Medial Patellofemoral Ligament Reconstruction: Current Concepts

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Abstract

Anatomical and biomechanical studies indicate that the medial patellofemoral ligament (MPFL) is the primary restraint to lateral patellar dislocation and displacement. The MPFL lies along the second layer of the medial side components and extends from the superior two-thirds of the patellar medial edge to the femoral insertion, providing 50–60 % of the biomechanical stabilizing force for the medial patella.

In recent years, MPFL reconstruction has become an accepted surgical treatment for patellofemoral instability. The goal of such a surgical intervention should be to restore normal anatomical function and stability, and complications of MPFL reconstruction remain the major cause of technical problems with the surgery.

Quantitative stress radiography of the patella performed in the outpatient clinic may provide important information about the indications for lateral release. Furthermore, the lateral release procedure increases lateral, but not medial, instability in patients with recurrent patellar dislocation who do not exhibit medial instability prior to surgery.

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The Anatomy and Biomechanics of MPFL

Anatomical and biomechanical studies revealed that the medial patellofemoral ligament (MPFL) is the primary restraint to lateral patellar dislocation and displacement (Warren and Marshall 1979; Andrish 2004; Panagiotopoulos et al 2006). The MPFL is a thin fascial band of approximately 53 mm in length (range 45–64 mm) (Tuxoe et al 2002). The anatomy of the medial side of the knee joint shows three layers: the first corresponds to the superficial retinaculum, the second to the MPFL and medial collateral ligament, and the third to the medial patellotibial ligament and the medial patellomeniscal ligament (Warren and Marshall 1979). Within this anatomical context, the MPFL extends from the superior two-thirds of the patellar medial edge to the femoral insertion, with the patellar end of the MPFL passing deep into the distal part of the vastus medialis obliquus, which overlays the MPFL at the patellar attachment and attaches to the proximal part of the patellar at the medial border. Recent anatomical studies located the femoral insertion site of the MPFL between the adductor tubercle and the medial femoral epicondyle (Nomura et al. 2000; Smirk and Morris 2003; Steensen et al. 2004; Fig. 1).

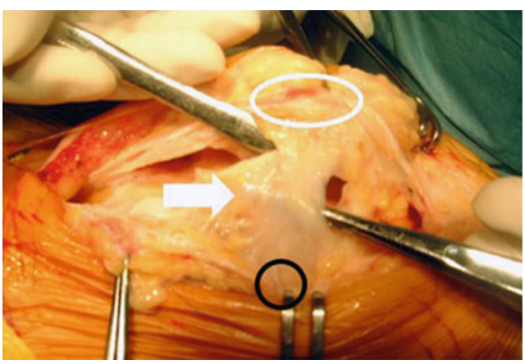

Fig. 1 Image of MPFL (*arrow*). *White circle* shows the natural MPFL attachment at the patellar site and the *black circle* shows the femoral attachment of the MPFL

Biomechanical studies show that the MPFL provides 50–60 % of the medial patella-stabilizing force (Conlan et al. 1993; Desio et al. 1998; Nomura et al. 2000). Conlan et al. (1993) further showed that the MPFL could resist 53 % of the biomechanical force needed to cause a 12.7-mm patellar lateral displacement. In a similar study, Desio et al. (1998) displaced the patella laterally at 20 % knee flexion, using a ball joint to allow patellar tilt. By sequential cutting of structures, they found that the MPFL had resisted 60 % of this force. The studies described above tested their knees near to full extension, because the patella is known from clinical experience to dislocate most commonly in a relatively extended posture. In addition, Amis et al. (2003) described that the contribution of the MPFL to resisting patellar lateral displacement was determined as the difference between the force measured at 10 mm lateral displacement before and after the MPFL was transected.

MPFL Reconstruction

MPFL reconstruction has become an accepted surgical technique for restoring patellofemoral instability over the last decade. Non-anatomical reconstruction of the MPFL can lead to non-physiological patellofemoral pressure and abnormal patellar tracking, whereas a surgical intervention should aim for anatomical reconstruction.

Femoral insertion is the critical part of an MPFL reconstruction since it allows isometric adjustments of the graft, resulting in a good clinical outcome.

The radiographic landmarks for the femoral MPFL center recommended by Schottle et al. (2007) are 1.3 mm anterior to the posterior cortex extension and 2.5 mm distal to the posterior origin of the medial femoral condyle, just proximal to the posterior point of the Blumensaat line on the lateral view (Fig. 2). On the other hand, Smirk and Morris (2003) reported that the best patellar attachment site should include the normal MPFL attachment, in the superior third of the patella, and an attachment in the middle of the patella.

