Technical Note

Medial Patellofemoral Complex Advancement for Recurrent Lateral Patellar Instability and Selective Acute Primary Patellar Dislocations

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Abstract: Medial patellofemoral complex (MPFC) is considered as the primary medial patellar restraint and has a static, as well as dynamic, component. MPFL reconstruction (MPFL-R) restores only the static component of MPFC, is associated with multiple technical concerns, and has a steep learning curve. Need for physeal sparing techniques and relatively high rates of complications including patella fracture are some other concerns with MPFL-R. We propose a simple procedure for advancement of MPFC onto patella, which is indicated in most of the recurrent lateral instabilities (with a positive lateral glide test result and an intact MPFL on magnetic resonance imaging). The procedure is also indicated in selective acute primary dislocations—those with associated chondral lesions and magnetic resonance imaging–documented isolated patellar side avulsion/injury. MPFC advancement is a more anatomical procedure that also restores dynamic medial checkrein of patella and can be performed even by a novice surgeon. MPFC advancement is devoid of the multiple technicalities of MPFL-R, does not require intraoperative imaging or any postoperative immobilization, and renders complications like donor graft-site morbidity and patella fractures irrelevant. It requires no modifications in patients with open physes and can be performed in isolation or with other procedures as per à la carte principle.

Patellar dislocation is a common knee disorder with high rates of recurrent instability after nonsurgical management of the primary dislocation. Medial patellofemoral complex (MPFC), the primary medial patellar restraint is typically disrupted in patellar dislocations. Medial patellofemoral ligament (MPFL) and medial quadriceps tendon femoral ligament (MQTFL) constitute MPFC, and it acts as a static, as well as dynamic, restraint (through attachments to the vastus medialis obliquus and quadriceps tendon).[1]

MPFL reconstruction (MPFL-R), the most favored surgery currently for lateral patellar instability, addresses only the static component of MPFC and replaces a minuscule ligament with a more robust and much stiffer graft. It is suggested both static and dynamic components of MPFC be included for an ideal reconstruction of proximal medial patellar restraints.[2] Although largely successful, the biggest challenge in MPFL-R is its steep learning curve and the multiple technical concerns associated with it. No gold standard technique of MPFL-R has been clearly defined yet, and technical errors constitute a major cause of complications and failures.[3] Deviation of femoral tunnel position by a mere 5 mm results in significant nonisometric length changes leading to high graft tension and elevated medial patellofemoral joint contact pressures.[4] An exact anatomic fixation point is difficult to attain despite multiple radiographic techniques.[5] Optimal knee flexion angle during graft fixation and consequences of over-tensioning of the graft continue to be discussed.[6] Concerns about violation of physis in skeletally immature patients and the need for physeal sparing techniques further add to the existing complexity.[7]

Apart from technical issues, high complication rates of up to one in every four patient is a concern after MPFL-R.[8,9] Patella fracture is still a dreaded complication, and

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Table 1. Salient features of the proposed procedure (MPFC advancement)

Indications	
Isolated MPFC advancement	Recurrent patellar instability (at least two documented episodes) with confirmation of lax medial restraints (patellar glide test) under anaesthesia without any underlying bony abnormality (see prerequisites)
	Acute primary patellar dislocation with patellar insertion avulsion/injury and associated chondral lesions
Prerequisites for isolated MPFC advancement	TT-TG distance < 20 mm
	Trochlear dysplasia grade A
	Patellar Caton-Deschamps index of less than 1.2
	Normal Q angle
	Normal hip anteversion
	No rotational deformities
When these prerequisites are violated, MPFC advancement must be accompanied with appropriate surgeries for underlying abnormalities	
Advantages	Anatomical procedure
	No or minimal chances of over-tensioning
	No need for donor graft
	No chances of Patella fracture as in reconstruction techniques with tunnels
	Simple procedure and easily reproducible even in patients with open physes
	Early range of motion can be started
	Easy reproducibility even by a novice surgeon
	No requirement of intraoperative fluoroscopy
Disadvantages	In acute primary patellar dislocation, with multi-focal MPFC injury or femoral side injury, advancement procedure is not useful
	Contraindicated in cases with generalized ligamentous laxity

