Ultrasound-Guided Percutaneous Repair of Medial Patellofemoral Ligament: Surgical Technique and Outcomes

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Medial Patellofemoral Surgical Repair Video

Abstract

A lateral patellar dislocation causes a medial patellofemoral ligament (MPFL) tear that begins affecting patellar biomechanics. Reconstruction is difficult because of the inability to reliably and accurately determine proper placement of sockets. Studies of MPFL anatomy have found significant variability in attachment site locations, which suggests MPFL procedures cannot be used universally and must be approached differently for each patient. Recurrent dislocations result in patellar and trochlear chondral and bony damage.

In this article, we present a novel technique that uses ultrasound to locate the MPFL tear and the MPFL attachment sites, and perform anatomical repair of the native tissue at the patellar attachment site, the femoral attachment site, or both. We also describe our retrospective analysis of 10 cases of this ultrasound-guided percutaneous procedure, performed since its development in 2013. In each case, patellar stability was restored completely and without complications.

The promising results, the ease of the surgery, and the limited rate of complications indicate this surgical technique should be considered before reconstruction and early in trauma cases, before onset of chondral or bony damage.

Take-Home Points

- Use ultrasound to identify integrity and location of MPFL tear.
- Anatomic repair allows native tissue to reintegrate into bone.
- Repairs done early can prevent complications of recurrent instability.
- Repair maintains biological and proprioceptive qualities of tissue.
- Ultrasound-guided percutaneous repair is quick and effective.

The medial patellofemoral ligament (MPFL) is the primary passive restraint to lateral patellar excursion[1-5] and helps control patellar tilt and rotation.[6,7] More than 90% of lateral patellar dislocations cause the MPFL to rupture, and roughly 90% of these detachments involve the femoral insertion.[4] Ensuing patellar instability often results from MPFL insufficiency. It has been suggested that re-creating the anatomy and functionality of this ligament is of utmost importance in restoring normal patellar biomechanics.[1-5,7,8]

Anatomical risk factors for recurrent patellar instability include patella alta, increased tibial tuberosity-trochlear groove (TT-TG) distance, trochlear dysplasia, and torsional abnormalities.[1-4,6] A medial reefing technique with a lateral tissue release traditionally was used to restore proper kinematics, but was shown to have associated postoperative issues.[9] In recent years, ligamentous reconstruction has become the gold standard for surgical intervention.[6-8] The precise location of the MPFL attachments, particularly at the femoral insertion, has been the subject of a great deal of debate. McCarthy and colleagues[10] suggested that the anatomical location at the femur is just anterior and distal to the adductor tubercle, but they noted that determining this location during surgery is difficult. Use of fluoroscopy has become the gold standard for identify-

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ing proper tunnel placement for reconstruction.[10,11] However, the inability of fluoroscopy to consistently identify the anatomical MPFL attachments has proved to be a shortcoming of this technique.[11,12]

In this article, we present a novel technique for percutaneous repair of patella- or femur-side MPFL tears. It is performed with ultrasound guidance, which allows accurate identification of anatomy before and after surgery (**Figures 1-3**). Ultrasound has several advantages over other techniques and has not been described in other published works on MPFL procedures (**Table 1**).

Methods

Patient Demographics

Dr. Hirahara developed this technique in 2013 and performed it 11 times between 2013 and 2016. Of the 11 patients, 1 was excluded from our retrospective analysis because of trochlear dysplasia, now considered a relative contraindication. Of the remaining 10 patients, 5 (50%) had the repair performed on the right knee. Eight patients (80%) were female. Mean (SD) age was 17.21 (3.53) years. One patient had concurrent femur- and patella-side

Table 1. **Advantages and Disadvantages of Ultrasound-Guided Repair of Medial Patellofemoral Ligament**

Advantages	Disadvantages
■ Accurate identification of tear	■ Proficiency with ultrasound required
■ Anatomical repair	■ Controversy about exact femoral and patellar attachments
■ Native tissue maintained	■ Midsubstance tear cannot be repaired
■ Can be used for patella- or femur-side tears, or both	
■ Minimally invasive	
■ Does not burn bridges for reconstruction	

