Case Report

Technical Failure of Medial Patellofemoral Ligament Reconstruction

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Abstract: In patients with chronic patellofemoral instability who have normal alignment and deficient proximal medial restraints, medial patellofemoral ligament (MPFL) reconstruction is a good option to treat patellar instability. However, medial subluxation, medial patellofemoral articular overload, and recurrent lateral instability are possible when the graft is positioned non-anatomically. The clinical presentation of MPFL femoral tunnel malpositioning has not been highlighted in the literature. We have had 5 patients referred to us after a malpositioned femoral MPFL graft led to disabling symptoms and a need for revision surgery. This report highlights the effects of a malpositioned graft and describes strategies to identify the anatomic MPFL insertion during surgery.

The medial patellofemoral ligament (MPFL) guides the patella into the trochlear groove during the first 30° of knee flexion.[1-4] In patients with chronic lateral patellofemoral instability who have normal alignment and deficient proximal medial restraints, MPFL reconstruction is a good option to treat patellar instability. Numerous techniques have been described with a variety of graft choices and fixation strategies.[5-22] Many studies have reported good outcomes with MPFL reconstruction,[12,23-26] but continued instability and cartilage breakdown are possible when the graft is positioned non-anatomically. Servien et al.[27] recently analyzed femoral tunnel position on radiography and magnetic resonance imaging (MRI) 1 year after MPFL reconstruction. Of the tunnels, 69% were in good position on radiography and 65% were in proper position on MRI; in contrast, 35% of tunnels were thought to be positioned anterior or proximal. Elias and Cosgarea[28] reported a 50% increase in peak medial patellofemoral pressure when an over-tightened MPFL graft is positioned proximally on the femur.

The clinical presentation of MPFL femoral tunnel malpositioning has not been highlighted in the literature. We have had 5 patients referred to us after a malpositioned femoral MPFL graft led to disabling symptoms and a need for revision surgery. We used the method described by Schottle et al.[29] and modified by Servien et al.[27] to determine femoral tunnel positioning on lateral radiographs (Fig 1). Of the 5 cases, 4 exhibited proximal graft position, and all 5 cases had an anteriorly positioned graft. Iatrogenic medial patella subluxation developed in 3 patients, and 2 patients had recurrent lateral instability. Two patients with medial subluxation were found to have severe medial patellofemoral arthritis.

CASE REPORTS

Case 1

A 39-year-old woman underwent an Elmslie-Trillat procedure, lateral retinacular release, and vastus medialis oblique advancement in 2008 for chronic lateral

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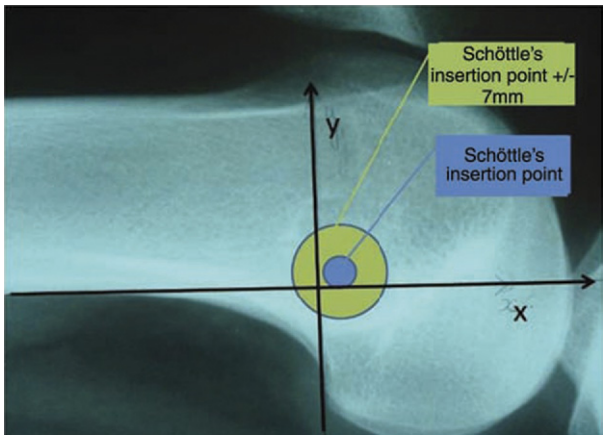

Figure 1. Femoral tunnel positioning. The normal femoral insertion of the MPFL is represented by the blue circle as described by Schottle et al.[29] This is found by the intersection of line x (tangential to posterior condyle) and line y (perpendicular to line x at posterior aspect of Blumensaat line). The green circle represents modification of the anatomic zone to ±7 mm because of the diameter of the femoral tunnel. (Reprinted with permission.[27])

patellofemoral instability. Recurrent lateral instability developed within 6 months. In 2009 a semitendinosus allograft MPFL reconstruction was performed. On referral to our office, the patient complained of chronic medial patellofemoral aching and acute episodes of patella shifting and popping, causing severe pain. Examination showed a positive medial patella subluxation test and a tight MPFL graft with medial tilt. Plain radiographs and computed tomography showed an anteriorly and proximally positioned femoral tunnel (Fig 2). The patient again underwent surgery, and arthroscopic examination showed medial patella facet arthritis, overload, and medial tilt (Fig 3). Arthroscopic release of the MPFL graft, patella chondroplasty, and open lateral imbrication were performed. This allowed the patella to track centrally and unloaded the arthritic medial facet. Postoperatively, the patient reported pain relief and resolution of her shifting and popping symptoms.

