

## Current Concepts for Patellar Dislocation

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Received: April 29, 2015; Accepted: May 11, 2015

**Context:** Patellar dislocation usually occurs to the lateral side, leading to ruptures of the Medial Patellofemoral Ligament (MPFL) in about 90% of the cases. Even though several prognostic factors are identified for patellofemoral instability after patellar dislocation so far, the appropriate therapy remains a controversial issue.

**Evidence Acquisition:** Authors searched the Medline library for studies on both surgical and conservative treatment for patellar dislocation and patellofemoral instability. Additionally, the reference list of each article was searched for additional studies.

**Results:** A thorough analysis of the anatomical risk factors with a particular focus on patella alta, increased Tibial Tuberosity-Trochlear Groove (TT-TG) distance, trochlear dysplasia as well as torsional abnormalities should be performed early after the first dislocation to allow adequate patient counseling. Summarizing the results of all published randomized clinical trials and comparing surgical and conservative treatment after the first-time patellar dislocation until today indicated no significant evident difference for children, adolescents, and adults. Therefore, nonoperative treatment was indicated after a first-time patellar dislocation in the vast majority of patients.

**Conclusions:** Surgical treatment for patellar dislocation is indicated primarily in case of relevant concomitant injuries such as osteochondral fractures, and secondarily for recurrent dislocations.

**Keywords:** Knee; Patella; Patellar Dislocation; Evidence-Based Medicine; Medial Patellofemoral Ligament; Patellofemoral Instability

### 1. Context

Patellar dislocations account for 2% - 3% of the knee joint injuries (1, 2). It is the most common cause of traumatic hemarthrosis in children, and the second most common in adolescents after ruptures of the anterior cruciate ligament (3). The patella is usually dislocated laterally, and subsequently causing ruptures of the Medial Patellofemoral Ligament (MPFL) in about 90% of the patients (1, 4). Patellar dislocation mainly affects young and active people with an almost equal distribution between male and female and a peak age of 10 - 20 years (2, 5-10). Most of the first-time patellar dislocations occur during sport activities, with reported incidence of 55% - 72% (2, 5, 11, 12).

Stability of the patellofemoral joint is maintained by the complex interaction of three stabilizing groups: static stabilizers (patellofemoral joint geometry), active (M. quadriceps femoris) and passive soft tissue stabilizers (retinacular ligaments). These stabilizers contribute in various extents to patellofemoral joint stability through the range of knee flexion (13, 14).

### 2. Evidence Acquisition

A search of the Medline library for studies on patellar

dislocation and patellofemoral instability surgical and conservative treatments was performed in April 2015. Additionally, the reference list of each article was searched for additional studies of interest. Studies were included if they either compared surgical and conservative treatments of patellar dislocations, or provided information on diagnostic tools, surgical techniques and outcomes of patellofemoral joint instability.

### 3. Results

#### 3.1. Study Background for Operative vs. Nonoperative Treatment of the First-Time Patellar Dislocation

Prognostic factors for patellofemoral instability and patient satisfaction after either surgical or conservative treatment following first-time patellar dislocation remain a matter of debate. However, there is a consensus regarding the indication of surgical treatment in case of relevant concomitant injuries such as osteochondral fractures (6, 9). Furthermore, patella alta, increased Tibial Tuberosity-Trochlear Groove (TT-TG) distance, trochlear

dysplasia as well as torsional abnormalities are suggested as prognostic factors for recurrent dislocation (15).

To date, a total of nine prospective randomized clinical trials, comparing conservative and surgical treatment after first-time patellar dislocation, were performed, reporting inconsistent results (7, 16-23). Especially limited number of the patients reduces the validity of the studies.

Sillanpaa et al. conducted two studies in a military hospital, both on over 90% of male patients (21, 22). The results revealed lower rates of redislocation after surgical treatment in one study (22), and equal redislocation rates but better regain of preinjury activity after surgery in the other one (21). Neither study showed clear subjective benefits in the long-term follow-up compared to conservative treatment.

Nikku et al. (18) reported the seven-year follow-up results of 127 patients after first-time patellar dislocation. In the conservative group, redislocations occurred in 39% of the patients, compared to 31% in the operative group. In the conservative group, the mean Kujala score was 90 - 94 points, and 81% of the patients were satisfied with their result. In the operative group, the mean Kujala score was 88 - 89 points, and only 67% of the patients considered their result satisfactory (18). The same research group had previously reported the two-year-results of this trial, showing no benefit from surgery compared to conservative treatment (19). As a conclusion, the authors did not recommend routine surgery after first-time patellar dislocation.

