Medial Side Patellofemoral Anatomy: Surgical Implications in Patellofemoral Instability

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Elizabeth A. Arendt

Historically, surgical procedures aimed at stabilizing the patella against lateral dislocations involved altering its dynamic stabilizers, most specifically the vastus medialis obliqus muscle. This procedure was often performed in combination with altering the distal bony alignment (medial tibial tubercle transfer). The importance of the medial static patella stabilizers, in particular the medial patellofemoral ligament (MPFL), has more recently been recognized as playing an important role in patellofemoral biomechanics [2, 3, 6]. Multiple studies have supported injury to this ligament with lateral patella dislocation [8, 9, 11].

The medial static stabilizers of the patella can be divided into the medial patellofemoral ligament, the medial patellotibial ligament (MPTL) and the medial patellomeniscal ligament (MPML). Together they form a triangular medial retinacular buttress with fibers more horizontally oriented (MPFL), more obliquely oriented (MPML), and more vertically oriented (MPTL) (Fig. 17.1). This triangular arrangement is capable of limiting lateral and superior/lateral translation of the patella.

The MPFL is a vertically oriented ligament found in the same layer and the Medial Collateral Ligament, and serves as a restraining ligamentous structure between the proximal patella and the femur. It is the prime soft tissue restraint to lateral patella translation [2,6]. The MPFL attaches to the femur 10 mm proximal and 2 mm posterior to the medial epicondyle, in the saddle between the medial epicondyle and the adductor tubercle (Fig. 17.2). During surgical

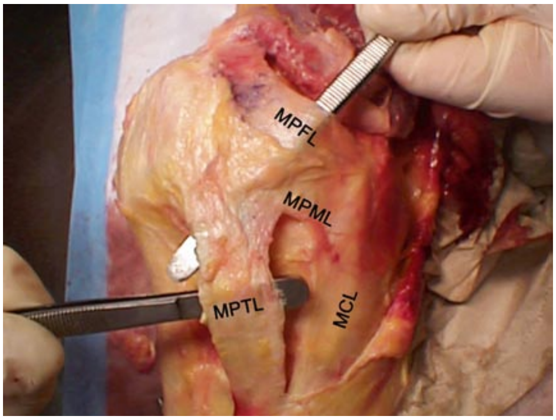

Fig. 17.1 Anatomic dissection of the medial aspect of the knee using a fresh frozen cadaveric specimen. One can see the relationship between the three medial-sided patellar ligaments. MPTL is in a more superficial layer than the MPML and MPFL (*MPFL* medial patellofemoral ligament, *MPML* medial patellomeniscal ligament, *MPTL* medial patellotibial ligament, *MCL* medial collateral ligament)

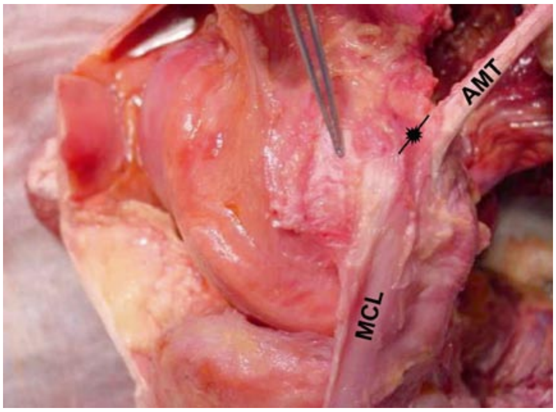

Fig. 17.2 Anatomic dissection of a fresh frozen cadaveric knee with muscles and capsule stripped from the medial side. The asterisk (*) shows the approximate "isoanatomic point" of the MPFL (*MCL* medial collateral ligament, *AMT* adductus magnus tendon)

E. A. Arendt, MD
Professor and Vice Chair, Department of Orthopaedic Surgery, University of Minnesota, 2450 Riverside Av., Suite R200, Minneapolis, MN 55454, USA
e-mail: arend001@umn.edu

S. Zaffagnini et al. (eds.), *Patellofemoral Pain, Instabilty, and Arthritis*,
DOI: 10.1007/978-3-642-05424-2_17, © Springer-Verlag Berlin Heidelberg 2010

dissection, it is perhaps easiest to reference the MPFL from the location of the adductor tubercle, as the adductor tubercle is a readily palpable bony prominence and a more discrete anatomical point. The MPFL attaches ~2 mm anterior and 4 mm distal to the adductor tubercle [7] (Fig. 17.3).