Case 2

A 33-year-old woman had an anteromedial tibial tubercle transfer and allograft MPFL reconstruction in 2008 for chronic lateral patellofemoral instability. Increasing pain developed postoperatively. When the patient presented to our office in 2009, she had a positive medial patella subluxation test, gross medial tracking of the patella, medial tilt, and significant medial retinaculum tenderness. Radiography and MRI showed an anteriorly positioned femoral tunnel (Fig 4). Repeat arthroscopy showed extensive medial patella facet cartilage loss, medial tilt, and a tight MPFL graft. Arthroscopic medial release and patella chondroplasty were performed, and patella tracking improved. Unfortunately, the patient continued to have disabling pain and limitation of daily activities. An isolated patellofemoral arthroplasty was performed, which gave her considerable pain relief and allowed her to return to low-demand activities (Fig 5).

Case 3

A 16-year-old female gymnast began having bilateral patellofemoral dislocations at age 13 years. She tried physical therapy but continued to have left knee patellofemoral dislocations with activities of daily living. In 2007 she underwent an Elmslie-Trillat procedure, lateral retinacular release, and MPFL repair to the femur with suture anchors. She subsequently had redislocation at 4 months postoperatively. In 2008 she underwent an MPFL reconstruction with a semitendi-

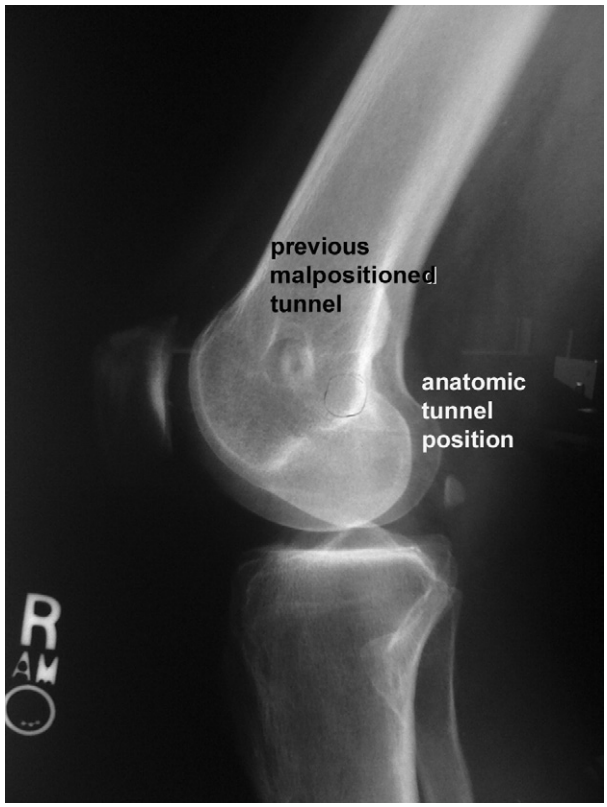

Figure 2. Lateral radiograph showing an anteriorly and proximally positioned femoral tunnel in a 39-year-old woman after an allograft MPFL reconstruction was performed (case 1). Medial patella subluxation and medial patella tilt developed from her malpositioned MPFL graft.

