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Journal

The American Journal of Sports Medicine, 47(1)

ISSN

0363-5465

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Publication Date

2019

DOI

10.1177/0363546518808486

Peer reviewed

PODCAST 5-in-5

Recurrence of Patellar Instability in Adolescents Undergoing Surgery for Osteochondral Defects Without Concomitant Ligament Reconstruction

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Background: First-time patellar dislocation with an associated chondral or osteochondral loose body is typically treated operatively to address the loose fragment. The incidence of recurrent instability in this patient population if the medial patellofemoral ligament (MPFL) is not reconstructed is unknown.

Purpose: To determine the recurrent instability rate in patients undergoing surgery for patellar instability with chondral or osteochondral loose bodies, as well as to identify and stratify risk factors for recurrent instability.

Study Design: Case series; Level of evidence, 4.

Methods: This was a retrospective analysis of adolescent patients treated operatively for acute patellar dislocation with associated chondral or osteochondral loose bodies between 2010 and 2016 at a single pediatric level I trauma center with minimum 2-year follow-up. Potential demographic, injury-related, radiographic, and surgical risk factors were recorded. The primary outcome variable was recurrent subluxation and/or dislocation. Secondary outcome variables included need for additional procedures, Kujala score, Single Assessment Numerical Evaluation (SANE) score, and patient satisfaction.

Results: Forty-one patients were included. In total, 61% experienced recurrent instability at a mean follow-up of 4.1 years and 39% required subsequent MPFL reconstruction. Tibial tubercle-trochlear groove (TT-TG) distance greater than 15 mm was a risk factor for recurrent instability ($P = .03$). Patients with TT-TG distance greater than 15 mm and greater than 20 mm had recurrent instability rates of 75% and 86%, respectively. MPFL repair did not reduce the rate of recurrent instability ($P = .87$). Recurrent instability was associated with significantly worse mean Kujala (93.9 vs 83.0; $P = .01$), SANE (88.9 vs 73.1; $P = .01$), and patient satisfaction scores (9.4 vs 7.3; $P = .002$).

Conclusion: If the MPFL is not reconstructed during index loose body treatment, children have a 61% recurrent instability rate. Patients with TT-TG distance greater than 15 mm, and particularly greater than 20 mm, are at highest risk for recurrent instability.

Keywords: patellar dislocation; patellofemoral instability; osteochondral defect; loose body

Patellar instability is the most common cause of acute knee hemarthrosis in children.[1] While the vast majority of patients sustaining a first-time patellar dislocation are treated nonoperatively, 15% to 44% of these patients will experience recurrent instability.[8,13,23] In certain high-risk groups, including the skeletally immature and those with patella alta and trochlear dysplasia, the incidence of recurrent instability may be as high as 88%.[10] This relatively high rate of recurrence with nonoperative management, along with the excellent outcomes of medial patellofemoral ligament (MPFL) reconstruction,[15,16,19,21] has resulted in a controversial trend toward broader indications for MPFL reconstruction in the acute setting.

One accepted indication for operative treatment of acute first-time patellar instability is the presence of a large chondral or osteochondral defect or loose body.[7] Osteochondral damage resulting in loose bodies may occur in 5% to 50% of cases of acute patellar instability.[5,12,14,20,25] The incidence of recurrent instability after the loose body has been removed or fixed is currently unknown. If a large percentage of these patients' knees subsequently redislocate and require an MPFL reconstruction, an argument can be made for either performing a concomitant MPFL reconstruction at the time of the initial loose body procedure or reconstructing the MPFL soon after in a staged procedure to potentially avoid a second dislocation and further articular damage.

The purpose of this study was to define the natural history of acute first-time patellar instability with osteochondral

The American Journal of Sports Medicine
2019;47(1):66–70
DOI: 10.1177/0363546518808486

defects treated operatively to address the loose body. Secondary objectives included identifying and stratifying risk factors for recurrent instability after the index surgery. Our hypothesis was that patella alta, trochlear dysplasia, and an increased tibial tubercle–trochlear groove (TT-TG) distance would be associated with recurrent instability.

