Medial Patellofemoral Ligament Repair Versus Reconstruction for Recurrent Patellar Instability

Two-Year Results of an Algorithm-Based Approach

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Background: Patellar instability remains a challenging problem for both the patient and surgeon. Medial patellofemoral ligament (MPFL) repair has historically had poor results, and due to this, there is currently a trend toward reconstruction.

Purpose/Hypothesis: This study was undertaken to investigate experience with repair versus reconstruction of the MPFL using a multifactorial treatment algorithm approach. Our hypothesis was that there will be no significant difference in outcome scores between patients in the MPFL repair and reconstruction groups.

Study Design: Cohort study; Level of evidence, 2.

Methods: A total of 24 patients with recurrent (≥2) lateral patellar dislocations were included. All had failed nonoperative treatment for more than 6 months, and all were observed for a minimum of 2 years. First, magnetic resonance imaging (MRI) was used to find the location of the MPFL tear. A tilt test was used to determine whether a lateral retinacular lengthening was required to allow the patella to have neutral tilt. If the MRI showed a tibial tubercle–trochlear groove (TT-TG) distance greater than 20 mm, a tibial tubercle osteotomy (TTO) was recommended. An MPFL reconstruction was performed if the entire ligament was inadequately visualized on MRI or if it was torn from both insertion sites. Failure was defined as recurrent lateral patellar instability after surgery. As a secondary outcome measure, Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm score, and Tegner score were calculated.

Results: All patients were evaluated with a mean follow-up of 51 months (range, 25-79 months). Sixteen patients initially underwent MPFL repair, 8 underwent reconstruction, and 3 also underwent TTO. MPFL reconstructions were performed in all patients who underwent TTO. One MPFL repair was to the anatomic femoral origin and 15 were to the patellar insertion corresponding to the site of tearing on MRI. A lateral retinacular lengthening was performed in 21 patients. There was 1 failure in the repair group (6%) and none in the reconstruction group. However, the patient who failed had a TT-TG distance of 26 mm but refused a TTO. She subsequently underwent revision with a TTO and MPFL reconstruction and did not have any further instability events. There were no significant differences between groups for any of the secondary outcome scores.

Conclusion: Using an algorithm-based approach, MPFL repair or reconstruction may lead to clinically acceptable results at 2-year follow-up.

Keywords: medial patellofemoral ligament; MPFL; patellar dislocation; repair

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Patellar dislocations are debilitating injuries for the patient and challenging problems for the surgeon. The incidence of patellar instability ranges from 5.8 to 77.8 per 100,000,[15,17,24] and recurrence rates of nonoperatively treated dislocations range from 15% to 50%.[2,13] The treatment of patella instability has varied over time, with most first-time dislocators treated nonoperatively unless a loose osteochondral fragment is identified.[20] Recurrent patellofemoral instability is generally treated operatively. A large number of different surgical treatments have been described, and recently, most treatments focus on the

repair versus reconstruction of the medial patellofemoral ligament (MPFL).

The MPFL has proven to be the primary soft tissue restraint to lateral patellar dislocation.[5,8] It originates just posterior to the medial epicondyle, lies just superficial to the knee capsule, and inserts on the superomedial patella.[12] Pathoanatomic studies have shown that the MPFL tears when the patella dislocates laterally.[14,22] However, patellar instability can be due to multiple pathoanatomic lesions; while the MPFL is often the culprit, it is not the only problem. Therefore, a multifactorial approach to patellar instability is needed. This includes observing for trochlear dysplasia, lateral positioning of the tibial tubercle, patella alta, pathologic limb alignment (ie, genu valgum), torsional deformities, pathologic patellar tilt, and the location of the tear of the MPFL.

Multiple techniques have been described to repair[6,14,22] and reconstruct the MPFL[9,18,19,21,26] in an attempt to restore its function as a checkrein to lateral displacement. Recently, the treatment pendulum has swung toward reconstruction of the MPFL due to studies showing high failure rates with repair.[1,3] Comparatively, reconstruction has enjoyed favorable outcomes, with good to excellent outcomes ranging from 83% to 87%.[9-11] However, there is currently no consensus on which surgical treatment is best for recurrent patellofemoral instability. To our knowledge, there are no comparative studies looking at outcomes after MPFL repair versus reconstruction. The purpose of this study was to report outcomes using an algorithmic approach to treat recurrent lateral instability of the patella. In this algorithm, MPFL reconstruction and repairs are performed for different clinical situations.