MPFC, Medial patellofemoral complex; TT-TG, tibial tuberosity–trochlear grove; Q angle, quadriceps angle.

methods to avoid patella fractures continue to evolve with varying success.[10] Other complications of MPFL-R include knee stiffness (flexion-deficit) and patellofemoral arthritis/pain. Variable rates of recurrent instability have been reported with MPFL reconstructions in pooled analyses.[8,11]

Recent pooled evidence suggests that other medial soft tissue procedures may not be inferior to MPFL-R, especially with respect to recurrent instability rates.[9,12] Using an algorithm-based approach, similar results of MPFL-R and MPFL repair were found (level II evidence).[13] Recognition of roles of other medial soft-tissue stabilizers such as MQTFL, medial patellotibial (MPTL) and patellomeniscal (MPML) ligaments has led to the development of procedures that can be used in isolation, as well as in combination with MPFL-R.[14,15]

In view of the above-mentioned concerns associated with MPFL reconstruction and the encouraging results of other soft-tissue procedures, we propose a technique of MPFC advancement (MPFL and MQTFL combined) on to the patella that is very simple to perform and addresses the basic pathology of insufficient proximal medial patellar restraints while retaining its dynamic nature.

Indications, Evaluations, and Imaging

The primary indication of MPFC advancement is recurrent lateral patellar instability with demonstrable positive lateral patellar glide test and an intact MPFL visible on preoperative magnetic resonance imaging (MRI). Another major indication includes selective acute primary lateral dislocations—those with associated chondral lesions and MRI-documented isolated patellar side avulsion/injury (Table 1). The procedure can be performed in adults, as well as in skeletally immature individuals, without any modifications.

MPFC advancement can be performed in isolation or in combination with other procedures as per à la carte principle. Isolated MPFC advancement is performed in the absence of any concurrent morphologic risk factors such as high-grade trochlear dysplasia, tuberosity malalignment, patella alta, and more (Table 1). In the presence of such risk factors, this must be combined with other appropriate procedures like trochleoplasty, tibial tubercle distalization, tibial tubercle lateralization, lateral release, and more.

Patient evaluation includes a thorough history including number of documented episodes, presence of continuous pain in between episodes (suggesting chondral damage), and mechanism of injury in acute

primary dislocations. Physical examination is focused at demonstration of instability and identifying any concurrent morphologic risk factors. Incompetency of medial patellar restraints demonstrable by lateral patellar glide of at least three quadrants must be present to consider MPFC advancement. Patellar apprehension sign, patellar tracking, patella tilt test, Q angle, assessment of coronal and rotational limb alignment, as well as assessment of generalized ligamentous laxity (Beighton index) are invaluable in the patient evaluation.

Imaging includes radiographs (anteroposterior, true lateral, and merchant views), computed tomography (CT) scanning, and MRI of the knee. A true lateral view is mandatory to assess patella height and trochlear dysplasia whereas a Merchant view allows assessment of patellar tilt. CT scanning is useful in assessing tibial-tuberosity to trochlear groove distance (TT-TG distance) and also in objective assessment of rotational profile in patients with suspected excessive femoral anteversion/tibial torsion. MRI is essential to evaluate loose bodies, chondral injuries, and characterization of tear pattern in acute primary dislocations, as well as demonstration of lax and scarred MPFL in recurrent cases. Failure to visualize MPFL along its entire length would render this procedure contraindicated. The procedure is also contraindicated in acute injuries where MRI demonstrates femoral side injury or multifocal injury of MPFC (Table 1). Careful scrutiny of MRI sections is essential, especially in acute primary patellar dislocations. TT-TG distance can also be measured on MRI; however, because of concerns regarding underestimation of TT-TG distance on MRI, the authors recommend CT scanning to assess the same.[16]