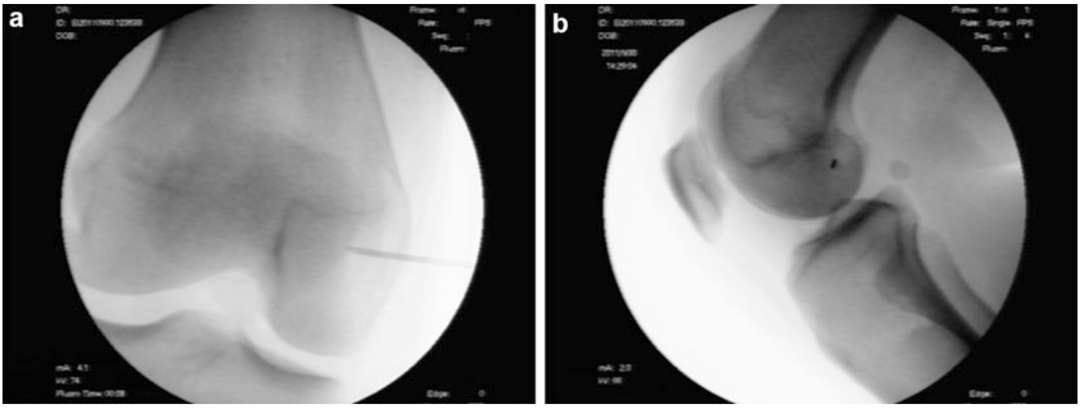

Fig. 2 Fixation point of grafted MPFL at the femoral site: (**a**) Coronal view. (**b**) Lateral view

The Surgical Procedures of MPFL Reconstruction

Many surgical procedures for MPFL reconstruction with excellent clinical results have been reported in the last two decades. In 1990, Suganuma et al. (1990) described an MPFL reconstruction method in a Japanese journal using an autograft tendon or an artificial ligament. Then, 2 years later, Ellera (1992) reported using an artificial polyester ligament that was fixed in a transverse drill hole of the patella and then fixed to the medial femoral condyle with a metal screw. Following these reports, many surgeons reported on MPFL reconstructions, with techniques including a free semitendinosus, gracilis, quadriceps, adductor tendon, a vastus medialis retinaculum autograft, and artificial ligament (Munuta et al. 1999; Cossey and Paterson 2005; Schottle et al. 2005). Fixation techniques have also varied, with femoral side fixations conducted such that the bone tunnel was made and fixed using an interference screw, the endobutton technique, direct suture, or a bone plug and staple (Muneta et al. 1999; Cossey and Paterson 2005; Schottle et al. 2005; Deie et al. 2011; Fig. 3). For children, to avoid damaging the femoral distal epiphysis, surgeons have mostly reported the tendon transfer technique whereby the graft was passed through the posterior one-third of the MCL femoral insertion, which acts as a pulley (Deie et al. 2003; Fig. 4).

The patellar site fixation was also variable, with three main techniques reported: (1) through a drill hole in the patella, (2) avoid drilling in the patella by using an anchor fixation or interference screw, and (3) suture fixation on the patellar surface with attachment to the medial site of the patella.

All techniques aimed to supply graft tissue from the medial aspect of the patella to the insertion site of the natural MPFL at the adductor tubercle of the medial femoral condyle, to reconstruct the ligament anatomically.

Complications of MPFL Reconstruction

Various complications have been reported with MPFL reconstruction including patellar fracture, recurrent lateral instability, patellofemoral arthrosis, loss of range of motion, and medial instability (Traunat and Erasmus 2009; Parikh and Wall 2011). Parikh et al. (2013) reported complications in 16.2 % of their 179 knees, with almost half resulting from technical problems. In addition, non-anatomical placement of the femoral tunnel could cause recurrent lateral instability and arthrosis of the patellofemoral joint. Female gender and bilateral cases were also reported as risk factors associated with postoperative complications. A small bone tunnel has been recommended to avoid patellar fracture after MPFL, and based on over 100 MPFL reconstructions, we recommend suture fixation on the patella.

