Surgical Treatment of Isolated Patellofemoral Osteoarthritis

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Abstract Isolated patellofemoral osteoarthritis in the healthy middle-aged population is a challenging problem. Fifty-one knees in 50 patients with isolated patellofemoral osteoarthritis were treated by partial lateral facetectomy, lateral release, and medialization of the tibial tubercle. The minimum followup was 7 months (mean, 20.2 months; range, 7–32 months). Preoperative radiographs showed Ahlbäck Grades III and IV lateral patellofemoral joint space narrowing. The mean age of the patients was 60.1 years (range, 46–81 years). The subjective outcome was based on the WOMAC and the McCarroll score. Postero-anterior flexion weightbearing views, lateral views, and 45° axial views were taken. According to the WOMAC score,

the scores improved considerably by 2.34 points with respect to pain and by 1.63 points with respect to function. The Insall-Salvati index decreased considerably but still remained in the physiologic range. The majority of these patients experienced improvement in their patellofemoral symptoms. However, the clinical outcome was not better in comparison to other surgical procedures. After the short followup, we would not recommend combined lateral facetectomy, lateral release, and medialization of the tibial tubercle until longer results are available.

Level of Evidence: Level IV Therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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Introduction

Cartilage lesions of the patella are not uncommon. A review of 31,516 knee arthroscopies showed 4% of knees with Grade IV osteoarthritis [11]. Of these, 21% had osteoarthritis at the patella and 15% at the trochlea. Patellofemoral osteoarthritis occurs in 89% at the lateral facet [20]. Other studies also have shown patellofemoral osteoarthritis most frequently involves the lateral facet [6, 14]. Valgus alignment increases the risk for progression of osteoarthritis in the lateral patellofemoral compartment. In addition to leg alignment, other factors such as patella or trochlea dysplasia, tibial malrotation, or direction and magnitude of quadriceps loading may play a role [21].

The typical presentation of patellofemoral osteoarthritis on radiographs begins with joint space narrowing at the lateral facet. Later, the lateral facet remodels into a concave shape and starts to ride over the lateral femoral condyle. Based on this pathologic feature, our surgical procedure was planned.

In this case series, lateral facetectomy and medialization of the tibial tubercle were performed to reduce pressure at the lateral patellofemoral compartment and to improve the position of the patella to the center of the trochlea groove by changing the concave lateral facet to a more plane shape. Biomechanical investigations have shown that after medial tubercle transfer, the peak contact pressure shifts toward the medial facet.

Therefore, the purpose of this study was to assess the impact of combined lateral facetectomy, lateral release, and medialization of the tibial tubercle on short-term clinical and radiographic outcomes. We hypothesized that this technique will improve radiographic alignment of the patellofemoral alignment and patient satisfaction would be improved as assessed by the WOMAC and McCarroll scores.

Materials and Methods

This is a prospective study of 51 consecutive knees in 50 patients who received a partial lateral facetectomy of the patella associated with lateral retinacular release and medialization of the tibial tubercle (Table 1). All patients reported patellofemoral pain, which was the result of osteoarthritis before surgery. The pain caused considerable limitation in activity. We attempted conservative treatment such as stretching, muscle strengthening, patella mobilization, and antiinflammatory medication in all patients for at least 6 months without patient satisfaction. All patients presented with joint space narrowing of Grades III and IV at the lateral aspect of the patellofemoral joint before surgery. Only minor concomitant narrowing (Grade I or II) was present at the medial or lateral tibiofemoral compartment in accordance with the grading by Ahlbäck [2] (Table 2). None of the patients had a history of patella fracture. The minimum followup was 7 months (mean, 20.2 months; range, 7–32 months).