Surgical Technique

The patient is positioned supine and placed under anesthesia; before inflation of the tourniquet, patellar instability is reconfirmed by a patellar glide test. This is important because some patients may not allow a glide test during bedside examination due to apprehension (especially in acute dislocations in adolescents). The same is compared with the contralateral side (if unilateral). The tourniquet is inflated, and preliminary arthroscopy to document the patellar tracking, degree of patellar tilt/rotation, and chondral pathology is done followed by addressing of intraarticular pathologies. The procedure described below is for recurrent lateral instability and necessary modifications (detailed later under special considerations) are needed in acute primary dislocations (Video 1).

Fig 1. Incision for MPFC advancement. A vertical paramedian skin incision along the medial border of patella is made. The red triangle denotes position of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

Fig 2. Release of superficial musculo-retinacular layer from patella without violating the deeper capsuloligamentous layer. Careful dissection of superficial musculo-retinacular layer from patella is done, such that deeper capsuloligamentous layer is not violated. Green thick arrow denotes superficial musculo-retinacular layer detached from the patella. Blue arrow shows intact deeper capsuloligamentous layer still attached to patella. Yellow arrow shows the medial border of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

Approach and Dissection

A vertical paramedian skin incision along the medial border of patella is made (Fig 1). Identification of medial portion of quadriceps tendon, vastus medialis and medial retinaculum is done. Starting around 2.5 cm above the proximal pole of patella, a vertical incision is made along its medial border extending up to the distal pole. This dissection has to be done carefully so that the superficial musculo-retinacular layer is separated from deeper capsuloligamentous layer and the capsuloligamentous layer is not violated (Fig 2). A "reverse L"—shaped flap of musculo-retinacular (including vastus medialis obliquus insertion) is raised. After initial separation of the flap, blunt dissection with a finger can be done between the two layers to extend the cleavage. Some difficulty may be encountered proximally where the layers are comparatively indistinct and are merged together. At the end of this dissection, intact capsular

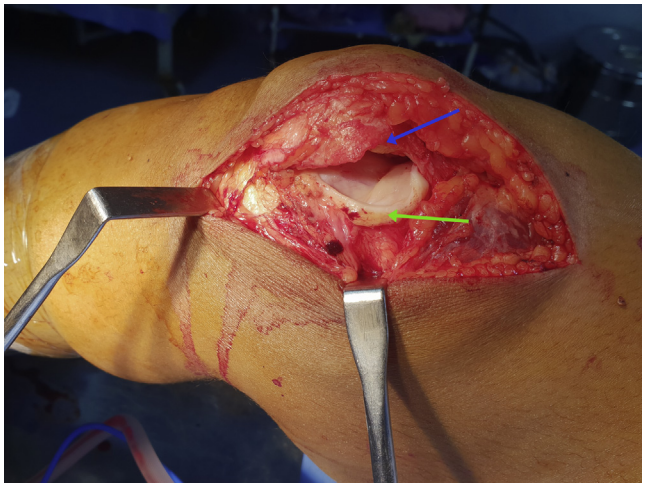

Fig 3. Release of the deeper capsuloligamentous layer from patella. An incision is made into the intact capsuloligamentous layer, very close to the margin of patella. Green arrow shows the detached margin of capsuloligamentous layer. Blue arrow shows the medial border of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

layer with MPFL is seen inserting onto the medial aspect of the patella (Fig 2). The marking of MPFL is enhanced by pushing the patella to the lateral side, which makes MPFL taut, and its marking becomes conspicuous (this also assesses intactness of MPFL in recurrent instability). At this point, the superficial flap may be tagged using sutures to aid in retraction.

