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Revision surgery for failed medial patellofemoral ligament reconstruction results in better disease-specific outcome scores when performed for recurrent instability than for patellofemoral pain or limited range of motion

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Abstract

Purpose Medial patellofemoral ligament reconstruction (MPFL-R) is an important treatment for recurrent patellar instability. Although complications such as redislocation, patellofemoral pain (PFP) and restricted knee range of motion have been reported, few studies have investigated the results of revision surgery for failed MPFL-R. Thus, the aim of this study was to determine the results of the tailored revision surgery after considering the cause of the reconstruction failure.

Materials and methods Between 2015 and 2019, 28 patients (male/female 9/19; age 26.2 ± 6.4 years) underwent revision surgery for failed MPFL-R. The patients were grouped into the "recurrent instability" (SG1) group and "PFP" and/or "restricted range of motion" (SG2) group. Preoperatively, the clinical data, anatomical risk factor profile, and position of the femoral MPFL tunnel were determined for each patient. The Banff Patella Instability Instrument 2.0 (BPII 2.0) and numerical analogue scale (NAS 0–10) were administered preoperatively and at the final follow-up for the subjective assessment of the PFP and knee joint function.

Results Overall, the BPII 2.0 score improved from 28.8 ± 16.6 points preoperatively to 68.0 ± 22.7 points ($p < 0.0001$) postoperatively. SG1 exhibited an increase in the BPII 2.0 score from 28.9 ± 20.2 points to 75.7 ± 23 points ($p < 0.0001$). PFP decreased from 6.8 ± 2.4 to 1.6 ± 1.9 ($p < 0.0001$), while the knee joint function increased from 4.3 ± 2.5 to 8.8 ± 1.6 ($p < 0.0001$). In SG2, the BPII 2.0 score increased from 28.7 ± 12.6 points preoperatively to 57.7 ± 19.7 points ($p = 0.0002$) postoperatively and was thus significantly lower than that in SG1 ($p = 0.038$). The intensity of PFP decreased from 6.6 ± 3.0 preoperatively to 2.1 ± 1.9 postoperatively ($p = 0.0006$), while the subjective knee joint function improved from 3.2 ± 1.4 preoperatively to 7.6 ± 2.3 postoperatively ($p < 0.0001$). The differences between the groups were not significant.

Conclusion Tailored revision surgery for failed MPFL-R significantly improves the patient-reported disease-specific quality of life. The study results indicate that patients undergoing revision surgery as a consequence of patellar redislocation appear to benefit more from revision surgery than those patients undergoing revision due to postoperative PFP and/or a limited knee joint range of motion.

Level of evidence Level IV.

Keywords MPFL · Patellar instability · Complication · Revision surgery

Introduction

Reconstruction of the medial patellofemoral ligament is an established procedure in the surgical management of patients with recurrent patellar instability [21]. When properly performed, MPFL reconstruction (MPFL-R) yields significant improvements in the functional outcome scores and is associated with a low risk of patellar redislocation [11, 15, 29]. In addition, MPFL-R has become increasingly helpful for

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patients with a primary patellar dislocation [13] and allows approximately 85% of patients to return to sports and 68% of this subgroup of patients to return to their preoperative level of athletic performance [17, 18].

The overall complication rate after MPFL-R, however, has been reported to range from 16 to 30% [26, 27], and the incidence of revision surgery has been reported to range from 1.2 to 2.4% [11, 16, 24, 27]. While a large number of complications can be explained by technical errors (i.e. malpositioning of the femoral tunnel, graft overtensioning) [34], it has been confirmed that postoperative clinical outcomes are negatively influenced by predisposing pathoanatomic factors of patellar instability that are not corrected (i.e. trochlear dysplasia, patella alta, femoral torsion, etc.) [4, 12, 16, 30, 31, 34].