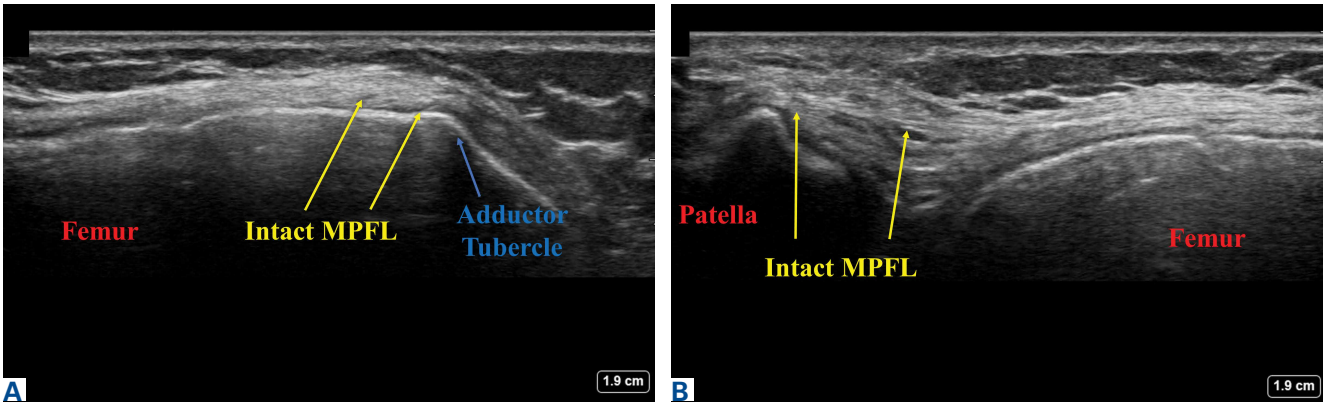

Figure 1. (A) Long-axis ultrasound of an intact medial patellofemoral ligament (MPFL) at the femoral attachment (blue arrow). (B) Long-axis ultrasound of an intact MPFL at the patellar attachment. Intact tissue attaches fully at each location (yellow arrows).

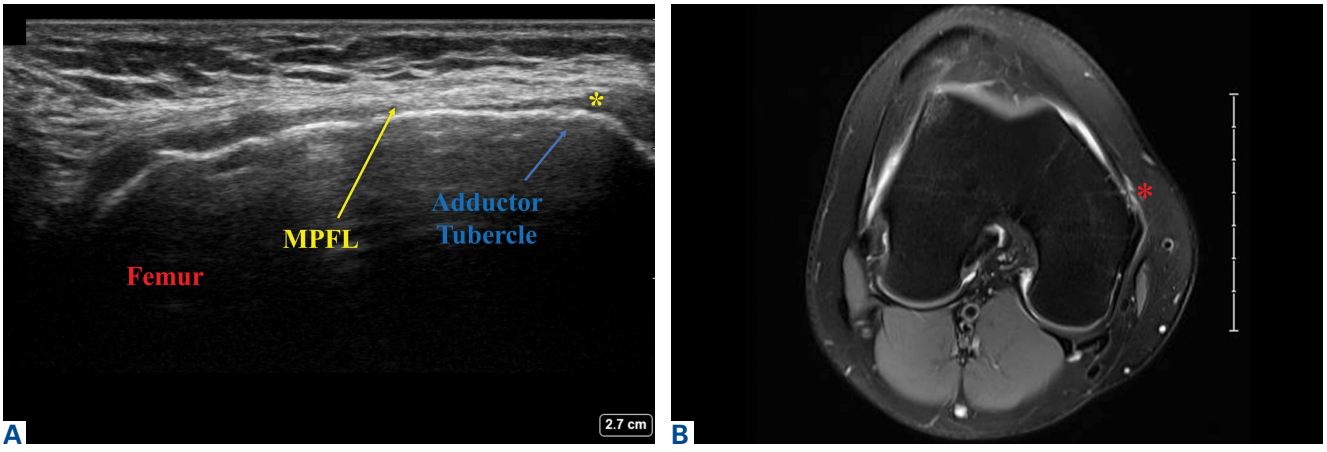

Figure 2. (A) Long-axis ultrasound of a medial patellofemoral ligament (MPFL) (yellow arrow) with a tear (*) at the femoral attachment near the adductor tubercle (blue arrow). (B) Correlative proton density fat-saturated axial magnetic resonance imaging of right knee shows MPFL tear at the femoral attachment near the adductor tubercle (*).

