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Abstractband

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DKG21-6 Vortrag
Deformitätenanalyse

The Intraarticular Malrotation of the knee - a previously disregarded aspect of patellofemoral instability?

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Aims and Objectives: Patellofemoral pain or instability (PFI) is often caused by femoral or tibial maltorsion. Despite normal torsion measurements (CT/MRI) in femur/tibia there are symptomatic patients with clinical high external rotation of the tibia (ROM shifted to external rotation). An intraarticular malrotation (IAR) of the knee may be the cause for chronic patellar maltracking or patellofemoral instability in these situations. The influence of the intraarticular rotation of the knee has not been sufficient considered and described yet. The aim of this study was to detect and quantify a possible intraarticular malrotation of the knee in symptomatic patients.

Materials and Methods: 100 patients with patellofemoral pain, instability or a suspected malalignment of the lower extremity that had been examined for torsional abnormalities via MRI were included in a retrospective study between 11/2018 and 05/2020. The torsion of the femur and tibia were measured using the method of Strecker and Waidelich. The IAR of the knee was measured in full extension; therefore the angle between the posterior femur condylar axis (PFCA) and the proximal posterior tibia plateau axis (PTPA) was analyzed.
Supplementary measurements were made using the following levels and values: 1) femur transepicondylar axis (FTEA); 2) the tibial plateau ellipsis axis (TPEA; axis through the center of two ellipses on the medial and lateral tibial plateau below meniscal level) 3) tibial tuberosity trochlea groove distance (TT-TG) and 4) tibial tuberosity posterior cruciate ligament distance (TT-PCL). In Long leg x-rays ("knee forward") measurements of the mechanical Femur-Tibia-Axis (mFTA), mechanical Medial-Proximal-Tibia-Angle (mMPTA) and Joint-Line-Convergence-Angle (JLCA) were performed.

Results: In 200 analyzed legs of 100 patients (Ø 23.5 ±8,6 (10-53)) the IAR of the knee was +5,4 ±5,2° (range -7,7 to +16,4°) external rotation (PFCA to PTPA). The mean femoral torsion was -29,5 ±10,7° (-74,9 to -0,8°) internal torsion, mean tibial torsion +36,9 ±8,4° (+9,7 to +62,3°) external torsion. The additional measurement from FTEA to TPEA showed an IAR of +4,7 ±5,2° (-8,0 to 16,6°) external rotation. Mean TT-TG was 16.3 ±4,0mm (6,8 to 30,1mm) and mean TT-PCL 21,6 ±3,4mm (10,6 to 32,6mm). The leg axis analysis showed the following results: mFTA: 0,9 ±3,0° (-7,1 to 11,5°) valgus; mLDFA: 86,2 ±2,1° (80,2 to 91,4°); mMPTA: 87,6 ±2,5° (82,2 to 96,6°); JLCA: 0,5 ±1,3° (-4,6 to 4,3°) medial convergence.

Conclusion: This study group is a population with expected abnormal torsion or IAR. Therefore, normal values for knee rotation cannot be defined in this study. However, the range of 24.1° of IAR may have a decisive influence on rotational alignment of the lower extremity and on the patellofemoral joint causing PFI or maltracking. This has not been described and sufficiently taken into account in the analysis of patellofemoral disorders yet. Additional studies are necessary to define the normal value and range of intraarticular rotation (IAR) in healthy patients.

Stichwörter:
Patellofemoral, Kneeversion, Torsion

DKG21-8 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Retrospective data analysis to compare the re-rupture rate and the stability of the operated knee after anterior cruciate ligament reconstruction using the Press-Fit-Hybrid® technique and the popular interference screw technique.

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Aims and Objectives: The reconstruction of the anterior cruciate ligament is considered to be the "gold standard" in the treatment of knee instability. The aim of the reconstruction is to restore the knee function as anatomically and biologically as possible in order to prevent a progression of the degeneration as a result of the original injury. The Press-Fit-Hybrid® technique (PFH) is a biological alternative to the conventional and popular interference screw technique (IF). The retrospective study analyzes whether the Press-Fit-Hybrid® technique leads to a lower re-rupture rate and better subjective stability. The secondary outcome is the objective knee stability.

Materials and Methods: The main feature of the patented Press-Fit-Hybrid® technology is the generation of femoral / tibial tunnels and bone cylinders. The systematic conditioning of the tunnels and the femoral and tibial hybrid fixation is, in addition to the femoral and tibial press-fit-fixation by bone cylinders, femoral with an adjustable fixation button and tibial with an anchor screw to which the distal transplant threads are securely fixed in the sense of redundancy. Autologous hamstring tendon transplants were used exclusively in both groups. The Press-Fit-Hybrid® technique has been used since November 2015. The last 50 patients of the previously used IF method and the first 50 patients of the new PFH technique were evaluated. The re-rupture rate and the patient's subjective feeling of stability are the primary outcome. Secondary outcomes are the Lachman test, Pivot shift test, Rolimeter difference, flexion and extension deficit using the neutral-0 method before and after surgery.

Results: The re-rupture rate decreased from 6% (n = 3, after 4.8 years in the IF group) to 2% (n = 1, after 4.3 years in the PFH group). 10 of the 50 patients in the PFH group but only 4 of the 50 patients in the If group described that the stability of the knee is now better or much better than before the injury. 6 patients in the PFH group and 7 patients in the IF group reported poorer stability than before the injury. The stability was as before the injury in the remaining patients (34/39). Lachman, Pivot Shift, Rolimeter difference and Neutral-0 Method improved significantly in both groups after surgery, but did not reveal any differences between the two groups, although the PFH group always achieved slightly better results.

Conclusion: The hypothesis that the Press-Fit-Hybrid® technique leads to a lower re-rupture rate and a better subjective feeling of stability was confirmed. The new Press-Fit-Hybrid® technique is a method, that is superior to the interference screw technique in this regard.

Stichwörter:
Knee, ACL, ACL-Reconstruction, Pressfit-Hybrid

DKG21-9 Vortrag
Frakturen rund ums Knie

Surgical treatment of chondral and osteochondral lesions of the knee joint using magnesium pins

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Aims and Objectives: For the refixation of chondral and osteo-chondral lesions different implants have been used so far: On the one hand, resorbable polymer pins with comparatively low stability are available, on the other hand mini titanium screws with good stability, which, however, have to be removed.
Alternatively, magnesium pins can now be used. Their practical applicability and clinical results were evaluated in a case series.

Materials and Methods: A total of 7 patients were operated on between 08/2016 and 12/2020, including 4 patients with OD at the medial femoral condyle and 3 patients with osteo-chondral lesion at the knee joint after patellar dislocation.
All patients underwent arthrotomy after previous MRI diagnosis and the lesion was openly refixed using magnesium pins (MAGNEZIX®). Immediately post surgery, radiographic control was performed. The follow-up period was 2-3 months. In 2 patients an MRI control was performed approx. 6 weeks p.o.. 6 treatments could be completed regularly. One patient is still under clinical control.

Results: All six completed patients were satisfied with the achieved result. There were no disturbances in wound healing or local reactions to the inserted implant. They have clinically all been without clinical symptoms and were fully mobilized about 10 weeks post surgery.
There were no restrictions in everyday life. Patients were able to return to sports or work after 3 months.
Further interventions (revision, hardware removal) were not necessary.
All postoperative X-ray controls showed regular results. In the MRI control after 6 weeks, tissue reactions around the implant were observed, which correspond to those of titanium implants.

Conclusion: The use of magnesium pins results in complete healing of the chondral or osteo-chondral lesions. The surgical technique using an open procedure is safe and, if indicated, can also be performed well arthroscopically. Intraoperatively, the implant gives the surgeon the good feeling of a stable restoration, which is ultimately reflected in the good results. The decisive advantage of the magnesium pins, however, is that no further surgery is required for implant removal.
In the meantime, we prefer using magnesium pins instead of polymer implants or titanium screws for the treatment of chondral and osteochondral lesions because they are both metallically stable and bio-absorbable.

Stichwörter:
chondral lesion, osteochondral lesion, magnesium pins (MAGNEZIX®), titanium screw, polymer implants,implant removal

DKG21-10 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Instrumented measurement of rotational knee laxity after primary anterior cruciate ligament rupture versus rerupture - A comparative study -

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Aims and Objectives: The aim of the current study was to objectify the rotational laxity after primary anterior cruciate ligament (ACL) rupture and recurrent instability secondary to ACL reconstruction. It is hypothesized that knees with recurrent instability feature a higher internal rotation laxity compared to knees with a primary rupture of the native ACL.

Materials and Methods: In a clinical comparative study of successive patients with primary ACL rupture and rerupture after ACL reconstruction were evaluated clinically and by instrumented measurement of the rotational and antero-posterior laxity with the Laxitester® and the KT1000®, respectively. In addition, the examination comprised IKDC 2000 forms, Lysholm Score, and Tegner Activity Scale. Power calculation and statistical analysis were performed (p-value <0.05).

Results: Twenty-four patients with primary ACL rupture and 23 patients with rerupture after ACL reconstruction were included. There was no significant side-to-side difference in anterior translation. In contrast, a significant side-to-side difference of the internal rotation laxity was found with a mean of 8.7 ±8.6° in patients with ACL rerupture compared to 3.6 ±4.5° in patients with primary ACL rupture (p=0.014). A side-to side difference of internal rotational laxity ≥10° was found significantly more frequent in re-ruptures (53.6%) compared to primary ruptures (19.4%; p<0.001). A highly significant relationship between the extent of the pivot-shift phenomenon and side-to-side difference of internal rotation laxity could be demonstrated (p<0.001). IKDC 2000 subjective revealed significantly better scores in patients with primary ACL tear compared to patients with ACL rerupture (56.4 ±7.8 vs. 50.8 ±6.2; p=0.01). Patients with primary ACL tears scored significantly better on the Tegner Activity Scale (p=0.02). No significant differences were seen in the Lysholm Score (p=0.78).

Conclusion: Patients with ACL rerupture feature significantly higher internal rotation laxity of the knee compared to primary ACL rupture. The extend of rotational laxity can precisely be quantified by instrumented measurements. This can be an aid for the indication of an anterolateral ligament graft in revision surgery of the ACL.

Stichwörter:
Rotational laxity, instrumented measurement, ACL, anterior cruciate ligament, re-rupture, anterolateral ligament, ALL.

DKG21-11 Vortrag
Frakturen rund ums Knie

Radiological outcome measures indicate an advantage of precontoured locking compression plates in elderly patients with split-depression fractures to the lateral tibial plateau (AO 41B3)

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Aims and Objectives: Precontoured locking compression plates (LCP) are designed to provide optimum support of the reduced joint surface fragments in fractures to the lateral tibial plateau. The utilisation of these implants has especially been emphasised in patients with fragility fractures and reduced bone quality. To date, there is a lack of evidence supporting the broad utilisation of precontoured LCP in split depression fractures (AO 41B3) of elderly patients. Thus, aim of the present retrospective comparative study was to investigate the radiological outcomes after open reduction and internal fixation of these fractures in young versus elderly patients.

Materials and Methods: The hospital's database was screened for fractures to the tibial plateau. Patients with isolated split depression fractures (AO 41B3) as well as open reduction and internal fixation were included. CT scans and radiographs were analysed. Details of the operative procedures were collected from the patients' records. Patients between 18 and 49 years were attributed as young, patients ≥50 as elderly. Additional sub-grouping was carried out into utilisation of precontoured LCP versus conventional implants. The Rasmussen Radiological Score (RRS) after a follow-up of approximately one year was set as the primary outcome parameter. Secondary outcome parameters were the RRS postoperatively as well as the medial proximal tibial angle (MPTA) at any timepoint investigated.

Results: A total of 61 consecutive patients was included. The young group encompassed 29 patients and the elderly 32 patients. The mean age in the young group was 38.2 ±7.8 years compared to 61.3 ±9.4 in the elderly group. Across the two age groups, there were no significant differences regarding size and depression depth of the lateral joint surface fragments or the void volume. The radiological outcome measures revealed no significant differences between young (RRS 7.7 ±1.7; MPTA 90.3 ±2.3) and elderly patients (RRS 7.2 ±1.6; MPTA 90.5 ±3.3) at final follow up and prior to implant specific subgrouping. After separating precontoured LCP and conventional implants, the radiological outcome measures revealed significantly impaired results in young patients with conventional implants (RRSC 6.9 ±1.6 vs. RRSLCP 8.5 ±1.5, p=0.015; MPTAC 91.5 ±1.9 vs. MPTALCP 89.1 ±2.1, p=0.01). The effect was even more pronounced in elderly patients, with highly significant deterioration of the radiological outcome measures for conventional implants compared to anatomically precontoured LCP (RRSC 5.7 ±1.6 vs. RRSLCP 8.2 ±0.8, p<0.001; MPTAC 92.6 ±4.2 vs. MPTALCP 89.2 ±1.4, p=0.002).

Conclusion: The utilisation of precontoured LCP in the treatment of split depression fractures to the lateral tibial plateau is associated with improved radiological outcomes. This effect is significant in young but even more pronounced in elderly patients. Consequently, precontoured LCP should closely be considered for internal fixation of any AO 41B3 fracture, but especially in elderly patients.

Stichwörter:
Radiological outcome; split depression facture; lateral tibial plateau; Schatzker II; precontoured LCP; elderly

DKG21-12 Poster
Frakturen rund ums Knie

Primary TKA as definitive treatment option for acute knee dislocation (Schenck IV) in the geriatric patient - case report

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Aims and Objectives: Acute ligamentous dislocation of the knee is a rare but complex injury. It is mainly associated with high-energy trauma in the young and active patient, in the obese population ultra-low velocity mechanisms are also reported. Knee dislocations are classified by Schenck et al. in type I to IV (1992).
Several therapeutic options have been proposed by different authors. These include conservative treatment, multi-stage reconstructive surgery and primary single-stage suture and ligament bracing. There is consent about indication for initial reduction and retention by external fixator in cases with severe tissue damage, open dislocations and concomitant neurovascular injuries.
Though, evidence for a certain therapeutic modality is still missing.
Additionally, the geriatric population - frequently not being able to fulfil the highly demanding rehabilitation programmes after ligament reconstruction for knee dislocation - are not taken into account sufficiently.
We present the rare case of a geriatric patient who sustained a high-grade knee dislocation and was successfully treated by primary hinged Total Knee Arthroplasty (TKA) and early mobilization protocol.

Materials and Methods: The 82-year-old multimorbid female patient (normal weight) was admitted to our emergency department after stair fall in the domestic environment.
At presentation deformity and loss of function of the left knee were documented. X-ray and subsequent CT-angiography confirmed a high-grade knee dislocation (Schenck type IV) without concomitant neurovascular injuries.

Results: Initial reduction retention by external fixator were performed in the operation theatre.
Within the following days different therapeutic options were discussed with the patient, considering the patient's abilities and request to return to her activities of daily life as quick as possible.
In conclusion, we made a decision against reconstruction and for implantation of a hinged TKA (MUTARS® GenuX® MK, Implantcast, Buxtehude, Germany).
Postoperative x-rays revealed adequately fixed femoral and tibial components and a correct limb alignment.
Early mobilization could be started under full weight bearing at the first day after surgery. The patient was shifted to a geriatric rehabilitation clinic within two weeks. Range of motion at discharge was extension/flexion 0/0/90°, autonomous mobilization was possible using a rollator.

Conclusion: Geriatric patients with their own abilities and demands are not taken into consideration sufficiently in present therapeutic concepts for the treatment of high-grade ligamentous knee dislocations. Extensive reconstructive surgery mainly refers to the younger population with good healing potential as well as compliance and ability regarding postoperative rehabilitation programmes
In patients of older age, lower functional requirements, multiple comorbidities and imminent loss of autonomy hinged TKA should be considered as a primary treatment option.

Stichwörter:
knee dislocation; knee arthroplasty; trauma; geriatric trauma; sports medicine; orthopedic surgery

DKG21-13 Poster
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Caton-Deschamps derived Patella-Height-Index for knee arthroplasty

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Aims and Objectives: Measuring patella-height has been a hot topic since decades. Multiple radiological indices exist for native knees and arthroplasty. True-patella-height is determined by the length of the patellar ligament. Pseudo-patella-height-alteration is a relative alteration of the patella-height referred to the femoro-tibial joint-line without change in the length of the patellar ligament. Proximalisation of the joint-line can be accidentally created during total-knee-arthroplasty (TKA) leading to pseudo-patella-infera (PPI). Patella infera can be a combination of TPI and PPI. Both components should be part of a complete patella-height-assessment, which demands a combination of patella-height-indices. If only one index is to be used, it should be made sure that this index can record functional patella-height fully.
The Insall-Salvati-Index (ISI) detects true patella-height only. The original Caton-Deschamps-Index (CDI) published in 1982 is commonly accepted as a measure of functional patella-height. As the tibial landmark used for this index is being resected during knee arthroplasty and as the tibial inlay is not visible on X-ray due to its radiolucency, the index in its original form cannot be used in knees with an implanted endoprosthesis. The "modified Caton-Deschamps-Index" (mCDI) for knee arthroplasty was published in 2016, but cannot detect PPI, which is common after TKA.
A derivate of the original CDI could be a simple analogue to the index published in 1982 using a modified tibial reference point at the anterior proximal point of the inlay, which can indirectly be found on the lateral knee radiograph (Fig. 1).
It was the aim of this study to determine the reliability of a derived Caton-Deschamps-Index for knee arthroplasty.

Materials and Methods: Several patella-height-indices were measured by three independent raters in two passes (after six weeks, random order). Intra- and interobserver agreements were determined and analyzed using the Intraclass-Correlation-Coefficient (ICC). For radiographic evaluation, lateral radiographs of 92 knees before and after primary TKA were used.

Results: We found high interrater reliability for all analyzed indices (Table 1). We found the highest agreements for the ISI preop and postop respectively. We also found very good intrarater reliability for the CDI, dCDI, ISI, and BPI (Table 2).

Conclusion: The derived Caton-Deschamps-Index (dCDI) can easily be used in knee arthroplasty and demonstrated high intra- and interrater agreement, which was similar to other commonly used and established patella-height-indices.

Stichwörter:
TKA; Patella height; Patella infera; Patella baja; Anterior knee pain; Insall-Salvati

DKG21-14 Vortrag
Endoprothese nach Umstellung

Does an innovative implant design reproduce kinematics in total knee arthroplasty?

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Aims and Objectives: Patient satisfaction after total knee arthroplasty still does not attain the results after total hip arthroplasty. One reason for this can be altered knee kinematics following this operation. Several designs of new implants try to rebuild natural knee kinematics. We hypothesized that an innovative implant design leads to better results concerning femoral rollback compared to an established implant design.

Materials and Methods: For this purpose 16 patients were examined during TKA, receiving either an innovative (ATTUNETM Knee System (DePuy Inc.)) or an established (PFCTM (DePuy Inc.)) knee system. All patients underwent computer navigation. Knee kinematics were assessed after implantation. Outcome measure was anterior-posterior translation between femur and tibia.

Results: We were able to demonstrate a significant higher femoral rollback in the innovative implant group ($p<0.001$). The mean rollback of the innovative system was 11.07 mm (95%-CI 10.79 - 11.26), of the established system 8.11 mm (95%-CI 7.84 - 8.42).

Conclusion: This study revealed a significantly increased femoral rollback of knees with the innovative prosthesis design. Our intraoperative finding needs to be confirmed using fluoroscopic or radiographic 3D matching under full weight bearing conditions after complete recovery from surgery.

Stichwörter:
innovative implant knee kinematics

DKG21-17 Vortrag
Rehabilitation wann ambulant, wann stationär?

Participation in a preoperative patient education session is a significant predictor of better WOMAC total index score and higher HRQoL one year after TKA or THA

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Aims and Objectives: During the last two decades the pre-, intra- and postoperative management of patients scheduled for primary TKA or THA went through remarkable changes. Enhanced rehabilitation programs (ERP) were developed and implemented in different countries. ERPs are based on three key fundaments: better preoperative information; reduction of pre- and postoperative stressors; and early postoperative mobilization with early return to normal daily-life activities. They normally include preoperative patient education (PPE). ERPs were associated with a reduction in the number of days spent in the hospital, with increased patient outcomes and a reduction of costs. The aim was to investigate whether patient-specific factors and preoperative patient-reported outcome measures significantly predict the 1-year WOMAC total index scores and the EQ-5D-5L health status index of patients that underwent THA or TKA within an ERP.

Materials and Methods: A retrospective observational study. The clinic database was searched for patients who have undergone primary THA or TKA between January 2016 and December 2018. The inclusion criteria were met by 676 (416 female) patients. Thereof, 373 patients underwent THA and 303 TKA. Multiple regression models to estimate the contributions of nine different independent variables to the explanation of 1-year WOMAC total index score or 1-year EQ-5D-5L index were carried out.

Results: The patients in the sample were on average 69.5 ± 10.3 years old. Six predictors explained 21.4% ($F(6, 669) = 30.9$; $p< 0.001$) of the 1-year WOMAC score. Junger age by the time of surgery ($p= 0.006$), higher preoperative EQ-5D-5L index ($p= 0.004$), lower PCCL classification ($p= 0.001$), lower preoperative WOMAC score ($p< 0.001$), participation in a PPE session ($p= 0.004$) and submitting for THA ($p< 0.001$) were significant predictors of better 1-year WOMAC scores.
Five factors were found as significant predictors of the 1-year EQ-5D-5L index ($F(5, 670)= 21.8$; $p< 0.001$). Higher preoperative EQ-5D-5L index ($p< 0.001$), lower PCCL classification ($p< 0.001$), lower preoperative WOMAC score ($p= 0.009$), participation in a PPE session ($p= 0.04$) and submitting for THA $p= 0.01$) were significant predictors of better 1-year EQ-5D-5L index. Preoperatively there were no significant differences between the mean WOMAC total index scores ($p= 0.8$) and the mean EQ-5D-5L health status indexes ($p= 0.9$) of the patients who attended the PPE session ($n= 335$) and those who did not ($n= 341$). One year after surgery the patients who attended the PPE session had a significant lower mean WOMAC total index score ($p= 0.004$) and significant higher mean EQ-5D-5L health status index ($p= 0.02$).

Conclusion: Better preoperative patient-reported outcomes, less comorbidities, younger age and submitting for THA were the strongest predictors of WOMAC total score and EQ-5D-5L index 1-year after THA or TKA. Despite conflicting results in the literature, we found a significant association between attending a PPE session and better PROMs at 1-year.

Stichwörter:
Patient-Reported Outcome Measures; WOMAC; Health-Related Quality of Life; TKA

DKG21-18 Vortrag
Rehabilitation wann ambulant, wann stationär?

TKA patients experience less improvement than THA patients at 3 and 12 months after surgery. A retrospective database cohort study

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Aims and Objectives: Patient related outcome measures (PROMs) are important to assess improvement in health status out of the patients' perspective. In the last decades different PROM instruments were developed. The West Ontario and MacMaster University Osteoarthritis Index (WOMAC) is a valid, reliable and responsive patient-centered self-reported health status questionnaire that was developed in the early 1980s as a disease-specific measure for hip and knee osteoarthritis patients. In our institution the WOMAC score is used routinely preoperatively and at 3 and 12 months after total hip (THA) and knee (TKA) arthroplasties. The aim was to investigate whether WOMAC scores changes after THA or TKA are gender and joint specific. Furthermore, we investigated whether the WOMAC scores are significantly different among patients with different clinically complexity levels (PCCL) and whether there were significant predictors of the 12-months WOMAC total index score.

Materials and Methods: A retrospective database cohort study was conducted. The data of 855 (553 female) THA and 684 (444 female) TKA patients who underwent surgery between January 2016 and December 2018 were analyzed. Generalized linear mixed models (GLMM) with a repeated measures data structure and fixed effects for "follow-up time" (FU), "gender", "joint" (TKA vs. THA) and interactions for "FU by joint" and "gender by joint" were carried out for the dependent variables WOMAC total score and the sub-scores pain, stiffness and function.