The patella attachment of the MPFL is wider than the femoral attachment, and is approximated at the junction of the upper and middle thirds of the patella, typically at the location where the perimeter of the patella becomes more vertical. As a percentage of the longitudinal length of the patella, Nomura et al. [10] reports the MPFL insertion 27 ± 10% from the proximal tip of the patella, while LaPrade et al. [7] places the mid-point insertion of the MPFL 41.4% from the proximal tip of the patella.

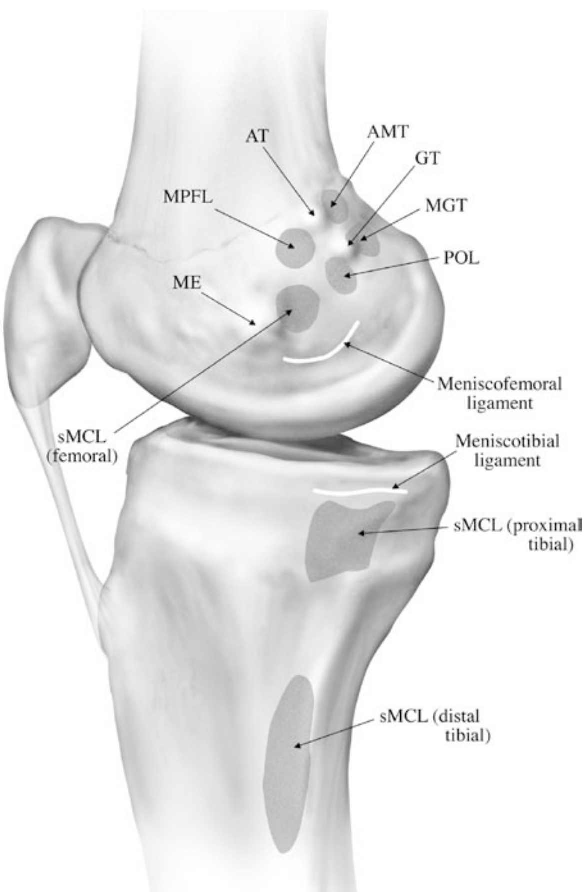

Fig. 17.3 Illustration of the femoral osseous landmarks and attachment sites of the main medial knee structures. *AT* adductor tubercle, *GT* gastrocnemius tubercle, *ME* medial epicondyle, *AMT* adductor magnus tendon, *MG*T medial gastrocnemius tendon, *sMCL* superficial medial collateral ligament, *MPFL* medial patellofemoral ligament, *POL* posterior oblique ligament. (Copyright permission: Journal of Bone and Joint Surgery American, 2007, 89, The Anatomy of the Medial Part of the Knee, LaPrade, 2000–2010)

The degree in which the MPFL is "covered" by the vastus medialis obliques (VMO) muscle fibers varies, depending on the distal extent of the oblique VMO fibers. In cases of VMO dysplasia, the anterior/superior fibers of the MPFL would coalesce with the distal/medial fibers of the quad tendon (Fig. 17.4a). In cases where the VMO had a more distal extent, more of the MPFL was "covered" by the VMO fibers (Fig. 17.4b).