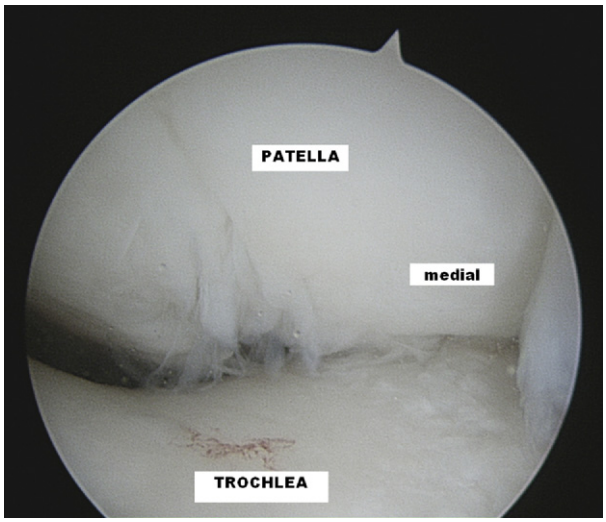

FIGURE 3. Intraoperative arthroscopic picture showing medial patellofemoral overload and medial patellar tilt in a 39-year-old woman with a malpositioned MPFL graft (case 1). The arthroscope is in the inferior-lateral arthroscopy portal looking up at the patella. The patient is supine.

nosus autograft. The femoral tunnel was anterior and proximal to the normal insertion site (Fig 6). Unfortunately, left knee recurrent lateral dislocations again developed 3 months postoperatively. The patient became extremely disabled and had intolerable spasms as a result of the dislocations. Despite bracing and a dedicated physical therapy program, she began having dislocations on a regular basis and was referred to our office for evaluation and treatment. In 2010 we performed a revision MPFL reconstruction with semitendinosus allograft, and the patient has not had any further patella dislocations.

Case 4

A 20-year-old woman had a lateral retinacular release in 1999 for chronic patellofemoral instability. In 2000 she underwent a medial tibial tubercle transfer for recurrent dislocation. She did well for 6 years but subsequently had recurrent instability events. In 2006 she had an MPFL reconstruction with semitendinosus autograft. She presented to our office in 2007 with complaints of daily subluxation episodes and an inability to run. On examination, she had positive lateral patella apprehension and hyperlaxity. Plain radiographs showed evidence of trochlear dysplasia and an anteriorly malpositioned femoral tunnel (Fig 7). In 2008 we performed a revision MPFL reconstruction with semitendinosus allograft, and the patient's condition has been stable since.

Case 5

A 19-year-old woman with a history of Ehlers–Danlos syndrome had bilateral lateral retinacular releases for chronic bilateral patellofemoral instability in 2005. Recurrent left knee patellofemoral instability developed, and she underwent an MPFL reconstruction with semitendinosus autograft in 2007. She did well for 1 year, but then increasing medial retinacular pain and acute dramatic patella popping developed. On presentation to our office in 2009, the patient was found to have a positive medial patella subluxation test and a tight MPFL graft. Plain radiographs showed an anteriorly positioned femoral tunnel (Fig 8). She underwent surgery including release of the MPFL graft, lateral patella stabilization, and debridement of a medial patella chondral lesion. The lateral one-third of her patella tendon was sutured to the iliotibial band as a restraint to medial subluxation. Although she continued to have occasional anterior knee discomfort