Results: The patients were on average 69.2 ± 10.7 years old. Follow-up time (FU) ($p< 0.001$), gender ($p< 0.001$), joint ($p< 0.001$), and the interaction FU by joint ($p< 0.001$) had significant effects on the WOMAC total and sub-scores. All patients perceived significant improvement in pain, stiffness and function between all FU times ($p< 0.001$), however patients after TKA perceived less improvement in all dimensions in comparison to patients after THA ($p< 0.001$) (Fig. 1). Regardless the FU time and the procedure, male patients perceived overall higher improvements in comparison to female ($p< 0.001$). There were significant differences between the mean WOMAC total scores of patients with different PCCL classifications at each FU ($p< 0.005$) (Fig. 2). Patients with higher PCCL had worse WOMAC total scores. The preoperative WOMAC score (ß= .20; p= 0.001), preoperative pain (ß= .14; p= 0.02), patients age (ß= .06; p= 0.05) and PCCL (ß= .13; $p< 0.001$) significantly predicted the mean WOMAC total score at 12 months [$F(4) = 31.4$; $p< 0.001$; R2= .13; Adj. R2= .13]. A lower preoperative WOMAC total score, lower preoperative WOMAC pain score, younger age and lower preoperative PCCL were significant predictors of better WOMAC scores 12 months after surgery.

Conclusion: The WOMAC score changes after THA or TKA arthroplasties are joint-specific. Patients after TKA perceived less improvement in all dimensions. The results of this study can be used to adjust patients' expectations before surgery.

Stichwörter:
TKA; Patient-Reported Outcome Measures; WOMAC

DKG21-19
Osteotomie

Poster

Osteotomies around the knee for correction of genu varum or valgum influence the coronal alignment of the ankle

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Aims and Objectives: Despite the fact that osteotomies around the knee represent well-established treatment options for the redistribution of loads and forces within and around the knee joint, unforeseen effects of these osteotomies on the ankle are still to be better understood. It was therefore the aim of this study to determine the influence of osteotomies around the knee on the coronal alignment of the ankle. We hypothesize that osteotomies around the knee for correction of genu varum or valgum lead to a change of the ankle orientation in the frontal plane by valgisation or varisation.

Materials and Methods: Long-leg standing radiographs of 154 consecutive patients undergoing valgisation or varisation osteotomy around the knee in 2017 were obtained and utilized for the purpose of this study. Postoperative radiographs were obtained after union at the osteotomy site. The hip knee ankle angle (HKA), the mechanical lateral distal femur angle (mLDFA), the mechanical medial proximal tibia angle (mMPTA) and five angles around the ankle were measured. Comparison between means was performed using the Wilcoxon-Mann-Whitney test.

Results: 154 patients (96 males, 58 females) underwent osteotomies around the knee for coronal realignment. The mean age was 51 ± 11 years. Correction osteotomies consisted of 73 HTO, 54 DFOs, and 27 double level osteotomies. Of all osteotomies, 118 were for valgisation and 36 for varisation. For valgisation osteotomies, the mean HKA changed from 5.8° ± 2.9° preoperatively to -0.9° ± 2.5° postoperatively, whereas the mMPTA changed from 85.9° ± 2.7° to 90.7° ± 3.1° and the malleolar-horizontal-orientation-angle (MHA) changed from 16.4° ± 4.2° to 10.9° ± 4.2°. For varisation osteotomies, the mean HKA changed from -4.3° ± 3.7° to 1.1° ± 2.2° postoperatively, whereas the mLDFA changed from 85.7° ± 2.2° to 89.3° ± 2.3° and the MHA changed from 8.8° ± 5.1° to 11.2° ± 3.2°.

Conclusion: Osteotomies around the knee for correction of coronal limb alignment not only lead to lateralization or medialization of the weight-bearing line at the knee but also lead to a coronal reorientation of the ankle. This can be measured at the ankle using the MHA. When planning an osteotomy around the knee for correction of genu varum or valgum, the ankle should also be appreciated - especially in patients with preexisting deformities, ligament instabilities, or joint degeneration around the ankle.

Stichwörter:
Deformity; Osteotomies; Realignment; Valgisation; Varisation

DKG21-20 Poster
Deformitätenanalyse

Supracondylar rotation osteotomy of the femur influences the coronal alignment of the ankle

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Aims and Objectives: Osteotomies represent well-established treatment-options for the redistribution of loads and forces within and around the knee-joint. Unforeseen effects of these osteotomies on the remaining planes and adjacent joints are not fully understood. The aim of this study was to determine the influence of a distal-femoral-rotation-osteotomy on the coronal alignment of the ankle. We hypothesize that supracondylar-external-rotation-osteotomy of the distal femur leads to a decrease of the Tibia Plafond Horizontal Orientation Angle (TPHA) by valgisation.

Materials and Methods: Long-leg standing radiographs and CT-based torsional measurements of 27 patients undergoing supracondylar-rotational-osteotomy of the femur between 2012 and 2019 were obtained and utilized for the purpose of this study. Postoperative radiographs were obtained after union at the osteotomy-site. The hip-knee-ankle-angle (HKA), the TPHA, the Mechanical Lateral Distal Tibia Angle (mLDTA), and other angles around the ankle were measured. Comparison between means was performed using the Wilcoxon-Mann-Whitney test.

Results: Twenty-seven patients with high femoral antetorsion (31.3°±4.0°) underwent supracondylar-external-rotation-osteotomy. The osteotomy led to a reduced antetorsion (17.4±5.1; $p<0.001$) and to a valgisation of the overall limb-alignment. The HKA decreased by 2.4°±1.4° ($p<0.001$). The TPHA decreased by 2.6° ($p<0.001$).

Conclusion: Supracondylar external rotation osteotomy of the femur lateralizes the weight bearing line by valgisation. As the TPHA is decreased (valgisation), the foot reacts by inversion and supination. This should be taken into account when indicating and planning an isolated external rotation osteotomy at the distal femur in patients with a preexisting valgus alignment of the lower leg or restricted mobility of the subtalar joint.

Stichwörter:
Derotation; Torsional alignment; Long leg axis; Anterior knee pain; Realignment

DKG21-22 Poster
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Cementless, cemented and hybrid fixation techniques in patient-specific unicompartmental knee arthroplasty: Is there a difference?

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Aims and Objectives: Implant survivorship and functional outcome are affected by fixation technique (cemented, cementless and hybrid), implant positioning and proper patient selection. Reasons for revision are most commonly pain and suspected aseptic loosening. The latter is often assumed if radiolucent lines (RLLs) are present - especially in patients reporting knee pain. Interestingly, RLLs occur five to seven times more frequently in cemented prostheses than in uncemented prostheses. Cementless UKA was introduced in an attempt to improve fixation. When cementless is compared to cemented fixation there is a higher rate of revision for the first six months, then after one year, a lower rate of revision. However, the National Joint Registry of the United Kingdom showed a continuing decline in uncemented knee operations.
Hybrid, the third option of UKA fixation, is represented by quite small numbers each year in national registries, and with higher revision rates compared to both cementless and cement fixation. It is in contrast to hybrid TKA, which showed excellent and even superior longterm survivorship when compared to cemented fixation.

Due to the paucity of data concerning hybrid UKA, it was the goal of this study to compare all three different UKA fixation methods. The purpose of this study was to evaluate the impact of fixation techniques on survival rate and functional outcomes, while considering confounding factors such as component alignment, patient selection and surgical experience. The hypothesis was that hybrid UKA is not inferior compared to cemented or uncemented UKA.

Materials and Methods: A total of 104 PSI-UKA were included, of which 40 were cemented, 41 uncemented and 23 hybrid prostheses. Preoperative UIS, as well as postoperative clinical (Oxford Knee Score (OKS), Forgotten Joint Score (FJS), Subjective Knee Score (SKS), range of motion) and radiological (RLLs, tibial and femoral component positioning) outcome, were assessed retrospectively.

Results: Survival rate of cemented UKA was 95% and 100% in the cementless (p=0.14) as well as in the hybrid group after a mean follow up of 28 months. RLLs were five times more frequent in the cemented than in the uncemented group (25% vs. 5%, p=0.011). Functional outcomes of the cementless group were significantly better than in the cemented group (OKS p=0.009, SKS p=0.001 and FJS p=0.007). The functional outcome of the hybrid group was between the cemented and cementless group. There was no statistical difference between planned and final component alignment of the tibial component in all groups. Surgeon's experience had no impact.

Conclusion: Survival was slightly higher in uncemented and hybrid compared to cemented prostheses, which may be associated with the lower incidence of RLLs in uncemented components. Significant better functional and clinical outcomes were achieved with uncemented prostheses compared to hybrid and cemented, additionally hybrid UKA showed a better outcome than cemented UKA.

Stichwörter:
unicompartmental knee arthroplasty, fixation technique, cemented, cementless, hybrid

DKG21-24
Osteotomie

Poster

Which factors comprise bone healing after open wedge high tibial osteotomy?

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Aims and Objectives: In the young and physically active patient with early-stage varus osteoarthritis of the knee, open wedge high tibial osteotomy (OWHTO) is considered as the method of choice to reduce the load of the medial compartment. Bone healing after OWHTO proceeds gradually by a filling of the osteotomy gap. This examination aimed at the analysis of several risk factors leading to a disturbance in bone healing after OWHTO.

Materials and Methods: A retrospective study analyzing the clinical and radiological course of all patients treated with an open wedge high tibial osteotomy from 2011 to 2017 was conducted. In this period, a total number of 124 procedures was performed in our orthopedic department. In 17 cases, the exclusion criteria were met, 6 cases were lost to follow up. Finally, 101 consecutive cases from 96 patients (27 female, 69 males, mean age 41,4 years, range 17 to 64 years) were included in this examination. All patients were treated with the same surgical technique, all osteotomies were stabilized with the same locking plate. The following risk factors were considered: Age, BMI, tobacco consumption, amount of tobacco consumption, severity of comorbidities, infection of the surgical area, occurrence of a lateral hinge fracture and the size of the opening wedge angle. The bone healing was evaluated using a modification of the Radiographic Union Score for Tibial fractures (mRUST). The assessment was performed on radiographs 3 days, 6 weeks, 3 months, 6 months, 12 months and 18 months after the osteotomy, according to the follow-up protocol. The following exclusion criteria were determined: incomplete patient records, inconsistent radiographic follow up.

Results: A disturbance in bone healing was observed in 16 of the 101 osteotomies. Correlation of the risk factors with a disturbance in bone healing was assessed by binary logistic regression analysis, t-test and chi-square test. Inter-and intraobserver reliability for the mRUST resulted in good values (r = 0.84 and r = 0.87, resp).
An increasing angle of the opening wedge correlated with a disturbance in bone healing (p=0.002). The calculated odds ratio indicated, that above an opening wedge angle of 9 degrees the likelihood for a disturbance in bone healing increases by 56 % for each additional degree of the angle. The presence of a lateral hinge fracture (Takeuchi type I and II) did not correlate with a disturbance in bone healing (p = 0.121). Smoking and the amount of tobacco consumption were not linked with a disturbance in bone healing (p = 0.583 and p = 0.616, resp.). For the risk factor age a statistical trend was recognizable (p=0.077) with the risk of a disturbance in bone healing in higher age.

Conclusion: Lateral hinge fractures seem not to have a detrimental effect on the filling of the osteotomy gap. An increase of the opening wedge enhances the risk of a disturbance in bone healing. Based on the findings of this examination, there is no decisive criterion to exclude a smoker from OWHTO.

Stichwörter:
open wedge high tibial osteotomy, bone healing, lateral hinge fracture

DKG21-25 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Comparison of allogeneic bone graft versus autologous corticocancellous graft in tunnel filling at two-stage ACL revision surgery. Radiological results of a prospective randomized trial.

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Aims and Objectives: Anterior cruciate ligament (ACL) reconstruction is a standard procedure in the active patient. However, the number of ACL re-ruptures also rises, with an increasing number of ACL reconstructions. In ACL revision surgery faulty tunnel position and widening require a two-staged treatment with tunnel filling and secondary ACL reconstruction to secure a proper fixation of the transplant.
The current standard for tunnel filling is autologous corticocancellous iliac crest graft harvesting. However, the iliac crest donor site is associated with a significant number of complications causing the quest for alternative tunnel filling materials.
The aim of this study was to investigate if allogeneic bone graft is non-inferior to autologous corticocancellous iliac crest graft in terms of radiological bone regeneration and tunnel filling.

Materials and Methods: The study was designed as a prospective, randomized trial, including 41 patients who required 2-staged ACL revision surgery. The patients were randomized in two groups. The first group (17 patients) was treated with iliac crest corticocancellous graft, the second group (24 patients) with allogeneic femoral head bone graft. 3 months postoperatively tunnel filling was measured via CT scan on standardized axial planes by dividing the area of the bone graft by the area of the whole tunnel. Additionally, the Hounsfield units of the filled area were compared to a representative native cancellous bone area of the proximal tibia. The operation time was assessed for both groups.

Results: The study showed comparable results in terms of tunnel filling for autologous and allogeneic grafts. The mean percentage of tunnel filling for allogeneic bone graft and autologous corticocancellous graft was 82,61% (SD 10,32) and 84,94% (SD 8,05), respectively (p=0,4415). Hounsfield units differed in both groups significantly (p<0,0001) compared to a representative native cancellous bone area of the proximal tibia. There was also a significant difference between the Hounsfield units with a mean of 630,5 (SD 182,1) units for the allograft and 431,7 (SD 186,1) units for the autograft (p=0,0015). Operation time was significantly shorter in the allograft group (mean of 36 (SD 10) minutes) when compared to to the autograft group (mean 46 (SD 14) minutes) (p=0,0154).

Conclusion: Allogeneic bone graft is comparable to the standard autologous corticocancelleous bone graft in terms of the achieved filling rates. Allogeneic as well as autologous plugs were well embedded to the tunnel wall in CT scans without any signs of resorbtion or cysts formation in both groups. Both allograft and autograft showed higher density values compared to normal cancellous bone. This has been reported repetitively in other studys and seems to be associated with the amount of calcified matrix and graft compaction. Nevertheless, autologous bone graft was closer to normal cancellous bone than the allogeneic graft. In addition, operation time can be significantly reduced by 22 % using allogeneic bone graft.

Stichwörter:
ACL revision, two staged revision surgery, tunnel filling, void filling, ACL failure, anterior cruciate ligament, allograft, autograft, allogeneic bone graft, ilic crest graft

DKG21-28
Osteotomie

Vortrag

Reliability of 3D Planning and Simulations of Medial Open Wedge High Tibial Osteotomies (HTO)

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Aims and Objectives: 3D planning is a critical step in the creation of patient-specific instrumentation for osteotomies that has not been scientifically validated. In medial open-wedge tibial osteotomy (HTO), the hinge axis and osteotomy plane influence the resulting anatomy, but accurate angular quantifications using 3D planning simulations are lacking. The objective of this study was to develop a standardized and validated 3D planning method of an HTO and to perform several simulated realignments to quantify and thus explain unintended anatomy changes.

Materials and Methods: Using 3D software (Geomagic Design 2014; 3D Systems, Rock Hill, SC, USA), a 3D digital tibial model was used to develop an HTO plan with medial opening of the tibia by 8mm. The HTO was performed as a biplanar osteotomy. The actual osteotomy plane was parallel to the medial slope and shifted distally by half the width of the tibial plateus. The hinge axis was 1.5cm distal to the lateral plateau. The other incision was made approximately 10mm posterior to the tibial tuberosity parallel to the tibial plateau. For interobserver and intraobserver testing, this 3D planning was performed on 13 human tibiae by two observers. In addition, four different hinge axis positions and five differently inclined osteotomy planes each were simulated. The osteotomy direction ranged from medial 0° to 30° anteromedial, while the tilt of the osteotomy plane compared to the Tibial Plateau was -10° to +10° (in 5° increments). All anatomic angular changes of these 20 planings were calculated using 3D analysis of 14 defined tibial landmarks.

Results: Multiple HTO planning by two investigators using standardized procedures showed only minimal differences in the relevant angular changes with ICC values > 0.96. In the 3D simulation, the change in the hinge axis was significantly associated with an increase in tibial slope. Each 10° rotation of the hinge axis resulted in a 1.7° increase in slope, so that an anteromedial cutting direction of 30° changed the slope by 5.1°. Tilting the osteotomy plane by 10° resulted in significant torsional changes of 2°, in addition to minor but significant changes in the medial proximal tibial angle (MPTA). The slope was not changed by this.

Conclusion: Standardized 3D planning of an HTO can be performed with high reliability. 3D simulations show that the position of the osteotomy plane is relevant to avoid unintended changes in the resulting anatomy. While the hinge axis mainly influences the slope, a tilt of the osteotomy plane has the greatest influence on tibial torsion. Preoperative 3D planning can be helpful to modify specific angles in various pathologies and minimize unintended changes in HTO.

Stichwörter:
3D-planning; HTO; osteotomy; open-wedge tibial osteotomy, hinge axis; osteotomy plane

DKG21-29
Osteotomie

Vortrag

Implementation of 3D planning for medial open-wedge tibial osteotomy (HTO) using 3D-printed sawing template and spacer

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Aims and Objectives: In everyday clinical practice, corrective osteotomies are planned on the basis of two-dimensional X-ray images. Three-dimensional (3D) changes in anatomy cannot be depicted or planned with these images. However, 3D planning of a medial open-wedge tibial osteotomy (HTO) can be helpful, especially in complex cases, to modify relevant angles in pathologies. To implement the 3D planning, patient-specific sawing templates and spacers were designed, produced and used to perform HTO in this study. Subsequently, the accuracy of the correction was analysed in comparison to the planning.

Materials and Methods: After segmenting CT data of twelve human cadaveric tibiae using ImFusion Suite (ImFusion GmbH, Germany), a HTO with a medial opening of 8 mm was planned on the respective digital tibia model using 3D software (Geomagic Design 2014 (3D Systems, Rock Hill, SC, USA). Based on these plans, it was possible to design sawing templates and spacers using Inventor Professional 2020 (Autodesk Inc., San Rafael, CA, USA) and to additively manufacture them using laser sintering in order to optimally implement the osteotomy plane and height. After physical adjustment of the tibial preparations with the specific instrumentation, the tibiae were CT scanned again, segmented and the medial proximal tibial angle (MPTA), medial and lateral tibial slope (TPS) and tibial torsion were determined in Geomagic by defined landmarks and a previously published procedure using a script. The results were compared with the original 3D planning. In addition, surface deviations between planning and result were displayed and quantified using nominal-actual comparison in GOM Inspect (GOM Gmbh, Germany).

Results: Compared with the planned HTOs, the lowest deviation in the actual osteotomies was found in the MPTA with 1.1°. The medial and lateral slope deviated on average from the examiners' plans with 1.57° and 1.66°, while the tibial torsion differed by an average of 5.67°. In the false-colour representation, nine postoperative tibiae showed a good with the respective planning.

Conclusion: With 3D sawing templates and spacers, 3D plans of an HTO can be turned into reality. At 9 of 12 conversions showed minor deviations. The deviations in the 3D measurement are due to the their method, and nominal-actual comparison can optimally make deviations from the planning visible. Based on the results, all steps are examined for errors and thus the entire procedure for performing patient-specific HTOs is optimised.

Stichwörter:
3D planning; HTO; osteotomy; open-wedge tibial osteotomy

DKG21-30 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Automated assessment of lower limb alignment based on artificial intelligence. An independent validation study on full leg radiographs.

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Aims and Objectives: The accurate assessment of lower limb alignment from X-rays ensures the correct indication of therapy and surgery planning for procedures such as corrective osteotomy and total knee arthroplasty. However, current manual digital methods used by physicians in clinical routine are time-consuming, thereby preventing the analysis of large-scale image datasets. The goal of this study is to develop and validate a fully automated, artificial intelligence (AI) based algorithm for the assessment of lower limb alignment parameters with high accuracy and reliability.

Materials and Methods: In total, 46 preoperative, weight-bearing, anterior-posterior full leg radiographs were evaluated by two expert human raters (R1 and R2; fully blinded) and twice by one of these raters (R1a, R1b) to evaluate inter- and intra-rater reliability in a prospective study setting. The radiographs were then measured automatically using the AI algorithm (R-AI) consisting of a sequence of four convolutional neural network models, which were trained to determine the following lower limb alignment angles: mechanical femoral-tibial angle (mFAmTA), mechanical lateral distal femoral angle (mLDFA), mechanical medial proximal tibial angle (mMPTA), mechanical lateral distal tibial angle (mLDTA), and the angle between the femoral shaft axis and the mechanical tibia axis (FSAmTA). To evaluate the agreement between the human raters and the AI, mean errors (95% confidence interval (CI), standard deviation) were computed and intra- and inter-rater reliability were assessed by single-measure intraclass correlation coefficients (ICC) for absolute agreement. ICC values larger than 0.75 were considered excellent (Cicchetti, 1994).

Results: ICC values for intra- (range 0.97-0.99) and inter-rater reliability (range 0.87-0.98) between human raters reflect excellent agreement for all evaluated parameters. Parameters could be measured automatically in 100% of cases for mMPTA, mLDTA and FSAmTA and in 96% of cases for mFAmTA and mLDFA. The automated measurement of all lower limb alignment angles by the AI algorithm achieved excellent ICC values when compared to human raters (range 0.82-0.99). Mean errors were lowest for mFAmTA (0.0°, 95%-CI: -0.2°-0.2°) and largest for mLDTA (0.4°, 95%-CI: 0.0-0.8°).

Conclusion: The novel, fully automated AI algorithm can measure lower limb alignment angles in pre-operative full leg X-ray images with excellent reliability and accuracy. The tool may facilitate routine diagnostic clinical tasks and independently analyze large-scale datasets for research purposes. Additional training images may further improve results and extend the application to post-operative images, where implants make automated measurements more challenging.

Stichwörter:
lower limb alignment, full leg radiographs, artificial intelligence

DKG21-31 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Return to Sports and Patient-reported Outcome Measures after Deepening Trochleoplasty and Concomitant Patellar Stabilizing Procedures in 111 Patients at 2 to 4 Years of Follow-up

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Aims and Objectives: There is limited reporting of return to sports after complex patellar stabilizing surgery. Therefore, the purpose of this study was to evaluate patient-reported outcome measures (PROM's), patients' ability to return to sport, and to investigate how the preoperative level of sports participation influence postoperative sports activity after deepening trochleoplasty (TP) and medial soft-tissue stabilizing surgery with and without additional bony re-alignment procedures.

Materials and Methods: Between April 2015 and April 2019, 144 complex patellar stabilizing procedures including deepening TP and MPFL-reconstruction or medial reefing with and without concomitant realignment procedures were carried out in 142 patients. The Banff Patellofemoral Instability Instrument 2.0 (BPII 2.0) was used to assess patient-reported disease-specific quality of life. The Tegner activity score was used to assess patients' level of sports activity. In addition, a numerical analog scale was used to evaluate the intensity of patellofemoral pain during rest and during activity, and subjective knee joint function. All parameters were assessed preoperatively and again at the final follow-up.

Results: Outcomes were available in 111 Patients (112 knees) (m/f 77/34, mean age 23.4 ± 7.8 years) giving a 77.7% follow-up rate at a mean of 39.2 ± 9.9 months (range 24 to 48 months). All PROM's improved postoperatively, independently of the patients' age, gender, and BMI.
Although two-thirds of patients returned to their preoperative level of activity or increased it, the overall Tegner score did not change significantly (preoperatively 4.5 ± 2.4; postoperatively 4.7 ± 1.6; p=0.365). Low-level athletes (preoperative Tegner score 0-4) significantly increased their level of sports activity (2.7 ± 1.4 to 4.1 ± 1.2 (p<0.0001)), whereas higher-level athletes (preoperative Tegner score 5-10) significantly decreased their activity from 6.8 ± 1.3 to 5.5 ± 1.7 (p<0.0001). The likelihood of return to the preoperative level was significantly higher in the low-level activity group than in the higher-level activity group (p=0.0001; 95% CI 4.186 to 29.74).
Return to daily life, return to activity, and return to sports was achieved at a mean of 4.5 ± 3.4 months, 7.7 ± 6.3 months, and 12.6 ± 7.8 months, respectively.