The MPTL is an oblique condensation of the medial retinaculum inserting on the tibia ~1.5 cm below the joint line, close to the insertion of the tibial collateral ligament

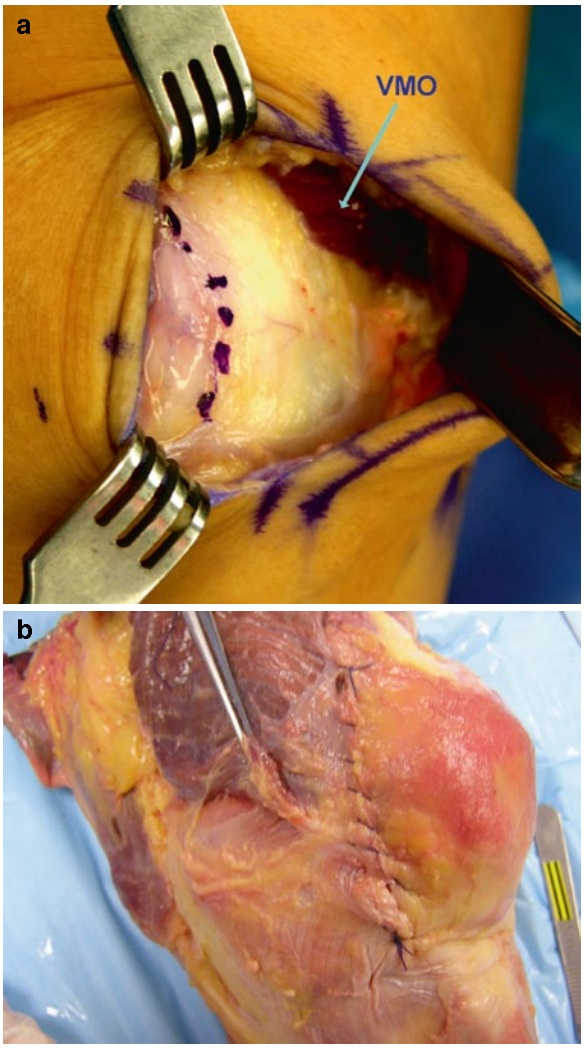

Fig. 17.4 (**a**) This is a surgical intraoperative photo of the medial aspect of a right knee, showing extreme vastus medialis dysplasia. The Medial patella is outline. One can see the medial retinaculum coalesce with the fibers of the quadriceps tendon. (**b**) This is a cadaver knee specimen. The distal and posterior fibers of the vastus medialis muscle are retracted, revealing the fibers of the MPFL that are "covered" by the muscle

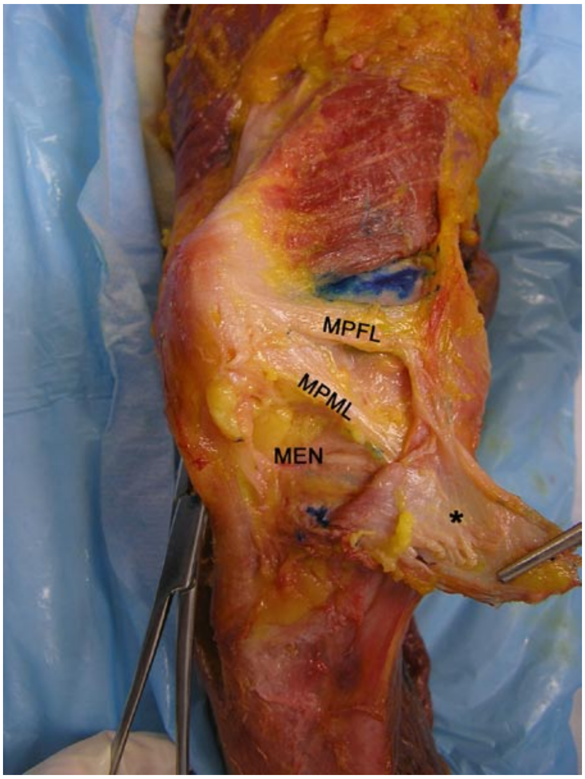

Fig. 17.5 Anatomic dissection of the medial aspect of the knee using a fresh frozen cadaveric specimen. The asterisk (*) indicates the reflected medial retinaculum which includes the MPTL. The distal portion of the medial meniscus is visualized. The MPML can be seen to extend over the meniscus and insert on the proximal aspect of the tibia in the close proximity to the coronary ligament insertion (*MPFL* medial patellofemoral ligament, *MPML* medial patellomeniscal ligament, *MPTL* medial patellotibial ligament, *MEN* meniscus)

(Fig. 17.1). Due to the more vertical orientation of its fibers, the MPTL is uniquely positioned to help resist lateral and anterolateral translation of the patella. There is debate as to the role of the MPTL in resisting lateral patella displacement, ranging from being an important secondary stabilizer [6] to being functionally unimportant [2]. MPTL is in a more superficial plane than MPFL, although Warren's three-layer anatomic concept of the medial retinaculum is more difficult to individually assess as dissection extends anterior and distal [15].