METHODS

This was an institutional review board–approved, retrospective review of medical records at a single pediatric level I trauma center. All patients treated operatively for acute patellar instability with associated chondral or osteochondral loose bodies between 2010 and 2016 were identified. Patients were eligible for inclusion if they met the following criteria: (1) documented first-time acute patellar dislocation, (2) operative treatment to address an associated loose body, and (3) minimum 2-year clinic or phone follow-up after the index procedure. Patients were excluded if they had a history of prior patellar instability on the surgical knee or underwent MPFL reconstruction during the index procedure.

Charts were reviewed for relevant demographic and historical information, including patient age, weight, body mass index, sex, injury laterality, history of prior knee surgery or contralateral patellar instability, and time to operative treatment. Generalized laxity or genu recurvatum documented in chart or operative notes was recorded. Operative notes were used to identify the loose body procedure and any additional procedures (eg, MPFL repair, microfracture, chondroplasty). When MPFL repair was performed, it consisted of either an arthroscopic or open repair/imbrication. The arthroscopic technique used 3 or 4 No. 0 sutures passed through the retinaculum at the site of the tear as visualized arthroscopically. An open repair consisted of repairing the medial tissue in a pants-over-vest fashion using 3 or 4 No. 0 sutures. This approach was typically used when an open medial arthrotomy was necessary to internally fix an osteochondral fracture. Postoperative complications, such as arthrofibrosis, infection, or symptomatic hardware removal, were noted as well as any residual apprehension on examination.

The primary outcome measure was recurrent instability, defined as any of the following: (1) the patient underwent subsequent MPFL reconstruction or other patellar stabilizing procedure or (2) the patient had further subluxation or dislocation episodes. Secondary outcomes included the Kujala Anterior Knee Pain Scale,[11] the Single Assessment Numerical Evaluation (SANE),[27] and patient satisfaction. If patients had less than 2 years of clinical follow-up, they were contacted by phone to obtain any missing information.

Radiographic Analysis

Preoperative knee imaging was evaluated by a single author (J.M.P.) using Merge PACS software. Anteroposterior knee radiographs were used to assess proximal tibia and distal femur physes for skeletal maturity. Patients with open or closing physes were classified as skeletally immature, while those with closed physes were classified as skeletally mature.[13] Patella alta was assessed by use of the Blackburne-Peel index[4] measured on lateral knee radiograph and the Insall-Salvati index[9] measured on sagittal knee magnetic resonance imaging (MRI). Patients were classified as having patella alta with Blackburne-Peel ratio 1.0 or higher or Insall-Salvati ratio 1.2 or higher.[4,9] TT-TG distance was measured on MRI using the deepest cartilaginous point of the trochlear groove and the center of the patellar tendon insertion as previously described by Schoettle et al.[24] Trochlear dysplasia was assessed on axial MRI using the trochlear depth index (TDI), as previously described by Pfirrmann et al.[22] Based on the results of Stepanovich et al,[28] TDI between 2 and 4 was classified as low-grade dysplasia, while TDI less than 2 was classified as high-grade dysplasia.

Statistical Methods

Potential factors associated with recurrent patellar instability were evaluated. Continuous dependent variables were analyzed by use of analysis of variance techniques, and all variables were assessed for normality and homogeneity of variance. Categorical dependent variables were studied by use of chi-square analyses. Alpha was set at $P < .05$ to declare significance, and SPSS v 12 was used to perform the analysis (SPSS Inc).