Conclusion: Patients undergoing surgery for complex patellar instability by deepening TP and concomitant patellar stabilizing procedures can expect good results and a high rate of return to sports activity. However, higher-level athletes should be informed that the likelihood of full participation at a competitive level is reduced.

Stichwörter:
Patellar instability, Trochleoplasty, Return to sports, BPII 2.0, Tegner score, Patella Instabilität, Trochleaplastik

DKG21-32 Poster
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Charcot Arthropathy Of The Knee Joint caused by AL-amyloidosis - Case Report And Literature Review

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Aims and Objectives: Charcot-Arthropathy in the knee is a rare diagnosis in general and only a few cases of Charcot-arthropathy related to a systemic amyloidosis are reported in the literature. This case report presents a 85-year old woman with a systemic AL-amyloidosis and a randomly diagnosed Charcot-arthropathy of the left knee as part of a preoperative investigation due to a trauma to the contralateral knee and hereby aims to review the literature and raise awareness for the disease pattern.

Materials and Methods: This descriptive report demonstrates a patients history, clinical examination, imaging and follow-up results after casting of the Charcot-joint and surgery of the contralateral side due to a traumatic chronic m. quadricepstendon tear. Diagnosis of Charcot-arthropathy was detected through anamnesis with a rapid loss of function (not being able to climb the stairs within one week), immunohistochemical plus nerve-biopsy ascertained amyloid associated neuropathy of the lower left limb and radiologic imaging.
Despite the 21 month prior diagnosed and treated AL-amyloidosis there was no imaging of the left knee so far and at the time of consultation with us the patient was already sitting in a wheelchair for 16 month.
Even though related chronic neuropathy occurs in 25% of the cases it can exceptionally be complicated by developing a Charcot-joint and further diagnostic via x-rays should be taken into consideration also to record the status quo in predestined joints like the foot and knee. Due to surgery to the contralateral knee we initiated conservative therapy through Mecron-orthesis to stabilize the Charcot-joint, reduce the risk of falling and ensure better transfers e.g. between wheelchair and bed etc. and performed x-rays of both feet and knees with no proof of osteodestruction in the other joints so far. Furthermore an intraoperative biopsy showed no histopathological signs of an amyloidosis even though the same symptoms like in the Charcot-knee began to arise recently. At that time the patient was discharged into rehabilitation.

Results: This case supports the common opinion that in contrast to the foot, conservative treatment of the knee is not sufficient most of the time. Therefore total knee arthroplasty and arthrodesis should be discussed with the patient as early as possible.

Conclusion: If noticed early enough, different treatment options can be discussed, a clinical manifestation with serious deformities and disability followed by lifestyle impairment as well as risk of another trauma like in this case can be prolonged or prevented. Not to forget that vice versa a diagnosis with neuro(arthro)pathy can reveal not only a more common diabetes mellitus but a systemic disorders like amyloidosis, too.

Stichwörter:
Charcot Arthropathy, Knee, AL-Amyloidosis

DKG21-33 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Does the Anterolateral Ligament protect the Anterior Cruciate Ligament in the most common Injury mechanisms? A human knee model study.

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Aims and Objectives: Anterior cruciate ligament (ACL) reconstruction has still risk of re-rupture and persisting rotational instability. Thus, extraarticular structures like the Anterolateral Ligament (ALL) are increasingly treated. The ALL however prevents namely the internal rotation of the tibia and it must be doubted that the ALL protects the ACL in other common injury mechanism which primarily include tibial external rotation. We now aimed to evaluate which extraarticular structures support the ACL in excessive tibial internal and external rotation using a knee finite element (FE) model.

Materials and Methods: Internal and external rotations of the tibia were applied to a FE model with anatomical ACL, Posterior Cruciate Ligament (PCL), Lateral Collateral Ligament (LCL), Medial collateral Ligament (MCL) and intact medial and lateral meniscus. Three additional anatomic structures (Anterolateral Ligament, Popliteal tendon and Posterior Oblique Ligament) were added to the FE model separately and then all together. The force histories within all structures were measured and determined for each case.

Results: The ACL was the most loaded ligament both in tibial internal and external rotation. The ALL was the main stabilizer of the tibial internal rotation (46%) and prevented the tibial external rotation only by 3%. High forces were only observed in the LCL with tibial external rotation. The ALL reduced the load on the ACL in tibial internal rotation by 21%, in tibial external rotation only by 2%. The POL reduced the load on the ACL by 8%, the PLT by 6% in tibial internal rotation. In tibial external rotation the POL and PLT didn't reduce the load on the ACL by more than 1%.

Conclusion: The ALL prevents the ACL in injury mechanism with tibial internal rotation but not in mechanisms with tibial external rotation. In injury mechanisms with tibial external rotation other structures that support the ACL need to be considered.

Stichwörter:
ALL; rotatory intability; ACL; FE model

DKG21-34 Vortrag
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Predictors for an unsuccessful conservative treatment of patients with medial patellar plica syndrome.

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Aims and Objectives: In several cases persistent medial knee pain remains after conservative treatment in patients with medial patellar plica syndrome. In recent literature accepted criteria for surgical indication are lacking. In this retrospective study patients after conservative treatment were evaluated to identify predictors for an unsuccessful outcome.

Materials and Methods: 132 patients with medial patellar plica syndrome between 2016-2019 were retrospectively evaluated. All patients received conservative treatment for three months. Surgery was indicated due to failed conservative treatment (n=76) with persistent medial knee pain and restriction of activity after three months. Preoperative MRI analysis, Lysholm score, pain by the Visual Analog Scale (VAS), postoperative sports participation (RTS) and Tegner Activity Score were collected at least 12 months after definite treatment. Statistical analysis was performed to evaluate differences between patients with successful and unsuccessful conservative treatment.

Results: There were significant differences in the clinical and radiological findings between patients with successful and unsuccessful conservative treatment. Patients with failed conservative treatment showed a significant larger diameter of the medial patellar plica (0.8 ± 0.3 mm vs.1.6 ± 0.4 mm; $p < 0.05$) and a significant higher rate of contact of the plica to the adjacent cartilage. Furthermore, these patients reported a significant higher rate of medial knee pain from flexion to extension and snapping symptoms.
At final follow up the patient-reported outcome by means of Lysholm score (96.25 vs. 95.93), RTS (96.2% vs. 97%) and Tegner activity score (6.0 vs. 6.01) was excellent after conservative and surgical treatment. There were no statistical differences in the preoperative and postoperative outcomes between both.

Conclusion: The diameter of a medial patellar plica >=1.2 mm and contact of the plica to the adjacent cartilage as well as clinical signs like persistent medial knee pain from flexion to extension with snapping symptoms can predict an unsuccessful conservative treatment and the need for surgical intervention in patients with painful medial patellar plica syndrome.

Stichwörter:
medial patellar plica; shelf syndrome; surgical treatment; conservative; predictors

DKG21-35 Poster
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Short term clinical and radiological outcomes after all-arthroscopic hydrogel-based autologous chondrocyte transplantation in the knee joint: a case series

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Aims and Objectives: Newly developed methods of hydrogel-based matrix-induced autologous chondrocyte transplantation (MACT) allow for an all-arthroscopic transplantation procedure. Aim of the study was to evaluate short-term clinical and radiological outcomes after hydrogel-based MACT therapy of chondral lesions in the knee joint.

Materials and Methods: A retrospective study on patients with isolated focal cartilage defects of the knee joint who were treated with arthroscopically conducted MACT was performed. Clinical scores were assessed at baseline and final follow-up using the Tegner Score, visual analogue scale (VAS), the International Knee Documentation Committee (IKDC) and the five subscales of the Knee Injury and Osteoarthritis Outcome Score (KOOS). MRIs of the treated knee joints were evaluated with the updated MOCART2.0 scoring system at follow-up.

Results: Twenty-nine consecutive patients were included in the study. Mean time to follow-up was 24.9 ± 1.1 months. Average VAS decreased significantly from 6.5 ± 3.1 preoperatively to 2.3 ± 1.6 at follow-up ($p<0.0001$). Tegner score increased from 3.1 ± 1.3 to 4.3 ± 1.2 ($p<0.0001$) and the IKDC from 43.8 ± 21.9 to 64.9 ± 18.9 ($p< 0.0001$). Also, all KOOS subscales displayed significant improvements. Patients showed similar improvements of nearly all clinical scores independent of the defect size. Average MOCART2.0 score was 70.0 ± 13.6 and 20 patients scored >= 70 points. All 8 patients with large defects (>5cm2) scored >= 75 points.

Conclusion: In this small study, injectable MACT showed convincing short-term clinical results. MOCART2.0 scores confirmed morphologic integrity of the transplanted chondrocytes. Thus, this minimally invasive technique seems to be a promising treatment option of focal cartilage defects of the knee joint, even for large-diameter lesions. Further prospective studies will be needed to assess the superiority compared to other treatment procedures.

Stichwörter:
Novocart Inject, Matrix-associated autologous chondrocyte transplantation, cartilage defect, knee, MOCART

DKG21-36
Osteotomie

Vortrag

Recurrent patellar instability relevantly impacts the physical but not the mental health-related quality of life - An assessment using generic and disease-specific quality-of-life questionnaires

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Aims and Objectives: Without appropriate therapy recurrent patellar instability (RPI) can persist for years and negatively affects the disease-specific quality of life (QoL). However, health-related quality of life (HRQoL) includes not only the area of physical but also of mental well-being. As a chronic disease RPI may negatively affect all dimensions of HRQoL but only little information is available on the influence of RPI on the mental health-related QoL dimension. Therefore, the aim of this study was to investigate to what extent mental well-being is impaired in patients with RPI and whether it improves equivalently to physical-related QoL after adequate surgical therapy. The hypothesis was that both the physical- and the mental dimension of HRQoL is reduced in patients with RPI prior to operative treatment.

Materials and Methods: A total of 36 at random selected patients (m/f 13/23; age 20±5a), who underwent surgical therapy for RPI between April 2015 and April 2018, were included in this prospective study. Generic HRQol and disease-specific Qol were assessed pre- and postoperatively using the Short Form 36 (SF-36) and the BANFF Patella Instability Instrument 2.0 (BPII 2.0), respectively. From the SF-36, the mental (MCS) and the physical (PCS) health component summary score were formed and compared with the German normative, age-equivalent SF-36 data set, which is 48.0 pts. for the MCS and 55.8 pts. for the PCS. Surgical therapy included isolated MPFL reconstruction in 16 pat. and with bony correction in 19 pat. Bony corrections included: tibial tuberosity transfer and/or varization/derotating femoral osteotomy. Unpaired and paired 2-tailed t-tests were used to assess differences between the pre- and postoperative clinical data, and between the study group and the normative data sets. A priori power-analysis revealed that 34 patients were needed to detect a difference in SF-36 score values of 5 pts. (SD 10) with a power of 0.80 (alpha error=0.05, effect size d=0.5).

Results: Preoperatively, mean PCS and BPII 2.0 score values were significantly reduced to 38.1 ± 12.6 pts. ($p<0.0001$) and to 36.1 ± 16.5 pts. ($p<0.0001$). The mean MCS averaged 50.9 ± 13.7 pts. and was thus not different from normative data sets ($p=0.22$).
After a mean follow-up of 43 ± 10 months, the PCS increased to 54.7 ± 6.1 pts. ($p<0.0001$), equivalent to overall population PCS values ($p=0.3$), and the BPII 2.0 increased to 79.1 ± 17.5 pts. ($p<0.0001$). Compared to the preoperative data the MCS remained unchanged at 53.3 ± 9.5 pts. ($p=0.29$).

Conclusion: The study results indicate that RPI has little effect on the mental, but significant effect on the physical dimension of HRQoL when assessed with the SF-36. Compared with the German normative, age-equavalent data set mental health is at a good level in these patients preoperatively and changes only slightly after surgical therapy. Surgical treatment, however, significantly improves the physical component in generic HRQoL and the disease-specific QoL in patients with RPI.

Stichwörter:
Knee, patella instability, SF36, BPII2.0

DKG21-38 Poster
Endoprothese nach Umstellung

Complex primary and revision TKA Demanding procedure - promising outcome

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Aims and Objectives: The balanSys REV system (BRS), Mathys Ltd Bettlach, was developed to treat complex primary and revision cases, especially with bone defects but intact ligaments. Therefore, mid-term survival and patient reported outcome measures (PROMs) for the BRS were investigated.

Materials and Methods: A retrospective review of patients who underwent surgery with the BRS between September 2010 and April 2018 was performed. A total of 50 knees were treated with the BRS, 16 (32 %) due to aseptic loosening, 12 (24 %) due to complex primary procedures, 9 (18 %) due to septic loosening and 13 (26 %) due to other reasons (necrosis n=1, instability n=2, pain n=3, fracture n=3, wear n=4). By the end of September 2019 all patients completed a questionnaire regarding surgery, complications and re-operations. Postoperative function was assessed using the WOMAC score. The assessment of the clinical outcome included the VAS for rest and load pain and satisfaction.

Results: The median clinical follow-up (FU) was 50.4 months (range 8.3 -109.1). Re-revision was required in three cases (diagnosis for BRS implantation: aseptic loosening n=2; pain n=1), resulting in a 5-year survivorship of 94.0%. One patient deceased prior to clinical follow-up with the prosthesis in situ. PROMs showed a mean postoperative WOMAC score of 13.9 points. Based on the VAS, patients presented with low pain (median VAS low and rest pain, 0.0) and were highly satisfied (median VAS satisfaction, 9.0).

Conclusion: This study showed high mid-term survivorship for a non-hinged total knee arthroplasty. Patients treated for infection were not subject to re-revision surgery. The clinical outcome was good to excellent for complex primary and revision cases.

Stichwörter:
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DKG21-39 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Accurate Wear Determination in Clinical Radiographs after Total Knee Arthroplasty using 2D-3D Registration and Artificial Intelligence: An In Vivo Validation

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Aims and Objectives: Polyethylene wear represents a significant risk factor for the long-term success of total knee arthroplasty. Current clinically available methods for wear measurement using standard radiographs provide insufficient precision and therefore cannot objectively and validly evaluate the annual wear in modern implant materials (e.g., highly crosslinked polyethylene) in the micrometer range. Alternative high-precision measurement methods, such as radiostereometric analysis (RSA), require cost-intensive, special equipment for double exposures and are therefore unsuitable for scientifically meaningful multicenter studies with large cohorts. Hence, this study aimed to develop and validate an automated algorithm for accurate and precise wear measurement in knee arthroplasty using clinical AP radiographs.

Materials and Methods: Twenty postoperative radiographs (knee joint AP in standing position) after total knee arthroplasty implantation were analyzed using the novel algorithm. A convolutional neural network-based segmentation was used to localize the implant components on the X-Ray. Afterwards, a 2D-3D registration of the CAD implant models precisely calculated the three-dimensional position and orientation of the implants in the joint at the time of acquisition. From this, the minimal distance between the involved implant components was determined. Its postoperative change overtime enabled the determination of wear in the radiographs. Furthermore, it was assumed, that neither wear nor creep were present in the first postoperative week and thus the inlay height could be used as a reference value to validate the calculated component distance. In collaboration with the manufacturer, the average fabrication height was accurately measured on 335 unloaded inlays and a validated finite element model was used to simulate the inlay deformation that occurs under body weight. The measured minimum inlay height, excluding the weight-induced deformation, served as ground truth for validation and was compared to the algorithmically calculated component distances from 20 radiographs.

Results: With an average weight of 94 kg in the studied cohort, it was determined that an average inlay height of 6.160 mm can be expected in the patient. Based on the radiographs, the algorithm calculated a minimum component distance of 6.158 mm (SD = 81 µm), which deviated by 2 µm in comparison with the expected inlay height.

Conclusion: For the first time, an automated method can be presented that enabled an accurate and precise determination of the inlay height and, subsequently, the wear in knee endoprostheses based on a clinical radiograph and the implant CAD models. The precision and accuracy are comparable to the current gold standard (RSA; error = 3 µm, SD = 58 µm; Kaptein et al., 2007), without having to rely on special radiographic setups. Therefore, the developed method can be used to objectively investigate novel implant materials, surface coating and designs, thereby improving the quality of patient care.

Stichwörter:
wear, knee endoprosthesis, wear measurement, 2D-3D registration, polyethylene

DKG21-40 Vortrag
Rehabilitation wann ambulant, wann stationär?

Which ACL re-injury-predictive functional testing can feasibly be implemented in everyday practice? A focus review on validity and reliability of tests after anterior cruciate ligament reconstruction.

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Aims and Objectives: While return to sports (RTS) testing is known to have a large impact on prevention of anterior cruciate ligament (ACL) re-ruptures, only few clinicians utilize objective data to assess patients after ACL reconstruction (ACLR).
The aim of this study is to provide a practical RTS testing guide adapted to individual requirements in a physicians practice or a rehabilitation centre as a gold-, silver- and bronze-version, based on the current literature on RTS testing in order to reduce the risk of re-injury after ACL reconstruction.

Materials and Methods: RTS functional tests, their re-injury-prognostic value, reliability, and implementation capacity were extracted from original articles in English or German examining re-injury risks/rates following primary (index) ACL injury, ACL reconstruction and RTS. When available we extracted these details not only for the RTS gold standard setup, but also for the clinically implementable non-gold-standard test alternatives.

Results: A total of 31 potential studies including 8,689 patients were identified, from which studies not reporting tangible pass or cut-off criteria, studies with a cohort of minors and duplicates were excluded. In the final analysis, we included 19 studies (moderate to high quality) on 7513 patients. From these studies a total of 21 RTS tests could be retrieved. Tests not validated (isolated or as part of a testing-battery) for their prognostic value for the risk of ACL re-ruptures were excluded. Within the scope of the study, finally 13 tests were considered eligible to create a gold- (12 tests), silver- (7 tests) and bronze- (5 test) standard test-battery for clinical settings.
In the gold-battery, Dynamic:Isokinetic knee extension, Dynamic:Isokinetic extension/flexion Quad/Hamstring Ratio, Single/Distance Jump, Triple Hop, Triple Cross Over Hop, 6m Timed Hop, Vertical (counter movement) Jump: Contact time mat, Drop Jump: Knee valgus moment [N·m·kg-1], Speedy Hop/Jump, Running T-Test, KOOS - ADLSs & SPORT and ACL - RSI were included. The silver standard tests consisted of 8-repetition maximum test knee extension, Single/Distance Jump, Vertical (counter movement) Jump: Inertial sensor, Drop Jump: Medial knee displacement [degrees], Speedy Hop/Jump, KOOS - ADLSs & SPORT and ACL - RSI. In the bronze-setting, one may assess Elastic band (Thera band)-test, Single/Distance Jump, Speedy Hop/Jump, KOOS - ADLSs & SPORT and ACL - RSI as functional tests.

Conclusion: Based on level 2 evidence, passing a combination of functional tests with pre-determined cut-off points used as RTS criteria is associated with reduced re-injury rates. A combination of isokinetic strength, hop and jump tests, and self-reported function are recommended during such RTS testing. With the introduction of three test-batteries based on the current literature, physicians are now able to include evidence-based RTS testing into their daily practice to support the function-based rehabilitation and re-injury prevention after ACL-reconstruction.

Stichwörter:
RTS test, RTS testing, practice, test battery, Testbatterie, klinische RTS Testung, Return to sport, Return to sport test, ACL re-rupture, Kreuzbandverletzung

DKG21-43 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Anterior cruciate injuries in the German Social Accident Insurance Institution - a statistical analyses of costs, reduction in earning capacity and inability to work.

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Aims and Objectives: Injuries of the anterior cruciate ligament (ACL) often occur in young patients at the beginning of their working life. Therefore, times of inability to work (AU), the treatment and remaining reduction in earning capacity (MdE) result in high costs for the German Social Accident Insurance (DGUV). The study focused on: Treatment costs, AU, MdE and the devolvement of the amount of ACL injuries in the years 2010-2018 in contrast to other injuries.

Materials and Methods: Data were obtained from the rehabilitation documentation (Reha-DOK) of the statistical office of the DGUV for the year 2016, region ACL and injury including partial, complete and undefined ACL ruptures for the following aspects: Amount of ACL injuries per year, age at the time of injury, sex, inpatient or outpatient treatment, AU, treatment costs, MdE and long term disabilities. The amount of ACL injuries from the years 2010-2018 were additionally compared to other injuries.

Results: The analyses included 4133 ACL injuries (66%male), complete ACL tears (n=3204). Most injuries occurred in the German Social Accident Insurance Institution for the administrative sector (23,3%) and the public accident insurance company (30.3%). The peak of age was between 15-30 years (40%) (average 34 ± 14 yeas). Inpatient treatment was performed in 83,4 %. The AU was more than 3 months in 50 % and 6-9 months in 12,5% (average 22 ± 21 weeks). Injury pension in 2019 was paid in 7.6 % with an MdE of 20% in 67%.
Costs from 2016 to 2019 were 87.127.209 Euro, 21.178 Euro per patient. Disabilities after MdE were instability (24%) reduction in strength (30,2%) and limitations in range of motion (81.9%).
From 2010 to 2018 the amount of ACL injuries has increased up to 37%, other injuries excluding to those of the ACL increased 0.6%.

Conclusion: ACL injuries are highly increasing in contrast to other injuries in the DGUV and associated with high costs. The age distribution results in long term impairment for young patients in the early years of their working life. Research should focus on the improvement of treatment to optimize patient's outcome.

Stichwörter:
ACL, DGUV, Cost analyze, MdE

DKG21-44 Vortrag
Frakturen rund ums Knie

Anterior Locking Plate Osteosynthesis of Patellar Fractures - Analysis of Complications and Functional Outcome

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Aims and Objectives: Tension band wiring is the standard procedure for patellar fractures, but is associated with a high rate of implant related complications and implant failure. Tension band wiring may fail, especially with multifragmentary and comminuted fractures. Plate fixation of complex patellar fractures seems to be superior to wiring, both clinically and biomechanically. The aim of this study was to evaluate complications after locking plate fixation in patellar fractures two years after surgery and to access the functional outcome.

Materials and Methods: As part of a prospective case series, all patients who had received locking plate fixation of a patellar fracture between April 2013 and May 2018 were clinically examined two years postoperatively and potential complications were evaluated.

Results: A total of 38 patients aged 19-87 years were included. Complications occurred in a total of five patients (13%), including one reactive prepatellar bursitis, one chronic infection and loss of reduction due to a dislocated pole fragment in three cases. The average active range of motion of the affected knee joint two years postoperatively was 133°. The Tegner activity scale score reached 3 points, the Lysholm score 95 points and the Kujala score 95 points.

Conclusion: With an overall relatively low complication rate and good clinical outcome, dislocated distal pole fragments are a common complication after plate fixation of patellar fractures. If preoperative diagnostic testing shows a pole fragment, a modified hook-plate can be used, with the possibility of fixing the pole fragment.

Stichwörter:
Multifragmentary patellar facture - anterior locking plate fixation - tension band wiring - complication rate - displaced distale pole fragment

DKG21-47 Vortrag
Deformitätenanalyse

Low Posterior Tibial Slope as a Risk Factor for PCL Graft Failure

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Aims and Objectives: To evaluate the impact of the posterior tibial slope (PTS) on patient-reported outcomes (PROs) and posterior cruciate ligament (PCL) graft failure rate after anatomic PCL reconstruction after a minimum 2-year follow-up. It was hypothesized that PTS would positively correlate with PROs, and that low PTS represents a significant predictor of PCL graft failure.

