Patellar Instability With and Without Trochlear Dysplasia: New Arthroscopic Medial Soft Tissue Plication With Pullout Technique

JIN HWAN AHN, MD, PHD; JUN HEE KANG, MD; NIRAJ SHARAD KASAT, MD; JAE GYOON KIM, MD

abstract

The aim of this study was to analyze clinical and radiologic results of an arthroscopic medial plication with the pullout technique and to define indications and limitations of this procedure for patellar instability. Records of 45 patients treated for patellar instability with arthroscopic medial plication with the pullout technique were reviewed. The mean patient age was 22.8±8.3 years. The tibial tuberosity-trochlear groove distance, trochlear depth (TD), and Insall-Salvati ratio were measured using magnetic resonance imaging taken preoperatively. Patients were evaluated clinically by the Insall and Kujala score and radiographically by measuring the congruence angle, lateral patellofemoral angle, and lateral patellar translation pre- and postoperatively. Patients were classified into 2 groups: group 1 comprised 23 patients with TD greater than or equal to 3.0 mm and group 2 comprised 22 patients with TD less than 3.0 mm. A significant improvement (P=.007) in postoperative clinical scores compared with preoperative values was observed. The congruence angle improved to 11.0°±20.6° (P=.006), the lateral patellofemoral angle improved to −1.6°±7.7° (P=.001), and the lateral patellar translation improved to 8.7±5.3 mm (P<.001) postoperatively. There were 5 (11%) failure cases. No significant difference existed in the number of failure cases and clinical scores between the 2 groups. This arthroscopic medial soft tissue pullout technique showed good clinical and radiologic results for patellar instability even in the presence of mild to moderate trochlear dysplasia. However, the technique showed limited success in severe trochlear dysplasia cases.

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Recurrent lateral patellar instability as a clinical entity is typically characterized by an unstable patella in patients who have repeat episodes of objective dislocation of the patella or experience repeat symptoms of subjective subluxation of the patella without complete dislocation, and it occurs most often when the knee is between 0° and 30° of knee flexion and the patella is not fully engaged into the patellar groove. Some factors have been recognized as being responsible for patellar instability; they have been divided into 2 main groups. The principle factors are: (1) soft tissue failure of the medial retinaculum and the patellar ligament (MPFL); (2) abnormal bony anatomy of the patella and the patellar groove.

Most surgeries typically involve 2 basic techniques: proximal soft tissue realignment and distal bony realignment. Proximal realignment is generally addressed by a combination of lateral retinacular release and medial retinacular imbrication. This can be performed using the open or arthroscopic technique. The traditional open technique often leads to pain, stiffness, prolonged rehabilitation, and poor cosmetic results, therefore, arthroscopic techniques have been reported in recent years.

Arthroscopic medial retinacular repair was first described by Yamamoto. It reinforces the passive stabilizers of the patellofemoral joint. Up-to-date, various arthroscopic techniques have been described for patellar instability, and satisfactory results have been observed with these techniques. Most of the arthroscopic techniques described previously for proximal soft tissue realignment have been indicated in patients with patellar instability for medial soft tissue insufficiency, medial retinacular tear, or midsubstance injury of the medial patellofemoral ligament (MPFL).

However, several authors described arthroscopic techniques for patellar instability with a bony abnormality, such as trochlear dysplasia. Trochlear dysplasia is an important bony abnormality causing patellar instability. Also, it is known that the lack of bony constraint in cases of trochlear dysplasia can put the ligament at risk for repeated failure because of structural deficiency, decreasing the native medial tether.

Dejour and Le Coutre described 4 types of trochlear dysplasia. Schottle et al showed that in patients with underlying Dejour grade B through D trochlear dysplasia, arthroscopic repair of passive patellofemoral stabilizers had limited success in terms of stability and clinical outcome. However, their arthroscopic techniques depend on medial soft tissue healing for stable reduction of the patella. Some authors described arthroscopic bony anchorage for patellar instability. Dodson et al suggested that restoring medial soft tissue tension by plicating and reefing the tissue may not be appropriate for all traumatic MPFL and medial retinacular injury patterns. They suggested using suture anchor repair for the medial soft tissues avulsed from the patella. However, their study had limited applicability to acute soft tissue avulsion cases only and did not address issues of trochlear dysplasia.