Extending distally in the same plane as the MPFL, there is a thickening of tissues whose fibers are obliquely oriented 45° from the vertical. This tissue plane originates from the patella just distal to the patella insertion of the MPFL; the only distinction between the two sites is a change in the fiber orientation, and anatomically is called the MPML (Fig. 17.5). Its bony insertion to the tibia just distal to the coronary ligament is consistent, more variably some fibers attach to the meniscus itself. In one cutting study, the MPFL was found to contribute 22% of the restraining force against lateral patella dislocation [2].

17.1 Surgical Implications

Though the MPFL is the prime soft tissue restraint to lateral patella translation, this structure, together with its medial-sided retinacular complex, provides significant restraint to lateral translation only in early knee flexion. As the knee progresses in flexion, trochlear geometry, patellofemoral congruence and in particular the slope angle of the lateral trochlear wall provides the major restraints to lateral patellar displacement [5]. In trochlear dysplasia, the groove is often not only flattened, but shortened. The shortened trochlear groove, when combined with a high riding patella (Patella Alta), will create a larger arc of motion before the patella is protected by the confines of the lateral trochlear wall, increasing the importance of the medial soft tissue restraints in stabilizing the patella against lateral dislocation.

When considering MPFL reconstruction, the ideal tissue for the graft would have similar stiffness, but greater strength, than the native MPFL. The current tissue choice used to reconstruct the MPFL is semitendonosis or gracilis tendon, either allograft or autograft. These tendons are significantly stiffer than the native MPFL [1].

MPFL reconstructions with stiff grafts can produce large increases in patellofemoral joint loading when small errors in graft length and/or attachment site are present [4]. This will have its biggest consequence if the graft length is "too short" for its arc of motion, and the length change through an arc of motion is restricted. This will result in reduced patellar mobility, and/or increased forces on the medial patellofemoral joint.

There is no evidence to date that the MPFL functions isometrically. The MPFL is most loaded (longest) in full extension with the quadriceps mechanism contracted. With the quadriceps mechanism relaxed, the "longest" length of the MPFL through a knee range of motion is debated and may vary with the position of the patella in the sagittal plane (Patella Alta). For one cadaver study [13], the femoral attachment site was most sensitive to position change, especially superior and anterior. The reconstruction ligament was "longest" at 60° of flexion.

There is some evidence that the reconstructed graft length tension pattern depends mainly on the femoral attachment point. The least change in graft length was with a point more distal on the patella and more proximal on the femur [14]. This was also the site that had the longest length between the two points.

The graft length and attachment sites should allow the patella to enter the trochlear groove from a lateralized position, as dictated by normal patellofemoral kinematics, and allow the slope of the lateral trochlear wall and the lateral patella facet to engage its trochlear position gradually. Its length should allow full knee flexion, with ~2 quadrants passive lateral glide of the patella in full extension, with a firm check rein to further lateral patella translation.

During surgery, the femoral insertion point should be exacting and documented. This can be done utilizing fluoroscopic visualization of a true lateral of distal femur identifying the appropriate femoral location [12], or by referencing off the adductor tubercle.

There is no objective evidence for an MPFL reconstruction graft tensioning protocol. This must be a compromise between overconstraint, causing medial patella pressure, versus slackness, which allows patella subluxation in early flexion. It appears prudent to tension a MPFL reconstructed graft with the patella contained in the groove at the knee flexion angle where MPFL graft length is the longest. During surgical reconstructed, one should document the angle of knee flexion and the tensioning protocol used to adequately assess outcomes of the procedure matched against one's surgical technique.

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