Materials and Methods: Patients undergoing anatomic single-bundle PCL reconstruction with a minimum 2-year follow-up were included in this retrospective cohort study. One observer performed a comprehensive chart review to collect patient-, injury-, and surgery-related data. Medial PTS was measured on preoperative strict lateral radiographs with less than 6 mm posterior condyle overlap. A questionnaire was emailed to each patient to collect validated PROs, including the International Knee Documentation Committee Subjective Knee Form (IKDC-SKF), Knee Injury and Osteoarthritis Outcome Score (KOOS), Lysholm Score, Tegner Activity Scale, and Visual Analogue Scale (VAS) for pain. Correlations between medial PTS and collected PROs were assessed using Spearman's rank-order correlations. A binary logistic regression model was conducted to evaluate whether PCL graft failure could be predicted by medial PTS. Level of significance: $p < 0.05$.

Results: A total of 79 patients with a mean age of 28.6 ± 11.7 years (range, 15-64 years) and a mean follow-up of 5.7 ± 3.3 years (range, 2.0-12.4 years) were included. After a median time from injury of 4.0 months (inter-quartile range, 7 months) isolated and combined PCL reconstruction was performed in 22 (28%) and 57 (72%) patients, respectively. There were no statistically significant differences in PROs and PTS between patients undergoing isolated and combined PCL reconstruction (all $p > 0.05$). No statistically significant correlations between PTS and PROs collected could be observed (all $p > 0.05$). Posterior cruciate ligament graft failure was observed in 14 (18%) patients after a median time of 17.5 months following PCL reconstruction. Statistically significantly lower PTS was found for patients with PCL graft failure compared to patients without PCL graft failure (7.0 ± 2.3° vs. 9.2 ± 3.3°, $p < 0.05$). No differences were found in PROs (all $p > 0.05$) between patients with and without PCL graft failure. Posterior tibial slope was found to be a statistically significant predictor of PCL graft failure, with a 1.3-fold increase in the odds of PCL graft failure for each one-degree reduction in PTS ($p < 0.05$).

Conclusion: In this study, it was shown that PTS represents a surgically modifiable predictor of PCL graft failure after anatomic singe-bundle PCL reconstruction. However, there was no correlation between PTS and PROs at a minimum 2-year follow-up.

Stichwörter:
Posterior Cruciate Ligament; Posterior Tibial Slope; PCL Graft Failure; PCL Reconstruction

DKG21-49 Poster
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Ultrasonography For Quantitative Assessment Of Knee Joint Effusions - Useful Tool For Objective Evaluation Of Rehabilitation Progress?

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Aims and Objectives: Clinical assessment of knee joint effusion as part of routine physical knee examination is gold standard, but lacks criteria and accuracy that would make it suitable for quantitative objective and reproduceable assessment across centres in scientific context or for individual adaptations in knee rehabilitation after surgical interventions.

External validation of bedside ultrasonography (US) for quantitative measurement of suprapatellar effusion size (ES) to improve diagnostic and individual rehabilitation strategies in knee rehabilitation after surgical interventions of anterior cruciate ligament reconstruction (ACLR) compared to the reference method.

Materials and Methods: US was performed in 37 patients (63% male, age 34.0 ± 11.4) from June 2020 to April 2021 in the ongoing CAMOPED-study in 5 centres (prospective, randomised, controlled, therapy-blinded, multicentre, DRKS00021739). Data was collected in patients with planned ACLR and during rehabilitation after surgery at the following time points: preoperative (preop), at discharge (postop), 3 + 6 weeks (prespecified time to primary endpoint) and 3 months postop. Knee was placed in 30° flexion while the suprapatellar recessus was scanned in longitudinal position under quadriceps tension in a standardised procedure. Mobile linear transducers were used for all examinations and effusion was measured as largest diameter of hypoechogenic area. Palpatory assessment was carried out prior to US by an independent investigator who was aware of the operation type and graded via objective International Knee Documentation Committee (IKDC) 4 level-Scale.

Results: Overall, a total of 135 sonographies were performed. There was a strong correlation of palpatory and US effusion ($r=0.8$, $p<0.001$) with lower variances in US compared to palpatory quantification $Y=-2.3 + 3.57*x$. ES (in mm) were: preop 1.8 [0.0 - 6.0], postop 6.8 [6.0 - 8.0] and consequently decreased significantly ($p<0.001$) time dependently 3 weeks after surgery 6.7 [4.7 - 7.7], 6 weeks 2.0 [0.0 - 5.8] ($p<0.01$ vs. postop) and 3 months 0.0 [0.0 - 0.1] ($p<0.01$ vs. postop) Palpatory quantification also showed time-dependent reduction of joint effusion ($p=0.001$). 6 weeks postop, no significant difference in ES was shown in US in patients with additional meniscal reconstruction (MR) compared to isolated ACLR (iACLR) (7.1 [2.7 - 10.4] vs. 2.0 [0.0 - 6.3], p=n.s.). In contrast, subjective palpatory effusion quantification suggested significant larger effusions in MR compared to iACLR (2.0 [2 - 3.5] vs. 1.5 [1.0 - 2.0], $p<0.01$).

Conclusion: Thus, postoperative suprapatellar effusion size can easily be quantified with standardised bedside ultrasound with high accuracy. As shown in this multicentre study, this method not only is superior in reducing bias of medical personnel especially for moderate to severe effusion but also offers a convenient and reliable tool for outcome measures in a multicentre treatment trial with the aim to optimise individualised recommendations during rehabilitation progress.

Stichwörter:
Ultrasonography, ACL, Active Motion Device, Knee Joint Effusion, Rehabilitation

DKG21-51 Vortrag
Rehabilitation wann ambulant, wann stationär?

Validity of a novel sensor-based application for home-based rehabilitation following anterior cruciate ligament reconstruction

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Aims and Objectives: Telerehabilitation might be an intriguing option to improve and monitor early rehabilitation of anterior cruciate ligament reconstruction (ACLR). Despite its self-evident potential, data on validity and safety are scarce.
The aim of this study was to assess the validity of a novel sensor-based application as an objective quantitative measurement tool on knee function during rehabilitation post ACLR in the ongoing ARCUS trial (DRKS 000024359) with regards to an international accepted measurement tool.

Materials and Methods: Prospective, longitudinal, randomized (standard post-OP rehabilitation with or without sensor), single-centre clinical trial in patients with ACL reconstruction less than 6 months after injury.
Validation of combined measures: coordination, strength and agility tests, as well as range of motion (ROM), assessed with a sensor-based application (Orthelligent, OPED) at 3 (primary endpoint), 6 and 12 months with regards to the subjective International Knee Documentation Committee (sIKDC) score, Tegner, Lysholm, and Functional Movement Screen. Further, safety and risk evaluation were conducted. To identify independent determinants of sIKDC, multivariate linear regression analysis for various sensor data of different pre-defined exercises was performed.

Results: From July 2019 to December 2020, 67 patients planned for primary ACLR (70.1% male, age 25 years [21-32], IKDC 47 [30-59], Tegner 6 [4-7], Lysholm 56 [42-72]) were included. At three months, significant correlations were detected for active and passive ROM (r=0.460, p=0.0004, y=52.52+0.58*x and r=0.358, p=0.025, y=93.34+0.41*x respectively) regarding the subjective IKDC. Further, significant correlations were found for strength and agility via the vertical jump test (r=0.426, p=0.011, y=-41.99+2.78*x) and side-hop test (r=0.367, p=0.042, y=3.66+0.58*x), as well as for coordination via the Y-Balance test (r=0.579, p<0.0001, y=32.04+1.08*x). Regarding the secondary endpoint at six months, strong correlation was detected for side hop (r=0.539 (p=0.004), y= -40.52+1.12*x), vertical jump (r=0.444, p=0.018, y= - 1.4E2+3.95*x) and Y-Balance (r=0.499 (p=0.008), y= 25.27+0.95*x). Vertical jump (ß=0.39, T=2.4) and passive ROM (ß=0.35, T=2.2) were independent predictors of the sIKDC score at 3 months (p=0.003) and the side-hop test (ß=0.45, T=2.4) of the sIKDC at 6 months (p=0.22). Moreover no adverse events related to the use of the sensor-based application were reported.

Conclusion: For the first time we were able to demonstrate, validation of a digital sensor-based application to objectively quantify knee function. This will have further implications for clinical and therapeutic decision-making, quality control of rehabilitation measures, and offers great opportunities in developing further scientific research questions.

Stichwörter:
Rehabilitation, Sensor, Telemedizin, VKB, ACL, ACL surgery, wearables

DKG21-52 Vortrag
Fokus Meniskus Naht und Ersatz

Clinical Outcome and Healing Rate after Arthroscopic Repair of Bucket Handle Meniscal Tears

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Aims and Objectives: The purpose of the present study was to evaluate clinical and radiographic outcomes of patients undergoing repair for acute bucket-handle meniscal tears (BHMT) as well as to assess the postoperative clinical and radiographic healing rate. It was hypothesized that patients who underwent repair for acute BHMTs would demonstrate significant functional improvement along with sufficient postoperative healing at a minimum follow-up of two years.

Materials and Methods: Patients who underwent arthroscopic repair for acute traumatic BHMTs between October 2011 and March 2016 and had a minimum follow-up of two years were included in the study. At final follow-up, clinical meniscal healing failure was defined according to Barrett's criteria including the presence of either swelling, clicking or blocking, tenderness of joint line, and a positive McMurray test. Postoperative outcome scores included the International Knee Documentation Society Score (IKDC), Lysholm score, Tegner activity score (TAS), and visual analog scale (VAS) for pain. The patient-acceptable symptomatic state (PASS) threshold was employed as a tool to assess the minimum score associated with patient satisfaction. In meniscal repair populations, a final IKDC score of 69.0 has been reported to correspond with the PASS. Side-to-side difference in knee laxity was measured using KT-2000. Further, magnetic resonance imaging (MRI) was performed at final follow-up. Radiographic healing was classified according to Henning's criteria in completely healed, partially healed, and non-healed.

Results: Forty patients with a mean age of 32.0 ± 11.5 were available for follow-up after 51.8 ± 14.3 months. Revision surgery by means of arthroscopic partial meniscectomy was performed in four patients (10%) prior to the follow-up visit. The clinical healing rate was 83.3% at final follow-up. Mean IKDC score was 82.8 ± 13.8 and Lysholm score was 77.4 ± 24.8. Of all patients, 87.5% reached or exceeded the PASS criteria for the IKDC score at final follow-up. The median TAS was 6 and VAS for pain was 0.46 ± 0.9. Side-to-side difference in knee laxity was higher in patients with concomitant ACL reconstruction (2.1 ± 2.7mm) compared to isolated BHMTs (1.0 ± 2.0mm). Age, sex and concomitant ACL reconstruction had no influence on the clinical healing rate or clinical outcome scores at final follow up ($P > 0.05$, respectively). MRI examination at final follow-up showed 69.4% healed, 25.0% partially healed, and 5.6% unhealed menisci. Interrater reliability was 0.87 (95% CI, 0.75-0.93) and thus considered excellent.

Conclusion: Patients who underwent repair for acute traumatic BHMTs achieved significant functional improvement along with postoperative healing at a minimum follow-up of two years. More specifically, the clinical healing rate was 83.3% at final follow-up, while MRI examination demonstrated 69.4% completely and 25.0% partially healed meniscal repairs, respectively. Further, 87.5% of patients reached or exceeded the PASS criteria for the IKDC score.

Stichwörter:
meniscal repair; magnetic resonance imaging; meniscus healing; clinical outcome; bucket handle meniscal tear

DKG21-53 Vortrag
Deformitätenanalyse

Neue 3D-Software für Analyse und Planung der Bein- und patellofemoralen Geometrie: Reliabilität und Genauigkeit

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Aims and Objectives: The importance in science and clinics of 3D methods in the field of deformity surgery and arthroplasty has increased significantly in recent years. Existing studies on the possibilities of analyzing lower limb geometry in 3D rarely include the complex anatomy of the patellofemoral joint. The new software "mediCAD® 3D Knee Sport" (Fa. Hectec, Altdorf, Germany) combines the analysis of lower limb alignment with detailed analysis of the patellofemoral joint and includes a osteotomy planning mode. The aim of the study is an investigation on reliability and accuracy of this "all in one" solution.

Materials and Methods: In a retrospective multi-observer study design, 3 post-mortem CTs (2m, 1w, 21 to 41 years) were used to have the software automatically generate 3D bone models of six legs. These were analyzed by 3 observers at 3 points in time, generating in total 54 values per analysis parameter. 11 parameters of lower limb and 7 of patellofemoral alignment were measured. The reliability of the measurements was evaluated using the intraclass correlation coefficient (ICC) of interobserver agreement for all measurement parameters. Accuracy was described using the mean deviation D from the mean and the standard deviation SD from D. A two-sided random effects model was used.

Results: Ten out of 18 alignment parameters showed excellent interobserver agreement, two good and three moderate agreement (including the mLDFA-3D). Poor agreement was found for the mMPTA-3D, the Trochlear Sulcus Angle and Trochlea Depth. Mean interobserver ICC of all parameters ranged from 0.32 to 0.99.
15 out of 18 parameters showed a low mean deviation D from the mean of < 2mm / 2°. Three parameters related to the patellofemoral joint showed medium or high D (Patella Tilt, Trochlear Sulcus Angle, Patellar Ridge Angle). These parameters also showed the highest values for the SD of D. The Trochlear Sulcus Angle was found to be the only parameter with a high mean deviation D greater than 5 mm / 5° with 5.67° ± 3.23°.

Conclusion: Overall accuracy and interobserver reliability are good in the current version of the software with exception of a few measurement parameters. The integration of osteotomy planning with calculation of the resulting anatomical analysis parameters as well as the automation of the creation of a 3-D model from the CT data set represent significant advances on previous workflows for everyday clinical use. The software is subject to continuous development. In particular, automation of anatomical landmark recognition could qualify future software solutions for routine clinical use.

Stichwörter:
patellofemoral anatomy; patella dislocation; 3D modelling; knee surgery; mediCAD;

DKG21-57 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Validation of a novel digital medical device after knee injury based on registry data of 604 patients

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Aims and Objectives: Telerehabilitation shows benefits in guideline-based rehabilitation programs for knee injuries. High-quality real-world data collected during use of a digital medical device (DMD) from rehabilitation (RH) in a patient registery provide decision-making basis for benefit assessment of objective measures of functional RH outcome. Primary aim was to show validity and detect adverse events (pain) of a DMD in stage-specific RH after surgical intervention of anterior cruciate ligament rupture (ACLR).

Materials and Methods: Primary raw data of a multinational European registry of users of a DMD (Orthelligent, ORS) in a home-based setting as add-on to the standard physiotherapy to perform specific tests in the categories range of motion (ROM, 3 tests), coordination (2 tests), strength/speed (2 tests) related to stage-specific RH after ACLR were systematically analysed by a core centre. A "fit index" is calculated from comparison of injured to the contralateral healthy leg and presented to patients. Statistical analyses were performed blinded to data retrieval from the database. A range data plausibility check was performed for all independent and dependent outcomes; data were cleaned accordingly. A minimum of 80% data completeness for key variables was prerequisite for subsequent analysis.

Results: More than 10,000 measurements stored from 2018 to 9/2020 from 604 patients with age- (median 26-30 years; < 16 years: 4%; >51 years: 9%) and gender-distribution (62% male) representative to the target population were analysed from individual tests performed over individual durations of more than 16 weeks. Indication for RH was ACLR in 73%. Preoperatively (15%; 12 month to directly pre-op), ROM, coordination and strength /speed were chosen with comparable frequency (97%, 92% and 59%). Postoperatively (85%), majority of tests were ROM (46% - 87%), followed by coordination (25% and 68%) and strength/speed (35% and 42%). ROM was used more often in the early weeks ($p<0.05$ vs. coordination and strength/speed) according to the stage-specific RH, indicating the external validity of the digital tool. Objective quantification of ROM during the course of RH corresponds to literature (passive and active ROM 6 weeks: 82° ± 21; 102° ± 23; 12 weeks: 103° ± 18; 117° ± 23 as well as fit-index) underlining the validity of the digital tool in clinical reality. Further, safety for the intended home-based use of the digital tool was confirmed by pain levels expected acc. to tests used corresponding to individual RH stages.

Conclusion: The DMD (ORS) may be used as effective, validated diagnostic instrument in telerehabilitation for objective quantification of knee function. Not only has the DMD been used for post-interventional rehabilitation, but also for decision-making prior to or without following surgical intervention of knee injuries. Data of this registry provides a real-world picture of rehabilitation process using digital functional assessment tools and provide basis for confirmatory prospective trials.

Stichwörter:
telerehabilitation, DiGA, digital medical device, registry study, ACLR, validation

DKG21-58 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Anteromedial rotatory knee instability cannot be addressed when reconstructing the medial collateral ligament

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Aims and Objectives: The purpose of this study was to investigate 6-degrees of freedom kinematics with special emphasis on anteromedial rotatory knee instability in knees with high-grade anteromedial injuries and related reconstructions. It was hypothesized, that an isolated reconstruction of the superficial medial collateral ligament (sMCL) cannot restore knee kinematics to normal.

Materials and Methods: For this study, 12 fresh-frozen human cadaveric knees were used. The knees were mounted onto a 6-degrees of freedom robotic testing system(KUKA KR 60-3). Knee kinematics were recorded with a force/moment sensor(ATI Theta FT-sensor; Schunk) during 1) 134N anterior tibial translation (ATT) performed at 5Nm external tibial rotation (ER) to simulate anteromedial rotatory instability (AMRI), 2) 5Nm ER, 3) 5Nm internal tibial rotation (IR), and 4) 10Nm valgus rotation. The following knee states were analyzed: 1) native, 2) sMCL and deep MCL (dMCL) resection, 3) sMCL reconstruction, 4) posterior oblique ligament (POL) resection, 5) POL reconstruction, 6) anteromedial capsule and retinaculum (AM) resection, and 7) AM reconstruction. The order of antero- and posteromedial cutting and reconstruction was randomized. An ANOVA with a post-hoc Bonferroni was performed ($p < 0.05$).

Results: Removal of the sMCL and dMCL resulted in a significant increase of ATT performed in ER at all flexion angles ($p<0.05$). This was further increased by resection of the anteromedial knee structures (NS). Reconstruction of the sMCL could reduce but not fully restore ATT in ER. Thus, ATT in ER following sMCL reconstruction was significantly higher compared to the native knee at all flexion angles ($p<0.05$). An additional AM reconstruction with a single-bundle Semitendinosus tendon did not significantly affect ATT in ER (NS).

Compared to the native knee, sMCL and dMCL removal significantly increased isolated ER at all flexion angles ($p<0.001$). After sMCL reconstruction ER was reduced to values comparable to the native knee at 0° and 30° of flexion. At higher flexion angles, sMCL reconstruction did however not sufficiently restore ER ($p< 0.001$). Resection of the anteromedial structures resulted in a further increase of ER (NS). This could not be restored to normal when performing an AM reconstruction.

Reconstruction of the POL was able to restore IR to normal at full extension. At higher flexion angles IR was significantly higher compared to the native knee ($p<0.05$).

Valgus rotation was significantly increased in sMCL and dMCL deficient knees ($p<0.001$). Reconstruction of the sMCL was able to restore valgus rotation at full extension and 30° of flexion.

Conclusion: Data of this study suggest that ATT performed in ER could not be restored to normal by an isolated sMCL reconstruction in sMCL/dMCL deficient knees. Adding an anteromedial reconstruction did not significantly affect knee kinematics. When facing patients with a high-grade AMRI surgeons should consider that current surgical techniques might not sufficiently address these pathologies.

Stichwörter:
knee, anteromedial, instability, medial collateral ligament, reconstruction

DKG21-59 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

When diagnosing an anteromedial rotatory knee instability an isolated sMCL injury is unlikely

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Aims and Objectives: The purpose of this study was to biomechanically investigate the contribution of the medial knee structures to anteromedial rotatory knee instability (AMRI). It was hypothesized, that the superficial medial collateral ligament (sMCL) is the main contributor to AMRI.

Materials and Methods: For this study, 8 fresh-frozen human cadaveric knees were mounted onto a 6-degrees of freedom robotic testing system(KUKA KR60/3). Forces in response to 1) 134N anterior tibial translation (ATT) performed in 5Nm external tibial rotation (ER) to simulate AMRI, 2) 5Nm ER, 3) internal tibial rotation, and 4) 10Nm valgus rotation were recorded with a force/moment sensor (ATI-Theta FT-sensor; Schunk). The aforementioned loading conditions were applied to the native knee and after sectioning the following structures: 1) medial retinaculum and fascia, 2) anteromedial capsule, 3) sMCL, 4) deep MCL (dMCL), 5) posterior oblique ligament (POL), 6) anterior cruciate ligament (ACL), 7) lateral collateral ligament (LCL), popliteus tendon, popliteofibular ligament. The contribution of each anatomical structure to the resultant forces was calculated and presented relative to the native knee. An ANOVA with a post-hoc Bonferroni correction was performed ($p<0.05$).

Results: The ACL was the primary stabilizer against ATT performed in ER between full extension and 60° of flexion (contribution of 50.2% at 30°; 31.2% at 60°) ($p<0.05$). The sMCL contributed maximally by 27.1% at 60° and 36.8% at 90° of knee flexion to restrain ATT in ER ($p<0.05$). However, close to extension, the contribution of the sMCL was lower than 15% (NS). Similarly, the anteromedial knee structures contributed by 8.6% at 0° to 14.9% at 90° to restrain AMRI (NS).

The anteromedial retincaculum and fascia contributed by 19.2% at 0° and 23.6% at 30° of flexion to restrain ER ($p<0.05$). The sMCL was the primary stabilizer against ER at 30° of flexion with a contribution of 25.2% ($p<0.05$). At deeper flexion angles, similar results could be obtained. The anteromedial capsule showed a significant contribution at 120° of flexion only ($p<0.05$), while at all other flexion angles the role of the capsule was negligible.

Not surprisingly, the sMCL was the primary stabilizer for valgus rotation, while internal tibial rotation was primarily restraint by the POL at 0° and 30° ($p<0.05$).

Conclusion: Data of this study suggest, that AMRI was primarily restraint by the ACL during the first 60° of flexion followed by the sMCL at flexion angles above 60°. Thus, when performing an anterior drawer test performed in ER at 90° of knee flexion, excess laxity might be primarily caused by the sMCL. In contrast, excess laxity during the Lachman test performed in ER might be due to injury to the anteromedial retinaculum and fascia.

Stichwörter:
knee, instability, anteromedial, ACL, retinaculum

DKG21-60 Poster
Fokus Meniskus Naht und Ersatz

Incidence of cyclops syndrome after primary anterior cruciate ligament reconstruction. Analysis of 2186 cases.

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Aims and Objectives: To analyse the rate of cyclops syndrome after primary anterior cruciate ligament reconstruction with hamstrings autograft.

Materials and Methods: A retrospective analysis of all primary cruciate ligament reconstructions (standardized technique with hamstrings autograft), performed between 2018 and 2019 in a single centre regarding the occurrence of revision surgery because of cyclops syndrome was performed. The documented data and surgical reports were checked for demographic factors and concomitant procedures. Subgroup analysis was performed for demographic and surgical differences. Additionally, the rates of revision surgery because of cyclops syndrome were compared using Chi2-test.

Results: In summary, 2186 anterior cruciate ligament reconstructions were performed (1299 (59.4%) male, 887 (40.6 %) female), mean age at index procedure was 31.0 ± 12.0 (7.0 - 71.0) years. In a follow-up time of 2.4 ± 0.6 (1.5 - 3.4) years, 57 arthroscopic arthrolysis were performed due to cyclops syndrome (2.6%). The mean time from index procedure to revision arthroscopy was 0.7 ± 0.5 years. In 640 patients (29.3%), an additional meniscus suture repair was performed. Subgroup analysis revealed a significant higher rate of revision arthroscopy due to cyclops syndrome in this cohort, compared to anterior cruciate ligament reconstructions without meniscus repair (3.9% (n=25) versus 2.1% (n=32), p = 0.014).