We performed this surgical procedure with the patient supine on a radiolucent operating room table and a tourniquet was inflated to 350 mm Hg on the affected leg. We performed a paramedian longitudinal skin incision over the patella for partial lateral facetectomy as described by Yercan et al. [40]. The lateral retinaculum was exposed

Table 1. Mean and range of the age and body mass index of the patients

Number of patients	Age (years)	Body mass index (kg/mm ²)
50	Mean, 60.1	Mean, 29.1
Female: 36	Range, 46–81	Range, 21–39
Male: 14		

Table 2. Radiographic findings at the femorotibial joint preoperatively and at followup according to Ahlbäck [2] classification

Classification by Ahlbäck	Preoperatively	At followup
Grade 1	24	20
Grade 2	27	28
Grade 3	0	3
Grade 4	0	0

and incised from the superior to the inferior pole of the patella along the lateral bony rim. We elevated the retinaculum and periosteum from the lateral aspect of the patella. A Lambott chisel was placed between the patella and trochlea for cartilage protection. For partial lateral facetectomy, we osteotomized the patella in the sagittal plane running slightly oblique from lateral to medial using a power saw. The synovium was closed and the lateral retinaculum remained divided. We medialized the tibial tubercle using a modified technique of Elmslie and Trillat [9, 10]. A second longitudinal skin incision was performed in line with the first incision more distally to expose the tibial tubercle. We placed two small Homan retractors over the tubercle to protect the skin and subcutaneous tissue. The periosteum was incised at the medial border of the tibial tubercle followed by the osteotomy. The lateral tibia periosteum remained intact. After the osteotomy, the periosteum at the lateral side of the tibial tubercle was mobilized. The tibial tubercle was medialized 10 mm and temporarily fixed with a Kirschner wire. As a result of the oblique osteotomy according to Fulkerson's technique [15], the medial displacement is accompanied by slight anterior displacement of the tibial tubercle. Patella tracking was examined throughout the range of motion to avoid overcorrection. The tibial tubercle then was fixed with two 4.5-mm cortical screws and the wound was closed in a standard layered fashion. Surgery was performed by three senior orthopaedic surgeons (WN, MR, RB) at the university department.

Postoperative rehabilitation consisted of continuous passive motion starting Postoperative Day 1 without limitation. Partial weightbearing was allowed for 6 weeks. At 6 weeks postoperatively, radiographs were obtained and full weightbearing was allowed provided the osteotomy of the tibial tubercle was fully healed.

The patients were assessed preoperatively and postoperatively with the WOMAC score [4]. The score was translated and validated into German by Stucki et al. [38] and consists of three main categories: pain, stiffness, and function. The scoring system described by McCarroll et al. also was used at followup [27]. The score is used especially for evaluation of the patellofemoral joint and combines physical findings and patella symptoms and consists of

60% subjective and 40% objective criteria. Patient-reported symptoms such as pain at rest; pain during sitting, walking, running, or stair climbing; episodes of locking or catching; and crepitation are considered in calculating this score. Patients without any of these symptoms were rated with 15 points. Physical findings such as tenderness at the center of the patella or at the medial or lateral facet, effusion, crepitation, quadriceps atrophy, or limitation of motion and limp also are evaluated. Patients with any of these clinical signs were rated with a maximum of eight points. The clinical assessment was performed by an independent examiner (AH) who had not seen the patients previously.

The radiologic evaluation was based on 45° postero-anterior flexion weightbearing views [32] lateral views, and the 45° axial view, which were taken preoperatively and at followup [17]. A TelosTM (Telos-GmbH, Marburg, Germany) device was used to take reproducible axial views. The axial view in 45° knee flexion is recommended to guarantee a reproducible and reliable setting [29]. The sensitivity for assessment of the patellofemoral disorder was shown to be greater with the axial view (52.5%) compared with the lateral view (30%) [7]. The xray beam has to be perpendicular to the film plane to avoid distortion of the image. We assessed the medial and lateral compartments by measuring the shortest distance between the femur and tibia and classified the joint space according to Ahlbäck [2] using the posteroanterior 45° weightbearing view. Joint line obliteration was divided into four grades: no obliteration of the joint space (Grade I), less than 50% obliteration (Grade II), greater than 50% obliteration (Grade III), and complete joint space obliteration (Grade IV). In the lateral view, the Insall-Salvati index [19] was used to describe patella position based on the length of the patella tendon (LT) divided by the diagonal length of the patella (LP). A ratio (LT/LP) of less than 0.80 or greater than 1.2 is considered indicative of patella infera or patella alta, respectively.

