MPFL reconstruction for PF instability. The soft (tissue) approach

E.A. Arendt

Department of Orthopaedic Surgery, University of Minnesota, 2450 Riverside Avenue, Suite R200, Minneapolis, MN 55454, USA

KEYWORDS
Lateral patella dislocation; MPFL; Surgical stabilization for lateral patella dislocation

Summary
Historically, anatomic factors have been identified that increase one’s risk for episodic lateral patella dislocations. A surgical treatment algorithm has been proposed which utilizes these risk factors. This algorithm depends primarily on realignment of the bony architecture. Increasingly, the soft tissue retinacular restraints have been shown to be important as an anatomic factor critical for patellofemoral stability; in particular, the medial patellofemoral ligament (MPFL) has been recognized as the essential stabilizer against lateral patella displacement. Current indications for MPFL reconstructions will be reviewed. The frequency of reconstructing the MPFL alone versus combining it with other realignment schemes in my last 30 patients will be presented.

Introduction
Historically, four principle anatomic factors have been identified that increase one’s risk for episodic lateral patella dislocations. These are trochlear dysplasia, excessive patella height (patella alta), excessive lateral patellar tilt, and excessive tibial tubercle/trochlear groove (TT-TG) distance. A treatment algorithm has been proposed to correct these factors that includes bony realignment [1].

Trochlear anatomy is recognized as being important in patellofemoral stability. Trochlear anatomy includes not only the depth of the groove, but also its length. The patella achieves increasing stability in flexion due to not only the confines of the trochlear walls (depth of the groove), but also increasing tension in the retinacular structures. When the trochlear groove is short and shallow, the patella has greater excursion in early flexion unprotected by the trochlea.

Likewise, patella position in the sagittal plane dictates the flexion arc at the time of patella engagement. The combination of an excessively high patella position combined with trochlear dysplasia offers increasing challenges for the kneecap to remain on a stable path to the protections of the trochlear groove in early flexion.

The retinacular restraints have only recently been given importance as an anatomic factor critical for patellofemoral stability. The retinacular restraints protect the limits of patellar motion. The medial patellofemoral ligament (MPFL) has been recognized as the “essential” stabilizer against lateral patellar displacement [2,3].

Patella tilt is a radiographic sign that is associated with the clinical entities of both lateral patella overload as well as lateral patellar dislocations. However, the tilt itself is not a primary factor, rather patella tilt reflects soft tissue imbalance.

The lateral offset of the tuberosity, characterized by a high Q-angle or excessive TT-TG, is important in load transmission, creating lateral patella facet overload. Its role in lateral patella dislocations can be debated.

E-mail address: arend001@umn.edu.
I submit that patella instability has two schools of thought. One is that anatomic alignment is the most important factor(s) and all elements of "malalignment" must be corrected. The other viewpoint is a "softer" approach that recognizes the importance of a restraint to lateral patella translation, and to stabilize or create this restraint can be sufficient in many cases with "uncorrected" bony alignment.

One must recognize the importance of the medial patellofemoral ligament. This has been well-reviewed in our literature through both biomechanical studies (cutting studies and loading studies), radiographic studies including stress X-rays, MRIs, and injury correlation [4].

**Indications for MPFL reconstruction**

- When there is loss of the medial retinacular patella stabilizer due to recurrent lateral patella dislocations.
- MPFL laxity must be documented by physical exam and/or stress radiographs and/or arthrometer testing.
- Not indicated for isolated patellofemoral (PF) pain.
- Not indicated for excessive PF lateral tilt and/or translation without instability.
- Not indicated for PF arthritis.

An exam under anesthesia and arthroscopy can be used to document laxity without guarding or apprehension. Arthroscopy is most helpful to stage cartilage lesions. Arthroscopy typically shows excessive lateral tilt and translation through a passive range of motion due to medial retinacular laxity with the joint distended. One cannot judge lateral maltracking based on this arthroscopic view.

The MPFL is used to contain the patella when it is subjected to the extremes of motion secondary to a lateralizing force. The MPFL is most often used alone without a distal realignment or a trochleoplasty when the bony constructs are normal or near normal.

When treating recurrent lateral patella dislocations, I use MPFL alone if there is:

- troclear dysplasia (TD) type A or normal trochlea;
- no trochlear spur;
- a tubero-sulcus angle of <10° valgus, and/or a TT-TG distance less than 20;
- patella alta <1.4 (I/S ratio)

When there is patella alta >1.4, I perform a distal tibial tubercle transfer, aiming for a post-op measurement of 1.1–1.2.

I medialize the tibial tubercle when the patella cannot be passively contained in the groove thru a passive range of knee motion, after appropriate lateral retinacular lengthening, if needed. Using this treatment scheme, in my last 25 patients I used MPFL alone 25% of the time, and soft tissue only 50% (MPFL with lateral lengthening) (Table 1).

Although objective measurements for a tibial tubercle location are more exacting, there is not complete agreement in the literature on what this measurement should be and how one should record it. The most frequented sited work is that by Dejour et al. [1] which sites the threshold for normality as greater than 20 mm of distance between the tibial tubercle and the center of the trochlear groove on two super imposed CT slices. This is an absolute measurement and not a ratio, and may not be an appropriate measurement for all size knees. There is some suggestion in the literature that the normal range is much smaller, with greater than 10 mm as abnormal [5,6].