Conclusion: The overall incidence of cyclops syndrome is low with 2.6%. There is a higher incidence in patients with restricted rehabilitation because of concomitant meniscus repair.

Stichwörter:
anterior cruciate ligament, cyclops syndrome, meniscus repair

DKG21-61 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Change in leg position during radiological whole-leg stance imaging and the effect on projected leg angle geometry using patients with endoprosthetic knee replacement as an example

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Aims and Objectives: Radiological imaging is mandatory for preoperative diagnostics, surgical planning and evaluation of the surgical outcome. This also includes preoperative and postoperative whole-leg radiographs, which are used to check the biomechanical axes.
In order to improve the quality and reproducibility of these images, we developed a device for standardized whole-leg radiographs (GBSA) at Itzehoe Hospital.
To verify the results, a study was conducted to compare the deviation of the angles during repeated examinations using conventional techniques with those under standardized conditions (setting device). Pre- and postoperative GBSA were compared in terms of angles not influenced by surgery.

Materials and Methods: A total of 24 patients who underwent knee TEP implantation underwent geometric measurement of leg angles pre- and postoperatively on native radiographs (GBSA).
Two groups of equal size were defined. Each patient in group 1 and 2 was assigned a case number from 1 - 12.
Group 1: Patients in whom GBSA was performed conventionally with Paley's leg adjustment (patella frontal) preoperatively and postoperatively. Without adjustment device.
Group 2: Patients in whom GBSA was performed under a standardized leg position using an adjustment device pre- and postoperatively.

Measurements were made pre- and postoperatively using Sectra IDS7 software, (version: 22.2.7.4217, Sectra AB, Sweden) and the orthopedic measurement tool (included in Sectra IDS7).
Leg angles were measured that were not affected by surgery.
mLPFW mechanical lateral proximal femoral angle
aMPFW anatomic medial proximal femoral angle
LDTW lateral distal tibial angle
CCD center collum diaphyseal angle
Methodology
The measurements were taken according to "Messverfahren und Klassifikationen in der muskuloskelettalen Radiologie" Verlag: Thieme, Autor: SimoneWaldt, Matthias Eiber, KlausWörtler, 2. , unchanged edition 2017 as well as the paper "Mechanical, Anatomical, and Kinematic Axis in TKA: Concepts and Practical Applicationsentaken" (Jeffrey J. Cherian, Bhaveen H. Kapadia, Samik Banerjee, Julio J. Jauregui, Kimona Issaand Michael A. Mont, www.ncbi.nlm.nih.gov/pmc/articles/PMC4092202/ , 2014 Mar 27).

Results: Statistics
The Kruskal-Wallis test

	Mean		p-value
	Group1	Group2	
mLPFW	2.25	0.25	0.001268
LDTW	3.25	0.75	0.002827
aMPFW	2.91	0.00	0.0000219
CCD	3.91	0.08	0.000226

Conclusion: The aim of this work is to show that the non-standardized leg adjustment with the radiologically reconstructed GBSA has relevant measurement deviations with regard to the leg angle measurement compared to the GBSA with the standardized leg adjustment using the self-developed adjustment device.
A standardized GBSA should become the standard procedure in trauma surgery and orthopedics in order to generate precise and reproducible data and thus improve the quality in endoprosthetic care of the knee joint.

Stichwörter:
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DKG21-62 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Anterior cruciate ligament autograft maturation process is time-dependent and correlates with return-to-sports

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Aims and Objectives: Magnetic resonance imaging (MRI) signal intensity is correlated to structural postoperative changes of the anterior cruciate ligament (ACL) autograft and biomechanical structural properties. The aim of the study was to investigate the ACL autograft maturation process by MRI over two years postoperatively, compare it to a native ACL signal and correlate the results with clinical outcome, return to sports, and knee laxity measurements.It was hypothesized that 1) the ACL would mature over time at 1 and 2 years postoperatively and would approximate the signal of a native ACL at final follow-up and 2) a higher grade of graft maturation (hypo-intense MRI signal) would positively correlate with better clinical outcome, RTS and knee stability.

Materials and Methods: ACL autograft signal intensity was measured in 17 male patients (age, 28.3 ± 7.0 years) after ACL reconstruction with hamstring autograft at 6 weeks, 3-, 6-, 12-, and 24 months postoperatively by 3 Tesla MRI (two readers). Controls with an intact ACL served as control group (22 males, 8 females; age, 26.7 ± 6.8 years). An ACL/PCL ratio (APR) and an ACL/muscle ratio (AMR) was calculated to normalize ACL signals to other intact soft tissues. APR and AMR was compared across time and to native ACL signal. Clinical outcome scores (IKDC score, Lysholm), return to sports (Tegner activity scale), and knee laxity measurement (KT-1000) were obtained and correlated to APR and AMR at the respective time points. Students t-test was used to find differences between ACL grafts and native ACLs and one-way analysis of variance (ANOVA) with Bonferroni correction to describe differences in APR and AMR over time. Statistical significance was set at $p < 0.05$.

Results: There were significant changes in MRI signal within the ACL graft over the postoperative period ($p < 0.01$). The APR and AMR of the ACL graft changed significantly from the lowest values at 6 weeks to reach the highest signal intensity after 6 months ($p < 0.001$). By then, the APR and AMR were significantly different from a native ACL 6 months after surgery ($p < 0.01$) but approached the APR and AMR of the native ACL at 1- and 2 years after surgery ($p < 0.05$). A hypo-intense ACL MRI signal was associated with return to the preinjury sports level two years after surgery ($p < 0.05$). No correlation was found between ACL MRI graft signal and clinical outcome scores or KT-1000 measurements.

Conclusion: ACL grafts undergo a continuous maturation process in the first two years after surgery. The ACL graft signals became hyper-intense 6 months postoperatively and approximated the signal of a native intact ACL at 12- and 24 months suggesting remodeling of the autograft's collagen tissue. Patients with a hypo-intense ACL graft signal at two years follow-up were more likely to return to the preoperative sports level.

Stichwörter:
anterior cruciate ligament; graft healing; ligamentization; MRI; hamstring autograft; graft maturation

DKG21-63 Vortrag
Deformitätenanalyse

Analysis of Bilateral Long Standing Radiographs by Artificial Intelligence

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Aims and Objectives: The analysis of long standing radiographs (LSR) also called long-leg radiographs is essential for diagnostics of defects, deformities and discrepancies of the lower leg, for treatment by reconstructive interventions, for hip, knee and ankle replacement and others.
More than two dozen of points and lines (landmarks) need to be defined to perform another good dozen of measurements for each pair of legs. Nowadays the measurements are made manually in digital DICOM viewers mostly where each measurement needs meticulous and time-consuming adjustment in magnification mode each and final evaluation and interpretation.
The application of artificial intelligence or better-called machine learning, neural networks and self-learning algorithms might reduce this time from at least 15 Minutes manually even for skilled examiners to a few seconds only if performed by the algorithm.

Materials and Methods: The analysis of the leg geometry in LSR requires the precise determination of landmarks like the centres of hip, knee and ankle joints, the definition of the axes of the femoral neck, femur (mechanical and anatomic), of the tibia and the entire leg. Having done this various angles and distances can be measured like the mechanical axis deviation (MAD), proximal femoral joint angles (CCDA, MPFA, ...), anatomical and mechanical distal femoral angles (aLDFA, mLDFA), proximal tibial angles (MPTA), distal tibial joint angles (LDTA) and others.
26 anatomical landmarks per pair of legs were defined and a specific, self-learning algorithm was programmed and trained by thousands of manual measurements. The algorithm now can automatically define those landmarks, measure all angles and distances, and generate an automated report within 1-2 seconds. Additionally, there is a user-friendly option for manual readjustments, only very rarely required. Any pathologic values are highlighted automatically.
A first evaluation of the algorithm was carried out on a set of 16 randomly chosen bilateral LSR unknown to the algorithm. An experienced examiner (F.G.), recorded his manual measurements according to our digital standard method (CorelDraw®) that we use in our daily practice for more than a decade. Those manual measurements were compared with the values produced by the algorithm.

Results: The comparison of the manual standard measurements with the results of the algorithm showed a maximum, mean error of 0.97 mm for femoral length and a minimum mean error of 0.41 mm for the MAD. In the measurements of the joint angles, the mean errors range between a minimum of 0.46° for the two distal femoral angles (aLDFA and mLDFA) and a maximum mean error of 1.64° for the ankle joint angle (LDTA).

Conclusion: The clinical experience of analyzing strongly suggests that the precision of the algorithm is well below the expected inter- and intra-observer reproducibility of manual measurements. And according to the nature of self-learning algorithms precision will improve even more.

Stichwörter:
Long Standing Radiograph, Artificial Inteligence, Long-Leg Radiograph, Machine Learning, Lower Extremity, Neural Networks and Self-Learning Algorithm, Alignment, Malalignment, Bow Leg, Knock Knee,

DKG21-64 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Rotational posterior drawer stress radiographs do not add any value in the diagnosis of combined posterior cruciate ligament injuries

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Aims and Objectives: Posterior tibial translation (PTT) in stress radiographs will increase with a combined posterior cruciate ligament (PCL) and posterolateral (PLC) lesion. However, there is no evidence on combined PCL and posteromedial lesions (PMC) and how the PTT will change, when the foot is placed in external (ER) or internal rotation (IR). Thus, the goal of the present study was to evaluate the PTT using stress radiographs in combined PCL and PMC/PLC instability. It was hypothesized that (1) a combined PCL and PMC/PLC injury leads to increased PTT in stress radiographs and (2) that IR and ER will alter the PTT measured in the stress radiograph.

Materials and Methods: 6 paired fresh frozen human cadaveric legs (n=12) were mounted in a radiographic posterior drawer device GA-III/E (telos GmbH, Woelfersheim-Berstadt, Germany). Rotation was simulated using an attached rig which was capable of rotating the foot 30° internally and externally. The x-ray source was mounted 1m above the laterally aligned specimen. The detector was positioned under the specimen, simulating a clinical stress radiograph setup. PTT was then performed in the intact specimen with application of 15kp (147.1N) to the tibial tubercle in 90° flexion of the knee. This was repeated with 30° internal and external rotation. The PCL, the PLC (lateral collateral ligament and popliteofibular ligament) and the PMC (medial collateral ligament and posterior oblique ligament) were cut consecutively in 6 knees, whereas the PMC was cut before the PLC in the other 6 knees. PTT was radiographically measured using the midpoint of the posterior lateral and medial femoral and tibial condyle/plateau parallel to the tibial plateau using Horos Viewer 3.3.6 (Horos Project, Annapolis, USA). Statistical analysis was performed using a 2-way repeated measurements ANOVA.

Results: The PTT significantly increased from 3.9±1.5mm to 13.3±3.1mm, when the PCL was cut. This further increased to 15.3±2.7mm and 15.1±3.1mm ($p< 0.05$) after additionally creating a combined PCL + PLC or PCL + PMC lesion, respectively. After completely destabilizing the knee (PCL + PLC + PMC) the PTT increased to 17.8±3.5mm ($p< 0.05$), respectively.
The posterior drawer in ER did not led to a significant change of the PTT in all of the tested specimen, whereas IR led to a slightly higher PTT, which was not significant (n.s.) compared to the neutral posterior drawer.

Conclusion: In PCL stress radiographs a PTT of more than 10 mm side to side difference should be suspicious to a combined PCL and PLC or PMC injury. Furthermore, a PTT of more than 14mm side to side difference should be suspicious to a combined PCL with PLC and PMC injury. Even though the posterior drawer in either IR or ER is a valid clinical tool in order to diagnose an additional PLC or PMC injury, the PTT in stress radiographs did not change significantly, when the foot was placed in IR or ER. Based on these results there is no added value in stress radiographs using rotational posterior drawer compared to the neutral position.

Stichwörter:
posterolateral corner, posterior cruciate ligament, posterior drawer sign, rotational instability, lateral collateral ligament, radiographic posterior drawer sign

DKG21-65 Vortrag
360° Versorgung bei Tibiaplateaufrakturen

Epidemiology and treatment strategies of tibial plateau fractures in the last 10 years - data from a European level-I-trauma center

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Aims and Objectives: 1% of all human fractures are tibial plateau fractures, with little detailed epidemiological data available. In recent years, the surgical treatment of this entity has changed significantly and, in addition to the anterolateral, other surgical approaches are now standard for complex fractures.

Materials and Methods: This retrospective study therefore examined the patient population in a german level I trauma centre over the last decade (2011-2020) in terms of epidimiology, mechanism of trauma and treatment strategy. Fractures were classified according to AO, Schatzker and Moore, taking into account age and gender distribution.
In addition to the cause of the injury, type of osteosynthesis and additional interventions were also recorded.

Results: A total of 607 patients (55.2% women, 44.8% men; mean age 53 years) were included, with 462 (76.1%) undergoing surgical treatment. Within the classifications, AO 41-B3 (24.9%), Schatzker 2 (26.78%) and Moore 3 (31.25%) fractures were the most common, with preoperative imaging diagnostics using CT and MRI increasing significantly over time (MRI: +15.6%; CT: +10%). The main types of trauma were falls (32.9%), bicycle accidents (15%), traffic accidents (21.1%) and skiing accidents (10%). In younger patients (below the average age), the male gender predominated (55%) and skiing accidents (14.8%) and high-energy trauma (23.5%) were more common. Among older patients, the female gender and falls dominated as the cause of accidents (40 %).
The treatment strategy changed over the decade: more combined treatments with significantly more double plates or additive screws were performed ; in addition, more patients received additive treatments of the menisci and ligament structures and bone defects are increasingly filled with allogenic material (36.4% allogenic; 35.5% autologous; 28.1% substitutes).

Conclusion: The gender distribution and type of trauma in this study are comparable to others. The cohort shows a remarkable increase in complex and dislocated fractures within the decade, which could be due to the increase in primary CT and MRI imaging and the associated better fracture understanding. In terms of treatment strategies, the posterior approach and the primary treatment of concomitant articular injuries are becoming increasingly important. When filling bone defects, the trend is towards allogeneic material.
How this change in treatment strategies influences the postoperative outcome must be clarified in further studies.

Stichwörter:
Epidemiology;Tibial plateau fracture;Central Europe; Level-I-Traumacenter;surgical treatment

DKG21-66 Vortrag
Frakturen rund ums Knie

Influence of the corona pandemic on fracture epidemiology by the example of tibial plateau fractures

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Aims and Objectives: Since the beginning of 2020, the corona pandemic has presented the German health care system with great economic and medical challenges. So far, little is known about the fracture epidemiology and its care strategies influenced by the changed behaviour of the population in times of lockdown.

Materials and Methods: In this retrospective study, the own patient collective in a level-I-trauma centre of tibial head fractures of the last decade including the year 2020 was compared with regard to epidemiology, classification, accident mechanism as well as seasonal distribution. The findings were analysed for possible associations with measures such as lockdown and curfews. The fractures were classified according to AO, Schatzker and Moore.

Results: In 2020, a total of 66 tibial plateau fractures were treated. This corresponds to a decrease of 9.6% compared to the previous year. In particular, complex and dislocation fractures decreased (41-C3 fractures: -54.5%) and in contrast, simpler fractures were more frequent (41-B2 +50%). With regard to the cause of accidents, a divergence in traffic and bicycle accidents can be observed: Traffic accidents show a decrease of 7.6% compared to the previous year, while bicycle accidents increased (+6.6%). Furthermore, ski accidents (-11%) decreased and the number of falls (+12.4%) increased. Fewer fractures were treated during lockdowns 1 and 2, in contrast, there was an increase between the lockdowns in summer (+2.6%) and autumn (+9.4%) compared to the previous year.

Conclusion: The corona pandemic has a strong impact on fracture epidemiology and morphology, as exemplified by tibial plateau fractures. There is a clear correlation between the decrease in tibial plateau fractures and measures such as lockdowns, curfews and the closure of ski resorts, while the adapted leisure behaviour of the population, with increased cycling, also shows its influence.

Stichwörter:
COVID-19;Fracture;Tibia Plateau; Level-I-Traumacentre;

DKG21-67
Osteotomie

Poster

Even in cases of pronounced osteoarthritis, DLO enables the restoration of a quality of life and appropriate work intensity comparable to that of the general population

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Aims and Objectives: Double Level Osteotomy (DLO) is recognized as a joint line preserving technique for the treatment of severe varus osteoarthritis. The aim of this study was to assess quality of life as well as work intensity prior to surgery and at time of return to work after surgery.

Materials and Methods: 24 patients (28 knees) with a mean age of 49.1 ± 9.5 years who underwent surgery by DLO (open wedge high tibial osteotomy and closed wedge distal femoral osteotomy) within a three-year period and consented to participate in this study were included. Duration of incapacity to work was evaluated. Health related quality of life (HRQL) measured with SF-36 questionnaire, the work intensity measured with REFA-classification and Tegner activity scale as well as visual analog scale (VAS) for pain level were assessed preoperatively and at the follow-up examination 18.0 ± 10.0 (range: 5-43) months postoperatively. SF-36, summarized by physical component summary score (PCS) and mental component summary score (MCS) and all eight subscales were compared to age, gender and geographical adjusted values of the general population.

Results: Duration of incapacity to work was 12.2 ± 4.4 (range: 6-20) weeks. A statistically significant pre- to postoperative improvement was found in all SF-36 subscales (all $P<0.05$) as well as for PCS ($P<0.01$). PCS was statistically significant reduced prior to operation compared to the general population ($P<0.01$) whereas MCS showed comparable values (n.s.). MCS also improved over the observation period, although not statistically significant (n.s.). Follow-up showed even better results than would be expected in the adjusted general population, therefore a significant improvement was not to be expected. Regarding work intensity, 17.9% of the patients (5/28) were unable to work prior to surgery based on knee symptoms. All patients were able to work at the follow-up. Tegner activity scale increased statistically significant ($P<0.01$) as well as VAS improved statistically significantly ($P<0.01$). No conversion to total knee arthroplasty occurred.

Conclusion: This study demonstrates that both work intensity and HRQL can be restored by DLO for severe varus osteoarthritis at short term follow-up. The physical aspect of HRQL is restricted prior to surgery, comparable to bicompartimental osteoarthritis of the knee, whereas mental aspects are not reduced. These results can guide surgeons in communicating realistic expectations when considering a DLO for patients.

Stichwörter:
double level osteotomy, DLO, quality of life, work intensity, return to work

DKG21-68 Vortrag
Deformitätenanalyse

Development and Validation of a Deep Learning Algorithm for Automated Comprehensive Analysis of the Leg Alignment

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Aims and Objectives: Within surgical treatment options for knee osteoarthritis such as knee joint replacement and realignment surgery, a comprehensive preoperative analysis of the alignment of the lower extremity is paramount. A deep learning (DL) model that performs automated analysis of the leg alignment on x-rays could accelerate the process currently performed by orthopedic surgeons and increase accuracy and reliability of preoperative planning. The purpose of this study was to develop a DL model for automated and accurate assessment of the leg alignment on anterior posterior hip-knee-ankle radiographs and compare the performance to orthopedic surgeons.

Materials and Methods: Two-hundred ninety-three patients (mean age 34.6±19.5 years, 74 female, 166 left side), who underwent mechanical alignment correction osteotomy at the authors' institution between 01/2010 and 01/2021 were retrospectively enrolled. Leg alignment analysis and placement of landmarks was performed by two orthopedic surgeons (OS1 and OS2) on anterior posterior hip-knee-ankle radiographs, serving as ground truth. Measurements included the mechanical lateral distal femoral angle (mLDFA), joint line convergence angle (JLCA), mechanical medial proximal tibia angle (mMPTA), mechanical lateral distal talus angle (mLDTA), anatomical angle (AMA), mechanical femorotibial angle (mFA-mTA). The data set was split 60%(n=176)/10%(n=29)/30%(n=88) for training, validation and hold-out testing. Twelve independent networks - each specialized in combining segmentation and object detection for the placement of the landmarks in a single anatomical region - were synthesized to adequately deal with the large resolution of the radiograph. The model was based on a COCO pretrained Mask-R CNN-ResNeXt-101 implemented in PyTorch. The mean difference of the individual angles between the DL model and the ground truth was measured in the hold-out test set and compared to the mean difference of OS1 and OS2 to evaluate the final performance of the DL model.

Results: Excellent agreement was observed between the predicted landmarks by the deep learning model and the landmarks annotated by the orthopedic surgeons, thus allowing for an accurate calculation of individual angles. The mean difference between the DL model and the ground truth was 1.2°±1.3° for mLDFA, 1.0°±1.7° for JLCA, 1.3°±1.6° for mMPTA, 1.3°±1.3° for mLDTA, 0.4°±0.7° for AMA and 0.5°±0.8° for mFA-mTA. In comparison, the mean difference between the human raters OS1 and OS2 was 1.0°±1.1° for mLDFA, 0.9°±1.2° for JLCA, 1.1°±2.0° for mMPTA, 1.4°±1.8° for mLDTA, 0.3°±0.3° for AMA and 0.3°±0.2° for mFA-mTA.

Conclusion: The developed DL model combining landmark detection with segmentation and object detection allowed for an accurate assessment of the leg alignment on hip-knee-ankle radiographs with a performance comparable to orthopedic surgeons. A model such as this could accelerate preoperative planning, as well as significantly increase its accuracy and reliability.

Stichwörter:
Deep learning, lower extremity malalignment, knee joint replacement surgery, mechanical correction osteotomy, osteoarthritis, landmark detection

DKG21-69 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Remaining anterior knee laxity correlates with poorer patients' outcome in revision ACL reconstruction

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Aims and Objectives: The correlation between a remaining anterior knee laxity and poorer patient-related outcome measures might be underrated in anterior cruciate ligament reconstruction (ACLR). A correlation between the reduced anterior knee laxity after ACLR and improved subjective symptoms has not been established in the current literature.
The purpose of this study was to evaluate the outcome of 200 patients with revision ACLR to demonstrate a possible correlation between a remaining knee laxity and functional scores. We hypothesize that a postoperative increased side-to-side- difference (SSD) correlates with poorer patient-related outcomes.

Materials and Methods: Between 2016 and 2019, we performed a revision ACLR in 234 patients. 200 patients (77 women and 123 men, mean age 30.8 ± 11 years, range 18-61 years) were evaluated, with a mean follow-up of 30.2 ± 9 months (range 24-67 months), in this retrospective study. Postoperative failure was defined as a side-to-side difference (SSD) of > 5 mm in the Rolimeter® test and a pivot-shift grade of 2 or 3. Postoperative SSD was divided into three groups (1: SSD< 3mm, 2: SSD 3-4mm, 3: SSD > 5mm).

Results: 12.5% of patients (n=25) showed a failed revision ACLR while there were 148 patients in the group of postoperative SSD < 3mm, 27 patients in the group SSD 3-4mm and 25 patients in the group SSD >5mm.
In total, the numbers of a positive preoperative Lachman test (100% (n=200) to 16% (n=32), p<0.001) and a positive pivot-shift test (97% (n=192) to 15.5% (n=31, p<0.001) were significantly reduced compared to the postoperative examination. Also, the VAS (4.1±2.5 to 1.3±1.7), Lysholm (50.6±22 to 84.5±15.3) and Tegner (3±1.4 to 5.9±1.6) scores significantly improved from pre- to postoperatively (p <0.001).
The postoperative functional scores of the groups of SSD< 3mm and SSD 3-4mm were significantly increased compared to the group of patients with a SSD of >5mm in the VAS, Tegner, Lysholm, IKDC and KOOS scores (p>0.001, except KOOS quality of life p=0.035). Beyond that, a postoperative SSD >5mm was determined to be independent risk factor associated with a reduced postoperative IKDC in the linear regression analysis (odds ratio, -15.3 [95% CI, -21.6 to -9.1]; p<0.001).