The purpose of this study was to analyze the clinical and radiologic results of a new arthroscopic medial soft tissue plication with the pullout technique and to understand its indications and limitations for patellar instability even with trochlear dysplasia. The hypothesis was that the arthroscopic medial soft tissue plication with the pullout technique would show good clinical and radiologic results for patellar instability despite trochlear dysplasia.

**Materials and Methods**

After ethics board approval, a retrospective study was performed by reviewing the results of arthroscopic medial soft tissue pullout and the lateral retinacular release technique for patellar instability performed by a single surgeon between 2003 and 2010. The study included 48 knees; patients were evaluated at a mean follow-up of 39.8±12.6 months (range, 24.0-88.0 months). Inclusion criteria were one or more episodes of recurrent dislocation or subluxation with no improvement with at least 6 months of conservative treatment before consideration for surgery without a valgus femorotibial angle (FTA) and with normal Q-angle and TT-TG distance. Exclusion criteria were previous knee surgery or major knee fractures. Three patients were excluded: 2 had a history of previous anterior cruciate ligament reconstruction surgery and 1 had a patella fracture. A total of 45 patients were included in the study. Mean patient age was 22.8±8.3 years (range, 13.0 to 46.0 years). The study group consisted of 16 males and 29 females and 25 left knees and 20 right knees. The mean period from symptoms to surgery was 47.0±54.0 months (range, 1.0 to 204.0 months). A definite history of trauma was noted in 40 patients, of which 22 were involved in sports and 18 had injuries sustained during daily living activities. Three patients had an insidious onset of instability symptoms.

**Surgical Technique**

Surgery was performed with the patient under general or spinal anesthesia. The patient was positioned supine on the operating table with an inflated tourniquet applied to the operative extremity. Using the standard anterolateral and anteromedial (AM) portals, routine diagnostic arthroscopy was performed to observe lesions of the menisci and cartilage, chondral or osteochondral fragments, and rupture of the anterior and posterior cruciate ligaments. Appropriate
treatment including partial meniscectomy, patellar and trochlear chondroplasty, and removal of loose bodies was performed. Patellar instability was assessed through the superolateral (SL) viewing portal (Figure 1). Boundaries of the patella were marked, and an approximately 2-cm longitudinal incision was made at the center of the patella. A 1.5-cm longitudinal incision at the level of the upper pole of the patella was made approximately 1.5 cm medial of the medial border of the patella, and blunt dissection was performed under the subcutaneous layer without incision at the capsule. The arthroscope was inserted through the SL portal, and a motorized shaver was inserted through the AM portal to debride the soft tissue and part of the cartilage of the medial border of the upper half of the patella. A spinal needle was inserted through the portal, and a polydioxanone suture (PDS) #0 was inserted and pulled out through the AM portal using a suture retriever (Linvatec, Largo, Florida). A spinal needle with the same PDS in situ was pulled out of the capsule and reinserted at the distal portion of the medial incision. Through the AM portal, using a suture retriever, another thread of the same PDS #0 was pulled out (Figure 2). The spinal needle was reinserted near the distal thread of the first PDS, and a Maxon #0 (Syneture, Norwalk, Connecticut) was inserted through the spinal needle and pulled out using the suture retriever. The spinal needle with the Maxon in situ was pulled out of the capsule and reinserted at the distal portion of the first insertion. Using the same technique, 1 more PDS suture was inserted both at the most proximal and distal portions of the medial incision. A total of 6 strands were inserted through the medial capsule (Figure 3). The fascia and retinaculum were incised over the central incision of the patella. The anterior cruciate ligament tibial guide (Linvatec) was inserted through the AM portal and fixed at the medial border of the upper half of the patella. A 2.4-mm guide pin was inserted through the central incision. A total of 3 guide pins were inserted at about 5-mm intervals at about 7, 9, and 11 o’clock (Figure 4). Guide pins were removed, and arthoscopic retriever (Arthrex, Naples, Florida) was inserted through the most superior tunnel, and 2 strands of PDS were pulled out of the patella. Using the same method, another 4 strands of PDS were pulled out through another 2 tun-
nels for a total of 6 pulled-out strands of PDS (Figure 5). Through the SL viewing portal, reduction of the patella was assessed by pulling the 6 threads with tension. Patellar tracking was evaluated both arthroscopically and manually to confirm that the initial contact was centralized and maintained throughout 0° to 90° flexion. If the patella is tilted laterally and the retinaculum appears very tight, a lateral retinacular release was performed. Through the SL viewing portal, Arthrobovie (Linvatec) was inserted. Approximately 1 cm lateral from the lateral margin of the patella, a retinacular release was performed until subcutaneous fat was observed. After rechecking the patellar tracking throughout flexion through the SL viewing portal, 6 strands of PDS were pulled out, and a Samsung Medical Center (SMC) sliding knot in the 30° flexed position was performed with the patella relocated in the trochlear groove (Figure 6).