RESULTS

A total of 52 patients met eligibility criteria, but 11 were lost to follow-up before 2 years, leaving a final cohort of 41 patients. No significant differences in demographic, historical, radiographic, or surgical variables were noted in a comparison of patients lost to follow-up versus those included in the final analysis. Average age was 13.8 ± 2.1 years (range, 9-18 years) and there were 19 females (46%) and 22 males (54%). Demographic data are summarized in Table 1. At a mean follow-up of 4.1 ± 1.1 years, 25

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One or more of the authors has declared the following potential conflict of interest or source of funding: E.W.E. has received payments from Orthopedics Corporation (consulting) and Arthrex (other speaking fees). A.T.P. has received payments from Smith & Nephew (education/other speaking fees), Arthrex (education), and SportsTek Medical (education). H.G.C. has received consulting payments from Orthopediatrics Corporation and Roche Molecular Systems. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

TABLE 1
Patient Demographic, Radiographic, and Surgical Data and Recurrent Instability[a]

	No Recurrent Instability (n = 16)	Recurrent Instability (n = 25)	*P* Value
Age, y, mean ± SD	14.1 ± 2.8	13.6 ± 1.6	.45
Male sex, %	50	56	.71
Body mass index, mean ± SD	23.9 ± 5.9	23.4 ± 6.0	.78
History of contralateral instability, %	25	12	.40
Generalized laxity, %	44	48	.79
Open physes, %	63	72	.52
Days between injury and surgery, mean ± SD	84.4 ± 144.3	51.5 ± 68.3	.33
TT-TG distance, mm, mean ± SD	14.2 ± 3.7	17.0 ± 5.2	.07
TT-TG distance >15 mm, %	38	72	**.03**
TT-TG distance >20 mm, %	6	24	.22
Insall-Salvati ratio, mean ± SD	1.4 ± 0.3	1.4 ± 0.2	.97
Blackburne-Peele ratio, mean ± SD	1.2 ± 0.5	1.1 ± 0.2	.22
Patella alta, %	69	92	.09
Trochlear depth index, mean ± SD	2.5 ± 1.1	2.1 ± 1.2	.24
Trochlear dysplasia, %			.12
High-grade	31	64	
Low-grade	56	28	
Loose body fixation, %	31	28	.82
Medial patellofemoral ligament repair, %	38	40	.87

[a]Bold values are statistically significant ($P < .05$). TT-TG, tibial tubercle–trochlear groove distance.

patients (61%) had experienced recurrent instability. This included 18 patients (44%) with dislocations and 7 patient (17%) with 1 or more subluxation episodes. Sixteen patients (39%) required subsequent surgery for patellar stabilization. No demographic or historical variable was significantly associated with incidence of recurrent instability ($P > .05$).

Radiographically, 28 patients (68%) were classified as skeletally immature. Patella alta was observed in 34 patients (83%). Trochlear dysplasia was noted in 37 patients (90%), with 21 (51%) classified as high-grade dysplasia and 16 (39%) classified as low-grade dysplasia. The average TT-TG distance was 15.9 ± 4.8 mm. Twenty-four patients (59%) had TT-TG distance greater than 15 mm and 7 (17%) had TT-TG distance greater than 20 mm. TT-TG distance greater than 15 mm was a significant risk factor for recurrent instability ($P = .03$). Patients with TT-TG distance greater than 15 mm and greater than 20 mm had recurrent instability rates of 75% and 86%, respectively (Table 2). No other radiographic variable was found to be a significant risk factor for recurrent instability ($P > .05$).

Patients underwent index operative treatment 64 ± 104 days after their initial injury (range, 1-450 days). In 25 cases (61%), the loose body was removed. Loose body fixation was performed in 12 patients (29%). Ten patients had open fragment fixation, whereas 2 patients had arthroscopic fixation. In the remaining 4 cases (10%), no loose body was found intraoperatively. No significant difference was found in the rate of recurrent instability between the loose body removal (62%) and fixation groups (58%) ($P > .05$).

Sixteen patients (39%) underwent MPFL repair during the initial procedure, consisting of 9 patients (56%) with open MPFL repairs and 7 (44%) with arthroscopic repairs.