Preoperative radiographic evaluation revealed a patella shape in accordance to Wiberg Type 1 in 33 patients and Type 2 in 15 patients. Two patients had a so-called “Hunter’s cap” (Jägerhut).

The skyline view was used to define patellofemoral alignment. The patella shape was classified according to Wiberg and Baumgartl [39]. The sulcus angle was used to measure the depth of the trochlea. According to Merchant [28], an angle of approximately $138^\circ \pm 6^\circ$ is considered normal. The congruence angle measures the position of the patella in relation to the center of the trochlea groove. Medial and lateral displacement is independent on leg rotation [30]. The patellofemoral index provides information regarding the thickness of the medial and lateral patellofemoral space. The smallest distance was measured

Table 3. Subjective assessment of the patients preoperatively and postoperatively using the WOMAC score

WOMAC	Preoperative	At followup	p Value
Pain	6.32 ± 2.2 (range, 1–10)	3.98 ± 2.57 (range, 1–10)	< 0.001
Stiffness	2.25 ± 3.4 (range, 0–8.5)	2.35 ± 3.05 (range, 0–9)	0.896
Function	6.04 ± 2.32 (range, 1–10)	4.41 ± 2.66 (range, 1–10)	< 0.001

Values are mean ± standard deviation.

between the medial and lateral facet of the patella to the medial and lateral aspect of the trochlea, respectively.

Data are reported as mean and range. The Wilcoxon test was used to determine differences between the preoperative and postoperative clinical and radiographic outcomes. Variables were measured using a simple linear correlation by Pearson. The level of statistical significance was set to an alpha level of $p < 0.05$. All data were analyzed with the SPSS statistical package (release 11.0; SPSS Inc, Chicago, IL).

Results

No malunion of the tibial tubercle occurred. At the last followup, none of the patients had required revision knee surgery.

Pain and function improved considerably according to the WOMAC score (Table 3). Thirty-seven patients assessed their knee as improved, nine as unchanged, and four as worse with respect to pain. Stiffness was not affected by the surgical procedure ($p = 0.896$). No correlation was found among the followup time, the age, body mass index, and the WOMAC score (Table 4). Patients with a Type 1 patella assessed their knee as better in the pain and function category according to WOMAC after surgery (Table 5). The postoperative congruence angle did not correlate with the pain category ($r = 0.23$, $p = 0.1$). However, with respect to function, the postoperative congruence angle showed good correlation ($r = 0.319$, $p = 0.027$). The McCarroll score was 12.1 points (range, 1–20) of a maximum of 23 points at followup. No correlation between patient age and the McCarroll score was noted (Fig. 1).

The patellofemoral index decreased considerably after surgery (Table 6). The sulcus angle was not affected by the procedure ($p = 0.558$). The Insall-Salvati index also decreased considerably at the time of followup compared with the preoperative index (Table 6). However, the position remained within the physiologic range. The congruence angle decreased ($p = 0.001$) by 12.5° postoperatively, but stayed out of the physiologic range.

Table 4. Correlation of the followup, body mass index, and age with the WOMAC score

WOMAC	Followup	Body mass index	Age
Pain	$r = 0.062$; $p = 0.674$	$r = 0.12$ $p = 0.42$	$r = -0.21$; $p = 0.15$
Function	$r = -0.284$; $p = 0.06$	$r = 0.04$; $p = 0.77$	$r = -0.68$; $p = 0.65$
Stiffness	$r = 0.140$; $p = 0.343$	$r = 0.24$; $p = 0.12$	$r = -0.12$; $p = 0.48$

Table 5. Comparison of the WOMAC score in relation to Wiberg Type 1 or Type 2

WOMAC	Wiberg Type 1	Wiberg Type 2	p Value
Pain	3.7 ± 2.26 (range, 1–7)	4.6 ± 3.3 (range, 1–10)	0.039*
Function	2.3 ± 3.01 (range, 0–8)	2.6 ± 3.4 (range, 0–9)	0.647
Stiffness	4.3 ± 2.4 (range, 1–10)	4.9 ± 3.3 (range, 1–10)	0.037*

Values are mean $\pm$ standard deviation; *significance level $p < 0.05$.