METHODS

Patient Population

After receiving institutional review board approval, consecutive patients undergoing MPFL repair or reconstruction for recurrent lateral patellar instability from January 2007 to November 2010 were treated using an algorithmic approach (Figure 1). All surgeries were performed by the senior author (J.L.D.), and follow-up was performed by clinic visit. All patients filled out standardized outcome questionnaires at 6 months and 1 and 2 years.

Treatment Algorithm

The treatment algorithm is illustrated in Figure 1. Patient history included the number of previous dislocations, mechanism of dislocation, and previous surgical and nonsurgical treatments. The physical examination was a complete knee examination, including patellar tilt test (Figure 2), patella apprehension test at 30° of flexion, and range of motion. If the patient was found to have a positive patellar tilt test, an arthroscopic lateral retinacular lengthening was performed in conjunction with the repair or reconstruction of the MPFL.

Plain radiographs, including a standing anteroposterior (AP) view of the knee, full-length AP view from hips to

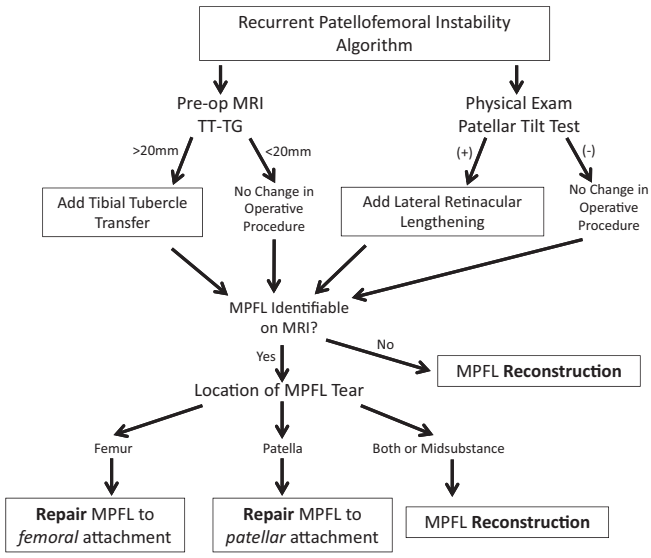

Figure 1. Algorithm for treatment of recurrent patellofemoral instability. MPFL, medial patellofemoral ligament; MRI, magnetic resonance imaging; TT-TG, tibial tubercle–trochlear groove distance.

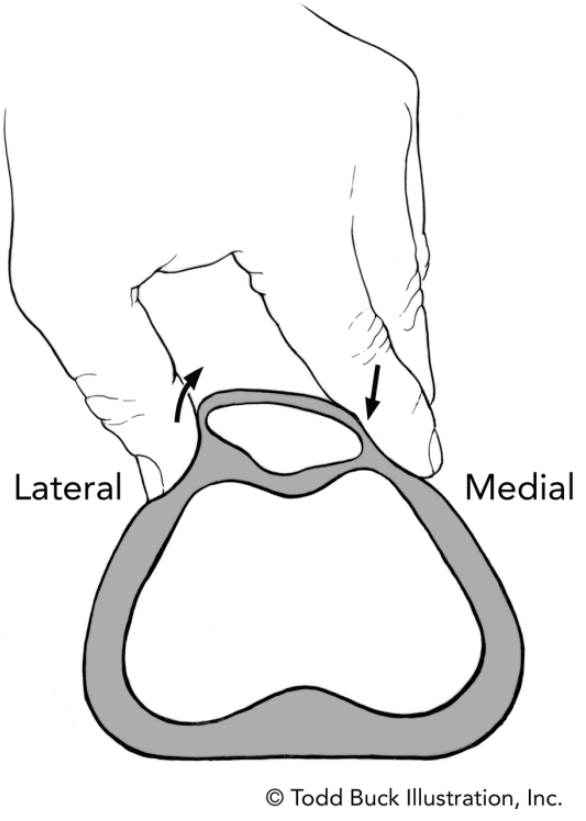

Figure 2. Patellar tilt test. The patella is centered in the trochlear groove and an attempt is made to elevate the lateral facet to neutral. If the patella will rotate to neutral, the test is considered to be negative; if it will not, the test is considered to be positive.