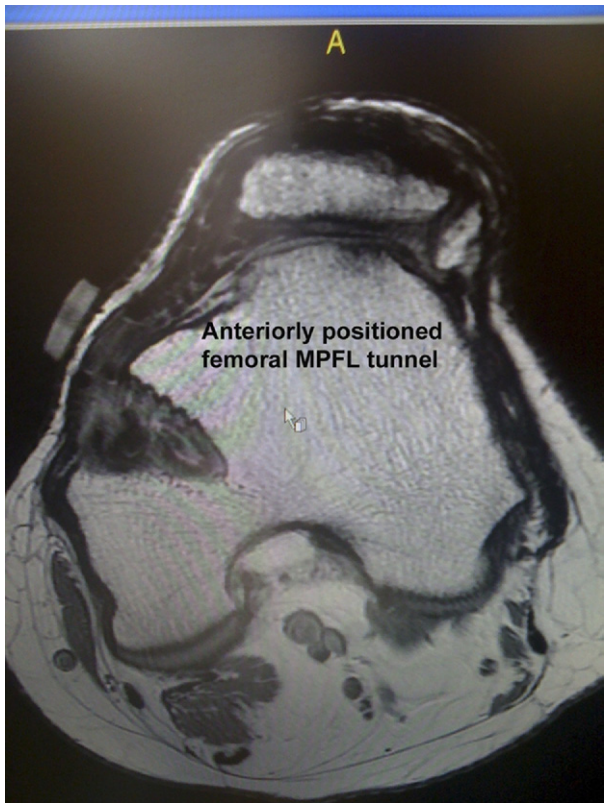

FIGURE 4. Axial MRI scan showing an anteriorly positioned femoral tunnel in a 33-year-old woman after an allograft MPFL reconstruction (case 2). Significant medial patella facet arthritis and medial tilt developed from her over-tightened and malpositioned MPFL graft.

Figure 5. Lateral radiograph of isolated patellofemoral arthroplasty performed in a 33-year-old woman for severe arthritis and disabling pain after failed MPFL reconstruction (case 2).

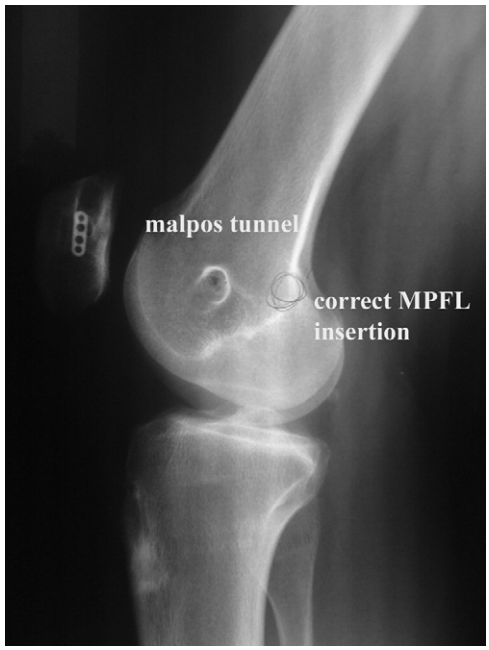

Figure 7. Lateral radiograph showing an anteriorly and proximally positioned femoral tunnel in a 20-year-old woman after an autograft MPFL reconstruction (case 4). Recurrent lateral instability developed. (malpos, malpositioned.)

postoperatively, she had no further episodes of painful patella popping.

DISCUSSION

Patellofemoral stability involves the coordinated interaction between static, dynamic, and osseous structures (Table 1). In full extension the patella is proximal to the trochlear groove and is dependent on soft-tissue restraints for stability. The MPFL is responsible for guiding the patella into the trochlear groove during the first 30° of knee flexion.[1] Correct patella centering in the groove during early knee flexion is essential for patellofemoral stability and is largely determined by the dynamic and static soft-tissue structures. With knee flexion beyond 30°, a non-dysplastic trochlear groove is the primary restraint to lateral patellar translation.[1] With increasing knee flexion, tension in the MPFL decreases considerably. In the setting of a normal trochlear groove and patellar height, the MPFL has been found to be isometric between full extension and 70° of flexion.[30] It provides restraint to lateral patella translation largely in the first 30° of knee flexion with no measurable MPFL tension in deeper flexion.[28] It is important to understand that studies looking at MPFL tension have been performed in patients with normal anatomy and these biomechanical relations may change when patella alta or trochlear dysplasia is present.

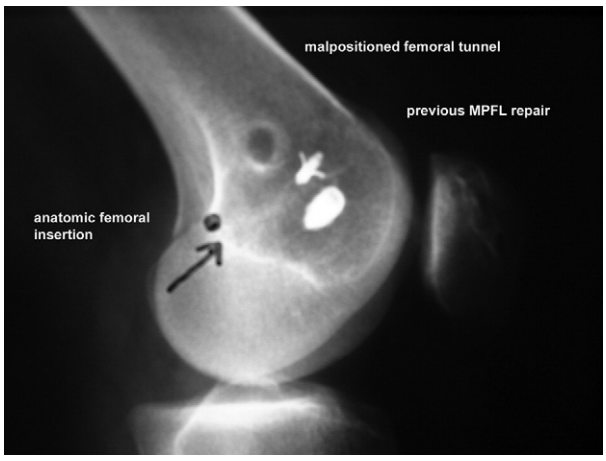

Figure 6. Lateral radiograph showing an anteriorly and proximally positioned femoral tunnel in a 16-year-old female gymnast after an autograft MPFL reconstruction (case 3). Recurrent lateral instability developed. The arrow points to the anatomic MPFL femoral insertion.