Common complications following MPFL-R are a limited knee joint range of motion (ROM), patellofemoral pain (PFP), and recurrent patellar dislocation or subluxation [4, 26, 27]. In a previous study, it was shown that revision surgery for failed MPFL-R, including the correction of bony pathoanatomic risk factors, could yield favourable clinical and functional outcome scores [34]. However, we noticed variance in the postoperative results [34]. Therefore, the aim of this study was to determine the results of revision surgery for failed MPFL-R in an extended patient cohort considering the three major complications after primary MPFL-R (i.e. limited knee joint ROM, PFP, and recurrent patellar dislocation). The hypothesis was that patients undergoing reoperation for recurrent instability would benefit more from revision surgery than patients who are undergoing revision surgery for postoperative PFP and/or limited knee joint ROM. This information would be useful in counselling patients towards the expected success of the revision surgery.

Materials and methods

This is a retrospective analysis of a longitudinally maintained database, which was approved by the ethics committee in Baden-Württemberg, Germany (F-2019-070). Between 2015 and 2019, revision surgeries were performed in a total of 28 patients (male/female 9/19; age 26.2 ± 6.4 years) due to complications following MPFL-R. The following conditions were considered complications that led to revision surgery: (1) clinically confirmed patellar redislocation or subluxation, (2) limited knee joint ROM that is persistent (maximum knee joint flexion ≤ 110°) after intensive physiotherapy (6-month period), and/or (3) postoperative PFP (numerical analogue scale (NAS) ≥ 5 (0–10)) persisting after conservative treatment in the presence of predisposing anatomical risk factors [34]. Patients who underwent surgical procedures other than MPFL-R in the past and patients who did not have a history of patellar instability and were treated with primary MPFL-R due to PFP were excluded [34].

The preoperative assessment included a detailed medical history and a thorough physical examination, including the evaluation of patellar stability in various degrees of knee joint flexion by the reversed dynamic patellar apprehension test (ReDPAT) [32]. Furthermore, the physical examination included an evaluation of the long axis of the leg with a focus on varus/valgus and torsional malalignment, the measurement of the knee joint ROM (using goniometer), and an evaluation of the J-sign (graded on a scale of I–III according to the method described by Zhang et al. [31]). All clinical examinations were performed by the first author and by the senior author of this study, and agreement was reached by consensus.

Radiographic imaging scans were conducted in all patients, including (1) anteroposterior standing long leg radiography, (2) true lateral knee joint radiography, and (3) magnetic resonance imaging (MRI) investigations of the affected knee. Additionally, torsional MRI scans were performed in cases with a clinically important rotational malalignment. The radiographic evaluation of the pathoanatomic risk factors for patellar instability included an assessment of the severity of trochlear dysplasia performed according to the method described by Dejour et al. (Dejour type A: mild dysplasia; Dejour types B–D: severe dysplasia) [10]. Patellar height was assessed according to the method described by Caton–Deschamps [8], and index values > 1.2 were considered to indicate patella alta. The distance between the tibial tuberosity and the trochlear groove (TT–TG) and the distance between the tibial tuberosity and the posterior cruciate ligament insertion (TT–PCL) were considered high when the values were > 16 and > 24 mm, respectively [3, 4, 25]. Clinically relevant valgus malalignment was considered when the values were ≥ 4° in the standing long leg radiograph. In addition, the accuracy of the femoral tunnel placement after MPFL-R was assessed in all of the included patients by determining the distance between the centre of the tunnel and the centre of the Schöttle point on the true lateral radiographs. This distance was considered pathological when the value was > 10 mm according to the method described by Hiemstra et al. [15].

Surgical correction of trochlear dysplasia was performed in cases with severe trochlear dysplasia (type B/D according to Dejour), with a positive ReDPAT ≥ 50° [32] and a high-grade J-sign (grades II–III) [31] as previously published [34]. Transfer of the tibial tuberosity (TTO) was considered when the TT–TG distance exceeded ≥ 20 mm, the TT–PCL distance exceeded ≥ 24 mm, and/or when the Caton–Deschamps index was ≥ 1.3. Femoral torsion was corrected by a derotational femoral osteotomy when the antetorsion exceeded 25°. Valgus correction was performed when the genu valgum value was ≥ 4°.

