/v)-alginate and 4.1% (w/v)-gelatin embedding hMSCs at 5 Mcells/ml. Bioprinted scaffolds were cultured in osteogenic medium comparing 0.7 and 7 ml/min flow rates to static control. Micro-computed tomography was performed weekly to analyze mineral deposition for up to 42 days. Computational Fluid Dynamic (CFD) simulations were run on scaffolds using COMSOL Multiphysics to evaluate fluid velocity, wall shear stress (WSS) and pressure distributions on scaffold fibers, and oxygen diffusion through the hydrogel.

Results: Bone formation was observed in all groups starting from scaffold edges. In internal cylindrical regions (d = 5.4mm), bone volume (BV) significantly increased in perfused culture as compared to static. In particular, it ranged from $0.73\% \pm 1.04\%$, $1.49\% \pm 0.87\%*$ and $8.24\% \pm 8.41\%$ at week 3 to $1.95\% \pm 1.49\%#$, $5.19\% \pm 1.68\%*$ and $17.7\% \pm 18.51\%#$ at week 6 in static, 0.7ml/min and 7ml/min samples, respectively (P-values *0.03, #0.02). WSS on scaffold fibers were equal to 3.67 and 36.86mPa in 0.7 ml/min and 7ml/min samples, respectively, pressure values were equal to 0.12 and 1.35Pa, respectively, while the entire scaffold was properly oxygenated in both perfused samples, confirming the absence of hypoxic regions.

Conclusions: The combination of experimental planning, based on CFD simulations, and dynamic culture, based on perfusion bioreactors, enhanced quantity and homogeneity of minerals deposited by hMSCs and construct oxygenation, compared to static control, and could help the development of adequate cellularized bone substitutes suitable for clinical applications.

P115

A 3D microfluidic in vitro model of an osteoarthritic joint as a screening platform for biological therapies.

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Introduction: Osteoarthritis (OA) is a multifactorial disease with an increasing incidence. Inflammation plays a key role in this pathology, but effective models to study OA pathological mechanisms and to evaluate the effects of therapeutic approaches have not yet been produced. For these reasons, we developed a 3D microfluidic model of an osteoarthritic joint to analyze both the inflammatory effect of arthritic synovial fluid (OA-SF) on articular cells and the immunomodulatory and regenerative capabilities of biological therapies.

Methods: We isolated and expanded articular chondrocytes, synovial fibroblasts and MSCs and harvested OA-SF from arthritic patients. The microfluidic chip comprised three communicating channels. Firstly, chondrocytes and fibroblasts were embedded in fibrin gel and injected in the two external compartments, with OA-SF in the middle. After 4 days we replaced SF with fresh OA-SF resuspended with MSCs from bone marrow or adipose tissue. Devices were cultured for further 6 days, and then we evaluated cell viability, morphology and migration by means of Live&Dead and fluorescent track analysis.

Results: The majority of the chondrocytes and fibroblasts injected in the device resulted alive during the entire culture period. The addition of OA-SF in the culture system determined an increase in cell viability, especially for the fibroblast. Moreover, it induced modifications in cell morphology and spreading. We also successfully injected in the synovial compartment the MSCs resuspended in the synovial fluid, without affecting their viability. Cytofluorimetric analysis confirmed the stemness of the MSCs before the injection.

Conclusions and perspectives: We developed a new microfluidic model that recapitulate an arthritic joint and it has proved effective in the culture of articular cells in a 3D environment in the presence of synovial fluid, an important player in the pathology rarely used for in vitro cultures. Moreover, this device allows the injection of different biological preparations for the OA treatment and the evaluation of their immunomodulatory and regenerative capabilities, confirming its effectiveness also as a screening platform for biological therapies.

P116

Cartilage Studies In Large Animal Model: What Can Be Done With the Domestic and Göttingen Pigs?

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Introduction: Porcine family is commonly used for cartilage research in preclinical testing, due to availability and knee morphology. Domestic pigs are large and gain 1kg / day, therefore, mid- to long-term studies are challenging. However, Göttingen mini-pigs reach maximum 45kg as adults. This study compares knee suitability of domestic pigs with mini-pigs for cartilage research.