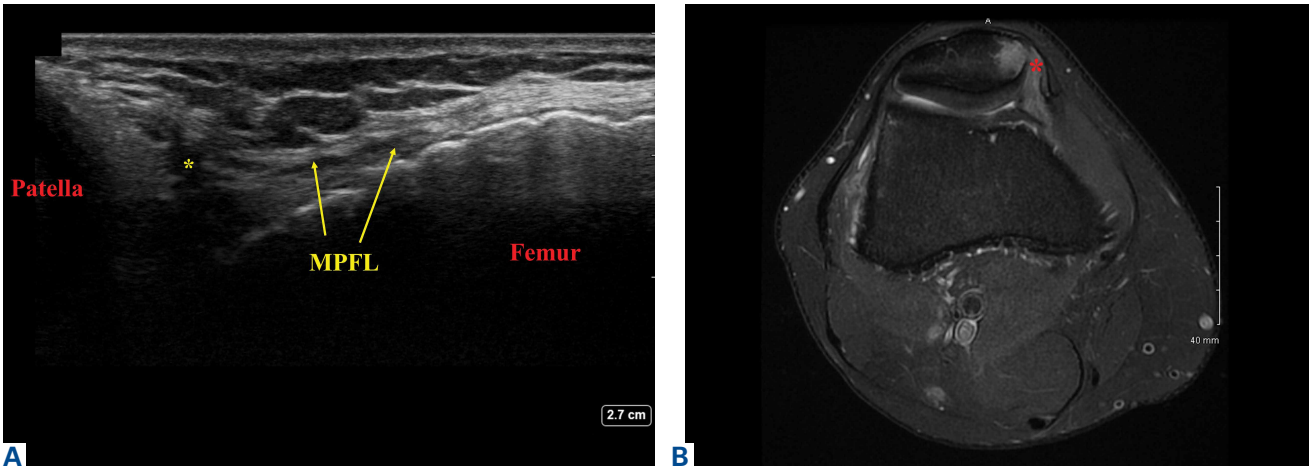

Figure 3. (A) Long-axis ultrasound of a medial patellofemoral ligament (MPFL) (yellow arrows) with a tear (*) at the patellar attachment. (B) Correlative proton density fat-saturated axial magnetic resonance imaging of left knee shows MPFL tear at the patellar attachment (*).

detachments; otherwise, 6 (60%) of 10 repairs were performed exclusively at the patella. We grade patellar instability according to amount of glide based on patellar width and quadrants. Normal lateral displacement was usually 1 to 2 quadrants of lateral glide relative to the contralateral side. Before surgery, 6 (60%) of the 10 patients presented with lateral glide of 3 quadrants, and 3 (30%) presented with lateral glide of 4 quadrants. All had patellar instability apprehension on physical examination.

Surgical Indications

Before surgery, MPFL integrity is determined by ultrasound evaluation. Repair is considered if the MPFL has a femur- or patella-side tear and is of adequate quantity and quality, and if there are minimal or no arthritic changes (**Table 2**). As the MPFL is the main constraint to lateral patellar displacement, patients continue to have excessive patellar instability if left insufficient.

Table 2. **Indications and Contraindications for Ultrasound-Guided Repair of Medial Patellofemoral Ligament**

Indications	Contraindications
■ Positive diagnosis of femur- and/or patella-side MPFL tear	■ Excessive TT-TG distance
■ Patellar glide excessive compared with that of contralateral side	■ Severe trochlear dysplasia
■ Appropriate and adequate tissue quality	■ Midsubstance MPFL tear
■ Subjective complaints of patellofemoral instability	■ Severe patellofemoral chondromalacia
■ Intact midsubstance MPFL	
■ Apprehension with instability testing	

Abbreviations: MPFL, medial patellofemoral ligament; TT-TG, tibial tuberosity-trochlear groove.