ankles, lateral view, and sunrise view were obtained for all patients. The full-length AP view was used to identify any malalignment of the mechanical axis in the coronal plane. The lateral view was used to evaluate for trochlear dysplasia using the Dejour criteria and for patella alta using the Blackburne Peel technique. Each patient also underwent magnetic resonance imaging (MRI) of the knee. The MRI was used specifically to identify any loose bodies, the location of the MPFL tear, and the tibial tubercle–trochlear groove (TT-TG) distance.[7,25] If a chondral or osteochondral loose body was identified, it was either removed or repaired, depending on the size of the fragment. If the TT-TG distance was abnormal (>20 mm), a tibial tubercle osteotomy (TTO) was recommended.

If the chronically torn MPFL could not be identified on axial MRI images or if the MPFL was torn in multiple locations, a repair was not considered and an MPFL reconstruction was performed. If the MPFL could be visualized along its entire length from patella to femur and the region of the tear was identifiable, then an MPFL repair to bone was made in the location of the tear. For example, if the tear was off the patella, it was repaired to the patella. Femoral-based tears were similarly repaired to the MPFL insertion on the femur.

Surgical Technique

Surgical procedures were performed in the order found in the algorithm. If indicated, a TTO was performed first, followed by lateral retinacular lengthening, and then repair versus reconstruction of the MPFL.

Tibial Tubercle Osteotomy

A 5- to 7-cm incision centered on the tibial tubercle was made. The medial and lateral borders of the patellar tendon were identified, and the anterior compartment muscles were reflected off the tibia. Kirschner wires were then placed medial to lateral, and an oblique (Fulkerson) osteotomy was made posterior to the tibial tubercle and tapered anteriorly at its distal aspect. The depth and angle of the cut was dependent on the amount of anteromedialization required. An Elmslie-Trillat osteotomy was not performed to avoid a thin tubercle fragment and subsequent risk of fracture. Using preoperative planning and radiographs, the tibial tubercle was translated so the resultant TT-TG was less than 15 mm and was then stabilized with 2 cortical lag screws. No distalization was performed, even in patients with radiographic patella alta.

Lateral Retinacular Lengthening

The lateral retinacular lengthening was performed arthroscopically if the tilt test was positive on preoperative examination. A curved radiofrequency probe was inserted into the anterolateral portal. Under direct visualization, partial-thickness cuts in the lateral retinaculum were created, analogous to the "pie-crusting" medial collateral ligament–lengthening technique, at multiple locations throughout the lateral retinaculum. An arthroscopic fluid pressure pump was used to stress the tissue at a pressure of 50 mm H_2O, which led to relative lengthening of the retinaculum. The patellar tilt test was again performed. If it remained positive, the lateral retinacular "pie crusting" was repeated until the tilt test was negative. No full-thickness lateral releases were performed in any patient.

MPFL Repair

Depending on the location of the tear, small skin incisions were made and the MPFL was surgically identified between layers 2 and 3.[16] An Allis clamp was placed at the torn edge. Then, suture anchors were placed at the anatomic insertion site (patella vs femur) after the site was prepared with a bur. The knee was then flexed to 30°, the surgeon centralized the patella in the trochlea, and a repair was performed after tensioning the MPFL.

MPFL Reconstruction

A small incision was made over the proximal-medial patella, and the medial face of the patella was exposed. Bleeding bone was achieved using a bur, ensuring the cortex was not completely breeched. Suture anchors were then placed at the 12:30, 1:30, and 2:30 clockface positions on the medial face of the patella (9:30, 10:30, and 11:30 for the left patella). The central portion of a semitendinosus allograft was then attached to the anchors using horizontal mattress sutures. The interval between layers 2 and 3 was developed using a curved clamp, and the graft was passed through this layer to the femoral incision.

A femoral-based incision was made over the femoral insertion of the MPFL. Fluoroscopy was not used to find the anatomic insertion. After protecting the branches of the saphenous nerve, the fascia was incised over the anatomic insertion. The graft ends were retrieved and whipstitched with No. 2 suture. A beath pin was passed from the bony insertion site (just distal and posterior to the adductor tubercle) to the lateral cortex, aiming anteriorly and proximally. An 8-mm reamer was used to create a bony socket approximately 40 mm in depth. The graft ends were passed into the tunnel via the beath pin. The surgeon held the patella in the center of the trochlea with the knee in 30° of flexion. The graft was tensioned and secured with an interference screw.

