Surgical Technique

Dynamic medial patellofemoral ligament reconstruction in recurrent patellar instability
A surgical technique

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Abstract

The medial patellofemoral ligament (MPFL) is the primary stabilizer of the patellofemoral joint; its reconstruction has been recommended in adults over the past decade after recurrent patellar instability. However, there has been no standardized technique for reconstruction, therefore, ideal graft and technique for reconstruction are yet undetermined. However, dynamic MPFL reconstruction studies claim to be superior to other procedures as it is more anatomical. This preliminary study aims at assessing the outcomes of MPFL reconstruction in a dynamic pattern using hamstring graft. We performed this procedure in four consecutive patients with chronic patellar instability following trauma. MPFL reconstruction was done with hamstring tendons detached distally and secured to patellar periosteum after being passed through a bony tunnel in the patella without an implant and using the medial collateral ligament as a pulley. In all 4 knees, the MPFL reconstruction was isolated and was not associated with any other realignment procedures. No recurrent episodes of dislocation or subluxation were reported at 24 months followup.

Key words: Hamstrings, medial collateral ligament pulley, medial patellofemoral ligament, Q-angle, recurrent patellar instability
MeSH terms: Patellar dislocation, dislocations, ligaments

Introduction

Recurrent patellar instability is common after a primary episode of traumatic patellofemoral dislocation.[1] Medial patellofemoral ligament (MPFL) is the main soft tissue restraint to lateral patellar translation.[2] There is damage to the MPFL in almost all cases of traumatic patellofemoral dislocation. Graft anchorage, viability and anisometry of reconstruct play an important role in outcomes of the procedure. Numerous surgical techniques such as proximal realignment, distal realignment, combined realignment, lateral retinacular release and MPFL reconstruction have been described to treat this instability. There has been no comparison between different techniques; therefore ideal graft and technique for reconstruction are yet undetermined. MPFL reconstruction has been recommended in adults over the past decade after recurrent patellar instability.[3,4] We present a surgical technique for MPFL reconstruction using hamstring graft in a dynamic pattern performed successfully in four patients [Table 1]. We used Kujala score and Crosby and Insall outcome rating scale to evaluate outcome [Table 2] and our patients were followed up for 24 months.

Case Reports

Case 1

29 year old woman who is a daily wage worker presented to the outpatient department (OPD) with right anterior knee pain since 4 months. She felt a popping sensation in her right knee after slipping from the foot board of a

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Table 1: Summary of case details

Case details	Case 1	Case 2	Case 3	Case 4
Age (in years)	29	18	26	27
Sex	Female	Male	Male	Male
Side (right/left)	Right	Right	Left	Right
Time to presentation after primary dislocation (in weeks)	16	20	12	18
Previous frank dislocations	8	6	6	4
Cause of primary dislocation (knee twisting while)	Boarding foot board of a bus	Playing basketball	Climbing down a ladder	Climbing down stairs
Previous knee surgeries	Nil	Nil	Nil	Nil
Anterior knee pain	+++	++	+	++
Apprehension test	+	+	+	+
Hyperlaxity	Negative	Negative	Negative	Negative
Radiological findings				
Lateral patellar tilt	+	+	+	+
Lateral patellar subluxation	+	+	+	+
Insall-Salvatti Index	0.91	1	1.1	1
Sulcus angle	133°	140°	136°	142°
MRI findings (MPFL tear at)	Patellar attachment	Patellar attachment	Patellar attachment	Femoral attachment
Q-angle (quadriceps angle)	18°	14°	15°	12°
Arthroscopic findings				
Chondromalacia patella	Positive	Negative	Negative	Negative
Patellofemoral joint maltracking	+	+	+	+
Osteochondral fragments	Positive	Negative	Negative	Negative
Modified Crosby and Insall scale	Good	Excellent	Excellent	Excellent
Kujala score	88	98	95	96