Surgical Technique

The patient is brought to the operating room and placed supine. Patellar stability of the affected knee is assessed and compared with that of the contralateral side with patellar glide. The knee is prepared and draped in usual sterile fashion. With the knee flexed at 90°, a tourniquet is inflated. Diagnostic arthroscopy is performed with standard anteromedial and anterolateral portals, and, if necessary, arthroscopic procedures are performed.

Femoral Attachment Repair

With the leg in extension, ultrasound is used to identify the tear at the femoral attachment (watch part 1 of the video online at www.amjorthopedics.com). A spinal needle is placed at the femoral insertion, typically just anterior and distal to the adductor tubercle (**Figure 4**).[10] A scalpel is used to make a 1-cm incision through the tissue and down to the attachment. The area is débrided and abraded. A drill is used to create an appropriate socket, and a 3.0-mm suture anchor (BioComposite Knotless SutureTak; Arthrex) is placed into the attachment site. A suture passer (Labral FastPass Scorpion; Arthrex) is used to pass the sutures through the leading edge of the torn MPFL in horizontal mattress fashion and tie it to the anchor, completing the repair. Lateral glide and range of motion (ROM) are tested to ensure adequate tensioning, and ultrasound can be used to corroborate proper anchor placement.

Patellar Attachment Repair

With the leg in extension, ultrasound is used to identify where the MPFL is detached from the patella (watch part 2 of the video online at www.amjorthopedics.com). A spinal needle is placed at

the detachment site (**Figure 5**). A scalpel is used to make a 1-cm incision down to the patella. The area is débrided and abraded. A drill is used to create a socket. A 3.0-mm suture anchor (BioComposite Knotless SutureTak) is then placed into the socket. A suture passer (Labral FastPass Scorpion) is used to pass the suture through the leading edge of the torn MPFL and create a horizontal mattress suture. The attached wire with loop (FiberSnare; Arthrex) is then used to pass the suture back through the knotless anchor to create a knotless construct. The sutures are pulled and tightened, completing the repair. Lateral-glide and ROM testing and ultrasound evaluation are performed to ensure appropriate tensioning and anchor placement. If necessary, another anchor may be used with the patellar attachment, as its site is broader than the femoral attachment site.

In this description, we showcase knotless and knotted techniques for each repair site. Either method is appropriate for the 2 repair sites. Owing to the superficial nature of the attachment sites—they may have very little fat, particularly at the patella—knot stacks are more prominent, can be felt after surgery, and have the potential to irritate surrounding tissues. Therefore, we prefer knotless fixation for both sites.

Rehabilitation

Rehabilitation after MPFL repair is much like rehabilitation after quadriceps tendon repair. The patient is locked in a brace in full extension when up and moving. Early weight-bearing and minimal use of assistive devices (crutches) are allowed because, when the leg is in full extension, there is no tension at the repair sites. Rehabilitation begins within 1 week, and normal daily function is quickly attained. The protocol emphasizes pain-free motion and suitable patellar mobility, and allows the immobilizing brace to be unlocked for exercise and sitting. During the first 4 weeks, quadriceps activation is limited; progression to full ROM occurs by 4 to 6 weeks. During the strengthening phase, loading the knee in early flexion should be avoided. Return to heavy lifting, physical activity, and sports is delayed until after 6 months in order to allow the construct to mature and integrate. Once the patient has satisfied all the strength, ROM, and functional outcome measurements, a brace is no longer required during sports and normal activity.

Results

Mean tourniquet time for each procedure, which includes diagnostic arthroscopy and ultrasound-guided percutaneous repair, was 26.9 minutes. After surgery, all patients had equivalent lateral patellar glides on the operated and contralateral knees (**Table 3**), complete resolution of pain and perceived instability, and full ROM, and they were able to return to their sports and usual activities. There were no complications, and no secondary surgeries required.