An incision is made into the intact capsuloligamentous layer, very close to the margin of patella (subperiosteal) extending from 2.5 cm above superior pole of patella to its inferior pole (Figs 3 and 4). This results in two flaps, the superficial flap (consisting of musculo-retinacular tissue) and the deeper

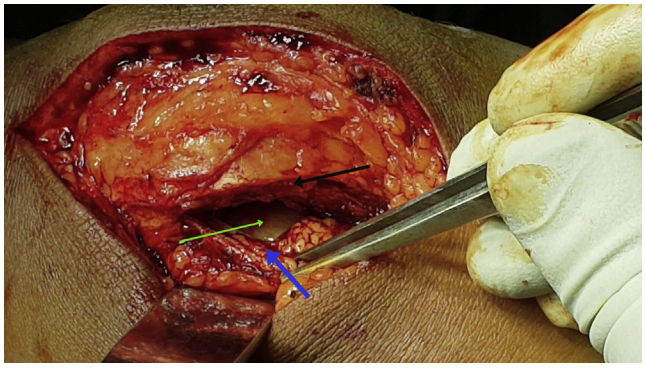

Fig 4. Demonstrating capsuloligamentous layer. Shows the deep capsuloligamentous layer after its detachment from patella (blue arrow: structure in the forceps). Green arrow shows the articular surface of femoral condyle under the patella. Black arrow shows the medial margin of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

Fig 5. Insertion of suture anchors. Two double loaded suture anchors are inserted onto the media border of patella (black star). Green arrow shows the proximal suture anchor while blue arrow is pointing to the distal anchor. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

capsuloligamentous flap (which contains MPFL and MQTFL along with capsule). The deeper flap is advanced onto the patella.

Advancement of MPFC

The medial border of patella is rasped to promote healing, and two double-loaded suture anchors (5.5 mm Zimmer Biomet Quattro X PEEK anchors loaded with two no. 2 UHMWPE nonabsorbable sutures) are placed onto the medial border of patella 1.5 cm apart in standard fashion after pilot holes are prepared (Fig 5). At this point we have 8 suture limbs

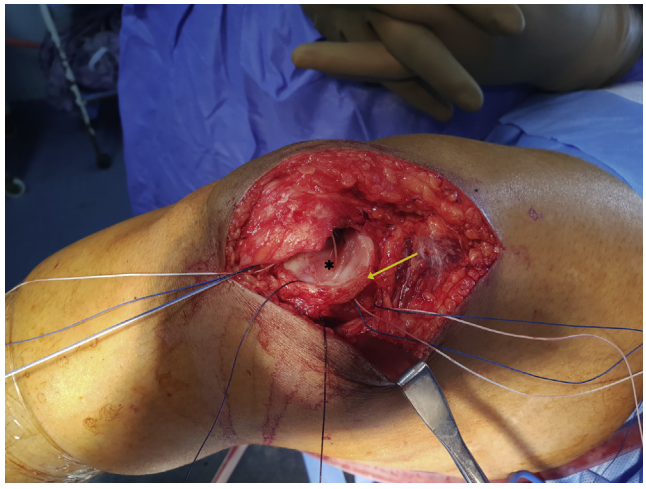

Fig 6. Passage of suture limbs into the capsuloligamentous layer for advancement. Each suture limb (from the two anchors) is shuttled into the capsuloligamentous layer two centimetres away from its edge. Yellow arrow points toward the freed edge of capsuloligamentous layer. Black star denotes the position (away from the edge) where the suture limbs are being shuttled. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

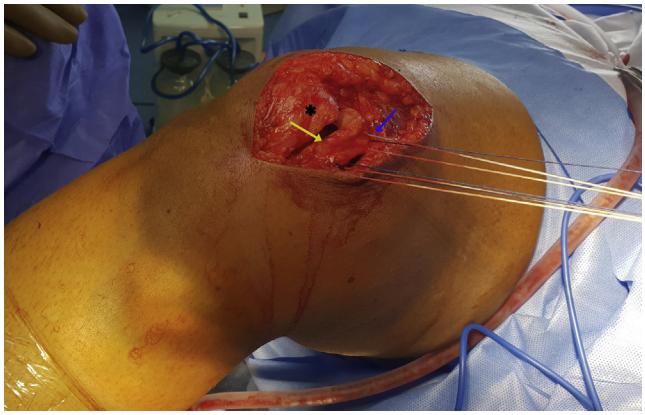

Fig 7. After shuttling of all suture limbs into the capsuloligamentous layer. Black star denotes patella, yellow arrow denotes the free margin of capsuloligamentous layer and blue arrow shows the evenly spread out shuttled suture limbs. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