In these referred patients, anterior and proximal placement of the MPFL femoral graft insertion led to 3 possible outcomes: medial patellofemoral articular overload, iatrogenic medial subluxation, or

Figure 8. Lateral radiograph showing an anteriorly positioned femoral tunnel in a 19-year-old woman after autograft MPFL reconstruction. Medial patella subluxation and medial patella tilt developed from her malpositioned MPFL graft.

recurrent lateral instability (Table 2). When an MPFL graft is placed proximally on the femur, there is increased graft tension when the knee is flexed.[28] As observed in 2 of our cases, patella articular destruction can occur from the very high compressive force generated by a non-isometric MPFL reconstruction graft. When a malpositioned and over-tightened MPFL graft is combined with a lateral retinacular release, iatrogenic medial subluxation and medial tilt can develop. When the graft is 3 mm shorter than the intact MPFL and positioned 5 mm proximal to the normal femoral attachment site, medial patellar tilt and peak medial patellofemoral pressure are dramatically increased.[28]

Table 1. *Considerations in Evaluation of Patients With Patellofemoral Instability*

Dynamic Factors	Static Factors
Quadriceps/vastus medialis oblique	MPFL
Hip abductor strength	Trochlear groove
Core stability	Alignment (q angle, TT-TG distance)
	Patella alta

Abbreviation: TT-TG, tibial tubercle-trochlear groove distance.

Table 2. *Adverse Outcomes Associated With Malpositioned MPFL Femoral Tunnel*

1. Medial patellofemoral articular overload
2. Iatrogenic medial subluxation
3. Recurrent lateral instability (from excessive graft tension and failure)

Medial patella subluxation is often overlooked as a cause of symptoms because patients will complain of the patella moving laterally when the knee is flexed. Patients often complain of pain and rapid lateral patella translation with early knee flexion. The medial patella subluxation test is easily performed by flexing the knee as a medial translation force is maintained on the patella. Patients will typically have dramatic reproduction of symptoms.

The third outcome was recurrent lateral patellofemoral instability. Nonanatomic femoral MPFL graft insertion leads to increased graft tension as the knee is flexed. Over time, this can lead to stretching of the graft and failure. It is interesting that tendon grafts used for MPFL reconstruction are typically substantially stouter than the native MPFL yet can be completely destroyed by the extreme force generated by improper positioning.

Proper femoral placement of an MPFL reconstruction graft is difficult and requires a thorough understanding of medial knee anatomy (Table 3). The insertion site of the MPFL, in the saddle between the medial epicondyle and the adductor tubercle, is typically more posterior than expected.[31] Palpating the adductor magnus tendon insertion can help with orientation during surgery because the normal MPFL insertion is anterior and distal to this. We like to make an incision large enough to clearly identify the adductor tendon and the medial collateral ligament. We recommend inserting a guidewire into the desired femoral location and then confirming accurate placement by checking graft isometry and using fluoroscopy. If the graft is fixed first in the patella and

Table 3. *Pearls for Confirming Appropriate MPFL Graft Insertion Intraoperatively*

1. Use a large enough skin incision to identify anatomy and clearly palpate the saddle between the medial epicondyle and the adductor tubercle.
2. Palpate the adductor magnus tendon to help with orientation: the MPFL femoral insertion is anterior and distal to this.
3. Confirm guidewire placement with fluoroscopy.
4. Check graft isometry with a free suture.

tunneled posteriorly, it can be wrapped around the guide pin to check isometry during knee motion. Ideally, graft isometry should be maintained during the first 50° to 70° of flexion and loosen slightly in terminal flexion. If the graft tightens during flexion, the femoral attachment point is likely too proximal. On radiographs, the optimal guide pin position is 1 to 2 mm anterior to the posterior cortical extension line and 1 mm proximal to the posterior aspect of the Blumensaat line (Fig 8).[29,32]