Rehabilitation
Postoperatively, as a part of a standard rehabilitation program, quadriceps contractions and straight-leg raises were encouraged after anesthesia. After 2 weeks, the patient was allowed to partially bear weight with crutch support, and the brace was unlocked to enable patients to begin gradual range of motion exercises. Full weight bearing and complete range of motion were allowed at 6 to 8 weeks. At 3 months, intensive weight-resisted vastus medialis obliquus and quadriceps exercises were started, and light sports activity was introduced; contact sports were allowed at 6 months.

Evaluation
Clinically, all patients were evaluated with the Insall scoring system before surgery and at the final follow-up. In addition, the Kujala score was evaluated postoperatively. Any complications after surgery were recorded and evaluated. A failure case was defined as a patient with postoperative subluxation or dislocation. All data were collected using medical records and using a telephone interview if data were not found in medical records.

Radiologic parameters were evaluated. Of these parameters, the congruence angle (CA), lateral patellofemoral angle (LPA), and lateral patellofemoral translation (LT) were used to report the radiologic results of the technique. In addition, preoperative FTA, preoperative trochlear depth (TD), preoperative Insall-Salvati index, and preoperative TT-TG were radiologic parameters affecting patellar instability. Preoperative magnetic resonance imaging (MRI) was used to assess trochlear dysplasia, TT-TG distance, and Insall-Salvati index; 1.5-T MRI (Signa; GE Healthcare, Milwaukee, Wisconsin) was used for all patients. Trochlear dysplasia was assessed by measuring TD, defined as the maximum distance of the deepest point of the trochlear groove from the line connecting the prominence of the medial and lateral trochlear facets on the axial image revealing 3 cm from the femorotibial joint line (Figure 7A). The TT-TG distance was measured by selecting the deepest point within the trochlear groove and the insertion center of the patellar tendon to the tibial tuberosity. Two lines perpendicular to the tangent line between the medial and lateral posterior condyles and passing the deepest point within the trochlear groove and the most prominent point

Figure 4: A 2.4-mm guide pin inserted through the central incision using an anterior cruciate ligament tibial guide (A). Three guide pins were inserted at approximately 5-mm intervals at approximately 7, 9, and 11 o’clock of the patella (B).

Figure 5: An arthroscopic retriever was inserted through the tunnel, and 2 strands of suture were pulled out of the patella (A). Using the same method, 6 strands of suture were pulled out through each of the 3 patellar tunnels (B). Illustration of 6 strands of suture pulled out through the patellar tunnel (C).