Outcome Measures

Our primary outcome measure was recurrent lateral patellar instability postoperatively within a 2-year postoperative period. This included frank dislocations as well as subluxations. Secondary outcome measures were validated patient outcome scores including the Knee injury and Osteoarthritis Outcome Score (KOOS), Tegner score, and Lysholm score. Evaluations were performed at 6, 12, and 24 months.

Statistical Analysis

A Student t test was used for statistical analysis when comparing outcome scores between the MPFL repair and reconstruction groups. A finding was determined to be statistically significant if $P < .05$.

TABLE 1
Patient and Study Demographic Data for Patients Undergoing Operative Intervention for Recurrent Lateral Patellar Instability[a]

Patient	Sex	Age, y	MPFL Repair	MPFL Reconstruction	Lateral Retinacular Lengthening	Tibial Tubercle Osteotomy	TT-TG Distance, mm
1	F	39		×			10.1
2	F	34		×			14.5
3	F	38		×	×		16.0
4	F	44	×		×		18.0
5	F	45	×		×		11.6
6	F	32	×		×		17.5
7	F	54		×			15.0
8	F	55	×		×		13.0
9	M	36	×		×		15.0
10	F	24	×		×		16.0
11	F	37	×		×		20.0
12	F	40	×		×		15.2
13	F	35	×		×		14.0
14	F	25	×		×		15.7
15	F	38	×		×		10.2
16	F	39		×	×		18.1
17	F	21		×	×	×	25.0
18	M	29	×		×		19.0
19	M	33	×		×		15.0
20[b]	M	31		×	×		24.0
21[b]	F	30	×		×	×	26.0
22	F	34		×	×	×	21.0
23	F	26	×		×		10.1
24	F	49	×		×		15.3

[a]F, female; M, male; MPFL, medial patellofemoral ligament; TT-TG, tibial tubercle–trochlear groove distance.
[b]Deviations from protocol. These patients did not want a tibial tubercle osteotomy as a primary procedure even though their TT-TG distance was >20 mm. Patient 21 was the lone failure in this study, who subsequently underwent a tibial tubercle osteotomy after failure of her primary procedure.

RESULTS

From January 2007 to November 2010, 24 consecutive patients underwent either MPFL repair or reconstruction due to lateral patellar instability. Mean follow-up was 51 months (range, 25-79 months). All patients were available for clinical follow-up. The mean age of the included patients was 36.2 years (range, 21-55 years). Three patients had a Blackburne Peel ratio $\geq$1.2, indicating patella alta. Thirteen patients had radiographic evidence of trochlear dysplasia using the Dejour criteria (type A, 9 patients; type B, 2 patients; type C, 2 patients).

Sixteen patients (67%) initially underwent MPFL repair. Eight patients (33%) initially underwent reconstruction. Arthroscopic lateral retinacular lengthening was also performed in 21 patients (88%) (Table 1). There were 3 patients (13%) who underwent TTO due to a TT-TG distance >20 mm. Demographics of patients are listed in Table 1.

There was 1 postoperative recurrent dislocation in our MPFL repair cohort for a recurrence rate of 4%. However, this patient breeched the algorithm, as she had a TT-TG distance of 26 mm, and was counseled to have an MPFL repair and TTO but refused the TTO. Her repair failed at approximately 16 months, and she was revised with an MPFL reconstruction as well as a TTO. Afterward, she had no recurrent instability. There were no recurrent dislocations in any patients initially treated with MPFL reconstruction.

The mean outcome scores in both the repair and reconstruction groups can be seen in Table 2. There were no statistically significant differences ($P < .05$) between the 2 groups in any of the standardized outcome scores.

There were 2 patients who deviated from the treatment algorithm. Both patients had TT-TG distances greater than 20 mm and were counseled to have a TTO. After being told of the risks, benefits, perioperative plan, and postoperative plan, both refused TTO as part of the primary procedure. One patient went on without any complications. However, as discussed previously, 1 patient with a TT-TG distance of 26 mm had recurrent instability episodes after MPFL repair.