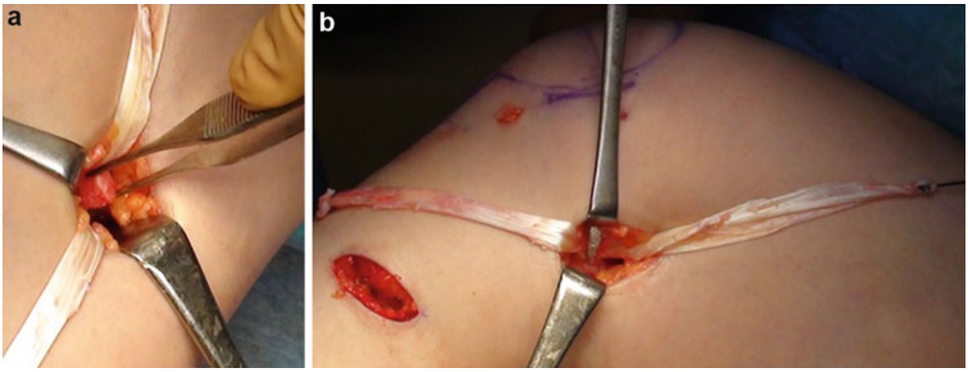

Fig. 3 Our surgical procedure – graft fixation at the femoral site. (**a**) The grafted tendon (semitendinosus tendon) was inserted at the bone tunnel and the plug was fixed. (**b**) Then, the staple was fixed over the bone plug and the grafted tendon

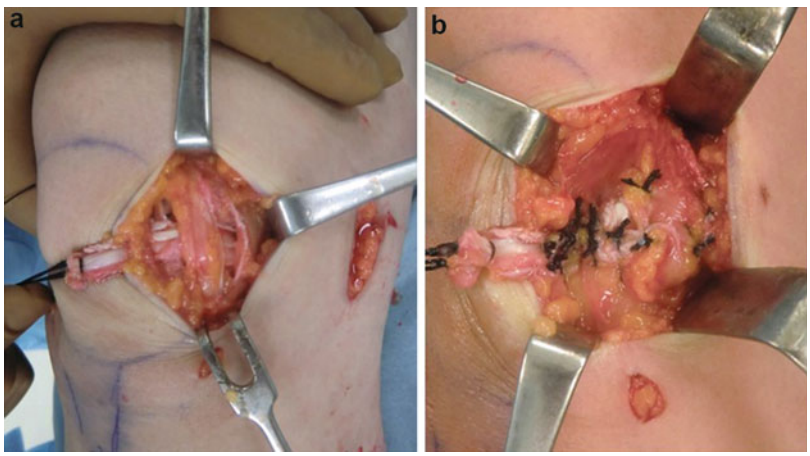

Fig. 4 Our surgical procedure – graft fixation at the patellar site. (**a**) The grafted tendon (semitendinosus tendon) was induced at the patellar surface. (**b**) The grafted tendon was then sutured at the periosteum of the patellar surface

Indication for Lateral Release with MPFL Reconstruction and Quantitative Stress Radiography of the Patella

Lateral release has been performed alone or in combination with medial tightening procedures to treat both acute and chronic lateral instability of the patellofemoral joint (Chen and Ramanathan 1984; Aglietti et al. 1989; Fithian et al 2004). Lateral release as an open or arthroscopic procedure is also performed to treat disorders of the extensor mechanism of the knee (Fulkerson and Shea 1990). Patellofemoral joint stability depends on several factors including the balance of quadriceps muscle forces, the articular geometry of the patella and femur, the retinacular structures of the MPFL, and the direction of the patellar tendon (Amis and Farahmand 1996). While MPFL reconstruction has become an accepted surgical technique to restore patellofemoral instability, there are many causes of patellar instability, making the selection of the best surgical treatment difficult. Lateral release is a surgical procedure that is sometimes performed to treat patellofemoral pain, maltracking, and instability. It is considered a relatively benign

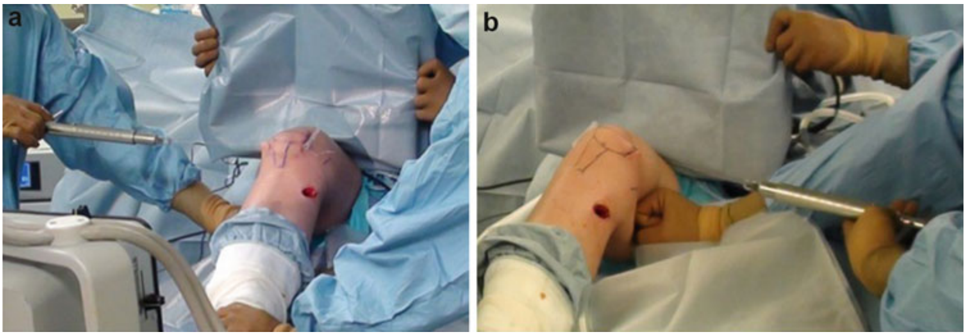

Fig. 5 Intraoperative quantitative stress radiography of the patella. Before lateral release at surgery, a soft wire (28 gauge) was inserted into the center of the patella from the lateral side to the inside, and then, 20 N stress was similarly applied from the medial to lateral direction (**a**) and from the lateral to medial direction to obtain axial images (**b**)

procedure, requiring minimal surgical intervention without the need for immobilization, and is associated with only minor complications (Henry et al. 1986; Schonholtz et al. 1987).