A greater concern about medialization of the tibial tubercle is over-medialization. A tibial tubercle that is parallel to the midline of the trochlea at 90° of flexion is normal (tubercle-sulcus angle). This measurement is easy to visualize clinically, and can be used as an objective measurement interoperatively in regards to how medial one should place the tibial tubercle when excessive lateralization is felt to be present. There are few guidelines to help the surgeon judge the amount of medialization of the tibial tubercle intraoperative, despite an objective preoperative measurement (i.e. a TT-TG). This has been recently reviewed [7].

Visual inspection of the knee is unreliable in determining the TT-TG measurements compared to CT measurements [8]. If a supratrochlear spur is present with TD type A, I remove it alone.

If TD is present to the degree that it prevents engagement of the patella into the groove, a trochleoplasty is performed. In my patient population over the last four years, this has occurred three times (< 3% of surgical cases).

**Medial side**

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. 1). Its patella attachment 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.

It is the prime soft tissue restraint to lateral patella displacement. However, it is only significant in early flexion.

As the knee progresses in flexion, trochlear geometry, patellofemoral congruence and in particular the slope angle of the lateral wall of the trochlea provide the major restraints to lateral patella displacement [9]. In trochlear dysplasia, the groove is often not only flattened, but shortened. The shortened groove 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.

---

**Table 1** 2008 Patellofemoral patient summary.

<table>
<thead>
<tr>
<th>MPFL (demographics)</th>
<th>N=25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age</td>
<td>22.6</td>
</tr>
<tr>
<td>Age range</td>
<td>12–57</td>
</tr>
<tr>
<td>Sex</td>
<td>7 M, 18 F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MPFL (surgical data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPFL alone</td>
</tr>
<tr>
<td>w/lateral retinacular lengthening</td>
</tr>
<tr>
<td>w/tibial tubercle medial</td>
</tr>
<tr>
<td>w/tibial tubercle distal</td>
</tr>
<tr>
<td>w/trochleoplasty</td>
</tr>
</tbody>
</table>
Figure 1  This is an anatomic fresh frozen cadaveric dissection of the medial side of a right knee. Pertinent structures are highlighted. Medial patellofemoral ligament (MPFL), vastus medialis obliquus (VMO).

How strong is the MPFL?

MPFL elongation to failure: mean 25.8 mm, standard deviation 6.6, range 14 to 34 [2]. Graft stiffness (change in length/ultimate load) likely matters (Table 2).

MPFL attachment sites—isometric/isoanatomic

There is no evidence to date that the MPFL functions isometrically. MPFL is most loaded (longest) in full extension with quads loaded. With quads relaxed, the “longest” length of the MPFL thru ROM is debated. By 60°, morphology of the patellofemoral joint contains the patella in normal knees (Figs. 2 and 3).

Surgical implications

The ideal graft would have similar stiffness, but be stronger, than the native MPFL. The current tissue used to reconstruct the MPFL is significantly stiffer than the native MPFL.

MPFL reconstruction with “stiff grafts” can produce large increases in PFJ loading if small errors in graft length and/or attachment site are present. This will have its biggest consequence if the graft length is “too short” for its arc of motion, and the length change thru an arc of motion is restricted. This will result in reduced ROM, increased forces on the medial patella facet, or both.

Graft attachment points: more research is needed. Some agreement that length changes pattern depends principally on the femoral attachment point. The least change was with a point more distal on the patella and more proximal on the femur [10]. This was also the site that had the longest length between the two points. For one cadaver study [11],

Table 2  Comparison of structural properties of various autograft tissues. Commonly used for ACL reconstruction.

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Number of specimens</th>
<th>Ultimate load (N)</th>
<th>Stiffness (N/mm)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACL</td>
<td>6</td>
<td>1725 ± 269</td>
<td>182 ± 33</td>
<td>Noyes et al. [13]</td>
</tr>
<tr>
<td>Semitendinosus</td>
<td>11</td>
<td>1216 ± 50</td>
<td>186 ± 9</td>
<td></td>
</tr>
<tr>
<td>Fascia lata</td>
<td>18</td>
<td>628 ± 35</td>
<td>118 ± 5</td>
<td></td>
</tr>
<tr>
<td>Gracilis</td>
<td>17</td>
<td>838 ± 30</td>
<td>171 ± 11</td>
<td></td>
</tr>
<tr>
<td>MPFL</td>
<td>10</td>
<td>208 ± 90</td>
<td>8</td>
<td>Amis et al. [2]</td>
</tr>
<tr>
<td>MPFL</td>
<td>12</td>
<td>145 ± 6</td>
<td>—</td>
<td>Arendt et al. [14]</td>
</tr>
<tr>
<td>MPFL</td>
<td>(modeling)</td>
<td>—</td>
<td>12</td>
<td>Elias and Cosgarea [12]</td>
</tr>
</tbody>
</table>
the femoral attachment site was most sensitive to position change, especially superior and anterior. The ligament was “longest” at 60° of flexion.

The graft length should allow the patella to enter the trochlear from a lateralized position, as dictated by normal PF kinematics, and allow the slope of the lateral trochlear wall and the lateral patella facet to engage its trochlear position gradually.

Intraoperatively, one should adjust the attachment sites to minimize the length change with knee flexion. If lengthening occurs in flexion, one can move the femoral attachment site more distal. If lengthening occurs in extension, one can move the femoral attachment site more proximal [12].

We still lack any objective evidence for an MPFL graft tensioning protocol. This must be a compromise between over-constraint causing medial patella pressure versus slackness which allows patella subluxation in early flexion. It appears prudent to tension your graft with the knee contained in the groove at the ROM where your graft length is the longest.

**Conflict of interest**

None.

**References**