Figure 4A
Figure 4B
Figure 5A
Figure 5B
Figure 5C
of tibial tuberosity were selected. These lines were transferred to axial MRI, and the distance between them was measured (Figure 7B). The Insall-Salvati index is the ratio of the patellar tendon length to the length of the patella and was measured on sagittal MRI (Figure 7C). The preoperative FTA was measured by using the anatomic axis of the femur and tibia on the standing anteroposterior radiograph of the affected leg. The preoperative and postoperative CA, LPA, and LT were measured on the Merchant view of a radiograph (Figure 8). Magnetic resonance images and radiographs were analyzed twice independently by 2 orthopedic surgeons at a 2-week interval. All measurements were performed on the picture archiving and communication system (PACS) imaging software to the nearest 0.01 mm. Patients were classified into 2 groups according to the preoperative TD measurement. Group 1 consisted of 23 patients with TD greater than or equal to 3 mm, and group 2 consisted of 22 patients with TD less than 3 mm. The authors selected patients with TD less than 3 mm for the trochlear dysplasia group because when a cutoff of 3 mm was chosen for TD, MRI had a sensitivity of 100% and a specificity of 96% for trochlear dysplasia.

Statistical Analysis

SPSS 17.0 for Windows (SPSS Inc, Chicago, Illinois) was used for statistical analysis. The McNemar-Bowker test was used to compare pre- and postoperative clinical scores. The paired t test was used to compare pre- and postoperative
RESULTS

The interobserver and intraobserver reliabilities of all radiologic measurements ranged from 0.83 to 0.89 and 0.85 to 0.92, respectively.

Clinical Results

No significant difference existed in the demographic data between the 2 groups. Mean preoperative Q-angle was 12.1°±3.2° (range, 8° to 18°). All patients consistently showed improvement in the Insall score postoperatively (P=.007) (Table 1). Postoperatively, mean Kujala score was 88.5±7.4 (range, 64 to 100). Functionally, all patients showed an improved ability in walking and climbing stairs. At the end of 6 months, all patients were able to resume contact sports.

Three patients reported knee stiffness after surgery at the end of 6 months because of poor rehabilitation. Two patients improved with arthroscopic adhesiolysis, and 1 patient improved with physiotherapy. There were a total of 5 (11%) recurrent patellar instability cases. Group 1 had 1 case of recurrent subluxation, and their TD was 3.0 mm. Group 2 had 4 recurrent dislocations; all TDs in this group were less than 1 mm. There was no significant difference in the number of failure cases between the 2 groups.

In group 1, 87% (20/23) of patients had excellent to good results, whereas 86% (19/22) of group 2 patients had excellent to good results. The mean postoperative Kujala score of group 1 was 89.5±7.1 (range, 65 to 100), and for group 2 it was 87.1±7.5 (range, 66 to 93). Postoperative clinical scores were not significantly different between groups 1 and 2 (Table 2).

Radiologic Results

Preoperative mean FTA measured by radiography was −3.2°±4.7° varus (range, −15.8° to 5.2°). Preoperative mean TD of patients was 2.1±1.7 mm (range, 0.2 to 6.2 mm), mean Insall-Salvati index was 0.89±0.12 (range, 0.85 to 1.1), and mean TT-TG distance was 15.4±2.9 mm (range, 8.3 to 20.0 mm) measured by MRI. Postoperative mean CA improved to 11.0°±20.6° (range, −39.7° to 50.7°; P=.006), mean LPA improved to −7.4°±7.7° (range, −15.8° to 14.3°; P<.0001), and mean LT improved to 8.7±5.3 mm (range, 1.5 to 24.2 mm; P<.0001) (Table 3). Postoperative radiologic parameters were also not significantly different between groups 1 and 2 (Table 4).

DISCUSSION

The principal findings of this study are that the arthroscopic medial soft tissue plication with the pullout technique and lateral retinacular release showed satisfactory clinical and radiologic results for patellar instability even in the presence of trochlear dysplasia. However, the technique showed limited success in severe trochlear dysplasia cases.