There were no other surgical complications, including stiffness, infections, painful hardware, or wound problems, at final follow-up. Postoperative range of motion was equivalent to the contralateral extremity in all cases at 6 months (data not shown).

DISCUSSION

The objective of this study was to evaluate the results of treating lateral patellar instability using an algorithm-based approach. This investigation identified no statistical

TABLE 2
Outcome Scores[a]

	KOOS						VR-12		
	Symptoms	Pain	ADL	Sport	QOL	Lysholm Total	PCS	MCS	Tegner
MPFL repair patients									
4	82.1	91.7	97.1	95.0	31.2	90.0	42.6	62.4	3.0
5	50.0	75.0	69.1	25.0	31.2	41.0	27.1	51.4	2.0
6	78.5	94.4	100.0	75.0	62.5	95.0	56.8	57.9	7.0
8	42.8	63.8	69.1	45.0	12.5	39.0	29.5	51.1	1.0
9	82.1	72.2	95.5	60.0	50.0	82.0	44.4	54.0	5.0
10	92.9	100.0	100.0	75.0	81.2	89.0	53.5	55.2	3.0
11	85.7	100.0	100.0	95.0	93.8	100.0	42.1	58.3	7.0
12	78.5	75.0	82.3	50.0	43.7	64.0	48.3	48.4	3.0
13	89.3	91.7	94.1	65.0	68.8	87.0	57.4	37.1	3.0
14	57.1	55.5	82.3	20.0	31.2	57.0	48.9	57.3	3.0
15	75.0	83.3	94.1	80.0	62.5	70.0	58.1	30.4	1.0
18	78.5	80.5	97.0	75.0	56.2	79.0	58.0	50.6	8.0
19	85.7	94.4	95.5	85.0	56.2	82.0	51.5	52.9	3.0
21	85.7	94.4	95.6	85.0	56.2	82.0	51.5	52.9	3.0
23	89.2	97.2	95.5	80.0	68.7	84.0	55.2	55.1	3.0
24	82.1	80.5	79.4	60.0	50.0	6.0	43.8	29.5	2.0
Mean	77.2	84.4	90.4	66.9	53.5	71.7	48.0	50.3	3.6
MPFL reconstruction patients									
1	50.0	61.1	67.6	25.0	12.5	46.0	29.7	58.2	2.0
2	60.7	83.3	91.1	40.0	31.2	60.0	44.8	60.3	3.0
3	100.0	100.0	100.0	90.0	75.0	95.0	54.2	56.0	3.0
7	42.8	63.8	69.1	45.0	12.5	39.0	29.5	51.1	1.0
16	32.1	27.8	23.5	0.0	12.5	20.0	15.6	54.6	1.0
17	85.7	94.4	97.0	90.0	87.5	91.0	52.3	55.5	3.0
20	64.2	88.8	91.1	70.0	75.0	87.0	50.4	52.8	3.0
22	82.1	77.7	97.0	35.0	62.5	80.0	38.0	56.8	2.0
Mean	64.7	74.6	79.6	49.4	46.1	64.8	39.3	55.7	2.3
P value, difference between repair and reconstruction	.12	.20	.15	.13	.50	.54	.08	.14	.11

[a]Four subsets of the Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm, Veterans RAND 12-Item Health Survey for Physical (VR-12 PCS) and Mental (VR-12 MCS) Health, and Tegner scores were used. Patient 21 was originally a repair patient but was revised to reconstruction. Outcome scores for her were obtained only after her reconstruction. ADL, activities of daily living; MPFL, medial patellofemoral ligament; QOL, quality of life.

difference in recurrent dislocation or validated outcome scores between the MPFL repair versus reconstruction groups.

There was 1 failure due to recurrent instability postoperatively in the MPFL repair group. However, it is difficult to conclude that this failure was due to the MPFL repair, as she deviated from the treatment algorithm against medical advice. Her preoperative MRI showed an elevated TT-TG distance of 26 mm, and we discussed our recommendation to perform a TTO but she elected to proceed only with the MPFL repair. One year later, she experienced recurrence of lateral subluxations. She was revised with an MPFL reconstruction and TTO and did not have further instability episodes.