MPFL=Medial patellofemoral ligament, MRI=Magnetic resonance imaging

Table 2: Crosby and Insall outcomes rating scale

Rating	Outcome
Excellent	No pain
	Normal activity
	No limitation in sports participation
	Full range of motion
	Knee subjectively normal
Good	Occasional discomfort
	Occasional feeling of stiffness or instability
	No participation in contact sports
	Slight loss of motion
	Knee is considered improved from surgery or nearly normal
Fair to poor	Pain most of the time
	Symptoms have improved by surgery, but recurrent instability is persistent
	Significant loss of motion is present
Worse	Pain is increased
	Instability or dislocation occur more frequently

bus while running to catch it 4 months ago. After this episode, she had severe pain and was unable to move her knee. She was then taken to a quack, after a local manipulation and massaging by him she was relieved of acute symptoms but had persistent knee swelling and mild knee pain. Patient returned to her daily activities the next day with minimal knee pain and difficulty in knee movements. She had similar episodes frequently (around 8) since then, particularly during stair climbing, squatting and while boarding or trying to get down a running bus. The patient was evaluated in the OPD, she had severe anterior knee pain, tenderness over medial patellofemoral joint, a positive apprehension test, no hyperlaxity. Her Q-angle was 18°. Radiographs showed lateral patellar tilt, bony fragment in the medial patellofemoral joint, lateral patellar subluxation, Insall-Salvatti Index-0.91, sulcus angle 133°. Magnetic resonance imaging (MRI) showed effusion of knee joint with tear in the MPFL at the patellar attachment, osteochondral defect in the lateral patellar facet and an osteochondral fragment in the medial patellofemoral joint. Of note, she had no other knee surgeries performed to the same knee. An arthroscopy showed chondromalacia of patella, patellofemoral joint maltracking and an osteochondral fracture of lateral facet of patella [Figure 1].

The patient was treated definitively with MPFL reconstruction by the technique described by us. Her pain resolved in 3 weeks, she returned to her daily routine in 6 weeks after surgery and at 24-month followup, Modified Crosby and Insall scale was good and Kujala score was 88.

Case2

18 year old male, a basketball player presented with right anterior knee pain and frequent subluxations and dislocation of the patella since 5 months. To start with he fell down and

twisted his knee while playing basketball for which he visited an orthopedician and was diagnosed to have right patella dislocation that was treated by immobilization in a cylindrical cast for 4 weeks. He returned to sports after the primary episode but experienced frequent anterior knee pain and multiple episodes of patellar subluxations and dislocations that is, 6 episodes of frank dislocations while playing which were reduced by his coach. The patient was evaluated in the OPD, he had severe anterior knee pain, tenderness over medial patellofemoral joint, a positive apprehension test, no hyperlaxity and a Q-angle of 14°. Radiographs showed lateral patellar tilt [Figure 2a], lateral patellar subluxation, Insall-Salvatti Index-1, sulcus angle 140°. MRI showed effusion of knee joint with tear in the MPFL at the patellar attachment [Figure 2b]. Of note, he had no other frank knee injuries or surgeries performed on the same knee. A preprocedure arthroscopy showed patellofemoral joint maltracking but no chondromalacia of patella.

The patient was treated definitively with MPFL reconstruction by the technique described by us. He returned to practice in 3 months and professional sports in 4 months, at 24-month followup, Modified Crosby and Insall scale was excellent and Kujala score was 98.

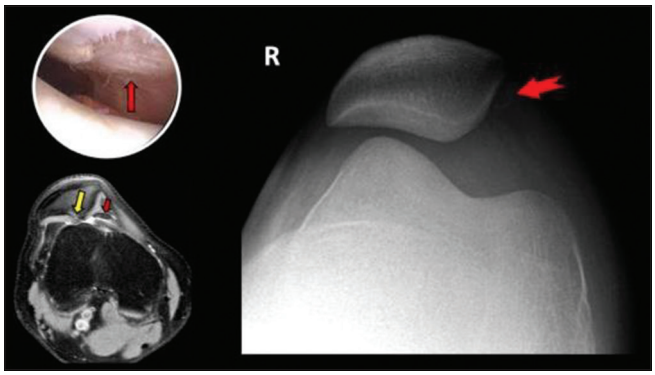

Figure 1: Radiographs of right knee joint skyline view showing: Lateral patellar tilt, a bony fragment in medial patellofemoral joint (shown with red arrow); Arthroscopic view (left upper picture) showing osteochondral defect in the lateral patellar facet (red arrow); Magnetic resonance imaging T2W (left lower picture) showing: Osteochondral defect in the lateral patellar facet (shown with yellow arrow) osteochondral fragment in medial patellofemoral joint (red arrow)