Many open procedures, including soft tissue realignment and bony procedures, have been popular for the treatment of patellar instability. Although these traditional operations have resulted in successful clinical outcomes to a varying extent, they generally accompany morbidity and poor cosmetic results. Therefore, arthroscopic techniques have been reported in recent years. Most authors showed a miniopen technique or all-arthroscopic techniques for soft tissue augmentation. All these techniques depend on the healing of the medial soft tissue structures for stable re-location of the patella. Failure to achieve stable and tension-free healing of the lax
medial soft tissue structures can cause recurrent patellar instability. In contrast to other studies, some authors presented bony anchorage procedures using a suture anchor. The arthroscopic medial soft tissue plication with the pullout technique in the current study was also a bony anchorage with medial reefing procedure. However, other authors used the technique only to repair MPFL, avulsion to the patella, which is contrary to the current technique. The unique advantage of the arthroscopic medial soft tissue plication with the pullout technique allowed bone to soft tissue healing of the injured medial soft tissue structure and provided stable and tension-free healing of the medial retinaculum and MPFL. The current technique also could be used for chronic patellar instability because 6 threads were used for medial soft tissue pullout, which allowed the authors to augment redundant medial soft tissue not only in the medial to lateral direction but also in the proximal and distal direction. This may be the cause of the satisfactory results in patellar instability even with trochlear dysplasia.

In the current study, the recurrent instability (subluxation and dislocation) rate was 11% (5/45). Most of the literature reported a recurrent instability rate of 0% to 8% after an arthroscopic technique in patellar instability. However, the causes of the current study’s high failure rate were the relatively large trochlear dysplasia group (22/45) and the large number of patients with trochlear dysplasia with TD less than 1 mm (12/22). Most of the previous literature did not show whether they included patellar instability with trochlear dysplasia.

Trochlear dysplasia is a major predisposing factor for patellar instability. Trochlear dysplasia also could be a major risk factor for the failure of operative stabilization of patellar instability. Nelitz et al analyzed failed cases after the operative treatment of patellar instability. Severe trochlear dysplasia (Dejour type B to D) as detected on MRI scans was found significantly more often in the failed group. They also reported that in patients with underlying severe trochlear dysplasia (Dejour grade B to D), arthroscopic repair of medial soft tissue had limited success in terms of stability and clinical outcome. The lack of bony constraint in cases of trochlear dysplasia can put the ligament at risk for repeated failure because of structural deficiency, decreasing native medial tether. Schöttle et al emphasized the concavity of the trochlear groove of the static stabilizer of the patella. In such cases, reconstruction of the MPFL and, in severe cases, deepening trochleoplasty can be considered more successful alternative procedures. However, trochleoplasty can be performed only after closure of the growth plate of the distal

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<td><strong>Comparison of Demographic Data and Clinical Results</strong></td>
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<td>Mean age, y</td>
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<td>Sex, No. M/F</td>
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<td>Follow-up period, mo</td>
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<td>Preoperative Insall score</td>
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<td>Postoperative Kujala score</td>
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<td>No. of failure cases</td>
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<th>Table 3</th>
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<td><strong>Comparison of Preoperative and Postoperative Radiologic Results</strong></td>
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<tr>
<td>Radiologic Parameter</td>
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<td>CA, deg</td>
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<td>LPA, deg</td>
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<td>LT, mm</td>
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Abbreviations: CA, congruence angle; deg, degrees; LPA, lateral patellofemoral angle; LT, lateral patellar translation.
Table 4