from the two anchors, and these suture limbs are shuttled into the deeper capsuloligamentous layer around 2 cm from the edge, one limb at a time (Fig 6). This shuttling should proceed in a mattress fashion such that the suture entry points into the capsuloligamentous layer is evenly spread out (Fig 7). Tying of adjacent limbs is followed in a distal-to-proximal direction. This advances the capsuloligamentous layer onto the medial aspect of patella and shortens the working length of MPFC (Figs 8 and 9). The advanced edge of the capsuloligamentous tissue is laid flat on to the anterior surface of patella and its extent of coverage is marked. Next, one suture limb from each knot is passed into the anterior soft tissue and periosteal layer of patella, taking full bite into the tissue (Fig 10). The corresponding sutures are tied, resulting in a firm seating of the advanced edge of capsuloligamentous layer (double row repair) (Fig 11).

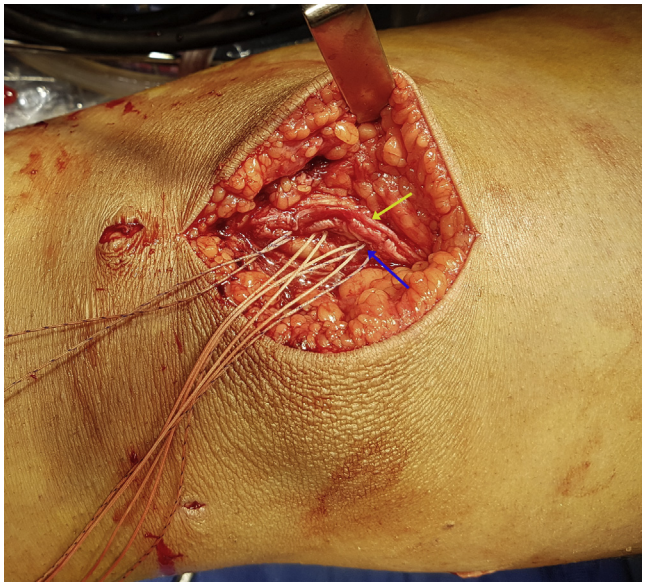

Fig 8. Advancement of capsuloligamentous layer. The shuttled suture limbs are to be tied in distal to proximal direction. This advances the capsuloligamentous layer onto the medial aspect of patella. Blue arrow shows the tied suture limbs and yellow arrow shows the edge of capsuloligamentous layer that should be used for double row repair over anterior surface of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the top (anterior aspect).

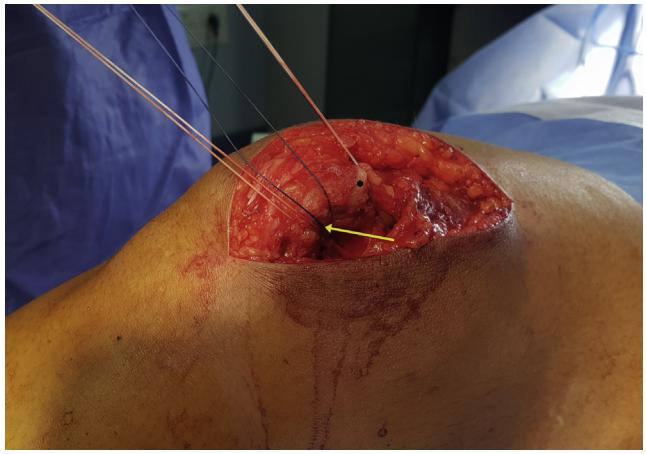

Fig 9. Another image after advancement of capsuloligamentous layer onto the medial surface of patella. Yellow arrow shows the tied suture limbs and black star denotes the edge of capsuloligamentous layer that is to be used for double row repair over the anterior surface of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