Table 1 Demographics, anatomical parameters and femoral tunnel malpositioning results for SG1 and SG2

	SG1 $n=16$	SG2 $n=12$
Trochlear dysplasia absent/mild/severe	1/8/7	7/3/2
Caton–Deschamps index	1.2 ± 0.3 (0.8–1.7)	0.9 ± 0.2 (0.7–1.2)
TT–TG distance (mm)	12 ± 6 (3–19)	12 ± 4 (5–18)
TT–PCL distance (mm)	18 ± 5 (6–23)	20 ± 4 (14–25)
Genu valgum (°) or varum (− °)	2 ± 2	− 1 ± 4
Tunnel malpositioning (> 10 mm)	4 (25%)	7 (58%)

TT–TG tibial tuberosity–trochlear groove, *TT–PCL* tibial tuberosity–posterior cruciate ligament

The mean values ± standard deviations are shown

The 28 included patients underwent revision surgery at a mean of 31.2 ± 22.9 (6–72) months after the primary MPFL-R. Sixteen patients (male/female 6/10; age 22.3 ± 3.5 years) underwent revision due to recurrent patellar instability, and 12 patients (male/female 3/9; age 31.4 ± 5.7) underwent revision due to PFP and/or a limited ROM (Table 1). The types of revision surgeries performed included revision medial patellofemoral ligament reconstruction (rMPFL-R), tibial tubercle osteotomy (TTO), release of the MPFL-R, deepening trochleoplasty and femoral derotation or varization osteotomy (Table 2).

For the evaluations, the validated Banff Patellofemoral Instability Instrument 2.0 (BPII 2.0) [6] was used to assess the patient-reported disease-specific quality of life (QOL) before surgery and at the final follow-up. A numerical analogue scale (NAS; 0–10 points) was used to assess the intensity of the PFP (0 = no pain; 10 = most severe pain) and subjective knee joint function (0 = severely restricted; 10 = normal function) preoperatively and again at the final follow-up. In addition, the patellar redislocation rate and knee joint ROM were assessed pre- and postoperatively. The responses to the BPII 2.0 and assessment of pain and function were made in the presence of an examiner, and appropriate instructions were given to the patients.

According to the underlying complication that led to the revision surgery, the patient cohort was divided into subgroup 1 (SG1), which included patients experiencing patellar redislocation or subluxation, and subgroup 2 (SG2), which included patients complaining of PFP and/or a reduced ROM. Patients with PFP and/or a reduced ROM were included in the SG2 because these two complications frequently occurred concurrently.

Statistical analysis

The normality of the continuous data was assessed, and the data are presented as the means ± standard deviations (ranges). Categorical and dichotomous data are presented as frequencies. The unpaired and paired two-tailed t-tests were used to assess the differences between the pre- and postoperative clinical data and between SG1 and SG2. All analyses were performed using GraphPad Prism (version 4; GraphPad Software, San Diego, CA, USA). The significance level was set at 0.05. A post hoc power analysis for the difference between two independent means (*t* test) was performed with G*Power Software (Version 3.1.3). With the given sample size of $n=28$, an alpha error probability of 0.05, and the calculated Effect size $d=0.85$, the achieved power (1-beta error probability) was 0.71 (one tailed) and 0.58 (two tailed), respectively.