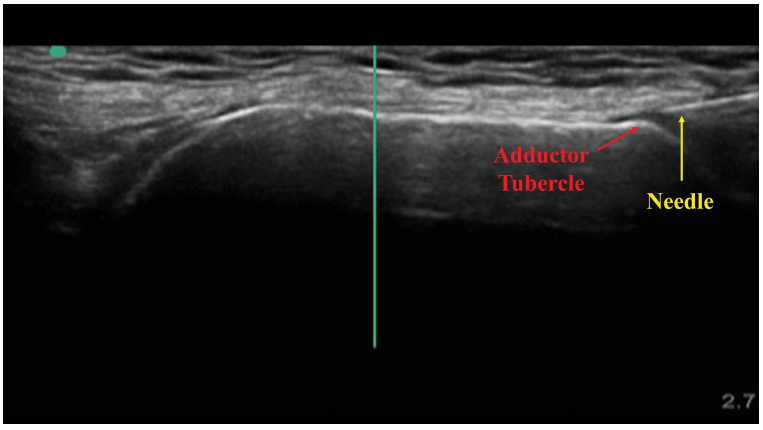

Figure 4. Intraoperative long-axis ultrasound shows a spinal needle (yellow arrow) near the adductor tubercle (red arrow). The spinal needle is used to pinpoint the attachment site and guide placement of the spear. This is the eventual location of the anchor at the femoral attachment of the medial patellofemoral ligament.

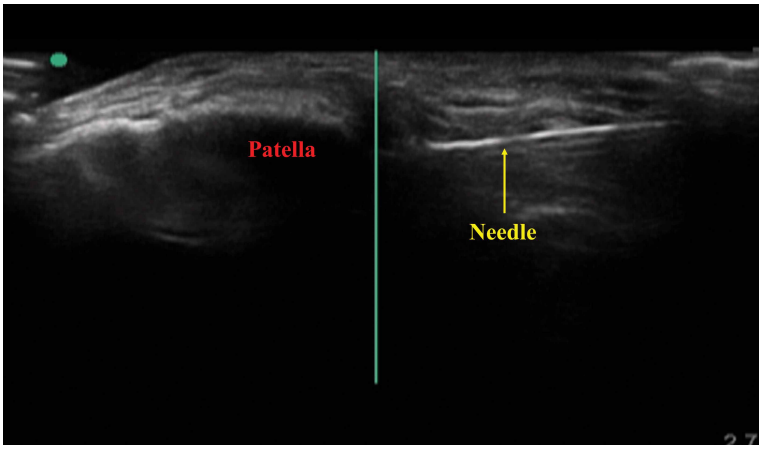

Figure 5. Intraoperative long-axis ultrasound of a spinal needle placement (yellow arrow) at the patella. The spinal needle allows for exact placement of the anchor at the patellar attachment of the medial patellofemoral ligament.

Discussion

Conservative management typically is recommended for acute patellar dislocations. In the event of failed conservative management or chronic patellar instability, surgical intervention is indicated. Studies have found that conservative management has recurrent-dislocation rates of 35% at 3-year follow-up and 73% at 6-year follow-up, and recurrent dislocations significantly increase patients' risk of devel-

Table 3. **Patients' Preoperative Patellar Glides**[a]

Patient No.	%
1	75
2	50
3	75
4	75
5	100
6	75
7	75
8	100
9	75
10	100

[a]Preoperative value of 50% indicates mobility of 2 quadrants of patella; 75%, 3 quadrants; 100%, 4 quadrants. All postoperative values were normal (patellar mobility was equal to that of their contralateral side).

oping chondral and bony damage.[13] MPFL repair is designed to restore proper patellar tracking and kinematics while maintaining the anatomical tissue. Lateral patellar dislocations often cause the MPFL to rupture; tears are reported in more than 90% of incidents.[4] The significant rate indicates that, even after a single patellar dislocation, the MPFL should be evaluated. The MPFL contributes 50% to 60% of the medial stabilizing force during patellar tracking[1,7,14] and is the primary restraint to lateral patellar excursion and excessive patellar tilt and rotation.[1-5] Its absence plays a key role in recurrent lateral patellar instability. With this structure being so important, proper identification and intervention are vital. Studies have established that redislocation rates are significantly higher for nonoperatively (vs operatively) treated primary patellar dislocations.[13] Simple and accurate percutaneous repair of the MPFL should be performed early to avoid the long-term complications of recurrent instability that could damage the cartilage and bone of the patella and trochlea.