In 2008, Christiansen et al. (7) randomized 80 patients with primary patellar dislocation into either conservative treatment or operative treatment by reinsertion of the MPFL to the adductor tubercle. Their two-year follow-up revealed a mean Kujala score of 78 and a 20% redislocation rate in the conservative group, compared to a mean Kujala score of 85 and a 17% redislocation rate in the operative group (7).

Palmu et al. (20) randomized 74 children and adolescents less than 16 years old. A clinical follow-up was performed after two years, and subjective phone-call questionnaires were completed after a mean of 6 and 14 years. This is the longest follow-up so far reported in the literature. In the conservative group, 75% of the subjects considered their result good or excellent, compared to 66% in the operative group. Redislocation rates were remarkably high in both groups (71% and 67% in the conservative and operative groups, respectively). As the only significant predictor of the long term outcome, a positive family history of patellar instability could be determined. Therefore, the authors voted against routine repair after patellar dislocation (20).

### 3.2. Indications for Nonoperative and Operative Treatment

A systematic review of 70 studies by Stefancin and Parker (6) recommended non-operative treatment for the majority of patients after first-time patellar dislocation,

with the exceptions of concomitant chondral and osteochondral fractures, and furthermore, somewhat blurred, exceptions for extended medial soft-tissue damage and strong lateralization of the patella. The meta-analysis by Smith et al. (24) revealed a tendency towards lower redislocation rates, but also higher rates of patellofemoral osteoarthritis after surgical treatment.

The most recent Cochrane Review (25) investigating surgical versus non-surgical treatment for patellar dislocation included five studies with a total of 339 patients and a varying follow-up of 2 - 7 years. All studies were criticized for methodological flaws. The authors concluded that there is insufficient evidence for any clinical outcomes difference between surgical or non-surgical treatment for primary patellar dislocation, and no evidence concerning recurrent patellar dislocation. They therefore recommended adequately powered randomized controlled multi-centric trials according to the contemporary standards (25).

Most recently, a systematic review of four overlapping meta-analyses by Erickson et al. (26) found that operative treatment of acute patellar dislocations may result in a lower rate of recurrent dislocations than non-operative treatment (24.0% vs. 34.6%), but did not improve functional outcome scores.

Regarding recurrent patellar dislocation and chronic patellofemoral instability, there are no randomized clinical trials at all.

To summarize, non-operative treatment is indicated after a first-time patellar dislocation in a vast majority of patients. Surgical treatment is indicated primarily in case of relevant concomitant injuries such as osteochondral fractures, and secondarily for recurrent dislocations.

### 3.3. Magnetic Resonance Imaging Analysis

A thorough analysis of the anatomical risk factors, usually by MRI, is conducted after the first dislocation. Children and adolescents may sometimes not be fully aware of having sustained a patellar dislocation (2, 27). Typical findings in the MRI are joint effusion, contusions of the cartilage on the lateral femoral condyle and the medial patella, chondral or osteochondral fragments, and a torn medial retinaculum and MPFL (2, 28). The evaluation of the MRI should include the following factors (13).

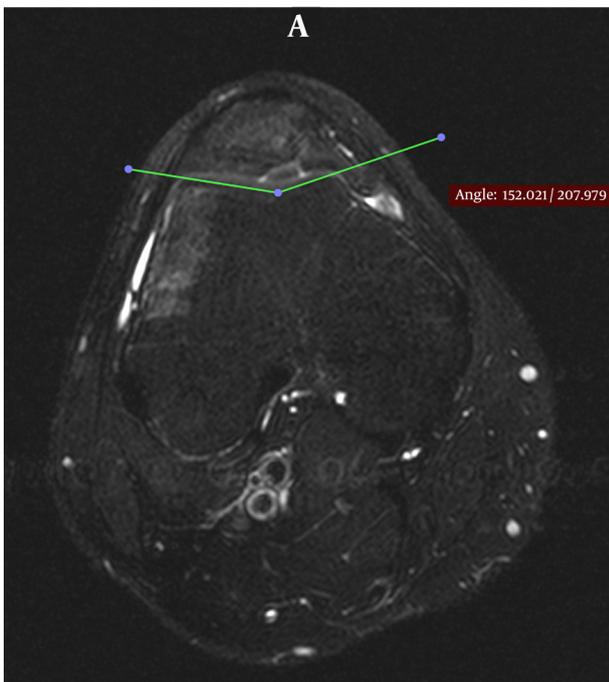
#### 3.3.1. Sulcus Angle

Sulcus angle was measured on transverse MRIs according to van Huyssteen et al. (29) (Figure 1).