Methods: Four domestic and 6 mini-pigs were used post euthanasia and their left knees dissected. Pigs in both groups had similar weight at the study start (40 kg). Using a standardized, 2cm superolateral approach, the accessible area of the lateral trochlear cartilage was measured. A medial para-patellar approach sparing the medial patellofemoral ligament visualized the trochlea (no patellar dislocation) and measured the entire cartilaginous trochlea. The number of 6mm diameter cartilage defects on the trochlea was recorded, with <4mm in between. Cartilage depth was measured in the trochlea center. To record morbidity in mini-pigs, the contralateral knee was analyzed post a two-step surgery: 1) cartilage harvest from superolateral approach, and 6 weeks later 2) creating 3-4 trochlear cartilage lesions via medial para-patellar tendon approach. They were full weight bearing without immobilization postoperatively. Morbidity was evaluated 3 to 6 months after the second surgery for patellar tendon shortening, and cartilage degeneration (ICRS classification). Spontaneous cartilage healing of the lesions was analyzed.

Results: Each approach allowed for different joint visualization, in domestics (trochlea: lat. 20% vs med 80% ; med condyle 50%), mini-pig (15% vs 70% ; 30% respectively.) Trochlea measured in domestics width 20 mm (18; 25) length 40 mm (37 ; 45), vs mini-pig W15 mm (13 ; 20) and L26 mm (23 ; 28). The narrow trochlea in mini-pigs allows only 4 lesions without overlap. Cartilage thickness in domestics was 3 mm vs mini-pig <1mm. A vascularized cartilage was noted in domestic pigs. No patellar tendon shortening was noted nor an arthrosis in comparing the 2 knees. In histological analysis, fibrocartilage healing was observed but no spontaneous return to hyaline cartilage.

Conclusion: Mini-pig model allows for long-term follow without much strain on the animal and the host structure but has a thinner cartilage and a narrower trochlea. Domestics have a larger joint surface and thicker cartilage making it comparable to the human knee, but vascularization may be a problem

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Redesigning commercial total hip replacement instruments: an educational project

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Introduction: Commercially available surgical instruments pass a strict certification process. In arthroplasty of large joints, the instruments are persistently exposed to significant mechanical stresses that can potentially lead to fatigue failure. In this educational project, we addressed a very rare case of fracture of the connection pin between femoral broach and handle. The specific aims were (1) to characterize the stress distribution to which the pin is exposed during surgery, (2) to design new connection mechanisms, which are more resistant to fatigue yet do not interfere with the surgical technique.

Methods: Biomechanics Master students from EPFL were presented with the case of pin failure in a CORAIL[®] broach. The pin was fractured during removal of the broach, which was then stuck in the femoral canal and required a long procedure to retrieve. The students were asked to study the mode of failure and to propose alternative designs. They were invited to attend surgeries with the CORAIL system to better understand the context.

Using computer assisted design and finite element modeling (FEA), they simulated stress patterns around the pin under surgically realistic loads to locate stress risers. They designed new pins that would eliminate stress risers, and validated them by FEA under similar loading conditions.

Results: Stress risers were identified at the notch level in the current pin design. FEA simulations were in accordance with the actual fracture pattern. Alternative pin designs with axial symmetry instead of unilateral notch were conceived, that would reduce peak stresses to safe levels. The other instruments were redesigned accordingly. An original idea was to add a safety thread in the broach for rescue in exceptional failures. The new designs were considered excellent by a panel of experts.

Conclusion: Pin failure was post hoc predictable based on FEA. Alternative pin designs appear to be more reliable, but clinical studies are needed to evaluate their pertinence in daily practice. Educational projects, such as this one, where engineering students work on a clinical case and have the opportunity to attend surgeries are beneficial for all parties. Students can express their creativity, exert their theoretical knowledge on real world problems and experience what a career in biomedical engineering might be. Clinicians benefit from by being exposed to new technologies, and in the best case, receive original solutions to their clinical problems.

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Influence of bone mineral density on mechanical properties of the cancellous bone within humeral head affected from glenohumeral osteoarthritis.

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Introduction: Mechanical properties of cancellous bone within humeral head are increasingly interesting due to popularity of locking plates for proximal humeral fractures and stemless shoulder prosthetic design. Age or pathology related systematic osteoporosis influences the density of bone in humeral head. However, inactivity or pathology of the shoulder joint may also change the local bone quality and lead to reduced primary stability of bone/prosthesis interface. It was the aim of our study to find if bone mineral density correlates with load/displacement response of cancellous bone within the humeral head.

Methods: We assessed the bone mineral density using micro-CT (0.04 mm voxel size) and correlated the results with indentation load/displacement response. Resected parts of humeral heads (patients undergoing total shoulder replacement, n = 18) were used as probes. The region of interest was defined 0.5 mm to 6 mm medial from resection plane, presuming that it should be representative for the correspondent bone lateral from the resection plane (i.e. the region where anchors of stemless prostheses are placed). As the first step, micro-CT scans and assessment of the bone mineral density within the region of interest was performed. Afterwards, indentation tests were performed using a large

probe (1 cm²) in a single destructive loading procedure. The load/displacement responses and bone mineral density values were correlated using linear and exponential models.