Understanding the possible errors in femoral tunnel positioning during MPFL reconstruction, as well as their complications, is key to performing the procedure successfully. The femoral tunnel can be positioned too proximally or too distally, with proximal tunnels causing grafts to become increasingly tight in flexion and distal tunnels causing tightness in extension. Femoral tunnels can also be placed too anteriorly or too posteriorly. In addition to tunnel position, there are other factors that contribute to a successful MPFL reconstruction. The position of the patellar tunnel and the presence of patella alta can also affect the function of the graft. Perhaps the most important issue, however, is how the graft is tensioned. Even a perfectly positioned graft can cause serious problems if it is fixed too tightly.

Regardless of the tunnel positions, a key factor in MPFL reconstruction is to maintain appropriate tension of the graft throughout knee range of motion. Thaunat and Erasmus[33] reported on 2 patients with anterior knee pain and decreased range of motion after over-tightened MPFL reconstructions. Beck et al.[34] showed that 2 N of graft tension restored normal patellar translation. Higher loads (10 and 40 N) significantly restricted motion and increased medial patellofemoral contact pressure. After confirmation of anatomic positioning of the tunnels, it is important to tension the graft with the patella centered in the trochlea (Table 4). Securing fixation without maintaining correct patellar position can over-constrain the patella and lead to symptoms of medial overload and possibly subluxation. In addition, it is also possible to make the graft too loose even if the tunnels are positioned appropriately.

It is likely that none of the MPFL reconstructions that are currently being performed are truly anatomic, or precisely reproduce the normal knee biomechanics. Most techniques use a single or double cord-shaped graft, much thicker and stronger than the ribbon-shaped native MPFL. In fact, one could argue that it is not necessary to reproduce normal biomechanics to prevent further patellar instability episodes and achieve seemingly good clinical results. In a recent study of 29 patients who underwent successful MPFL reconstruction with a minimum follow-up of 2 years, 9 of 29 were believed to have improperly positioned femoral tunnels by radiographic analysis and 10 of 29 were believed to have improper placement by MRI analysis.[27] The authors found no correlation between tunnel position and clinical outcome. They did urge caution in interpreting their study results, suggesting that the outcome measurement tools may not have been sensitive enough to identify differences between groups, and noted their concern that patients with malpositioned tunnels "may have an increased incidence of osteoarthritis in the long term."[27] We share this concern and advocate anatomic placement of the femoral and patellar ends of the graft with fixation that reproduces the normal tension characteristics of the native MPFL.

MPFL reconstruction is a challenging procedure in which many factors can affect the outcome. Graft position in both the femur and the patella, as well as graft tensioning, contribute to the overall outcome of the reconstruction. Whereas malpositioning of the femoral tunnel may not necessarily always lead to failure of an MPFL reconstruction or be the sole cause of failure, tunnel positioning does play an important role in maximizing the function of the graft. We believe that malpositioning of the MPFL femoral graft insertion in these cases contributed to iatrogenic medial subluxation, medial patellofemoral articular overload, and recurrent lateral instability. Similar to the evolution of anterior cruciate ligament reconstruction, we believe that anatomic positioning is more important than graft choice or fixation method in MPFL reconstruction surgery.

TABLE 4. *Pearls for Setting Appropriate MPFL Graft Tension*

1. In full extension, the patella is not centered in the trochlear groove and estimating correct MPFL tension/length is difficult.
2. Have an assistant hold the lateral border of the patella flush with the lateral trochlea in 30° of knee flexion while the graft is tensioned. This prevents overtightening the MPFL graft.
3. Tension the MPFL with the knee in 60° of knee flexion, with the patella fully centered in the trochlear groove. This is when the MPFL is at its maximal length. A checkrein to lateral translation will exist without overtensioning the patella.
4. The goal is not to over-tighten the MPFL graft. The MPFL graft should guide the patella into the trochlear during early knee flexion. The patella should engage and center in the trochlea at 20° to 30° of knee flexion.

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