The average normal sulcus angle is approximately  $138 \pm 6^\circ$ . A sulcus angle larger than  $145^\circ$  is an indicator of trochlear dysplasia (30-32).

#### 3.3.2 Dysplasia of the Trochlea

Trochlear dysplasia is measured according to the classification of Dejour et al. (31) and Dejour and Saggin (33).



**Figure 1.** Measurement of the Sulcus Angle to Determine Trochlear Dysplasia on Axial Magnetic Resonance Imaging Slice (T2)

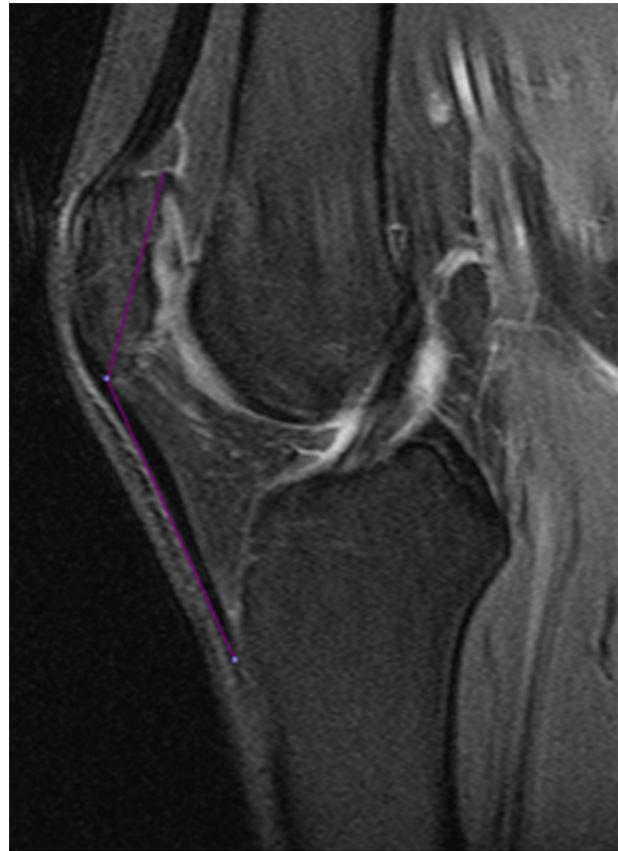
Trochlear dysplasia is categorized according to the above mentioned studies into A (fairly shallow trochlea), B (flat or convex trochlea), C (asymmetry of the trochlea facets: lateral trochlea convex, medial facet hypoplastic), and D (asymmetry of the trochlea facets, vertical joint and cliff pattern). On a true lateral X-ray, the crossing sign, which is a line represented by the deepest part of the trochlear groove crossing the anterior aspect of the condyles, is an indicator of trochlear dysplasia (30, 31, 34). Increased trochlear dysplasia is described as a risk factor for patellar instability (6, 35). The shape of the trochlear groove and degree of trochlea dysplasia are considered similar in pediatrics and adults (2).

### 3.3.3. Depth and Facet Asymmetry of the Trochlea

It is measured on transverse MRIs according to Pfirmann et al. (36). Patients with higher-type trochlear dysplasia or asymmetry are described to benefit from a surgical management not only addressing the soft tissue, but also including bony corrections such as the medialization of the tibial tubercle or trochleoplasty (37, 38).

### 3.3.4. The Insall-Salvati Index

Determination of the patellar height is a ratio of the patellar tendon length to the longest sagittal dimension of the patella on sagittal T1-weighted images (39, 40) (Figure 2). An Insall-Salvati index larger than 1.2 indicates a patella alta, and an index smaller than 0.8 indicates a patella baja (41).