Conclusion: In patients following revision ACLR, anterior and rotational knee laxity can be successfully reduced while increasing postoperative functional outcome. A remaining postoperative SSD >5mm was associated with inferior patients' outcome compared to a SSD < 5mm as it led to reduced functional scores. A SSD >5 mm represents an objectifiable parameter in the definition of failure of revision ACLR and this is the first study to show this difference in revision ACLR.

Stichwörter:
correlation remaning anterior knee instability and functional outcome

DKG21-70 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Additional lateral extra- articular tenodesis in revision ACL reconstruction does not influence the outcome of patients with low-grade anterior knee laxity

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Aims and Objectives: There is limited evidence on the indications of lateral extra-articular tenodesis (LET) in revision ACLR. The aim of this study was to evaluate the influence of the LET in patients with revision ACLR with preoperative low-grade anterior knee laxity.

Materials and Methods: Between 2013 and 2018, 78 patients who underwent revision ACLR with preoperative low-grade anterior knee laxity (< 6mm side-to-side difference (SSD)) were included in the retrospective cohort study. An additional modified Lemaire tenodesis was performed in 23 patients during revision ACLR and the patients were clinically examined with a minimum of 2 years after revision surgery. Postoperative failure of the revision ACLR was defined as SSD in Rolimeter® testing > 5mm or pivot shift grade 2/3.

Results: In total, failure of the revision ACLR occurred in 11.5% (n=9) of the cases at a mean follow up of 28.7 ± 8.8 (24 to 67) months. Patients with an additional LET and revision ACLR did not show a significantly reduced failure rate (13% vs. 11%) or an improved clinical outcome according to the postoperative functional scores or pain in regards to patients with an isolated revision ACLR (Tegner 5.7±1.3 vs. 5.9±1.5, n.s.; IKDC 77.5±16.2 vs. 80.1±14.9, n.s., Lysholm 81.9±14.2 vs. 83.8±14.5, n.s.; VAS 1.9±2.2 vs. 1.2±1.7, n.s.).

Conclusion: An additional LET in patients with revision ACLR with low-grade anterior knee laxity does not influence patient-related outcomes or failure rates. Subjects with preoperative low-grade anterior knee laxity may not benefit from a LET in revision ACLR.

Stichwörter:
revision ACLR, LET, indication, low-grade anterior knee instability

DKG21-71 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Partially layered quadriceps-tendon autografts provide lower failure rates and improved clinical results compared to hamstring tendon grafts in revision ACL surgery

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Aims and Objectives: We developed a quadriceps-tendon graft technique using a long, partially layered soft tissue quadriceps tendon graft (plQUAD) for anterior cruciate ligament reconstruction (ACLR). The aim of this study was to evaluate the outcome of patients with revision ACLR using the plQUAD technique compared to a hamstring tendon graft (HT).

Materials and Methods: Between 2017 and 2018, 95 patients who underwent revision ACLR were included in the retrospective case series. With a follow up of 26.9 ± 3.7 (mean±SD, 24 to 36) months, 89 patients (plQUAD: n=43, HT: n= 46) were clinically examined after revision surgery. Postoperative failure of the revision ACLR was defined as side-to-side difference (SSD) in Rolimeter® testing > 5mm or pivot shift grade 2/3.

Results: In total, 9 patients (10.1%) were identified with a failed revision ACLR, while patients with plQUAD had a significant lower failure rate compared to HT (2.3% vs. 17.4%, p=0.031). The mean postoperative SSD was also significantly reduced in the plQUAD group (1.3 ± 1.3mm (0-5) vs. 1.8 ± 2.2mm (0-9), p=0.043) in Rolimeter testing. The preoperative Lachman and pivot-shift test significantly improved in both groups (p<0.001) and patient-related outcome including Tegner and IKDC was significantly increased in the plQUAD group compared to the HT group (Tegner score 5.8 ± 1.8 vs. 5.6 ± 1.5, p=0.043 and IKDC 83.8 ± 12.2 vs. 78.6 ± 16.8, p=0.037) at the latest follow-up. Pain was also significantly reduced in the plQUAD group than in the HT group (0.9 ± 1.1 to 1.6 ± 2 points (p=0.014) according to the VAS scale at the time of follow-up.

Conclusion: The plQUAD technique demonstrates significant improvement of preoperative knee laxity and satisfactory patient-related outcome measures. Compared to the hamstring tendon grafts, the plQUAD technique showed lower failure rates and increased Tegner and IKDC in revision ACLR.

Stichwörter:
long, partially layered soft tissue quadriceps-tendon graft

DKG21-72 Vortrag
360° Versorgung bei Tibiaplateaufrakturen

Intraarticular osteotomy of malunited tibial plateau fractures: an analysis of clinical results with a mean follow-up after 4 years

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Aims and Objectives: Malunions are a common complication after tibial plateau fractures (TPF), leading to stiffness, pseudo-instability and posttraumatic osteoarthritis. The purpose of this study was to analyse the clinical outcome after intraarticular osteotomy of malunited TPF and to perform a failure analysis.

Materials and Methods: Between 2013 and 2018, 23 patients (11 males, 12 females; 43.8 ± 12.8 years) with intraarticular osteotomy after malunited TPF were included in the retrospective study. Clinical examination and postoperative scores were collected with a minimum follow-up of 24 months. Malunion was measured on pre- and postoperative CT scans and localized according to the 10-segment classification while the leg axis in the frontal plane was measured pre- and postoperatively on long leg standing radiographs.

Results: Excellent and good clinical outcome was achieved in 73.9% (n = 17) of the cases and patient related outcome improved significantly (Tegner 3.3 ± 1.6-5 ± 1.8, $p < 0.001$; clinical Rasmussen 14.6 ± 3.8-24.9 ± 4.4, $p < 0.001$). Radiological parameters also improved as an intraarticular step-off was reduced from 9 ± 3.8 to 0.6 ± 0.8 mm ($p < 0.001$) and a lower limb malalignment from 7.2 ± 4.8° to 1.5 ± 1.9° ($p = 0.003$). Failure analysis showed that an impaired clinical result correlated with a postoperative extension (n = 3, $p < 0.001$) and flexion deficit (n = 4, $p = 0.035$).

Conclusion: Intraarticular osteotomy of malunited TPF lead to good clinical results with significant clinical and radiological improvement in most cases while an impaired patient outcome correlated with a limited range of motion. This study is the first failure analysis of intraarticular osteotomy after malunited TPF published up to now.

Stichwörter:
Tibial plateau fracture · Malunion · Intraarticular osteotomy · Failure analysis

DKG21-73
Osteotomie

Vortrag

Slope-correction osteotomy with lateral extra-articular tenodesis and revision ACL reconstruction is highly effective in treating high-grade anterior knee laxity

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Aims and Objectives: Both an elevated posterior tibial slope (PTS) and high-grade anterior knee laxity are often present in patients who undergo revision anterior cruciate ligament (ACL) surgery, and these conditions are independent risk factors for ACL graft failure. Clinical data on slope-correction osteotomy combined with lateral extra-articular tenodesis (LET) do not yet exist. The purpose of this study was to evaluate the outcomes of patients undergoing revision ACL reconstruction (ACLR) and slope-correction osteotomy combined with LET.

Materials and Methods: Between 2016 and 2018, we performed a two-stage procedure: slope-correction osteotomy was performed first, and then, revision ACLR in combination with LET was performed in 22 patients with ACLR failure and high-grade anterior knee laxity. Twenty patients (6 women and 14 men, mean age 27.8 ± 8.6 years, range 18-49 years) were evaluated, with a mean follow-up of 30.5 ± 9.3 months (24-56 months), in this retrospective case series. Postoperative failure was defined as a side-to-side difference (SSD) of > 5 mm in the Rolimeter® test and a pivot-shift grade of 2 or 3.

Results: The PTS decreased from 15.3° to 8.9°, the SSD decreased from 7.2 to 1.1 mm, and pivot shift was no longer evident in any of the patients. No patients exhibited revision ACLR failure, and all patients showed good to excellent postoperative functional scores (mean and SD: VAS 0.5±0.6; Tegner 6.1± 0.9; Lysholm 90.9±6.4; KOOS symptoms 95.2±8.4; KOOS pain 94.7±5.2; KOOS function & daily living 98.5±3.2; KOOS function and sports 86.8±12.4; KOOS quality of life 65.4±14).

Conclusion: Slope-correction osteotomy in combination with LET is a safe and reliable procedure in patients with high-grade anterior knee laxity and a PTS of > 12°. Normal knee joint stability was restored, and good to excellent functional scores were achieved after a follow-up of at least two years.

Stichwörter:
Slope-correction osteotomy, lateral extra-articular tenodesis

DKG21-74 Vortrag
Deformitätenanalyse

Intraoperative Assessment of Lower Limb Alignement - Accuracy of the X-Ray Grid Method compared with a Long Standing Radiograph

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Aims and Objectives: The Long Standing Radiograph (LSR) is the inevitable cornerstone for analysis of the leg geometry and for preoperative planning of deformity correction procedures. For intraoperative alignment control (IAC) several techniques e.g. the cauter cable method, the alignment rod or navigation systems are described. The X-ray grid (XRG) is a radiolucent custom made resin hard paper plate with predefined, integrated radiopaque lines. On this device, the patient is positioned, which allows the assessment of the mechanical axis of the leg by intraoperative fluoroscopy. This study compares the accuracy of the XRG method with the gold standard of a preoperative LSR analysis.

Materials and Methods: In this retrospective study preoperative LSR of 84 patients who underwent deformity correction were compared with their intraoperative equivalent of the x-ray grid method. The images were analyzed regarding the mechanical axis deviation (MAD) in frontal plane, joint line convergence angle (JLCA), and quality of patella centering. The effect of age, gender, body mass index (BMI), etiology, amount of JLCA, centering of patella and the effect of degree and direction of preoperative deformity was determined.

Results: The mean absolute difference of MAD between the two techniques was 2.0% (SD ± 1.1%) with a high correlation coefficient ($R = 0.96$, $p < 0.01$). With minor deformities the matching between the two images is higher and decreases significantly with increasing extent of deformity, especially in severe valgus deformities ($R = 0.60$, $p < 0.01$). The same effect was observed for varus deformities, but not at a significant level ($R = 0.26$, $p = 0.09$). In addition, the accuracy decreases with a higher mismatch of the JLCA between LSR analysis and XRG method ($R = 0.34$, $p < 0.01$). Age, gender and etiology had no influence on the accuracy in the measurement of the MAD.

Conclusion: Application of the XRG method is a valid option for intraoperative determination of leg alignment. In comparision to other techniques, a higher degree of correlation between intraoperatively assessed values and preoperative LSR could be observed. Only in case of severe deformity or distinctive mismatch of pre- and intraoperative assessed JLCA, a significantly lower comparability of the results of LSR and XRG method was observed.

Stichwörter:
X-Ray Grid, Long Standing Radiograph, Long-Leg Radiograph, Intraoperative Alignment Control, Alignment, Malalignment, Hip, Knee, Ankle, Femur, Tibia, Lower Extremity

DKG21-75 Poster
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Keine erhöhte Rate an Cyclops-Läsionen und Extensionsdefiziten bei Verwendung der "remnant augmentation" Technik nach VKB Rekonstruktion

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Aims and Objectives: Die stumpferhaltende "remnant augmentation" Technik bei vordere Kreuzbandrekonstruktion (VKB-R) soll Vorteile für den postoperativen Umbau und die Propriozeption haben. Es wird jedoch vermutet, dass der größere Durchmesser des Transplantats zu Impingement-Phänomenen mit einer höheren Rate an Zyklopenläsionen führt. Ziel der Studie war es, zu untersuchen, ob die "remnant augmentation" Technik zu einer erhöhten Rate von Cyclopsläsionen und Extensionsdefiziten im Vergleich zur herkömmlichen VKB-R führt.

Materials and Methods: Die Patienten wurden ein Jahr nach der Operation nachuntersucht. Der primäre Endpunkt war eine arthroskopische Arthrolyse aufgrund eines Extensionsdefizits oder eines Cyclops-Syndroms. Sekundäre Endpunkte waren die Kniefunktion (KOOS), Schmerz (NRS), Patientenzufriedenheit und Rückkehr zur Sportart.

Results: 164 Patienten wurden in die Studie eingeschlossen, davon erhielten 60 das Verfahren "remnant augmentation" (Gruppe 1). In Gruppe 1 wurde eine Cyclops-Resektion durchgeführt, während in der Gruppe ohne Restverbleib des alten VKB drei Cyclops-Läsion arthroskopisch reseziert werden mussten (Odds Ratio 0,6). Es gab keinen Unterschied zwischen den Gruppen in der Kniefunktion (KOOS), Schmerz in Ruhe und bei Belastung (NRS) und in der Patientenzufriedenheit. Die Rückkehr zur Sportart nach einem Jahr war in der Gruppe 1 etwas höher.

Conclusion: Das "remnant augmentation" Verfahren zeigt etwas weniger Zyklopenläsionen ohne Einfluss auf sekundäre Zielparameter wie Kniefunktion, Schmerzen und Patientenzufriedenheit.

Stichwörter:
VKB, remnant augmentation, Cyclops

DKG21-76
Osteotomie

Vortrag

Use of tranexamic acid in medial open wedge high tibial osteotomy

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Aims and Objectives: Aim of this study was to evaluate the effect of tranexamic acid (TXA) on the outcome after medial open wedge osteotomy.

Materials and Methods: A prospective non-randomized comparative study with 52 patients has been performed. In both treatment groups the same surgical technique for the medial open wedge HTO was used. In group 1 (N: 26) the patients received 1 g TXA i.v. preoperatively, in group 2 (N: 26) no TXA was given. Primary outcome measure was the decrease in hemoglobin concentration. Secondary outcome criteria were postoperative pain, intraarticular effusion (measured by ultrasound), range of motion (ROM) at discharge, peri- and postoperative complications and the KOOS PS (pre- and postoperatively at one year follow up).

Results: Hemoglobin decrease was significantly less in the TXA group compared to the non TXA group. Postoperative pain and intraarticular effusion was also significantly lower and ROM at discharge was higher in the TXA group. There was no group difference in peri- and postoperative complications and the pre- and postoperatively KOOS PS.

Conclusion: The results of the present study show the systemic application of 1 g TXA reduces hemoglobin drop and postoperative morbidity (pain, intraarticular effusion, and ROM) after tibial open wedge HTO.

Stichwörter:
Open wedge HTO, tranexamic acid, deformity correction, TXA, complication, fast track, enhanced recovery

DKG21-77 Poster
Fokus Meniskus Naht und Ersatz

New tibial fixation technique for medial meniscus posterior root repair

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Aims and Objectives: Several tibial fixation techniques for medial meniscus posterior root repair are present and all have their pitfalls and difficulties. Therefore, a new technique using polyether-ether-ketone (PEEK) -interference screw fixation is presented and evaluated.

Materials and Methods: A series of consecutive medial meniscus posterior root (MMPR) repairs were followed prospectively, performed in a single-centre in 2019 with the following technique: Placement of two non-resorbable loops (Fiberwire) into the MMPR, drilling of a tibial tunnel into the anatomic insertion of the MMPR (diameter 4.5 mm) and tibial fixation using and 7 x 25mm PEEK-Interference screw inserted into the tibial tunnel while tensioning the loops. Epidemiologic and surgical data of the patients were collected. Intra- and postoperative complications were documented, and the patients were followed for failure of the root repair and revision arthroscopy. Further, during revision arthroscopy, the mode of failure (cut out in the meniscus, loop tear, tibial fixation failure) was documented.

Results: In summary 31 patients were included in the study. Female 77.4% (n=24), Age at time of root repair 49.6 ± 8.0 years, body-mass-index 31.5 ± 7.1 kg/m2. In 19.4 % (n=6) concomitant procedure was performed (two microfracture, three partial lateral meniscus resection and one osteochondral transplantation). There were no intra- or postoperative complications. After a follow-up of 2.0 years (1.1 - 2.3) the overall rate of failure was 12.9 % (n=4). Mean time from index to revision arthroscopy was 0.6 ± 0.3 years. In all failure cases the failure mode was classified as cut out in the meniscus. No failure because of loop tear or tibial fixation was present.

Conclusion: Tibial PEEK-interference screw fixation in MMPR repair is a safe, easy, and reliable technique. A certain rate of failure, irrespective of the tibial fixation, must be expected.

Stichwörter:
medial meniscus posterior root tear, root repair, tibial fixation, PEEK-screw, meniscus repair

DKG21-78 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Physiological patellar tracking in healthy individuals: Normal values for dynamic 3 Tesla Magnetic Resonance Imaging

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Aims and Objectives: To provide normal values for physiological patellofemoral tracking in a representative group of healthy individuals, using real-time 3T-MRI and to test for dynamic MRI's reliability

Materials and Methods: One hundred knees of healthy individuals (48 females,52 males) with no history of patellofemoral symptoms were scanned with dynamic MRI-sequences, during repetitive cycles of flexion (40°) and full extension. Within a 30-seconds-time-frame, three simultaneous, transverse slices were acquired. Dynamic mediolateral patellar translation (dMPT) and dynamic patellar tilt (dPT) were measured on two occasions by two independent examiners. Common radiological parameters were measured using static MRI, and correlations were calculated.

Results: 100 knees (53 right, 47 left, 26.7±4.4 years, BMI 22.5±3.1) were included. Mean height was 170.1±7.7cm in women and 181.8±6.4cm in men. Average patella diameter was 37.9±2.7 (95%CI 37.1-38.7)mm in women and 42.4±3.2 (95%CI 41.5-43.3)mm in men. In females, the patellar diameters and intercondylar distances were significantly smaller than in males ($p<0.001$). Radiological parameters for patellar maltracking were within the normal range. During the range of motion, mean dMPT was 1.7±2.4 (95%CI 0.9-2.5)mm in females and 1.8±2.7 (95%CI 1.1-2.6)mm in males ($p=0.766$). Mean dPT was 1.3±2.9° (95%CI 0.4-2.1°) in females and -0.2±3.8° (95%CI -1.2-0.9°) in males ($p=0.036$). Neither dMPT nor dPT was correlated with height, BMI or patellar diameter. Intercondylar distance correlated weakly with dPT ($r=-0.241, p=0.041$). Intra- and interrater reliability were excellent for dMPT and dPT.

Conclusion: This study established normal values for proximal patella tracking, with dynamic MRI serving as a reliable method. Normal dMPT proximal to the trochlea groove was 1.7±2.5 (1.2-2.2)mm, independent of size or sex. Normal dPT showed a dependency on sex and was 1.3±2.9 (0.4-2.1)° in women and -0.2±3.8 (-1.2-0.9)° in men.
These values provide a baseline for objective evaluation of pathological patella tracking in patellar instability, using dynamic MRI.

Stichwörter:
patella, tracking, maltracking, dynamic MRI, normal values, patellofemoral

DKG21-79 Vortrag
Deformitätenanalyse

Influence of axial limb rotation on alignment measurements on long-leg radiographs: a systematic review

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Aims and Objectives: In daily clinical practice, limb rotation on long-leg-radiographs (LLR) is a major topic: Is the limb properly positioned? How much limb rotation is present on the radiograph? How does it influence the measured limb alignment? Moreover, surgeons must decide whether LLR should be repeated due to the presence of limb malrotation determined between additional radiation exposure for the patient and measurement inaccuracy.
This systematic literature review aimed to provide an overview of studies that discussed lower limb rotation on LLR to describe 1) the prevalence of limb rotation on LLR; 2) how limb rotation can influence anatomic and mechanic limb alignment measurements alone and in combination with knee flexion or varus/valgus alignment; and 3) the impact on diagnosis, treatment selection, surgical planning, or surgical outcomes.

Materials and Methods: A literature search was conducted in 06/2020 using the database MEDLINE using the search terms ((radiology OR x-ray) lower limb alignment). One researcher screened all titles and abstracts for potentially relevant articles. All studies describing factors that possibly influence alignment measurement on radiographs were included to full-text screening. Experimental studies and clinical studies analyzing either anatomic or mechanical alignment measures were included. Full texts were finally included if at least one of the abovementioned research questions were addressed. References and citations of the finally included articles were scanned for additional relevant articles matching the abovementioned aims and inclusion criteria.

Results: 20 studies were included showing large heterogeneity, comprising cadaver (n=6), patients (n=9), and synthetic bones (n=5). Limb rotations on LLR were 7.4°±3.9° IR (range, 8° external rotation [ER] to 14° internal rotation [IR]), 8.1°±9.3°IR (36°IR-16°ER), 8.0°±9.0° IR (29.4°IR-22.1°ER), and within 3.1°±2.7° from the neutral position. Seven studies reported that ER causes less apparent valgus and leads to more varus and IR causes more valgus and leads to less varus. However, there is no consensus on which extent rotation influence alignment measures. We found that two studies describing an average change of >2° hip-knee-ankle angle (HKA) between 15°IR and 15°ER. A smaller change in HKA was found in three studies. There is a consensus that the impact of rotation on the mechanical alignment is higher if additional sagittal knee angulation, such as knee flexion, is present. All four studies analyzing the influence of rotation in combination with knee flexion (5°-15°) showed an HKA change of >2° between 15°IR and 15°ER.

Conclusion: Malrotation is frequently present on LLR, possibly influencing the measured alignment especially in knees with extension deficit. Surgeons must consider this when measuring and treating deformities (HTO or TKA), and analyzing surgical outcome. Especially in patients with osteoarthritis with knee extension deficits or postoperative swelling, the effect of malrotation is significantly greater.

Stichwörter:
Rotation, limb alignment, long-leg radiographs, lower limb

DKG21-80 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Complications in robotic knee arthroplasty

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Aims and Objectives: Question: Does the application of a new robotic system in total and unicompartimental knee arthroplaysty cause new problems? Pre- Intraoperative ond post OP?
Does the need for an extra person (MPS=Mako Product specialist) ad any inconvinience?

Materials and Methods: Material & Methods: in a retrospective study we analysed the first 500 consecutive cases of knee arthroplasty unsing the new robotic arm system called MAKO(R). A special focus was on problems who forced the surgeon to switch back to manual workflow. And to what extend the new system added formerly unknown complications to the procedure. We split up into pre, intra and post OP complications due to the procedure who only occure in the robotic group. The TKA system was used before so no change to the implant, no new surgeon entering the group.All surgeons where trained in cadaver lab befor using the application.
All surgeons were Senior- oder main surgeons before.

Results: Result: We analysed the first 500 consequtive cases after introduction of the MAKO(R) system. Pre OP complications were 17 blurred CT scans and 5 defect tips of the sharp probe (blue). All were detected bevor the surgical procedure itself. Except for one case.
Intra OP we detected bumped arrys, MICS/Motor defect, joint soiling of the robot.
post op: we detected 3 revisions due to drill dust in the tibial site of the tracker.
Over all we had 22/500 (4,4%) pre OP complications, 14/500 (2,8%)surgeon relatet and 6/500 (1,2%) system relatet complications during the surgery.
3/500 (0,6%) post OP.
We faced 3/500 0,6% conversion to conventional due to the robotic system, none in the last 300 cases, No cases where lost due to the MPS so far.

Conclusion: Conclusion: Robotic asisted TKA using this particular robotic system is a very safe procedure. You must know your conventional TKA procedure as a retreat option

Stichwörter:
TKA, Robotic, MAKO, Complications

DKG21-82 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Comparing MRI examination of a persisting knee dislocation with popliteal artery dissection, post reduction MRI and intraoperative findings - a rare MRI case study

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Aims and Objectives: Acute dislocation of the knee is a rare but complex injury.
It is defined as a complete disruption of the femorotibial joint integrity with damage to ligamentous, tendinous, bony and neurovascular structures.
In order to understand the extend of the trauma and plan the surgical therapy, preoperative knowledge of the damaged structures is essential.
When admitted to the emergency department conventional plain radiographs as first-line diagnostic tool provide information about direction of dislocation and fractures.
In the vast majority of cases initial reduction is performed either in the preclinical setting or immediately after initial x-ray in the emergency department.
At this diagnostic stage, the extend of soft tissue injury (e.g. ligaments, meniscus) can only be suspected by clinical examination, which is limited due to pain and swelling.