An MPFL repair study by Camp et al[3] revealed a recurrence rate of 28% (8/29 knees). In most repairs, the authors used suture anchors to repair the MPFL to either the patella or the femur; however, MRI was used in only 17 patients (59%) to find the location of the MPFL tear. Additionally, 7 patients (24%) had a medial reefing technique performed instead of a suture anchor repair as the MPFL was found to have an intrasubstance tear. The authors also found a significant increase in recurrent dislocation in patients with nonanatomic repair of the MPFL femoral insertion; 4 of these 5 patients (80%) suffered a recurrent dislocation. In contrast to our algorithm, patients undergoing a concomitant TTO (n = 3) were excluded from their study, and no patients had concomitant treatment of their lateral retinacular length (3 patients had a lateral release performed in a previous surgery). Because of the varied surgical techniques used throughout the study, it is difficult to draw conclusions as to the efficacy of anatomic MPFL repairs.

A retrospective study by Arendt et al[1] included 55 knees in 48 patients who underwent MPFL repair. The MPFL was torn off the femur in all patients. Suture anchors were used to fix the MPFL back to the femur, and all patients also underwent vastus medialis oblique advancement to the superomedial border of the patella. Early-term results found a redislocation rate of 46%. These authors found a high incidence of trochlear dysplasia (96%) as well as patella alta (86%) and cited these as major factors that resulted in their higher redislocation rate. In contrast with our investigation, no patients were treated using TTO (8 had previous TTO

before MPFL repair) or lateral retinacular lengthening treatment (none had previous treatment before MPFL repair).

The treatment algorithm in this study utilizes a multifactorial approach to the patient. If a patellar tilt test was positive on physical examination, lateral retinacular lengthening was performed. MRI was used for 3 reasons: (1) to measure the TT-TG distance, (2) to see whether the entire MPFL was visible on axial cuts, and if so, (3) to determine the location of the tear. If the TT-TG distance was greater than 20 mm, then a TTO was recommended. If the MPFL was not visible on MRI, then an MPFL reconstruction was performed. The location of the tear (whether femoral or patellar) determined the location of the primary repair.

This study has several limitations. MRI was used instead of computed tomography (CT) to measure the TT-TG distance. A recent study showed that CT and MRI measurements of TT-TG distance are not equivalent, and MRI measurements are generally lower than those using CT.[4] Additionally, each cohort was relatively small with relatively short follow-up, and 2 patients deviated from the treatment protocol against medical advice, warranting a larger study to truly validate the efficacy of this algorithm. Finally, the outcome scores in our patient population were not as high as other comparable studies,[23] which may be due to the older mean age and lower activity levels of our cohort. Not included in this treatment algorithm are other pathoanatomic factors such as trochlear dysplasia, patella alta, and rotational malalignment of the femur. The reasoning is that there is no consensus on how to treat these factors. For example, if a patient has trochlear dysplasia, should we be treating them primarily with a trochleoplasty? Some would argue yes, while others would say no. It is true that this algorithmic approach may not be successful in all patients, and more invasive, controversial procedures (tibial tubercle distalization, trochleoplasty, etc) may need to be performed if failure occurs.

CONCLUSION

The use of MPFL repair or reconstruction for the treatment of recurrent lateral patellar instability may achieve a similar rate of recurrence and outcome at 24-month follow-up if an algorithmic approach is used to determine operative management.