TABLE 2
Recurrent Instability Rate
by Tibial Tubercle–Trochlear Groove (TT-TG) Distance

	Incidence of Recurrent Instability, %
TT-TG distance <15 mm (n = 17)	41
TT-TG distance ≥15 mm (n = 24)[a]	75
TT-TG distance ≥20 mm (n = 7)[b]	86
Overall (n = 41)	61

[a]Significantly higher incidence compared with TT-TG distance <15 mm ($P = .03$).

[b]No statistically significant difference compared with TT-TG distance <15 mm ($P = .22$).

A preoperative MRI was available in 13 patients, demonstrating failure of the MPFL at its patellar attachment in 7 patients, midsubstance tears in 4 patients, and multiple tear locations in 2 patients. Three patients had only preoperative computed tomography scans, so tear location was not assessed. An MPFL repair was not associated with a lower incidence of recurrent instability ($P > .05$). The 16 patients with medial repair had a 62.5% recurrent instability rate, compared with a 60% recurrence rate in patients who had no MPFL procedure. Complications were observed in 2 patients (5%) and consisted of 1 patient with postoperative arthrofibrosis and another patient with hypertrophic scarring. In addition, 3 patients (7%) subsequently elected to have implants removed.

Functional outcome scores were collected from patients who did not undergo a second procedure for patellar stabilization. Patients with recurrent instability had significantly worse mean Kujala (93.9 vs 83.0; $P = .01$), SANE

TABLE 3
Functional Outcomes by Recurrent Instability Status[a]

	No Recurrent Instability (n = 16)	Recurrent Instability (n = 8)	*P* Value
Kujala score (0-100)	93.9 ± 7.2	83.0 ± 11.7	**.01**
Single Assessment Numerical Evaluation score (0-100)	88.9 ± 11.1	73.1 ± 14.6	**.01**
Patient satisfaction (0-10)	9.4 ± 1.0	7.3 ± 1.7	**.002**

[a]Bold values are statistically significant ($P < .05$).

(88.9 vs 73.1; $P = .01$), and patient satisfaction scores (9.4 vs 7.3; $P = .002$). In addition, patella alta ($P = .03$) and increased TT-TG distance ($P = .01$) were each independently associated with lower Kujala scores (Table 3).

DISCUSSION

The results of the current study suggest that in patients who undergo surgery for a first-time patellar dislocation with an osteochondral or chondral loose body, recurrent instability is common, regardless of whether the MPFL is repaired or neglected. Patients with a TT-TG distance greater than 15 mm are at especially high risk, with a 75% chance of future instability. Furthermore, patients who go on to experience recurrent instability have poorer functional outcomes, underscoring the importance of optimally managing these patients at the time of their first surgery.

When patients who have sustained a first-time patellar dislocation are indicated for surgery because of a large (>1 cm) osteochondral fracture or chondral loose body, the surgeon has 4 options on how to manage the MPFL tear: (1) The MPFL injury can be ignored or neglected, a procedure that has the potential advantages of being faster, more cosmetic, and associated with a quicker recovery; (2) the MPFL can be repaired, particularly in cases where a medial arthrotomy has been performed to enable fixation of an osteochondral fracture; (3) the MPFL can be reconstructed concurrently during the initial loose body procedure; or (4) the MPFL can be reconstructed in a second staged procedure after the patient regains range of motion, if there is concern about postoperative stiffness or if it will be necessary to return to the operative room to remove retained implants. Currently, the orthopaedic literature contains little evidence to guide surgeons with this preoperative or intraoperative decision.