Fig. 1 The number of points based on the McCarroll score was plotted against the patient's age. No correlation was noted ($r = 0.2$, $p = 0.174$).

The posteroanterior weightbearing view showed a medial joint space of 5.2 mm (range, 3–8 mm) preoperatively and 4.8 mm (range, 1–8 mm) at followup ($p = 0.018$). No significant ($p = 0.78$) progressive joint space narrowing was noted in the lateral joint with 6.4 mm (range, 3–8 mm) preoperatively and 6.3 mm (range, 3–8 mm) at followup. According to the Ahlbäck grading system, progression of joint degeneration was seen in four knees (Table 2).

Discussion

In this study, a partial lateral facetectomy and transfer of the tibial tubercle was performed for two reasons. First, patients with advanced osteoarthritis at the lateral patellofemoral joint have alterations of the subchondral bone associated with osteophytes, which cause the lateral facet to appear concave. Second, considerable variation in the surface geometry of the articular cartilage and the

Table 6. Values of angles measured in the axial view

Radiographic measurements	Preoperative	At followup	p Value
Sulcus angle	$140.4^\circ \pm 9^\circ$ (range, 113° – 156°)	$141^\circ \pm 8.9^\circ$ (range, 113° – 156°)	0.558
Congruence angle	$37^\circ \pm 26^\circ$ (range, -20° – 60°)	$24.5^\circ \pm 29.2^\circ$ (range, -22° – 65°)	0.001
Patellofemoral index	38.6 ± 42.9 (range, 2–120)	12.4 ± 25.5 (range, 1–80)	< 0.001
Insall-Salvati index*	1.14 ± 0.18 (range, 0.81–1.32)	1.08 ± 0.16 (range, 0.69–1.43)	0.01

Values are mean $\pm$ standard deviation; *the Insall-Salvati index was measured in the lateral view.

corresponding subchondral bone has been observed by computed tomography (CT) and MRI [36]. Cartilage thickness is 1.25 ± 3.26 mm at the apex of the patella and 1.38 ± 2.8 mm at the trochlea groove, estimating a total thickness of 2.63 mm. Loss of cartilage at the lateral facet will shift the patella more laterally and causes tilt (Fig. 2A). Increased pressure will occur at the lateral facet while overriding the lateral femoral condyle. Isolated partial lateral facetectomy does not realign the patella in the trochlea groove [40]. Similarly, isolated transfer of the tibial tubercle may be insufficient because of the congruency between the concave shape of the lateral facet and the convex shape of the lateral condyle. When the lateral facet is overriding the convex lateral condyle, it does not allow for recentralization of the patella into the trochlea groove (Fig. 2B). Thus, partial lateral facetectomy and medialization of the tibial tubercle was performed as a combined procedure.

Surgery was performed in active middle-aged patients in hopes of delaying partial or total joint arthroplasty. In contrast, elderly patients with patellofemoral osteoarthritis do better after TKA than after patellofemoral replacement or débridement procedures [23]. Nevertheless, TKA in patients with severe patellofemoral osteoarthritis more often requires patella realignment procedures and there is an increased risk of impaired knee function [31]. Thus, surgical management in younger active patients remains questionable.

The patients in this study were evaluated after a mean of 20 months. The short followup does not allow us to provide

Fig. 2A–B Radiographs were taken in the axial view of the patellofemoral joint (A) before surgery and at (B) followup.

any general recommendations regarding the surgical technique. However, the patients in our study showed considerable improvement in pain and function according to the WOMAC score. In contrast, studies after isolated partial lateral facetectomy solely reported considerable improvement based on the Knee Society score [40] and good and moderate results in 90% [26] of the patients after 8 and 2 years, respectively, which is better compared with the results of the current study. However, the number of patients was much smaller in both studies. According to scoring system of McCarroll et al., only 45% of our patients were satisfied. A comparable success rate of 61% was reported after facetectomy at a followup of 3.9 years in their study [27].