Results: The average bone mineral density was 120.4 mg HA/cm³ (range 13.3 to 362). Our results showed high correlation between the bone mineral density and the slope of load/displacement curve: $r = 0.90$ for linear model, and $r = 0.91$ for exponential model ($p1 \times 2 + p2 \times 3$).

Conclusions: Predominant factor determining bone quality and mechanical resistance to pressure appears to be the bone mineral density. In our model, the high coefficients of determination leave little unexplained variance that could potentially be attributed to trabecular structure. Further investigations about 3D trabecular orientation and anisotropy are necessary.

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Well leg compartment syndrome in trauma surgery – femoral shaft fracture treated by femoral intramedullary nailing in the hemilithotomy position: case series and review of the literature

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Introduction: Well leg compartment syndrome (WLCS) is a rare complication, which can occur following orthopaedic interventions. During surgeries on a traction table, such as femoral nailing, the contralateral “well leg” is often placed in the hemilithotomy position, thus facilitating the use of fluoroscopy. This position (also named the Lloyd-Davis position) consists of hip flexion, abduction, external rotation and knee flexion. WLCS is associated with significant morbidity and mortality because delay in diagnosis and treatment can lead to loss of function and even life-threatening complications. We present the cases of two teenaged patients who underwent femoral nailing on a traction table and developed WLCS. We also present a review of the literature and developed the following guidelines.

Methods: We followed 2 cases of WLCS after a femur fracture treated with intramedullary nailing, well leg in hemilithotomy position. Both were under 20 years old, BMI <26kg/m². They respectively had an open Gustilo II AO 33 A3 left femur fracture and a closed right femoral fracture AO 32C1. Both developed WLCS 1 to 2 hours after surgery. One had intracompartmental pressure measurements, the other not because of clear diagnosis. Both underwent a four compartments fasciotomy with 2 incisions. Both fully recovered without any neurovascular or wound complication 4 to 5 months at the follow up.

Results:

We have developed the following practical guidelines:

- Every patient whose surgery lasts more than 2 hours must be considered at risk of developing WLCS.
- Reduce the time in the hemilithotomy position to a minimum.
- Reduce and measure the flexion of the hip and knee in order to place the limb as close as possible to the level of the right atrium.
- Mobilise the uninjured leg every 2 hours.

- Avoid the Trendelenburg position.
- Avoid hard supports and compressive bandages. Keep the ankle free.
- Avoid hypovolemia before, during and after the intervention.
- Avoid vasoconstrictors.
- Inform nursing staff and junior colleagues of the recommendations and of the first signs of compartment syndrome.
- Never delay a fasciotomy.

Conclusion: Orthopaedics surgeons need to be aware of the risk factors for WLCS and have high index of suspicion.

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The value of routine serum C-reactive protein samples before elective orthopaedic surgery in asymptomatic patients – a literature review

PD Dr. Ilker Uçkay

Objective: There are settings routinely performing pre-operative serum C-reactive protein (CRP) samples before elective implant surgery, notably before arthroplasty. While this approach is valid for research purposes, the clinical or preventive benefits are less clear.

Methods: We performed a survey in Switzerland and France, among selected infectious diseases physicians and surgeons who are specialized in orthopaedic infections; and reviewed existing literature and guidelines we retrieved with the English MeSH terms “preoperative CRP” or “surgical CRP” linked to “surgery” and “complications or “infection”: We excluded cases with a diagnostic use of CRP upon clinical suspicion of infection.

Results: In Switzerland, one CRP determination costs 10 Francs. In our survey, only a minority of Swiss and French settings seem to perform preoperative CRP sampling routinely. International or national guidelines do not recommend it either. According to the lecture of 85 specific articles, the preoperative CRP might have panoply of reasons for being slightly and transiently elevated and can be associated to postoperative complications after cardiac or colorectal surgery; but is mostly a surrogate of the underlying illness or stress. Regarding orthopaedic surgery and traumatology, we identified three papers associating preoperative CRP's with postoperative complications: one traumatology article in the elderly; one paper on elective interventions without case-mix adjustment, and one paper investigating the fate of arthroplasty in patients with rheumatoid arthritis. In terms of outcome, no paper proved that pre-operative routine CRP sampling modified the decisions of the surgeons or the fate of the patient.

Conclusion: The routine pre-operative serum CRP sampling before elective orthopaedic surgery in asymptomatic patients (besides the classic symptoms justifying the planned surgery) doesn't justify the costs of measuring it.

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