Comparison of Pre- and Postoperative Radiologic Parameters

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<tr>
<th>Radiologic Parameter</th>
<th>Mean±SD (Range)</th>
<th>Group 1 (n=23)</th>
<th>Group 2 (n=22)</th>
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<tr>
<td>Preoperative TD, mm</td>
<td>4.1±6.12 (3-6.2)</td>
<td>1.3±61.4 (0-2.9)</td>
<td>.006</td>
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<tr>
<td>FTA, deg</td>
<td>23.4±4.3 (215.8-4.9)</td>
<td>23.2±4.6 (210.5-5.2)</td>
<td>.35</td>
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<tr>
<td>Insall-Salvati ratio</td>
<td>0.9±0.11 (0.85-1.0)</td>
<td>0.8±0.13 (0.92-1.1)</td>
<td>.13</td>
<td></td>
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<tr>
<td>TT-TG distance, mm</td>
<td>17.2±3.5 (9.3-20.0)</td>
<td>15.1±4.7 (8.5-19.4)</td>
<td>.23</td>
<td></td>
</tr>
<tr>
<td>Postoperative CA, deg</td>
<td>15.2±19.9 (228.7-50.7)</td>
<td>7.9±21.0 (239.7-40.2)</td>
<td>.26</td>
<td></td>
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<tr>
<td>LPA, °</td>
<td>20.38±8.7 (214.8-14.3)</td>
<td>22.5±7.0 (215.8-8.7)</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>LT, mm</td>
<td>8.5±5.2 (3.5-24.2)</td>
<td>8.9±5.4 (0.0-22.5)</td>
<td>.54</td>
<td></td>
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</table>

Abbreviations: CA, congruence angle; deg, degrees; FTA, femorotibial angle; LPA, lateral patellofemoral angle; LT, lateral patellar translation; TD, trochlear depth; TT-TG, tibial tuberosity-trochlear groove.

The morphology of the cartilaginous trochlea differs markedly from that of the underlying bony trochlea in patients with trochlear dysplasia, and true axial radiographs do not represent the natural bony trochlear morphology and so mislead further clinical management. Additionally, preoperative evaluation using MRI in patellar instability may be helpful. Nelitz et al. emphasized the need of a thorough preoperative analysis including MRI to identify the underlying pathology and to apply individually tailored therapy to avoid failure of patellar instability surgery.

The main limitation of the current study was that it was retrospective without a control group. Second, the number of patients was relatively small. Third, it was a short-term study, and longer follow-up is required to evaluate the results of this arthroscopic technique. Fourth, the study did not show results for abnormal TT-TG distance or Insall-Salvati index, which are also bony factors for patellar instability, and did not consider generalized ligament laxity, which could be one of the confounders of patellar instability. However, the authors were able to evaluate trochlear dysplasia without the effects of other bony factors. Additionally, the major risk factor for failure after operation for patellar instability is trochlear dysplasia. The TT-TG distance did not seem to be a major risk factor for failure after operation in patellar instability, and patellar height can also be an anatomic variant that is asymptomatic in most individuals. Therefore, TD measurement for evaluating trochlear dysplasia can be useful in patellar instability. Finally, the authors were unable to compare preoperative and postoperative Kujala scores. Preoperatively, clinical assessment was performed using the Insall score. However, the Insall scoring system had limitations as a method for looking at true knee function after a procedure. Therefore, the Kujala score was added during the follow-up period. Although the preoperative and postoperative Kujala score could not be compared, the current status of patients could be evaluated more precisely using multiple scoring systems.

Indications for this arthroscopic technique include recurrent patellar instability resulting from laxity of the medial retinaculum; injury of the MPFL body; and appropriately selected cases with trochlear dysplasia, TT-TG less than 20 mm, normal Q-angle and Insall-Salvati index. MRI is considered to be a valuable preoperative investigation in all patients with patellar instability. The authors recommend using arthroscopic medial soft tissue plication with the pullout technique as the primary procedure in patellar instability with or without trochlear dysplasia; however, in cases with TD less than 1 mm, the technique should be used with caution.

**Conclusion**

The described arthroscopic medial soft tissue pullout technique and lateral retinacular release showed good clinical and radiologic results for patellar instability even in the presence of trochlear dysplasia. However, the technique showed limited success in severe trochlear dysplasia cases.
REFERENCES