REFERENCES

1. Arendt EA, Moeller A, Agel J. Clinical outcomes of medial patellofemoral ligament repair in recurrent (chronic) lateral patella dislocations. *Knee Surg Sports Traumatol Arthrosc*. 2011;19:1909-1914.
2. Bitar AC, Demange MK, D'Elia CO, Camanho GL. Traumatic patellar dislocation: nonoperative treatment compared with MPFL reconstruction using patellar tendon. *Am J Sports Med*. 2012;40:114-122.
3. Camp CL, Krych AJ, Dahm DL, Levy BA, Stuart MJ. Medial patellofemoral ligament repair for recurrent patellar dislocation. *Am J Sports Med*. 2010;38:2248-2254.
4. Camp CL, Stuart MJ, Krych AJ, et al. CT and MRI measurements of tibial tubercle-trochlear groove distances are not equivalent in patients with patellar instability. *Am J Sports Med*. 2013;41:1835-1840.
5. Conlan T, Garth WP, Lemons JE. Evaluation of the medial soft-tissue restraints of the extensor mechanism of the knee. *J Bone Joint Surg Am*. 1993;75:682-693.
6. Davis DK, Fithian DC. Techniques of medial retinacular repair and reconstruction. *Clin Orthop Relat Res*. 2002;402:38-52.
7. Dejour H, Walch G, Nové-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. *Knee Surg Sports Traumatol Arthrosc*. 1994;2:19-26.
8. Desio SM, Burks RT, Bachus KN. Soft tissue restraints to lateral patellar translation in the human knee. *Am J Sports Med*. 1998;26:59-65.
9. Drez D, Edwards TB, Williams CS. Results of medial patellofemoral ligament reconstruction in the treatment of patellar dislocation. *Arthroscopy*. 2001;17:298-306.
10. Ellera Gomes JL. Medial patellofemoral ligament reconstruction for recurrent dislocation of the patella: a preliminary report. *Arthroscopy*. 1992;8:335-340.
11. Ellera Gomes JL, Stigler Marczyk LR, César de César P, Jungblut CF. Medial patellofemoral ligament reconstruction with semitendinosus autograft for chronic patellar instability: a follow-up study. *Arthroscopy*. 2004;20:147-151.
12. Feller JA, Feagin JA, Garrett WE. The medial patellofemoral ligament revisited: an anatomical study. *Knee Surg Sports Traumatol Arthrosc*. 1993;1:184-186.
13. Fithian DC, Paxton EW, Stone ML, et al. Epidemiology and natural history of acute patellar dislocation. *Am J Sports Med*. 2004;32:1114-1121.
14. Garth WP, DiChristina DG, Holt G. Delayed proximal repair and distal realignment after patellar dislocation. *Clin Orthop Relat Res*. 2000; 377:132-144.
15. Harilainen A, Myllynen P, Antila H, Seitsalo S. The significance of arthroscopy and examination under anaesthesia in the diagnosis of fresh injury haemarthrosis of the knee joint. *Injury*. 1988;19:21-24.
16. LaPrade RF, Engebretsen AH, Ly TV, Johansen S, Wentorf FA, Engebretsen L. The anatomy of the medial part of the knee. *J Bone Joint Surg*. 2007;89:2000-2010.
17. Mehta VM, Inoue M, Nomura E, Fithian DC. An algorithm guiding the evaluation and treatment of acute primary patellar dislocations. *Sports Med Arthrosc Rev*. 2007;15:78-81.
18. Muneta T, Sekiya I, Tsuchiya M, Shinomiya K. A technique for reconstruction of the medial patellofemoral ligament. *Clin Orthop Relat Res*. 1999;(359):151-155.
19. Nomura E, Inoue M. Surgical technique and rationale for medial patellofemoral ligament reconstruction for recurrent patellar dislocation. *Arthroscopy*. 2003;19:E47-E49.
20. Oestern S, Varoga D, Lippross S, et al. Patella dislocation [in German]. *Unfallchirurg*. 2011;114:345-358.
21. Panni AS, Alam M, Cerciello S, Vasso M, Maffulli N. Medial patellofemoral ligament reconstruction with a divergent patellar transverse 2-tunnel technique. *Am J Sports Med*. 2011;39:2647-2655.
22. Sallay PI, Poggi J, Speer KP, Garrett WE. Acute dislocation of the patella. A correlative pathoanatomic study. *Am J Sports Med*. 1996; 24:52-60.
23. Schneider DK, Grawe B, Magnussen RA, et al. Outcomes after isolated medial patellofemoral ligament reconstruction for the treatment of recurrent lateral patellar dislocations: a systematic review and meta-analysis. *Am J Sports Med*. 2016;44:2993-3005.
24. Sillanpää P, Mattila VM, Iivonen T, Visuri T, Pihlajamäki H. Incidence and risk factors of acute traumatic primary patellar dislocation. *Med Sci Sports Exerc*. 2008;40:606-611.
25. Smith TO, Davies L, Toms AP, Hing CB, Donell ST. The reliability and validity of radiological assessment for patellar instability. A systematic review and meta-analysis. *Skeletal Radiol*. 2011;40:399-414.
26. Xie G, Zhao J, Huangfu X, He Y. Medial patellofemoral ligament reconstruction using semitendinosus tendons: polyester suture augmentation versus nonaugmentation. *Am J Sports Med*. 2012;40: 1365-1374.