Materials and Methods: CT and/or CT-angiography may be added in cases of fractures and to exclude popliteal vascular co-injuries.
Subsequent MRI will be attached afterwards as is considered the gold standard for patients with cartilage, ligament and other soft tissue injuries of the knee.
The reliability of MRI itself in differentiating the injured structures depends on image quality and the musculoskeletal radiologist.
Finally, the preoperative identification of the anatomical injury pattern remains a challenging task.

Results: We present the case of a 17-year-old girl (normal weight) who sustained an acute knee dislocation after falling from a wall. The extend of injury was misinterpreted in another hospital and plain radiographs were not carried out. Two days after trauma, elective MRI revealed the persisting dislocation of the knee joint, and CT-angiography showed concomitant popliteal artery dissection. The patient was immediately shifted to our traumatology department. Closed reduction and retention by external fixator as well as femoropopliteal bypass surgery were done as emergency surgical procedures. For planning purposes, another MRI post reduction was performed.
The vitality of the leg could be preserved, and definitive surgical treatment (ligament repair and bracing, ligament reconstruction) was conducted afterwards.

Conclusion: This rare case study presents an MRI examination in a persisting knee dislocation and compares the findings with a second post reduction MRI as well as intraoperative findings of surgical joint reconstruction, focussing on presumed injury mechanism, bone bruise and cartilage damage, injury of cruciate and collateral ligaments, meniscal and posteromedial/posterolateral corner injuries.

Stichwörter:
knee dislocation; magnetic resonance imaging; MRI; popliteal artery dissection; diagnostics

DKG21-84 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

MPFL-reconstruction using non-resorbable synthetic suture material with soft-tissue patellar fixation yields comparable outcomes to MPFL-reconstruction with a pedicled quadriceps tendon autograft at a minimum 2-year follow-up

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Aims and Objectives: Several different techniques for reconstruction of the medial patellofemoral ligament (MPFL-R) using various autologous tendon graft options have been described in literature and utilized in clinical practice. In the recent years there has been growing interest in the utilization of synthetic materials as adequate and viable alternatives to autograft MPFL-R. Purpose of this study was to evaluate the results of a novel MPFL-R technique using non-resorbable suture material with soft-tissue patellar fixation in comparison to MPFL-R using a pedicled quadriceps tendon autograft at a minimum 2-year follow-up. The hypothesis was that the results of synthetic MPFL-R are not inferior to those of autologous tendon graft reconstructions.

Materials and Methods: Between November 2018 and June 2019, 19 patients (male/female 6/10; mean age 26 ± 7 years) with a history of recurrent lateral patellar dislocations (LPD) underwent MPFL-R using non-resorbable synthetic suture material (FiberTape®) as an isolated procedure or in combination with the correction of predisposing factors of LPD. The Banff Patella Instability Instrument 2.0 (BPII 2.0) and a numerical analog scale (0-10) for patellofemoral pain and subjective knee joint function were used to assess patients-reported quality of life prior to and following the surgery. The control group of 38 patients (male/female 12/26, mean age 26 ± 6 years) who underwent MPFL-R with a pedicled quadriceps tendon flap was matched 1:2 by sex, age, anatomic risk factors, and their concomitant correction during surgery. Power analysis revealed that 54 patients (study group n=17; control group n=35) are needed to detect a difference in BPII 2.0 score values of 10 points (SG 15) with a power of 0.80 (alpha error 0.05, effect size d=0.75).

Results: The BPII 2.0 score increased from 35.0 ± 21.7 points to 79.7 ± 13.3 points (P<0.0001) in the study group and from 44.3 ± 19.6 points to 80.9 ± 15 points (P<0.0001) in the control group from preoperatively to postoperatively, respectively, and without any significant difference between them at the final follow-up (p=0.57). In addition, patellofemoral pain and subjective knee joint function improved significantly in both
groups (P<0.0001, P<0.0001), without any significant difference between them at the final follow-up (p=0.17, p=0.80). None of the patients experienced failure of the MPFL-R with consequential recurrence of patellar instability. Evaluation was performed postoperatively at a mean 24.6 ± 6.0 months (range, 24-29 months) in the study group and 35.8 ± 9.9 months (range, 23-57 months) in the control group (P<0.001).

Conclusion: The results of this study indicate that the proposed technique can serve as a viable option for MPFL-R with satisfactory outcomes in terms of patient-reported outcome measures, overall knee joint function, patellar stability, and relief of patellofemoral pain. Advantages include less soft-tissue trauma, preservation of autologous tendon and hardware-free, soft-tissue patellar-fixation.

Stichwörter:
MPFL, Patient-reported outcomes, MPFL-reconstruction, MPFL-Bracing, Synthetic materials

DKG21-87 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Novel autologous arthroscopic one-step cartilage repair - First 18 months clinical and MRI results.

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Aims and Objectives: The treatment of cartilage lesions is still a challenging procedure. In 1983, the minced cartilage Technique was first described. Chondral fragments were removed, cut into fragments and fixed into chondral defects. Salzman and colleagues continued this open technique with favorable clinical results. Due to development this technique can be performed arthroscopically in a one-step procedure. The aim of this study is to evaluate the efficacy of a single arthroscopic-session cartilage therapy.

Materials and Methods: In this case series, a novel technique shall be presented. In this technique an arthroscopy is performed to evaluate and debride the focal cartilage defect. Cartilage cells must be harvested to fill the defect. If there are still vital cartilage cells in the defect, these are harvested via an adapter attached to the shaver. If the defect does not contain vital tissue, cartilage cells are harvested from the defect margin. Blood is drawn to produce a platelet rich plasma (PRP). The cartilage cells are mixed with PRP to ensure adequate nutrition. Furthermore, the PRP is used to produce an autologous thrombin for the fixation of the cells. For implantation, the fluid is removed. Then the defect is filled up to 50-80% of the lesion height under the use of an applicator. The cells are fixed with the autologous thrombin. Postoperatively the patients walk with crutches for 4-6 weeks with no weight bearing depending on the size of the defect. Since 2019, a total of 120 consecutive patients suffering from chondral or osteochondral lesions of the knee joint were treated using this procedure. The Visual Analog Scale (VAS), the Knee Injury and Osteoarthritis Outcome Score (KOOS) and the Tegner Activity score were recorded pre-surgery, 3, 6, 12, 18-months post-operative. The Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) 2.0 was used to evaluate the cartilage quality.

Results: Of all 120 treated patients, 65 patients have completed 6 month, 53 patients 12 months and 31 patients 18 months questionnaires. In 13.9% the defect was located trochlear, in 21.3% retropatellar, 58.3% femoral (36.1% MFC, 22.2% LFC) and 3.7% tibial. In all 65 cases, MRI show satisfactory filling of the defects after 6 months. Two patients (1.7%) developed a local transitional osteoporosis due to weight bearing and dissolved over time. One patient (0.8%) developed a postoperative infection. In the first 12 months, 49 patients (92.5%) showed complete filling of the defect, two (3.8%) with small remaining fissure gaps. All patient-reported outcomes (VAS, KOOS, Tegner) improved over the 18 months period.

Conclusion: These first clinical and imaging results are very satisfactory - it is a safe and promising technique. A continuous improvement of the functional scores and a rapid decrease in the pain score were reported. However, further long-term results are important to support the technique.

Stichwörter:
knee, cartilage, autolouges, minced, repair, single-step

DKG21-88 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Revision of unicompartimental arthroplasty - Retrospective analysis of 100 revised cases

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Aims and Objectives: The revision rates of unicompartimental knee arthroplasty (UKA) are typically higher than those of total knee arthroplasty (TKA). The main reasons are progression of arthritis, dislocation of the inlay, aseptic loosening, infection, a symptomatic secondary compartment or patellofemoral osteoarthritis. The aim of this retrospective analyses was to evaluate patients in our clinic who underwent revision of UKA. We report on 100 revisions of UKA as well as the procedures and implants used during revision.

Materials and Methods: This retrospective study was based on the revision procedures after primary UKA between 2004 and 2020. In this time, 4101 patients were treated with a primary total or partial prosthesis and 2844 (69.3%) received a primary UKA. Furthermore, 100 UKA revisions (3.5%) were reported of which three were revised more than once. Fourteen revisions were from external sites and 86 from the clinic. In addition to anthropometric data, length of stay of the primary prosthesis, the duration of hospitalization and the type of secondary prosthesis were also recorded.

Results: For the 100 revised UKA patients (71.9 ±11.0 years, BMI 29.0 ±5.3 kg/m²), mean time between primary implantation and revision was 53.7 (±60.1) months. The mean hospital stay after revision was 10.9 (±6.9) days. Of all revised patients, 61% were female and 39% male compared to the primary UKA treatment of 574 patients with a ratio of 50.3% male and 49.7% female. The full prothesis was performed in 43% of the patients. The inlay was revised in 29% of the patients. In 22% of revised patients the inlay as well as the tibial plateau was exchanged. In five patients (5%) the femoral and tibial component and the inlay were exchanged. In one case (1%) a revision of the femoral component was performed. One plate osteosynthesis for a tibial fracture was carried out. Within these five subclasses, in three cases (3%) a re-revision was needed due to secondary inlay luxation and in a single case (1%) a constrained revision implant was necessary due to a periprosthetic fracture.

Conclusion: The main reasons for revision of UKA were a change to TKA due to progressive arthritis and inlay failures. A well-defined patient algorithm, enhanced instrumentation and surgical technique, patient specific pre-operative planning and instrumentation could lead to a reduction of revision in failed unicompartimental arthroplasty. Therefore, the durability of UKA should be observed and causes for revision surgery should be analyzed.

Stichwörter:
knee, unicompartimental, uka, revision, unicondylar, tka, arthroplasty

DKG21-90 Vortrag
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The Association between Anterior Cruciate Ligament Tear Location and Bone Bruise Distribution and Depth: Implications for the Biomechanical Injury Mechanism.

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Aims and Objectives: Bone bruises (BB) frequently occur around the knee joint after anterior cruciate ligament (ACL) injury and can provide insight into the biomechanical injury mechanism. To date, it is unclear whether different injury mechanisms may lead to divergent ACL tear locations. The aim of this study was to analyze the relationship between BB distribution and depth patterns and ACL tear location.

Materials and Methods: A retrospective analysis of 446 consecutive patients who presented with acute noncontact ACL injury at our institution between December 1st, 2016, and November 30th, 2020, was performed. Only patients with complete ACL tear verified during subsequent arthroscopy were included. Magnetic resonance imaging (MRI) was utilized to classify BB location (medial/lateral tibial/femoral compartments), BB depth (superficial/shallow/deep/extensive/generalized) ACL tear location (distal remnant length) and concomitant injuries (medial/lateral meniscus and medial/lateral collateral ligaments). Demographic characteristics included age, gender, and body mass index (BMI), laterality, type of sport and time between injury and MRI. Multiple linear regression analysis was used to identify independent predictors of ACL tear location.

Results: A total of 158 skeletally mature patients (82 women, 35.7 ± 13.2 years; 76 men, 32.5 ± 11.1 years) met the inclusion criteria for recent MRI and acute noncontact ACL tear. Older age (beta = 0.31, $p < 0.001$) and presence of BB in the lateral tibial plateau (beta = -0.27, $p < 0.001$) predicted a more proximal tear location of the ACL. Furthermore, less BB depth in the lateral femoral condyle showed a trend (beta = -0.14; $p = 0.054$) toward increasingly proximal ACL tears. Gender, BMI, laterality, type of sport, concomitant injury and time between injury and MRI showed no significant relationship. Interrater reliability analysis showed excellent and substantial degree of agreement between all raters for distal remnant length (ICC = 0.92) and bone bruise distribution (kappa = 0.95 - 1.00) and depth (kappa = 0.68 - 0.75).

Conclusion: ACL tear location after an acute noncontact injury is associated with distinct patterns of BB distribution and depth, most notably involving the lateral compartment. These findings indicate that proximal ACL tears result of low-energy trauma and lesser knee valgus angles compared to mid-substance tears. Consequently, when assessing MRI of a suspected acute noncontact ACL tear, the absence of BB in the lateral tibial plateau can be indicative of a proximal tear. Finally, these data may hold value for decision making in the surgical approach of ACL tear pertaining to primary repair vs. reconstruction.

Stichwörter:
knee joint;anterior cruciate ligament;tear location;bone bruise;injury mechanism

DKG21-91 Vortrag
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QUALITY OF LONG-STANDING RADIOGRAPHS FOR LIMB DEFORMITIES: ASSESSMENT OF THE PATELLA POSITION

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Aims and Objectives: Long Standing Radiographs (LSR) are the clinical standard for assessing lower extremity alignment and a prerequisite for analyzing and planning various surgical procedures. In several studies, a positioning with centered patella and fibular head overlap (FHO) with the proximal third of the tibia is recommended in order to minimize rotational projection errors in the determination of the alignments and angles. The aim of this study was to quantify which patella deviation (PD) from the center of the knee joint is tolerable and which FHO is to be determined with the patella centered.

Materials and Methods: In this study, we retrospectively evaluated PD and FHO in LSR without severe deformities or total knee replacement (TKR). PD was measured using two different methods (M1 and M2). Intra-class correlation coefficients (ICC) were carried out to quantify the inter-rater reliability through multiple measurements by two observers. Based on the mean amount of PD and the standard deviations, three quality groups were defined. The FHO was quantified and evaluated for centered, internally and externally rotated knees.

Results: X-ray measurements of a total of 741 lower extremities (367 right, 374 left) were available for the analysis, including 407 men and 334 women. A high inter-rater reliability was found for both PD and FHO (PD M1 ICC = 0.83, PD M2 ICC = 0.89 and FHS ICC = 0.82). The mean amount of PD in the 741 lower extremities was 3.5 mm (95% CI: 3.3-3.7 mm) for M1 and 4.1 mm (95% CI: 3.9-4.4 mm) at M2. The LSR were divided into three quality groups: group A with a PD of less than 5 mm; Group B with a PD between 5 and 10 mm and Group C with a PD of 10 mm and more. The majority (70.9%) of the LSR were classified in Group A. The FHO in group A was 21.3%. FHO decreased significantly with internal rotation of the patella.

Conclusion: For a high quality LSR with minor influence on rotational projection errors, the PD should be a maximum of 5 mm. In Comparison to other publications, in our study the FHO in centered patella position is about 1/5 and not 1/3. This study helps identify malpositioning in LSR by measuring PD or, if impossible, FHO.

Stichwörter:
Long Standing Radiograph, Long-Leg Radiograph, Radiology, Alignment, Malalignment, Deformity, Bow Leg, Knock Knee

DKG21-92 Vortrag
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Tear Types of Acute Noncontact Anterior Cruciate Ligament Injury in Skeletally Mature Patients: Does Age make a Difference?

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Aims and Objectives: Anterior cruciate ligament (ACL) tear is a common injury of the knee joint. Recent developments in primary repair highlight the critical factor of tear location in healing potential. As part of an ongoing retrospective analysis, we aim to investigate the distribution and associated patient and injury factors of different ACL tear types.

Materials and Methods: 446 consecutive patients who presented with acute noncontact ACL injury between December 1st, 2016, and November 30th, 2020, were retrospectively reviewed. Only patients with complete ACL tear verified during subsequent arthroscopy were included. Magnet resonance imaging (MRI) was utilized to determine ACL tear type. Type I, II, III, IV and V were classified for proximal avulsion, >90%, 90% - 70%, 70% - 25%, 25% - 10% and <10% distal remnant length (RL), respectively. Demographic characteristics included age, gender, and body mass index (BMI). Laterality, type of sport, associated knee injuries (meniscus and collateral ligaments) and time between injury and MRI were also analyzed. Kruskal-Wallis-Test and Fisher's exact test were performed to elucidate differences in tendencies of metric variables and frequencies of categorical variables, respectively.

Results: 158 (82 female/76 male) skeletally mature patients 34.2 ± 12.3 years of age met inclusion criteria. Tear types were distributed as type I, 11 (7.0%), type II, 28 (17.7%), type III, 116 (73.4%), type IV, 1 (0.6%) and type V, 2 (1.3%). Age at time of injury showed a statistically significant difference in tendencies with average age of 39.1 ± 15.2, 41.8 ± 12.3, 32.2 ± 11.2, 28 and 17.5 ± 2.1 for types I, II, III, IV and V, respectively (Chi Square = 17.74, $p < 0.001$). BMI (24.36 ± 3.97), time between injury and MRI (4.54 ± 5.168 days), gender, laterality (82 right, 77 left), type of sport and associated knee injuries showed no significant differences among tear types.

Conclusion: These findings substantiate preceding notions, that proximal rupture location is predominantly seen in older patients, while mid-substance ruptures make up the majority of acute noncontact ACL injuries in young patients. These data may be valuable for physicians approaching surgical decision making of ACL injury treatment pertaining to primary repair vs. reconstruction

Stichwörter:
anterior cruciate ligament rupture, anterior cruciate ligament, ACL tear location, ACL tear type, ACL injury

DKG21-93 Vortrag
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Infiltration of the Hoffa's fat pad in patients with osteoarthritis of the knee

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Aims and Objectives: Cell therapy using multipotential stromal cells is used in a variety of clinical settings to induce tissue regeneration. Promising results have also been achieved in the therapy of osteoarthritis. MSCs have been demonstrated to be safe. They can be used in a one step procedure as "minimally manipulated mesenchymal stem cells" or after in vitro expansion. The in vitro step allows for the selection of a more homogeneous cell population, meeting the standard criteria for MSC identification. In vitro expansion of MSCs is cost intensive, time consuming and furthermore associated with gradual accumulation of senescent cells, telomere erosion, and changing phenotypes. These disadvantages could be surpassed by the use of "minimally manipulated mesenchymal stem cells" from bone marrow or adipose tissue such as the adipogenic stromal-vascular fraction (SVF).
The SVF is obtained by mechanical processing of adipose tissue and contains heterogeneous population of stem, progenitor and adult cells. Those adipose tissue-derived stem cells (ADSCs) available in SVF secrete several soluble factors with anti-inflammatory, immunomodulatory and analgesic effects.
The study investigates whether infiltration of the Hoffa's fat pad with autologous SVF is an effective and safe treatment option in patients with gonarthritis. Furthermore, the number and viability of the injected cells as well as their influence on the therapeutic outcome will be evaluated.

Materials and Methods: This is a prospective study. Patients with osteoarthritis receive infiltration of SVF into the Hoffa fat pad. The number and viability of the cells are measured with a cell counter. The clinical outcome is checked using VAS and KOOS with a follow-up period of 1 year.

Results: Evaluable courses over 1 year are available for 33 patients and 36 knees. An average of 45 million cells were injected with a standard deviation of 25 million cells. After 6 months a significant improvement of the VAS and the respective subscales of the KOOS could be observed compared to the baseline. After one year of follow-up, a significant improvement in all KOOS subscales compared to baseline was still observed. A significant correlation between reduced knee pain on the VAS and the number of injected cells was observed. Thus, patients injected with a higher number of cells seem to have a better outcome. The average viability of the cells was 64,4% with a standard deviation of 15,9%. A correlation between higher cell viability and better outcome on the QOL subscale of the KOOS was observed. There were no major complications or side effects.

Conclusion: These initial results show that treatment with SVF is a safe therapeutic option that has the potential to relieve joint pain and significantly improve function. The cell number and viability of the injected cells appear to be important factors influencing the therapy outcome.

Stichwörter:
Knee, osteoarthritis, MSC, SVF, intra-articular injection

DKG21-94 Vortrag
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Influence of MPFL Reconstruction on the Patellofemoral Contact Mechanism in Patients with Low Flexion Patellar Instability - an in vivo MRI Study

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Aims and Objectives: The medial patellofemoral ligament (MPFL) is one of the main stabilizers of the patella in extension and early knee flexion. MPFL reconstruction is considered an established procedure for the treatment of patients with patellofemoral instability near extension. Although the procedure shows low rates of recurrent dislocations, little is known about the effect of MPFL surgery on the patellofemoral contact mechanism during the first 30° of knee flexion.
The present study investigated the effect of MPFL reconstruction on the patellofemoral contact area using in vivo MRI images in different flexion positions before and after surgical stabilization.

Materials and Methods: In the present prospective cohort study, 12 healthy volunteers and 12 patients with low flexion patellar instability were analyzed before and after surgical treatment with MPFL reconstruction. MRI scans in a custom-designed knee brace were used to determine the patellofemoral cartilage contact area. Comparative measurements using 3D cartilage and bone meshes were made of knee-healthy volunteers and patients with patellofemoral instability preoperatively, and of patients pre- and postoperatively.

Results: The patellofemoral contact area of healthy volunteers was 141.91±49.36mm in 0°-Flexion, 208.71±85.54mm in 15°-Flexion and 377.92±62.31mm in 30°-Flexion. The preoperatively assessed contact area of patients with patellofemoral instability showed 73.93±47.03mm in 0°-Flexion, 118.48±57.77mm in 15°-Flexion and 280.97±87.35mm in 30°-Flexion. Postoperatively, this was 169.20±58.65mm in 0°-Flexion, 203.05±73.75 in 15°-Flexion and 342.13±61.08 in 30°-Flexion. Therefore, there was a significantly reduced patellofemoral contact area in 0°-Flexion (p=0.003), 15°-Flexion (p=0.009) and 30°-Flexion (p=0.006) in comparison of knee-healthy volunteers and patients with patellar instability. Postoperatively, there was a significant increase of the contact area in 0°-Flexion (p=0.002), 15°-Flexion (p=0.012) and in 30°-Flexion (p=0.075). A complete normalization of the contact area could not be achieved.

Conclusion: Patients with low flexion patellar instability showed a significant reduction of the patellofemoral contact area at 0° as well as at 15° and 30° Flexion. MPFL-reconstruction increases the contact area significantly over the range of motion of early flexion. Complete normalization of contact kinematics however could not be achieved. Further factors should be identified in the future to achieve further normalization of the contact mechanism.

Stichwörter:
Knee, Patellofemoral Instability, MRI, MPFL, Reconstruction, Contact area

DKG21-96 Vortrag
Deformitätenanalyse

3D assessment of the lower limb anatomy by two different methods

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Aims and Objectives: Three-dimensional (3D) surgical planning for the use of patient-specific implants and cutting guides is becoming increasingly popular in orthopedic surgery. However, currently there is an increasing number of 3D software solutions for the user in the clinical routine. Compared to conventional 2D analysis, these are more complex but offer the advantage of simultaneous assessment of patellofemoral and tibiofemoral anatomy without being dependent on patients position. The aim of this study was to compare two 3D assessment methods of lower limb anatomy.

Materials and Methods: In this study, 60 full leg CT data of a young cohort (age 18-50y) were evaluaed. The results of a current commercial software solution (mediCAD® Knee 3D Sport)(Method A) were compared with an already published, standardized and validated 3D analysis protocol (Method B). Common joint angles, torsion angles, leg axes and patellofemoral indices were recorded. To create the 3D models, volume rendering was used for method A and segmentation for method B. The main difference between the two methods is the landmark positioning with pinpointing on slice images and subsequent visual control on the 3D model (method A) compared to direct placement of the landmarks on the 3D model (method B). The mean values with standard deviation, the absolute difference (d) and the correlation (R) of the measured values were calculated.