In the past, the importance of lateral release in the prevention of recurrent patellar dislocation has been emphasized (Chen and Ramanathan 1984). However, when lateral release is used alone as a procedure to treat patellar instability, the failure rate is unacceptably high (Aglietti et al. 1989; Kolowich et al. 1990; Shellock et al. 1990; Fithian et al. 2004). Furthermore, some reports have described medial dislocation after lateral release (Hughston et al. 1996; Clifton et al. 2010).

It is now rare for lateral release to be performed alone and usually involves an additional technique to correct the balance of the patella. However, even after MPFL reconstruction, performing lateral release can result in serious complications, including medial subluxation of the patella (Hughston et al. 1996; Clifton et al. 2010). Therefore, determining the indications for lateral release during MPFL reconstruction is very important. We have consistently performed quantitative stress radiography of the patella to make such a decision since 1988 (Ochi et al. 1992, 1993). The efficacy of this approach, which can be performed in the outpatient clinic, is valuable as an indicator for lateral release and to evaluate instability of the patella before and after lateral release.

Preoperative and Intraoperative Evaluation of Patellar Laxity

Quantitative Stress Radiography of the Patella

The recurrent dislocation patellar knees have undergone the stress radiography to detect patellar laxity. All patients were evaluated radiographically in the outpatient clinic and then again at the time of surgery before and after the lateral release procedure (detailed procedure and data, Niimoto et al., KSSTA under revision). In the outpatient clinic, patellar stress radiography views were obtained at 45° knee flexion with 20 N stress from the medial to lateral direction and from the lateral to medial direction using a pushing apparatus (Ochi et al. 1992; Clifton et al. 2010). The intraoperative stress views obtained before and after lateral release are as follows: a soft wire was inserted into the center of the patella from the lateral side to the inside (Fig. 5a) and 20 N of stress was similarly applied from the medial to lateral direction and from the lateral to medial direction to obtain axial images (Fig. 5b). Then, we evaluated the laxity of the patella.

Preoperative and intraoperative stress views were well correlated both the medial and lateral laxity. Medial laxity shows no significant differences before and after lateral release. However, the lateral laxity after lateral release significantly increased to compare the lateral laxity before lateral release.

These data gain the results from patients with recurrent patellar dislocation. In these patients, the patellar stress radiography obtained in the outpatient clinic was as useful as conventional radiography performed in anesthetized patients prior to surgery as an indicator for lateral release. In addition, the lateral instability increased significantly after the lateral release procedure, whereas there was little change in medial instability, in patients with recurrent patellar dislocation in whom lateral release was indicated on the basis of patellar stress radiography.

Ochi et al. (1993) have obtained quantitative stress radiography images of the patella when selecting the treatment strategy for patellar instability and deciding whether to perform the lateral release procedure since 1988. They described two main types of lateral dislocation: one in which the lateral retinaculum is tighter than normal and another in which the medial retinaculum is looser than normal (Ochi et al. 1993). They also highlighted that patients showing medial laxity on stress radiography before surgery would experience medial patellar dislocation with lateral release.

Although lateral release is widely used to perform worldwide, the procedure has resulted in serious complications, including medial subluxation of the patella. Even now, lateral release performed in isolation to treat patellofemoral disorders remains contentious. It is important to appreciate what can be achieved with the release of the lateral retinaculum (Clifton et al. 2010). Thus, we strongly recommend quantitative patellar stress radiography to indicate lateral release and to avoid the possible complication of patellar instability treatments.

Conclusions

1. MPFL reconstruction is now a promising surgical treatment for patellar instability.
2. The complications of MPFL reconstruction are mainly due to technical problems.
3. Quantitative stress radiography of the patella in the outpatient clinic could be very useful in determining indications for lateral release.
4. The lateral release procedure increases lateral, but not medial, laxity in patients with recurrent patellar dislocation who do not exhibit medial laxity prior to surgery.

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