Table 2 The revision surgery procedures performed in SG1 and SG2

	SG1 $n=16$	SG2 $n=12$
rMPFL-R	5 (31%)	3 (25%)
MPFL-Release	–	4 (33%)
rMPFL-R + TTO	1 (6%)	1 (8%)
rMPFL-R + deepening trochleoplasty	4 (25%)	2 (16%)
rMPFL-R + TTO + deepening trochleoplasty	3 (19%)	–
Varization or derotational Osteotomy	3 (19%)	2 (16%)

rMPFL-R revision medial patellofemoral ligament reconstruction, *TTO* tibial tubercle osteotomy

The absolute and relative values are shown

Results

Overall, the BPII 2.0 score improved from 28.8 ± 16.6 points preoperatively to 68.0 ± 22.7 points ($p<0.0001$) postoperatively. SG1 exhibited an increase in the BPII 2.0 score from 28.9 ± 20.2 points preoperatively to 75.7 ± 23.0 points postoperatively ($p<0.0001$). The NAS for PFP decreased from 6.8 ± 2.4 points to 1.6 ± 1.9 points ($p<0.0001$), while the NAS for knee joint function increased from 4.3 ± 2.5 points to 8.8 ± 1.6 points ($p<0.0001$).

In SG2, the BPII 2.0 score increased from 28.7 ± 12.6 points preoperatively to 57.7 ± 19.7 points ($p=0.0002$)

postoperatively and was, thus, significantly lower than the scores in SG1 ($p = 0.038$). The intensity of pain decreased from 6.6 ± 3.0 points preoperatively to 2.1 ± 1.9 points postoperatively ($p = 0.0006$), while the subjective knee joint function improved from 3.2 ± 1.4 points preoperatively to 7.6 ± 2.3 points postoperatively ($p < 0.0001$), and the differences between SG1 and SG2 were not significant (n.s.) (Fig. 1a–c).

Recurrent patellar dislocations were not observed during the follow-up, but 3 patients in SG1 complained of temporary patellar subluxations. In SG1, the knee joint flexion angle averaged $117 \pm 30°$ preoperatively and reached $132 \pm 8°$ postoperatively (n.s.). In SG2, the knee joint flexion angle was limited to $103 \pm 27°$ prior to the revision surgery and improved to $126 \pm 8°$ postoperatively ($p = 0.012$). Again, the postoperative differences between SG1 and SG2 were not significant.

Discussion

The most important finding of the present study was that tailored revision surgery for failed MPFL-R yielded significant improvements in the patient-reported outcome measures. In addition, the patients who underwent a revision surgery due to recurrent patellar instability achieved higher QOL score values measured by the BPII 2.0 than the patients who underwent a surgical revision due to PFP and/or a limited knee joint ROM. However, the subjective ratings of postoperative pain and knee joint function did not differ between the groups.

MPFL-R with an autologous tendon graft has become an established surgical procedure for recurrent patellar instability. Numerous studies have demonstrated good clinical results with low redislocation rates [21]. Although the overall complication rate following MPFL-R has been reported to range between 16 and 30% [26, 27], few studies have