Case 3

26 year old man who is a railway employee presented with left anterior knee pain and frequent dislocation of the patella since 3 months. To start with he fell down and twisted his knee while climbing down a ladder for which he visited a physician and was diagnosed to have left patella dislocation that was treated by immobilization in a long leg knee brace for 3 weeks. He had frequent anterior knee pain and frequent dislocations of the patella (probably 6) which were less painful than the primary episode and were self reducible. The patient was evaluated in the OPD, there was diffuse swelling and tenderness over medial patellofemoral joint, a positive apprehension test, no hyperlaxity and a Q-angle of 15°. Radiographs showed lateral patellar tilt, lateral patellar subluxation, sulcus angle 136° [Figure 3a] and Insall-Salvatti Index-1.1 [Figure 3b]. MRI showed efussion of knee joint with tear in the MPFL at the patellar attachment. Of note, he had no other surgeries performed to the same knee. A preprocedure arthroscopy showed patellofemoral joint maltracking.

The patient was treated definitively with MPFL reconstruction by the technique described by us. He returned to work in 6 weeks, at 24-month follow up, Modified Crosby and Insall scale was excellent and Kujala score was 95.

Case 4

27 year old man who is a typist by profession presented with right anterior knee pain and frequent dislocations of the patella since four and a half months. To start with he fell down and twisted his knee while climbing down a staircase after which he had a patellar dislocation, the dislocation was self reduced with minimal knee manipulation. He later experienced 4 episodes of knee dislocations and consistent anterior knee pain. There was tenderness over

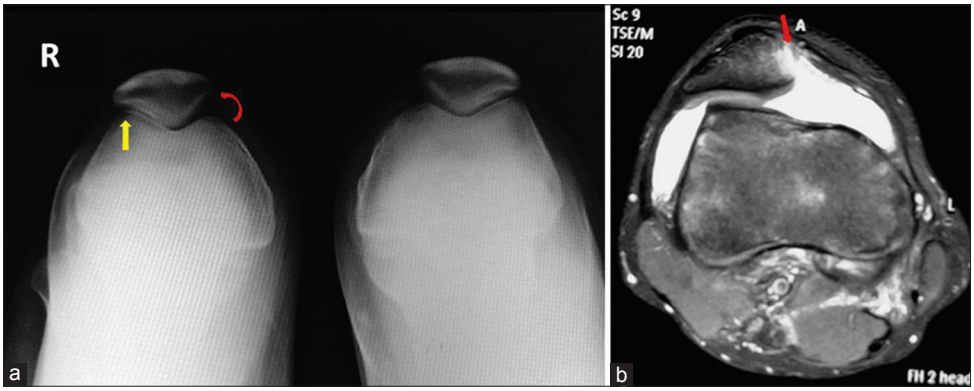

Figure 2: (a) Radiographs of both knee joint skyline view showing: Patellar lateral subluxation in right knee (yellow arrow); Patella tilt in right knee (red arrow) (b) Magnetic resonance imaging T2W of right knee joint showing: Patellar subluxation to lateral side; Patellofemoral ligament tear at patellar attachment (red arrow); Medial patellar retinaculum rupture joint effusion

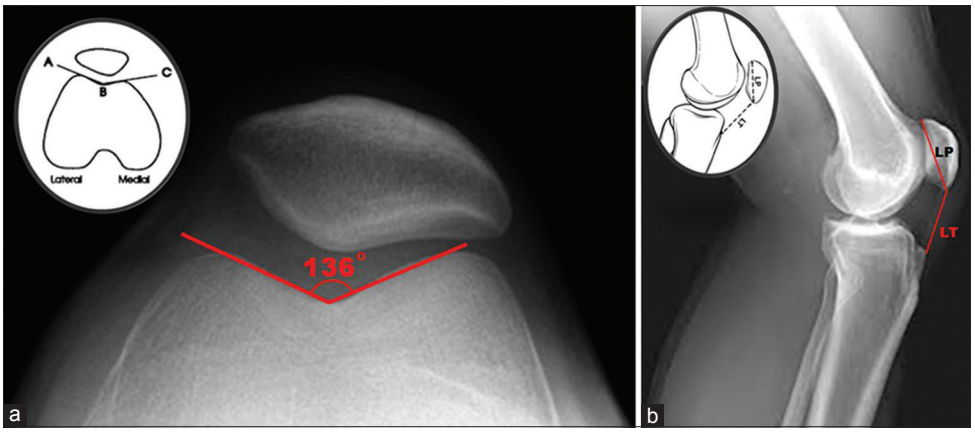

Figure 3: (a) Radiographs of left knee joint skyline view showing: sulcus angle (b) Radiographs of left knee joint lateral view showing Insall-Salvatti Index [ratio of Length of Patella (LP) to Length of patellar Tendon (LT)]