Given that approximately 40% of our patients required a future stabilization procedure within 5 years of their first patellar dislocation and we found no evidence for improved outcomes with MPFL repair, we believe that strong consideration should be given to initially reconstructing these knees (or at least a subset of them that are at highest risk) to avoid subsequent dislocations. Patients with recurrent or chronic patellar dislocation are at high risk for additional cartilage lesions of increasing size and severity, which may require advanced cartilage repair techniques.[30]

The results of the current study are not the first to demonstrate that MPFL repair has limited utility in preventing future instability. Several randomized prospective clinical trials comparing surgical repair of the medial patellofemoral ligament versus nonoperative treatment of acute patellar instability have been performed previously. The results of these studies also showed no significant differences in the short-term and medium-term outcomes of the two treatment groups.[17,18,20]

Recently, a randomized controlled trial was published looking at outcomes of patients undergoing a first patellar dislocation who received either an MPFL reconstruction using a quadriceps tendon technique or nonoperative treatment.[3] The results of the study showed not only a lower recurrence rate in the acute surgical group but also better clinical outcomes. In addition to this trial, mounting evidence shows that excellent clinical outcomes can be achieved with MPFL reconstructions.[15,16,19,21] Techniques have also been developed for skeletally immature patients, who compose the patient cohort at greatest risk of recurrent instability if treated nonoperatively. In a study of 21 skeletally immature patients with recurrent instability treated with MPFL reconstruction, Nelitz et al[16] reported that no patient had recurrent dislocation at average 2.8-year follow-up. As a result of these studies, as well as our institution's experience, we have begun performing concomitant MPFL reconstructions more frequently in the index management of acute patellar instability with an associated loose body.

An MPFL reconstruction is not without risk. Current surgical techniques use grafts that are significantly stronger than the native MPFL, which can result in nonphysiologic overloading of the patella, especially if the grafts are malpositioned.[2,29] This could lead to patellofemoral osteoarthritis later in life, although long-term outcomes after MPFL reconstruction in children are relatively unknown. Other reported complications of MPFL reconstruction include patellar fracture, graft failure, stiffness, and pain.[26] It is therefore important to identify the patients at highest risk for recurrent instability, as these patients may be better candidates for concomitant MPFL reconstruction during the index procedure.

In a study of 266 knees, Jaquith and Parikh[10] identified 4 risks for recurrent instability in the pediatric population: skeletal immaturity, trochlear dysplasia, patella alta, and a history of contralateral instability. Patients with all 4 risk factors were found to have an 88% rate of recurrent instability.[10] Lewallen et al[13] found skeletal immaturity and trochlear dysplasia to be risk factors for recurrent instability in a series of 222 pediatric knees. In the current study,

a large percentage of patients had these same risk factors for instability, including 68% who were skeletally immature, 83% with patella alta, 90% with trochlear dysplasia, and 17% with a history of contralateral patellar instability. This likely explains why our cohort had such a high (61%) recurrence rate. Interestingly, we did identify a separate risk factor that was most predictive of recurrent patellar instability: a TT-TG distance greater than 15 mm. Further studies are necessary to clarify the role of TT-TG distance measurement in the treatment algorithm for acute patellar instability.

The limitations of this study include its retrospective nature and its relatively short-term follow-up. As time passes, it is likely that a greater percentage of patients will go on to experience further instability and require surgical intervention, as was recently shown by Christensen et al.[6] Therefore, our numbers may understate the real extent of the problem. The relatively small sample size may have made the study underpowered to detect other risk factors for recurrent instability. The retrospective design of the study does not enable us to predict which surgical stabilization procedure, whether it be bony or soft tissue, is optimal at the time of the initial dislocation or in the event that a subsequent surgical procedure is required. Finally, evaluation of the extent of cartilage injury sustained in redislocation events would have strengthened our conclusions.

In conclusion, if the MPFL is not reconstructed during initial loose body treatment, children have a 61% recurrent instability rate. Patients with TT-TG distance greater than 15 mm, and particularly greater than 20 mm, are at highest risk of recurrent instability. These data inform clinicians, patients, and families in deciding whether to proceed with a concomitant MPFL reconstruction or a bony stabilization procedure, such as a tubercle transfer or trochleoplasty, in the index management of acute pediatric patellar instability with osteochondral defects.

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