Results: The following parameters and their deviation from each other with correlation could be determined: Medial tibial slope (10.9 ± 3.2 vs 11.9 ± 3.5; d = 2.7; R = 0.28), lateral tibial slope (8.5 ± 3.5 vs 9.2 ± 3. 8; d = 2.92; R = 0.38), Tibial Torsion (38.0 ± 8.4 vs. 36.4 ± 8.7; d = 7.0; R = 0.36), Femoral Torsion (23.3 ± 9.5 vs. 15. 4 ± 8.3; d = 9.8; R = 0.64), Mechanical Lateral Distal Femoral Angle (87.3 ± 2.7 vs. 87.2 ± 2.1; d = 2.0; R 0.33), Medial Proximal Tibial Angle (87.3 ± 2.9 vs. 87.6 ± 2.4; d = 2.3; R = 0.42) Hip Knee Angle (174.7 ± 3.4 vs. 175. 0 ± 3.2; d = 2.4; R = 0.20), TT-TG (13.0 ± 3.5 vs. 17.1 ± 3.6; d = 4.7; R = 0.56), Patella-Shift (2.4 ± 1.8 vs. 2. 7 ± 2.1; d = 1,4; R = 0,36), Patella Tilt (15.3 ± 5.7 vs. 12.6 ± 6.3; d = 4,8; R = 0,48), Sulcus Angle (127,1 ± 7,6 vs. 148.4 ± 7.7; d = 21.3; R = 0.16), Trochlea Depth (8.4 ± 1.5 vs. 4.5 ± 1.4; d = 3.6; R = 0.31), Patellar Ridge Angle (134. 9 ± 8.3 vs. 124.6 ± 6.3; d = 10.5; R = 0.27) and Insall-Salvati index (1.2 ± 0.2 vs. 1.2 ± 0.2; d = 0.15; R = 0.82).

Conclusion: Both methods allow the assessment of relevant parameters for preoperative analysis and planning and provide similar mean values in this young cohort. However, the correlations are weak to moderate, and in some cases significant differences can be seen in the direct, non-averaged comparison. Several factors can add up here. In addition to procedural differences, there are also different definitions of landmarks and observer related deviations. An intensive scientific dialogue is therefore necessary to further standardize and improve the promising 3D assessment tools.

Stichwörter:
3D assessment, preoperative planning, medicad, patellofemoral joint

DKG21-97 Vortrag
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The fairytale of 'isolated' anterior cruciate ligament injuries

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Aims and Objectives: In anterior cruciate ligament (ACL) injuries, concomitant damage to peripheral soft tissues are associated with increased rotatory instability of the knee. Injuries to the medial soft tissue structures and to the meniscal ramp can lead to anteromedial rotatory instability (AMRI), whereas damage to the anterolateral complex (ALC) increases anterolateral rotatory instability (ALRI). The purpose of this study was to investigate the incidence, injury patterns and risk factors of anterolateral and medial collateral ligament complex injuries as well as meniscal ramp lesions in patients with complete ACL ruptures.

Materials and Methods: Patients who underwent anterior cruciate ligament (ACL) reconstruction for MRI confirmed complete ACL rupture between 2015 and 2019 were retrospectively included in this study. Patients' characteristics and clinical finding, concomitant injuries in MRI and tibial slope were evaluated. Preoperative MRIs were evaluated and the grade and location of injuries to the ALC (i.e. Kaplan fibres (KF), anterolateral ligament (ALL)), superficial MCL, deep MCL, the posterior oblique ligament (POL) and to the meniscal ramp were recorded. All patients were clinically assessed under anaesthesia with standard ligament laxity tests.

Results: 100 patients (80 male, 20 female) with a mean age of 22.3 ± 4.9 years were included and neither had an isolated ACL rupture. The incidence of concomitant MCL complex injuries was 67% and meniscal ramp lesions were diagnosed in 16%. sMCL injuries occurred in 62%, dMCL in 31% (93.4% meniscofemoral) and POL in 11% with various injury patterns. A dMCL injury was highly associated with MRI grade II sMCL injuries and bone edema at the medial femoral condyle (MFC) adjacent to the dMCL attachment site (both, $p<0.01$) but also occurred in isolation (4%). Meniscus ramp lesions were also associated with injuries to the sMCL ($p<0.01$) and dMCL ($p<0.01$) as well as bone edema in the posterior medial tibia plateau ($p<0.05$). ALC injuries were noted in 63% of cases. The majority of injuries were to KF (39% isolated injury and 19% combined with ALL injury). There was a very low incidence of isolated ALL injuries (2%). High grade pivot shift test and tibial slope were not associated with the presence of peripheral soft tissue injuries.

Conclusion: In the studied patients with complete ACL rupture, all of them exhibited concomitant soft tissue injuries to peripheral structures. Incidence of medial collateral ligament injuries was higher compared to the anterolateral side. The high correlation between dMCL and ramp lesions suggests that some ACLs are injured involving tibial external rotation stretching fibres of the dMCL and meniscal ramp and possibly causing AMRI. KF (the deep capsulo-osseous layer of the ITB) were the most commonly injured structure of the anterolateral complex. As clinical consequence, knee surgeons must pay close attention to concomitant peripheral injuries and their resulting rotatory knee laxity in ACL ruptures to treat patients appropriately.

Stichwörter:
magnetic resonance imaging; medial collateral ligament; Kaplan fibres; anterolateral ligament; ramp lesion

DKG21-98 Vortrag
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Changes in lower limb alignment due to flexion and rotation - 3D simulation of radiographic measurements

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Aims and Objectives: Many radiographic lower limb alignment measures are dependent on patients' position, which makes a standardised image acquisition of long standing radiographs (LSR) essential for valid measurements. This is not always possible in the case of postoperative imaging or injuries. The aim of this study is to investigate the influence of rotation and flexion of the lower limb on common radiological alignment parameters using 3D simulation.

Materials and Methods: 3D bone models (n=10) of the lower limb generated from CT scans were aligned in an anatomic coordinate system (ACS) in a standardised way. To calculate the mechanical proximal tibial angle (MPTA), the mechanical lateral distal femoral angle (mLDFA), the hip knee angle (HKA) and the mechanical axis deviation (MAD), defined landmarks from previous studies were set to evaluate the alignment. All models were rotated in 5° steps around the longitudinal mechanical axis up to 15° internally and externally and additionally flexed in 10° steps along the femoral intercondylar axis up to 30°. This resulted in 28 models for each leg. All measurements were automatically projected into the coronal plane to mimic radiographic imaging. Angles and distances were automatically evaluated with a Python script and mean differences from neutral position are evaluated.

Results: All parameters showed significant differences due to the position changes of the bone models. The MPTA increases with internal rotation and decreases with external rotation and the MLDFA vice versa. With the knee extended, this effect on the MPTA is small (up to -0.7° to +0.3°),but reaches clinical significance at 10° flexion (up to -2.3° to +1.7°) and is strong at 30° flexion (up to -6.2° to +3,6°). The impact of rotation and flexion on the MLDFA was slightly weaker with a mean deviation of (up to -0,7° to +0,7°) at 0° flexion, getting significant at 10° flexion (up to -1,6° to +2,1°) and strong at flexion 30° (up to -3,8° to +4,8°).
The MAD is more laterally with external rotation and more medially with internal rotation similar to MLDFA. The effect is clinically significant at 10° flexion (up to -18,0mm to +2,3mm) and strong at 30° flexion (up to -35,3mm to +18,8mm). HKA angles seem to be more affected by flexion than by rotation. With the knee extended, the mean deviation was small (up to -1,3° to +1,0°) but increased towards more varus with flexion 10 (up to -3,3° to -4,7°) and flexion 30° (up to -12,5° to -14,7°).

Conclusion: Axial Rotation and flexion of the lower limb have a huge impact on the projected 2D measurements in coronal plane in a 3D simulation of limb alignment measures. This must be taken into account when evaluating X-ray images with malpositioning of the lower limbs. In particular, extension deficits of the knee make LSR prone to error and this calls into question direct postoperative alignment controls. In addition this study underlines the relevance of 3D imaging and measurements, especially when standardised positioning in LSR is not possible.

Stichwörter:
2D measurements; 3D measurements; radiographic measurements; X-ray measurment lower limb; influence of rotation and flexion

DKG21-99 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Refixation of the anterior cruciate ligament: a biomechanical analysis of suture techniques in a porcine model.

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Aims and Objectives: With advances in arthroscopic technique, anterior cruciate ligament (ACL) remnant preserving reconstruction is gradually gaining attention with respect to improving proprioception and enhancing early revascularization of the graft. Systematic evaluations of various suture technique parameters such as the number and passes of the suture used as well as the knotting technique are still pending. We therefore aimed to evaluate the mechanical pull-out strength of various suture methods for optimization of ACL refixation.

Materials and Methods: 48 fresh knees from mature domestic pigs were dissected and the femoral attachment of the ACL was peeled off. For the pull-out tests, the tibial bones were fixed with 30° flexion angle and the cruciate ligament sutures were knotted through a guide over the fixation clamp on an electrodynamic testing machine (LTM 5, ZwickRoell GmbH & Co. KG). The 48 knees were divided in 8 groups and sutured as follows (Scorpio-Needle®, FiberWire® #2): A) 1 suture (2, 4, 6 passes), B) 2 sutures (2, 4, 6 passes each; sutures knotted separately), and C) 2 sutures (2, 4 passes each, sutures knotted together as a loop). Following mechanical pre-condition, the failure strength and stiffness were measured, and the failure mode was described.

Results: Suture failure (suture pull-out of ACL) occurred as follows in the various groups: A) 2 passes: 4x, 4 passes: 4x, 6 passes: 1x; B) 2 passes: 6x, 4 passes: 3x, 6 passes: 1x; and C) 2 passes: 6x, 4 passes: 6x. Suture material failure (rupture of suture) occurred as follows: A) 2 passes: 2x, 4 passes: 2x, 6 passes: 5x; B) 2 passes: 0x, 4 passes: 3x, 6 passes: 5x; and C) 2 passes: 0x, 4 passes: 0x. The failure strength was significantly higher with two wires used compared to the single one (180 ± 120 N vs. 380 ± 80 N (two passes), 270 ± 70 N vs. 470 ± 80 N (four passes) and 310 ± 30 N vs. 530 ± 50 N (six passes)). Stability of the wires knotted together as a loop were significantly inferior.

Conclusion: The results suggest that using two sutures and six suture passes with separately knotted sutures results in the highest failure strength representing the preferred option for increasing the mechanical stability of ACL refixation. However, it remains unclear whether these maximum failure strengths are required in patient's daily activity and thus maximum stability achieved justifies the more difficult operation technique.

Stichwörter:
ACL, rupture, refixation, suture technique, experimental biomechanics

DKG21-100 Poster
Endoprothese nach Umstellung

Combined femoral osteotomy and total knee arthroplasty in a 64-year-old patient with former distal femur osteotomy and septic knee arthritis

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Aims and Objectives: Preservation of the native knee joint using an osteotomy has shown good results with a considerable long-term survivorship. Nevertheless, some patients show a progression of their arthritis requiring total knee arthroplasty (TKA) in the further course. Implantation of a TKA is significantly aggravated or nearly impossible if pathological joint angles result from the index surgery. Thus, in certain patients the combination of osteotomy with subsequent implantation of TKA seems advisable, but can be surgically demanding.

Materials and Methods: In this case report we present a 64-year-old patient which was referred from another clinic. The patient had radiotherapy and subsequent varus osteotomy of the distal femur in 1971. In the further course the patient was satisfied but septic knee arthritis in 2020 required multiple surgeries. Upon referral to our clinic ROM was Flex/Ext 0/10/60 with persistent septic arthritis and positive cultures (S. aureus, Coryne bakt, Staph. Epidermidis, Propioni acnes). A standing long-leg ap view revealed a varus deformity of 18°, mLDFA 103°, mMPTA 87° and mLDTA 77°. The CORA was located at the former distal femur osteotomy.
Decision was made for a two-stage revision with removal of cartilage and insertion of an antibiotic-loaded spacer and antibiotic therapy. After 6 weeks aspiration and blood samples were unsuspicious wherefore surgery was undertaken. Due to the highly pathological joint angles a distal femoral osteotomy was planned using a lateral distal femoral plate and subsequent implantation of a constrained-condylar TKA.

Results: Surgery was started with a distal femoral closing wedge osteotomy. An osteotomy wedge of 20 mm was removed and the osteotomy was closed. A distal femoral Tomofix plate was located slightly dorsal at the femur in order to place the screws away from the TKA stem. For the proximal plate holes, monocortical periprosthetic screws were used to avoid alteration of TKA fixation. Then a constrained-condylar TKA (Attune Revision) with a cementless femoral stem was inserted. The length of the cementless stem was chosen to bridge the osteotomy cuts and allow anchorage proximally. Postoperatively the patient was then mobilized with partial weight bearing for 6 weeks and the standing long-leg ap view revealed a neutral axis of 0°, mLDFA 92° , mMPTA 90° and mLDTA 90°.

Conclusion: Pathologic joint angles after osteotomy might be challenging when planning TKA. Although technically demanding, correction of highly pathological joint angles should be considered using an osteotomy and subsequent implantation of the TKA. However, careful preoperative planning is required, especially placement of the plates and screws as well as the type of TKA.

Stichwörter:
osteotomy, TKA, distal femur osteotomy

DKG21-101 Poster
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Bone Bruise Distribution and Depth after Acute Noncontact Anterior Cruciate Ligament Tear.

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Aims and Objectives: Bone bruises (BB) in the femur and tibia are frequently seen on magnet resonance imaging (MRI) after acute cruciate ligament (ACL) injury and can provide insight into the biomechanical mechanism of injury. The aim of this study was to analyze the distribution and depth of BB after acute noncontact ACL tears.

Materials and Methods: A retrospective review of 446 consecutive patients who presented with acute noncontact ACL injury at our institution between December 1st, 2016, and November 30th, 2020, was performed. Only cases of skeletally mature patients with verified complete tear on subsequent arthroscopy were included. MRI were utilized to classify the location (anterior/central/posterior condyles of medial/lateral tibial/femoral compartments) and depth (superficial/shallow/deep/extensive/generalized) of BB. Demographic characteristics included age, gender and body mass index. Laterality, type of sport and time between injury and MRI and associated knee injuries was also recorded. Fisher's exact test was performed to evaluate for significant BB distributions and Wilcoxon signed-rank test was performed to evaluate differences in BB depth.

Results: 158 patients (82 women, 35.7 ± 13.2 years; 76 men, 32.5 ± 11.1 years) were included, of whom 152 (96.2 %) had BB on MRI. Average time between injury and MRI was 4.54 ± 1.68 days. BB occurred more frequently in the lateral compartment (tibial: 94.3% tibial, femoral: 63.3%) vs. medial compartment (tibial: 51.9%, femoral: 46.2%) ($p = 0.005$) and were more frequently located centrally and posteriorly within the femur (lateral: 99.0%, medial: 82.2%) and tibia (lateral: 98%, medial: 92.7%), respectively. However, BB in the medial femoral condyle were also seen in the posterior region (medial: 17.8%; lateral: 2.0%). Generalized BB were most pronounced within the lateral tibia (lateral: 76.6% vs. medial: 22.2%) and the lateral femur (lateral: 44.2%; medial: 18.3%) and when present bilaterally, lateral BB were more pronounced ($p < 0.001$). Laterality, type of sport, time between injury and MRI and associated knee injuries had no significant effect on the BB distribution and depth ($p > 0.05$). Interrater reliability analysis showed excellent and substantial degree of agreement between all three raters for bone bruise distribution (kappa = 0.95 -1.00) and depth (kappa = 0.68 - 0.75), respectively.

Conclusion: The findings of this study demonstrate high lateral tibial plateau involvement in acute noncontact ACL injuries. With significant signal alterations in the posterolateral compartment indicating predominant stress and varying femoral distribution patterns proposing a rotatory component, these data support the hypothesis, that knee valgus and anterior tibial translation may be major components of noncontact ACL injuries.

Stichwörter:
knee joint;anterior cruciate ligament;bone bruise distribution;bone bruise pattern;bone bruise depth;injury mechanism

DKG21-104 Vortrag
Frakturen rund ums Knie

Retrospective analysis of complications after osteosynthesis of patella fractures

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Aims and Objectives: The reasons for complications after osteosynthesis of patella fractures with surgical revision are diverse. In addition to renewed trauma, incompliance or implant failure, this retrospective, multicenter cohort study examines the influence of patient-specific factors on the occurrence of postoperative complications.

Materials and Methods: Medical records of n=231 patients with surgically treated patella fractures between 01/2013 and 12/2018 were analyzed. A total of n=135 patients were contacted and included in the study. Subjective knee function, activity level and current pain were analyzed with Tegner-Lysholm score, Tegner activity score, IKDC score and numeric rating scale. The occurrence of revision surgery or complications were documented. The statistical evaluation was carried out using a t-test and linear regression models.

Results: In n=14 patients (10.4%), a traumatic (n=2) or atraumatic (n=12) complication occurred, whereby a secondary fracture dislocation was most common in 71.4% after 52±42 days. Patients with complications initially suffered comminuted (57%, OTA/AO type C3) or transverse (43%, OTA/AO type C1) fractures, which were stabilizied after 1.7±3.2 days (vs. 3.5±4.8 in patients without complications) in 92.9% with tension band wiring and in 7.1% with locking plate fixation. 35.7% (vs. 43%) had a distal pole fracture; 35.7% (vs. 22.3%) were open fractures. Patients with complications did no show concomitant injuries; 15% without complications had further fractures of the affected extremity. Age (64.9±11.1 vs. 55.2±17.5 years; p=0.174), female gender (64.3% vs. 44.6%; p=0.745), nicotine abuse (14.3% vs. 8.3%; p=0.248), regular alcohol consumption (7.1% vs. 8.3%; p=0.474) or osteoporosis (14.3% vs. 5.8%; p=0.202) did not influence the occurrence of a complication in this cohort.
The final follow-up was 62.6 ± 20.7 (vs. 60.3 ± 20.6) months postoperatively. The patients with complications complained significantly greater pain, especially during exercise (NRS: 2.07±3.0 vs. 0.63±1.18; p=0.0006). The Tegner-Lysholm score (81.2±17.7 vs. 91.6±12.8; p=0.007) and IKDC score (71.6±23.2 vs. 83.4±21.9; p=0.004) had significantly lower values. The activity level was also significantly lower at the final follow-up (3.0±1.6 vs. 4.0±1.2, p=0.008).

Conclusion: Atraumatic complications occur early, about 6 weeks postoperatively. The frequent secondary fracture dislocations require further adjustments of surgical treatment, especially in comminuted fractures. No patient-specific factor could be found in this cohort that favored the occurrence of a postoperative complication. The medium-term, functional results after complications and surgical revision were, however, significantly worse.

Stichwörter:
patella fracture, complication, revision surgery, osteosynthesis

DKG21-105 Vortrag
Deformitätenanalyse

END POINT FIRST, a Universal Planning Method for Deformity Correction Procedures

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Aims and Objectives: Preoperative planning in deformity correction procedures is a significant tool to alleviate surgical morbidity and achieve a better surgical outcome. Good planning may also anticipate intra-operative difficulties and avoid possible complications. There are several planning methods available (e.g. CORA, Miniacci), but here we would like to share the END-POINT-FIRST (EPF) planning method. For the past two decades, we are using EPF-Method for all our limb lengthening and deformity correction procedures. With many hundreds of successful surgeries, EPF has become the method of choice in our institution. To assess the reliability and illustrate this method's principles, we present an in-depth review of various deformity correction procedures.

Materials and Methods: The EPF-method works on various cost-effective digital graphic programs and even on transparent paper. We are using vector-based graphic software with a multi-layers option for both analysis and planning on frontal and/or sagittal views. In long-standing radiographs, there is a normal range of each joint orientation relative to the mechanical and anatomical axis of the femur and/or tibia. The normal joint orientation is used to accurately plan the realignment of the deformity and also considering the extent of required lengthening/shortening of the limb. In conventional planning using external fixation, osteotomies are mostly performed at the true level of a deformity. On the other hand, each internal implant (nail, plate, screws, lengthening nail, lengthening plate) has individual properties that define its fit and stability in the fragments after the osteotomy. Thus, the IMPLANT SPECIFIC FIT (ISF) and its position will determine the level and shape of the IMPLANT SPECIFIC OSTEOMOMY (ISO). The basic principle of the EPF-method is the virtual construction of the desired end-point of any correction. First, the NEW MECHANICAL AXIS (nMA) is determined and set as a reference. Next, by using the nMA and according to ISF and ISO, we can estimate the immediate postoperative and end-Treatment results. A retrospective review comparing the implementation of EPF-method with postoperative results in various procedures.

Results: The EPF-method takes into consideration the individual type, size and fixation properties of the chosen implant (ISF). In axis correction procedures, the shape and size of the osteotomy wedge can be measured directly, and the chosen implant's position is determined. The intraoperative implementation of the EPF-Method is also highly reliable.

Conclusion: In comparison to other planning methods, the EPF-method can be applied to all internal and external implants. It has the advantage of showing both immediate postoperative and end-Treatment results. It is especially useful in the case of dynamic treatments such as distraction osteogenesis. The key facts for deformity correction, even in complex deformities, are shown in details.

Stichwörter:
Deformity, Osteotomy, Analysis, Knock Knee, Bow Leg, Preoperative Planning, Lower Limb, Hip, Knee, Ankle

DKG21-106 Vortrag
Fokus Knie (klinische Untersuchung, Bildgebung,Regenerative Therapie)

Age dependent functional valgus position and knee- and hip flexion-angles in a group of professional female soccer players

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Aims and Objectives: Functional valgus and low knee flexion angles after landing maneuvers are well-known risk factors for knee injuries. The purpose of the present study was to assess these risk factors and to investigate the impact of age and body-mass-index (BMI) in a group of professional female soccer players using app-based motion analysis.

Materials and Methods: 47 professional female soccer players from three teams, U17, U20 and adults (FC Bayern) with a mean age of 20 years (14-33) were enrolled in this prospective study. Data for age, BMI, training intensity, dominant leg and previous history for knee injuries were recorded. Clinical examination included knee function and functional tests: single leg squats for both knees and drop jump with counter movement. All tests were recorded with a 2D mobile motion analysis app (HUDL, Lincoln, NE, USA) in frontal and sagittal view and analyzed by three independent investigators. Hip- and knee flexion were measured in the sagittal view at the deepest position during the drop jump test. The single leg squat was categorized as fair or poor according to Crossley grading criteria. Inter- and intrarater reliability were calculated. Significance was set at $p<0,05$.

Results: First, the MAA (mobile motion analysis app) was evaluated. The Intrarater Correlation for sagittal views was calculated at ICC3: 0,993 (0,987 - 0,997, $p< 0,0001$). For frontal views Cohens Kappa was 0,82 (0,82 - 0,82). The Interrater Correlation for the three investigators was ICC3: 0,961 (0,933 - 0,978, $p< 0,0001$) for sagittal views and Fleiss Kappa at 0,849 (0,750 - 0,948) for frontal views.
In the entire group of female soccer players there were no significant correlations between age/knee angle ($p= 0,931$), age/hip angle ($p= 0,750$), bmi/knee angle ($p= 0,267$) or bmi/hip angle ($p= 0,717$). However, in the youth teams (U17 and U20 combined) there was a significant positive correlation between age and knee flexion angle (p: 0,017) as well as with hip flexion angle with ($p= 0,015$). Furthermore, there was a significant positive correlation between BMI and knee angle ($p= 0,034$). In contrast, the correlation between BMI and hip angle was not significant ($p= 0,059$).
Investigating the single leg squat, there was a higher rate of functional valgus in the younger teams. While in the U17 team 64,3% of the screened legs showed a functional valgus, 47,2% of the legs in the U20 team and 30,6% in the adult team were categorized as "poor". Even though these differences were not significant ($p= 0.0772$).

Conclusion: Results of the present study showed that knee- and hip flexion angles of professional female soccer players are dependent on age and BMI. Additionally, functional valgus was more frequently observed in younger players.
The present study underlines the prevalence of typical risk factors of ACL injuries in different age groups. Therefore, training for young female athletes should focus on functional knee stability to prevent future injuries. Further studies should aim on identifying the underlying factors.

Stichwörter:
functional valgus, female soccer players, risk factor, knee injuries, knee hip flexion angles, single leg squat, vertical drop jump