Despite incomplete realignment of the patellofemoral joint, the postoperative congruence angle correlated well with knee function according to the WOMAC score. Patients scored their function better when they obtained a lower and more natural congruence angle.

Most of the radiographic parameters did not correlate with the clinical outcome based on the WOMAC score. Other investigators also have reported the radiographic appearance does not always correlate with the clinical symptoms [5, 40]. This may be one of the reasons so many

surgical techniques such as débridement [13], microfracture [16], lateral release [1], trephine and drilling [27], isolated lateral facetectomy of the patella [40], transfer of the tibial tubercle [9, 10, 34], patellectomy [24, 25], patellofemoral arthroplasty [3, 4], or even TKA [23] are recommended. An assumption is that other structures of the knee, which were not addressed by the current treatment protocol, may have contributed to pain sensation such as the synovial tissue, the patellar fat pad, or the medial or lateral joint capsule. The effect of muscle force on patellar tracking also plays an important role [21]. Neurosensory mapping of the internal knee structures showed no sensation on the patella cartilage surface [12]. In contrast, the anterior synovial tissue, the fat pad, and the capsule were the most sensitive sites in the knee. This phenomenon might partially explain why there is poor correlation between the degree of patellar chondromalacia and malpositioning and clinical outcome based on the subjective assessment. Soft tissue balancing and the degree of synovitis might play an important role in clinical symptoms. Body mass index did not show any effect on clinical outcome as already shown in other studies [35, 37].

The Maquet procedure is also common in patients with patellofemoral osteoarthritis [34]. Long-term followup showed 80% good results, and tibial tubercle elevation of 20 mm to reduce patellofemoral joint pressure was recommended. Reduction of the patellofemoral pressure at the lateral facet also was observed after 10 mm of medialization of the tibial tubercle [22]. Others have recommended medial displacement greater than 20 mm [18]. Computer simulations of patellofemoral joint surgery have been used to study the effect of anterior and antero-medial tubercle transfer on patients with subluxation and osteoarthritis of the patellofemoral joint [8]. There was a considerable decrease in contact stress in all simulated operating procedures with no difference between different surgical techniques.

Computed tomography scanning before surgery to determine the tibial-tuberosity-trochlea groove (TT-TG) distance was not performed, which might be another limitation of this study. It remains unclear whether subluxation of the patella was caused solely by lateral patellofemoral osteoarthritis or by an increased TT-TG distance. However, to our knowledge and according to the patients' charts, none of the patients experienced patella dislocation throughout their life. The patellofemoral congruence angle improved in our study patients but remained outside the physiologic range. Based on the results, a CT scan should be strongly recommended before surgery to be able to quantify the need for tibial tubercle transfer.

Patients with a Type 1 patella did better after surgery than patients with Type 2 with respect to pain and stiffness category based on the WOMAC score. One may assume

that as a result of the larger medial facet in Type 1 patellae, peak contact pressures might be lower than in Type 2 patellae.

Medial tubercle transfer has to be performed with caution because of the development of a patella infera as shown in this study. Others have reported similar results [33]. Patella infera may increase patellofemoral contact pressure. Yet, the decrease of the Insall-Salvati index in this study remained in the physiologic range.

Some improvement of patellofemoral symptoms were seen in the majority of patients. However, compared with other surgical procedures such as isolated facetectomy or tibial tubercle transfer, the clinical results seem to be inferior. Based on the clinical and radiologic findings, we cannot recommend the combined surgical procedure in isolated patellofemoral osteoarthritis of young and middle-aged patients. Longer-term followup studies are required to evaluate the progression of osteoarthritis and the clinical results.

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