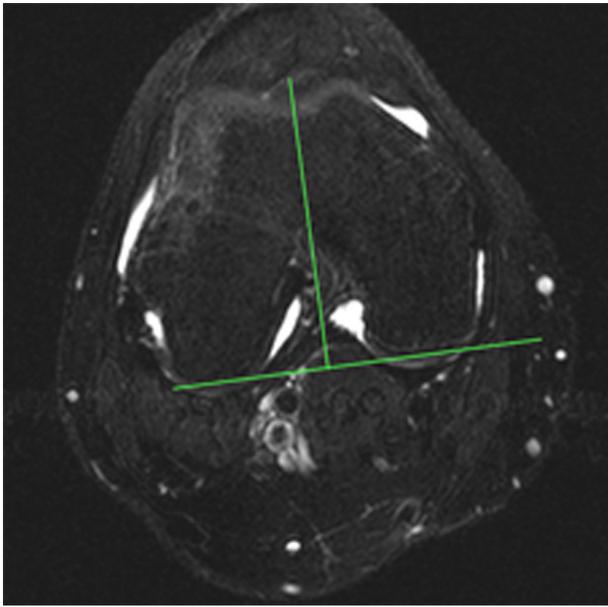
**Figure 2.** Measurement of the Insall-Salvati Index to Determine a Patella Alta on a Sagittal MRI Slice (T2)

### 3.3.5. Tibial Tuberosity-Trochlear Groove Distance

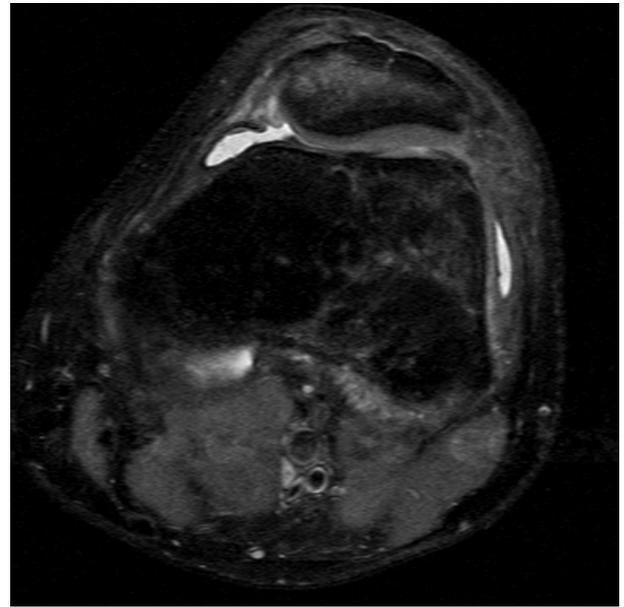
It is measured on transverse CT or MRI slices according to Schoettle et al. (42) (Figures 3 and 4). The transverse CT- or MRI-slices at both the position of the tibial tuberosity (TT) and the trochlear groove (TG) are cross-sectioned, and the distance between the TT and the TG is measured. Dejour et al. (31) suggested a threshold of 20 mm for a pathologically increased TT-TG in 1994, while following authors suggested to lower the limit to 15 mm as an indication of tubercle realignment surgery in symptomatic patients (35, 43).

### 3.3.6. Rupture Patterns of the Medial Patellofemoral Ligament

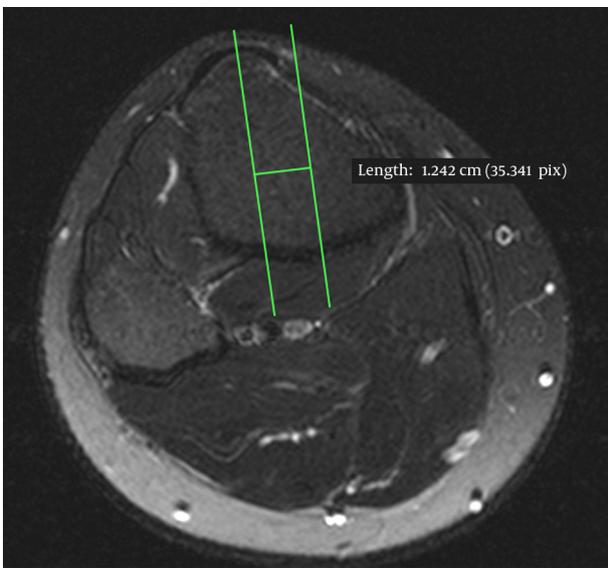
It is determined on transverse images according to the method introduced in previous studies (2, 44, 45). It distinguishes between complete and incomplete ruptures as well as patellar based (Figure 5), femoral based (Figure 6) intraligamentary or mid-substance (Figure 7), and combined ruptures. Ruptures of the MPFL can be complete or partial, with an about equal distribution described in the literature (13, 45, 46). Since decision-making also depends on the kind of MPFL injury, the identification of the rupture site by MRI is of particular importance (2).