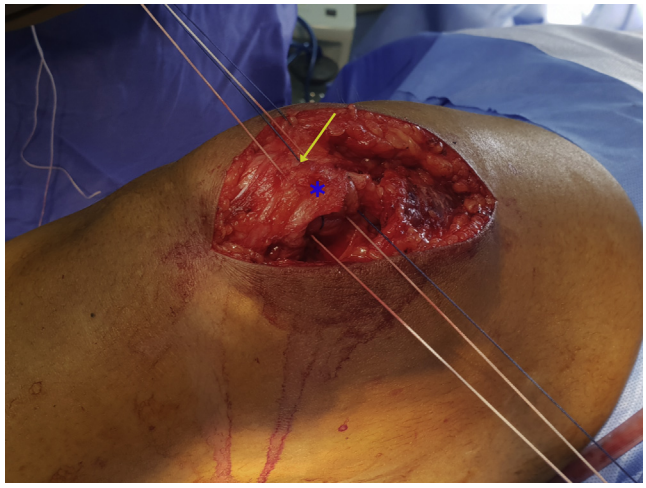

Fig 10. Shuttling of suture limbs into the anterior soft tissue and periosteal layer of patella, taking full bite into the tissue. Yellow arrow denotes the shuttled suture limbs and the star denotes anterior surface of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the medial aspect.

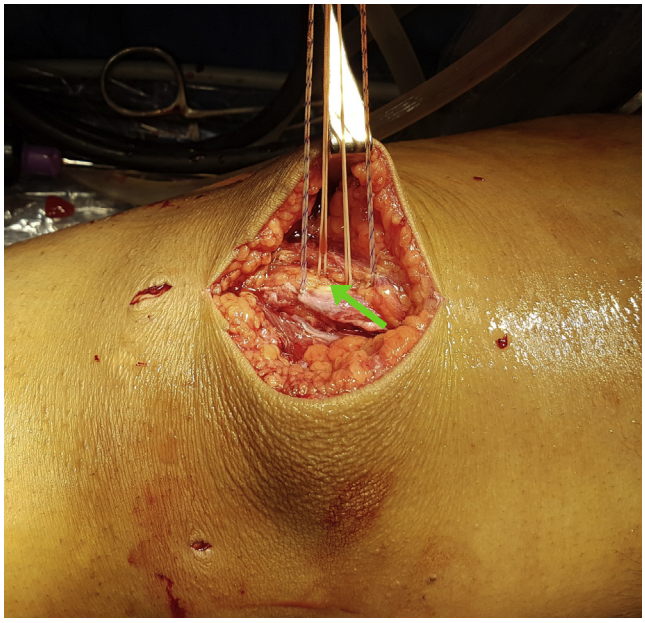

Fig 11. After double row repair (edge of capsuloligamentous layer advanced over anterior surface of patella). Green arrow shows the advanced capsuloligamentous layer over the anterior surface of patella. Patient is supine, head end of the patient is to the right of the photograph, and the view is from the anteromedial aspect.

Tied sutures are cut and regular tension-free closure of superficial musculo-retinacular layer is done using absorbable sutures (Fig 12). No attempt is made to advance these layers because this may lead to anisometry similar to other medial plication procedures. Patella-glide and tracking are checked, and closure of skin and subcutaneous tissue is done in regular fashion.

Postoperative Rehabilitation

No immobilization is required. Active range of motion exercises from the first day helps in healing and isometry of the ligaments.