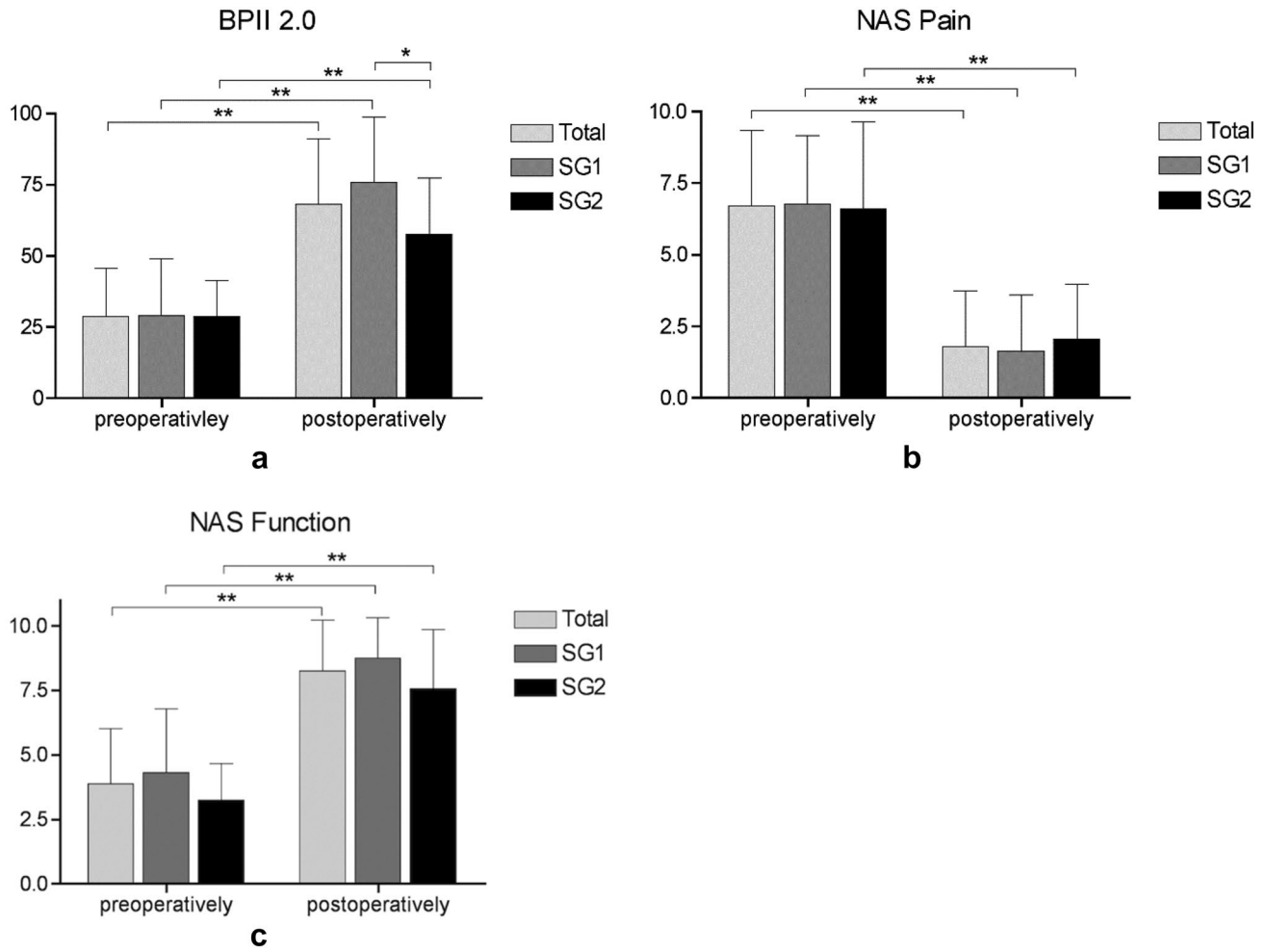

Fig. 1 **a**–**c** The preoperative and postoperative scores for the entire patient cohort and subgroups SG1 and SG2 regarding **a** BPII 2.0, **b** NAS for pain, and **c** NAS for function

investigated the results of revision surgery [9, 20]. In addition to patellar redislocation, PFP and limited knee joint ROM are considered functional MPFL-R failures, which can lead to considerable disability in everyday life and during athletic activities [34].