The primary advantage of this technique is its novel use of musculoskeletal ultrasound to accurately identify anatomy and pathology and the placement of anatomical repairs. Accurate preoperative and intraoperative assessment of MPFL anatomy is vital to the success of a procedure. Descriptions of MPFL anatomy suggest discrepancies in the exact locations of the femoral and patellar attachments.[2,5,7,10,12,15,16] Tanaka[5] noted that, even within paired knees, there was "marked variability" in the MPFL insertions. McCarthy and colleagues[10] contended the femoral attachment of the MPFL is just anterior and distal to the adductor tubercle, the landmark addressed in this technique. Steensen and colleagues[16] described this attachment site as being statistically the "single most important point affecting isometry" of the MPFL. Sallay and colleagues[4] asserted that an overwhelming majority of MPFL tears (87%) occur at the adductor tubercle. The variable distribution of tear locations and the importance of re-creating patient anatomy further highlight the need for individualized treatment, which is afforded by ultrasound. Fluoroscopy has been inadequate in identifying MPFL anatomy; this modality is difficult, cumbersome, inaccurate, and inconsistent.[11,12] Conversely, ultrasound provides real-time visualization of anatomy and allows for precise identification of MPFL attachments and accurate placement of suture anchors for repair during surgery (Figures 3, 4).

For femur-side and patella-side tears, repairs can and should be performed. For midsubstance tears, however, repair is not feasible, and reconstruction is appropriate. MPFL repair is superior to reconstruction in several ways. Repair is a simple percutaneous procedure that had a mean tourniquet time of 26.9 minutes in this study. For tissue that is quantitatively and qualitatively adequate, repair allows the structure to reintegrate into bone without total reconstruction. In the event of multiple tears, the percutaneous procedure allows for repair of each attachment. As the MPFL sits between the second and third tissue layers of the medial knee, reconstruction can be difficult and invasive and require establishment of a between-layers plane, which can disrupt adjacent tissue.[4,7,17] Repair also maintains native tissue and its neurovascular and proprioceptive properties.

Reconstruction of the MPFL has become the gold-standard treatment for recurrent lateral patellar instability but has limitations and complications.[3,7,12,17] Reconstruction techniques use either surface anatomy palpation (requiring large incisions) or fluoroscopy to identify tunnel placement locations, and accurate placement has often been difficult and inconsistent. Our repair technique has several advantages over reconstruction. It does not burn any bridges; it allows for subsequent reconstruction. It does not require a graft and, using small suture anchors instead of large sockets and anchors, involves less bone loss. It also allows for early repair of tears—patients can return to activities, sports, and work quicker—and avoids the risk of chondral and bony damage with recurrent dislocations. According to our review of the MPFL repairs performed by Dr. Hirahara starting in 2013, the procedure is quick and successful and has outstanding outcomes.

Another treatment option for recurrent lateral patellar instability combines reefing of the medial patellofemoral tissues with a lateral release. This combination has had several postoperative complications and is no longer indicated.[9] TT transfer and trochleoplasty procedures have been developed to address different aspects of patellar instability, increased TT-TG distance, and dysplastic trochlea (Table 2). Both types of procedures are highly invasive and difficult to perform, requiring technical expertise. They are best used when warranted by the anatomy, but this is uncommon. The technique we have presented allows for easy and reliable repair of dislocations in the absence of associated pathology that would require larger, more complex surgery. The ease of use and accuracy of musculoskeletal ultrasound make this technique superior to others.

Conclusion

The MPFL is a vital static stabilizer of the patella and as such should be evaluated in the setting of patellar injury. The novel preoperative and intraoperative use of musculoskeletal ultrasound described in this article allows for easy real-time identification of the MPFL and simple and accurate percutaneous repair of torn structures. Nonoperative treatments of acute patellar dislocations have higher rates of recurrent dislocations, which put patella and trochlea at risk for bony and chondral damage. Given appropriate tear location and tissue quality, repairs should be considered early and before reconstruction. To our knowledge, a reliable, easily reproducible MPFL repair was not described until now. We have reported on use of such a technique and on its promising patient outcomes, which should be considered when addressing MPFL injuries.

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