Special Technical Considerations

If a large osteochondral injury fragment requiring fixation is found, it can be done after creation of the flaps and before advancement of capsuloligamentous layer. The musculo-retinacular layer is often torn in acute primary dislocations. Dissection of the musculo-retinacular layer from the capsuloligamentous layer may be difficult and requires careful handling of tissues. In addition, one needs to be on the lookout for multifocal injury to MPFL that may sometimes be missed on MRI. A good repair of the torn retinacular layer is required without any advancement.

Discussion

MPFC advancement can be considered analogous to the Karlsson modification of the Brostrom procedure for ankle instability.[17] Conceptually, MPFL can be equated to the anterior talofibular ligament, in the sense that they both are thin sheet-like structures and heal after injury in an elongated lax state. Similar to the Karlsson modification, the capsuloligamentous complex is mobilized as a whole for advancement, and a bone to ligament healing is intended in this procedure. MPFL reconstruction, on the other hand, is equivalent to peroneal tendon nonanatomic reconstructions (like the Watson Jones procedure), which results in suboptimal outcomes in ankle instability.[17]

Major advantages of MPFC advancement are its anatomical nature of restoration of medial restraints, the simplicity of the procedure, and that it can be reproduced in patients with open physis without any concern of growth plates. Furthermore, MPFC advancement avoids multiple shortcomings associated with MPFL reconstruction. The procedure addresses both MPFL and MQTFL, thus retaining the dynamic nature of checkrein balancing force. Being anatomical, chances of over-tensioning are minimal and therefore result in less stiffness and patellofemoral pain. Complications of graft donor site morbidity, patella fracture, and resultant effects of a malpositioned femoral tunnel during reconstruction are made irrelevant by MPFC

Fig 12. Repair of the musculo-retinacular layer. After repair of the superficial musculo-retinacular layer. The stars on the photographs denote orientation, green star showing the proximal aspect, whereas black star denotes the medial aspect. Green arrow points to the repaired musculo-retinacular layer. The patient's head end is to the top of the photograph, and view is from the top.

Table 2. Pearls and Pitfalls of Medial Patellofemoral Complex advancement

Pearls
Careful scrutiny of MRI sections is essential, especially in acute primary patellar dislocations
MPFL visualization on MRI
Perform examination under anaesthesia and document instability
Carefully preserve the capsuloligamentous layer while incising musculo-retinacular layer from medial border of patella
Separate musculo-retinacular layer from capsuloligamentous layer with careful dissection
Tag the superficial flap (consisting musculo-retinacular layer) with sutures to aid in retraction
Use double loaded suture anchors
Shuttle suture limbs from anchors uniformly across the entire length of capsuloligamentous tissue using a leading suture with a thin needle (nylon 3-0, Vicryl)
Suture limbs tied distal to proximal
Pitfalls
Separation of musculo-retinacular layer can be difficult from capsuloligamentous layer as they are adhered, especially proximally. Progressing distal to proximal during this dissection helps.
Severely attenuated and flimsy MPFL may require reconstruction
Do not attempt to advance superficial layers, which may result in anisometry.

MRI, magnetic resonance imaging; MPFL, medial patellofemoral ligament.

advancement technique. In addition, there is no requirement of intraoperative image intensifier, and no postoperative immobilization is required after MPFC advancement.

Risk and Limitations

One major limitation of MPFC advancement is that it is not indicated for acute primary dislocations with femoral side or midsubstance or multifocal injuries. Another limitation in cases with recurrent instability is that the MPFC must be visualized in toto for this procedure to be successful. Generalized ligamentous laxity and other collagen disorders must be considered as contraindications for the procedure. Table 1 delineates salient features of MPFC advancement whereas Table 2 enumerates the pearls and pitfalls associated with it.

In conclusion, MPFC advancement technique offers an alternative to MPFL reconstruction in recurrent lateral patellar instability and selective acute primary lateral patellar dislocations. It restores the dynamic medial checkrein balancing forces and is devoid of the multiple technicalities and complications associated with MPFL reconstruction. The procedure needs no modification in patients with open physes and can be performed even by a novice surgeon.

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