PFP and limited knee joint ROM occurred concurrently in 12 out of 28 (42.8%) patients, and these patients were thus included in SG2. In 7 patients (58% of SG2), revision (r)MPFL-R and MPFL-R release were performed due to technical errors, mainly involving the misplacement of the femoral tunnel, either proximal and/or ventral. In particular, a proximally or ventrally misplaced femoral tunnel may lead to the overtensioning of the MPFL graft, resulting in a painful knee flexion deficit [23], an increased retropatellar contact pressure [28] and PFP [22]. Hiemstra et al. showed that a deviation of the centre of the femoral tunnel of > 10 mm from the Schöttle point was associated with worse patient-reported outcomes, although this finding is not consistent with other studies in the literature [15]. This correlation is in accordance with the results observed in the current study. In this subgroup, the anatomical risk factors were judged to be significant enough to require surgical correction for the sake of PFP relief in five patients (42%). The types of corrections performed included TTO distalization, varization/derotational osteotomy, and deepening trochleoplasty in addition to rMPFL-R. Although trochleoplasty surgery has been primarily reserved for the treatment of patellar instability, a recent study demonstrated that in a subgroup of patients with PFP and severe trochlear dysplasia, deepening trochleoplasty and concomitant realignment procedures can significantly reduce pain and improve subjective knee joint function [33].

Recurrent instability (SG1) was mainly associated with the prevalence of anatomical risk factors (69%; Table 2). Malpositioning of a femoral drill channel was found in 31% ($n = 5$) of patients. It has been shown in the past that the pathoanatomic risk factors for patellar instability negatively influence the functional outcomes of conservative treatment and isolated MPFL-R [2–4, 12, 14, 16, 30]. In particular, a severe dysplastic trochlea is considered one of the most significant risk factors for poor clinical outcomes after isolated MPFL-R [3, 4, 14], with failure rates up to 7% [4]. Conversely, revision surgery for MPFL-R failure, including the correction of major anatomical risk factors, has been shown to yield a significant improvement in the BPII 2.0 outcome measures [34].

A recent study found that the distance from the tibial tubercle to the lateral trochlear ridge was significantly associated with recurrent patellar instability in a paediatric population [29]. There is still no clear consensus in the current literature on whether an increase in the TT–TG and TT–PCL distances affect the outcomes of MPFL-R [12, 16, 19]. In our study, we did not observe an increased TT–TG/TT–PCL distance to be a reason for the MPFL-R failure. However, patella alta was present in five patients and was deemed worthy of correction by TTO distalization. Although the effect of patella alta on the postoperative outcomes is also unclear based on the currently available literature, there are a few reports that suggest that a high-riding patella (Caton–Deschamps index > 1.3–1.4) is a predictor of poor MPFL-R outcomes [5, 7].

This study aimed to examine the patient-reported disease-specific QOL of patients who had revision surgery for failed MPFL-R with regard to the clinical complications leading to revision surgery. While patients with recurrent patellar instability after MPFL-R seem to benefit well from revision surgery, this does not seem to be as successful for patients with PFP and a limited knee joint ROM. This information is helpful in advising patients towards the expected success of the revision surgery. However, the results of this study must be interpreted in light of several limitations: (1) Only the short-term results of a small cohort of patients are presented in this study. However, no study that evaluated a larger sample size of MPFL-R failures was known to us. (2) The majority of primary MPFL-R surgeries were conducted outside of our institution ($n = 24$), so it was not possible to determine exactly what the initial findings were that led to the decision to proceed with an isolated MPFL reconstruction. (3) In every patient, the clinical assessment of femoral and tibial torsion was performed, but only the patients with abnormal findings underwent a torsional MRI investigation. Finally, the postoperative evaluation was performed using a disease-specific QOL questionnaire (BPII 2.0), NAS assessment to evaluate pain and the knee joint function, and we assessed the ROM. However, the results were neither verified by functional testing nor correlated with another outcome score. However, the BPII 2.0 is considered the most decisive and recommended score for evaluating patients with patellofemoral instability [1].

Conclusion

Tailored revision surgery for failed MPFL-R significantly improves the patient-reported disease-specific quality of life. The study results indicate that patients undergoing revision surgery as a consequence of patellar redislocation appear to benefit more from the revision surgery than those patients who are undergoing a revision due to postoperative PFP and/or a limited knee joint range of motion.

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Declarations

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval This study was approved by the ethics committee of the medical council Baden-Württemberg, Germany (F-2019-070).

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