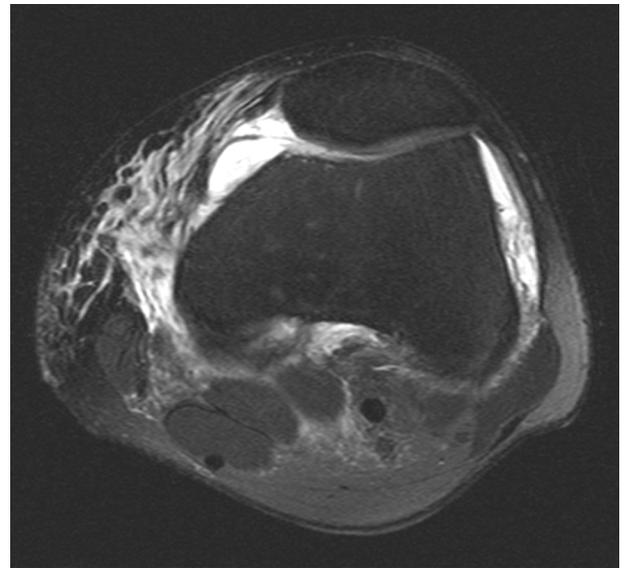
**Figure 3.** Measurement of the Tibial Tuberosity-Trochlear Groove Distance on the Femoral Axial Magnetic Resonance Imaging Slice (T2)



**Figure 5.** Patellar Based Rupture of the Medial Patellofemoral Ligament on Axial Magnetic Resonance Imaging Slice (T2)



**Figure 4.** Measurement of the Tibial Tuberosity-Trochlear Groove Distance on the Tibial Axial Magnetic Resonance Imaging Slice (T2)



**Figure 6.** Femoral Based Rupture of the Medial Patellofemoral Ligament on Axial Magnetic Resonance Imaging Slice (T2)

Since the particular risk factors for recurrent dislocations are patella alta, increased TT-TG-distance, and trochlear dysplasia as well as torsional abnormalities (15), they should be analyzed early after the first dislocation to allow adequate patient counseling.

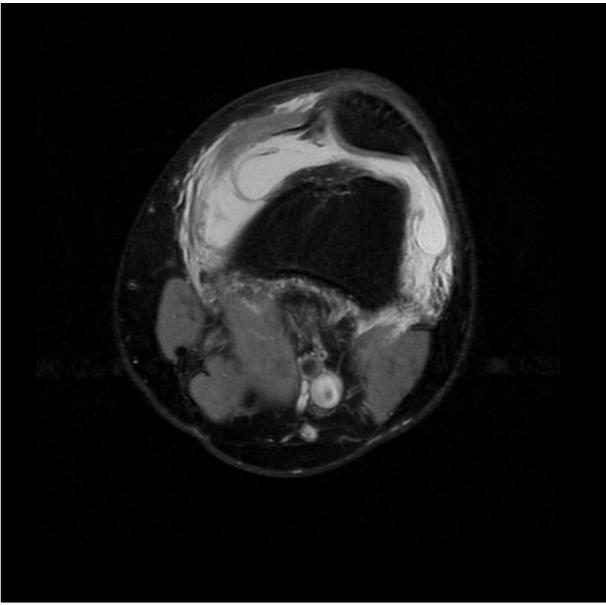
### 3.4. Surgical Treatment Options

There is no level I data regarding indications of the different surgical treatment options. Traditionally, a reefing suture of the medial patellofemoral soft-tissues combined

with a lateral release has been performed as the standard procedure for many years. Since lateral release creates a risk for secondary medial patellofemoral instability (47), nowadays it is only rarely indicated anymore.

### 3.5. Medial Patellofemoral Ligament Repair or Reconstruction

Recently, a variety of techniques with promising short-term results are suggested for reconstruction of the MPFL.



**Figure 7.** Complete Intraligamentary (Mid-Substance) Rupture of the Medial Patellofemoral Ligament on Axial Magnetic Resonance Imaging Slice (T2)

MPFL repair or reconstruction is indicated in the presence of a physiological TT-TG distance ( $< 15$  mm) (48), and only mild trochlear dysplasia (type A/B according to Dejour et al. (48)). Depending on the rupture site (13), refixation is either performed with suture anchors for femoral-based or patellar-based ruptures (Figures 5 and 6), or arthroscopic suture for intraligamentary/mid-substance ruptures (Figure 7). Repair instead of reconstruction is especially indicated for children and adolescents with open physes, as the femoral insertion of the MPFL is located in the area of the distal medial femoral epiphysis.

MPFL reconstruction can be performed with either a gracilis (49-52) or semitendinosus tendon (53-55), quadriceps tendon graft (56), or patellar tendon graft (16). The transfer of the distal adductor magnus tendon is advocated by some authors to avoid donor site morbidity (57, 58)

The recent study by Bitar et al. (16) represents the first prospective randomized clinical trial comparing MPFL reconstruction with conservative management. They reported a significantly better mean of final Kujala score in the surgical group (88.9 points) than in the non-operative group (70.8 points). Consequently, the surgical group presented a significantly higher percentage of 'good/excellent' results (71.43%) compared to the non-operative group (25.0%). In the non-operative group, 35% of the patients sustained recurrent dislocations or subluxations, whereas no recurrences or subluxations were reported in the surgical group.

However, these results should be interpreted cautiously, since the study only included a total of 41 knees and a two-year follow-up. The role of medial reconstruction should be evaluated carefully in the light of different risk factors (children, valgus knee, trochlear dysplasia etc.).

### 3.6. Tibial Tuberosity Transfer and Trochleoplasty

The transfer of the tibial tuberosity represents an advancement of the Trillat procedure (59). It is indicated in the presence of a pathologically increased TT-TG distance ( $> 15/18/20$  mm) (48, 60). Usually a combined distalization and medialization of the tuberosity is performed after a coronary osteotomy, with subsequent screw osteosynthesis.

Trochleoplasty is a highly invasive surgical procedure which deepens and remodels the trochlear groove to allow improved patellar tracking. This procedure is indicated in the presence of high-level trochlear dysplasia (types B - D based on Dejour et al. (33, 48)) and intact patellofemoral joint cartilage as a last resort. It is usually combined with MPFL reconstruction. The postoperative rehabilitation is protracted and the risk of patellofemoral osteoarthritis is potentially increased (33, 38). However, with recent improvements of surgical techniques, results are satisfactory to restore patellar stability and improved clinical scores and no patellofemoral osteoarthritis at a mean seven-year follow-up (61).

## 4. Conclusions

Summarizing the results of all published randomized clinical trials and comparing surgical and conservative treatment after first-time patellar dislocation until today indicated no evident significant difference between children, adolescents, and adults.

A thorough analysis of the anatomical risk factors with a particular focus on patella alta, increased TT-TG-distance, and trochlear dysplasia as well as torsional abnormalities should be performed early after the first dislocation.

Surgical treatment is primarily indicated in case of relevant concomitant injuries such as osteochondral fractures, and secondarily for recurrent dislocations. Complications almost exclusively occur after surgical treatment. Even though there still is a lack of evidence, there is a strong tendency towards conservative treatment after a first-time patellar dislocation. The advantages and disadvantages of different therapeutic strategies should be brought out to the patient.

## Authors' Contributions

Study concept and design: Maximilian Petri, Max Ettinger, Timo Stuebig, Stephan Brand, Michael Jagodzinski, Mohamed Omar; acquisition of data: Maximilian Petri, Max Ettinger, Timo Stuebig, Stephan Brand, Mohamed Omar; analysis and interpretation of data: Maximilian Petri, Max Ettinger, Timo Stuebig, Stephan Brand, Mohamed Omar; drafting of the manuscript: Maximilian Petri, Michael Jagodzinski, Mohamed Omar; critical revision of the manuscript for important intellectual content: Max Ettinger, Timo Stuebig, Stephan Brand, Christian Krettek, Michael Jagodzinski; statistical analysis and administrative, technical, and material support: Max Ettinger, and Christian Krettek, Michael Jagodzinski; study supervision: Michael Jagodzinski and Christian Krettek.

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