medial patellofemoral joint, a positive apprehension test, no hyperlaxity and a Q angle of 12°. Radiographs showed lateral patellar tilt, lateral patellar subluxation, Insall-Salvatti Index-1, sulcus angle 142°. MRI showed effusion of knee joint with tear in the MPFL at the femoral attachment [Figure 4]. Of note, he had no other surgeries performed to the same knee. A preprocedure arthroscopy showed patellofemoral joint maltracking.

The patient was treated definitively with MPFL reconstruction by the technique described by us. He returned to work in 6 weeks, at 24-month follow up, Modified Crosby and Insall scale was excellent and Kujala score was 96.

Operative procedure

The surgery was performed in supine position under tourniquet control. Patients were reexamined under anaesthesia to confirm marked lateral patellar translation and instability [Figure 5(a)]. A diagnostic arthroscopy was performed in all patients before starting reconstruction. The ipsilateral gracilis and semitendinosus tendon is freed from its attachment distally taking care that all accessory attachments are also freed for a minimum distance of 100–120 mm [Figure 5(b)]. Care must be taken not to detach the tendon from its muscle and not to strip the periosteum of the proximal tibial tubercle. The distal ends of tendons are to be reefed for control to redirect the tendons. The coupled tendon diameter is to be measured with a graft sizer.

Medial collateral ligament pulley

In 30°–45° of knee flexion, a 2–3 cm longitudinal skin incision was made in the area of the medial epicondyle and the adductor tubercle. The proximal attachment of the medial collateral ligament (MCL) was identified and its posterior one-third of the superficial layer was elevated without disturbing its attachment distally or proximally. The free ends of both the tendons were passed subcutaneously beneath the fascia but superficial to the joint capsule and

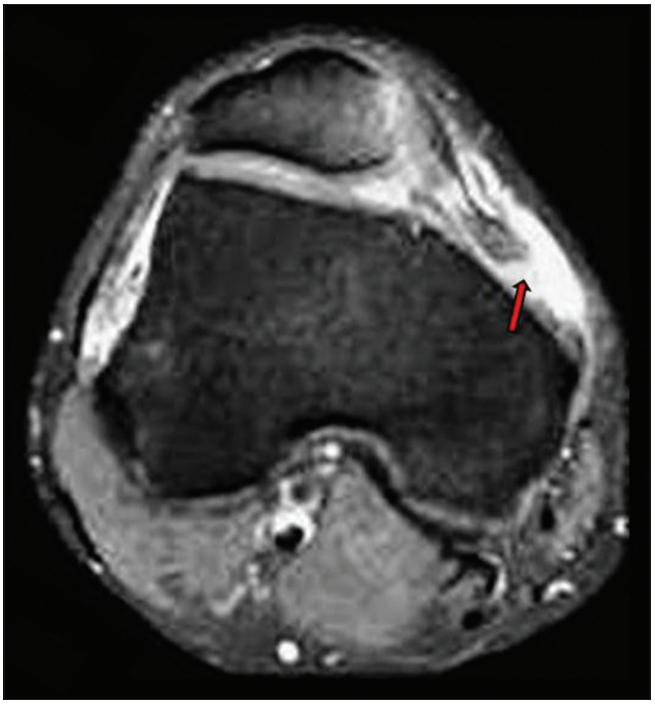

Figure 4: Magnetic resonance imaging T2W of right knee joint showing: Patellofemoral ligament tear at femoral attachment (red arrow); Medial patellar retinaculum rupture

then redirected from underneath this MCL sling gaining a pulley effect [Figure 6(a)].

Fixation of graft to patella

At this point, attention was focused on the patella and a 2 cm anterior skin incision was made over the central part of the medial border of the patella. A small periosteal flap was cut to expose the medial border of the patella. A guide wire was passed through the patella directing superolaterally under fluoroscopic control. Approximate reamer size of graft diameter was passed over the guidewire to drill a tunnel through the thickness of the patella. The two free ends were passed subcutaneously beneath the fascia and into the

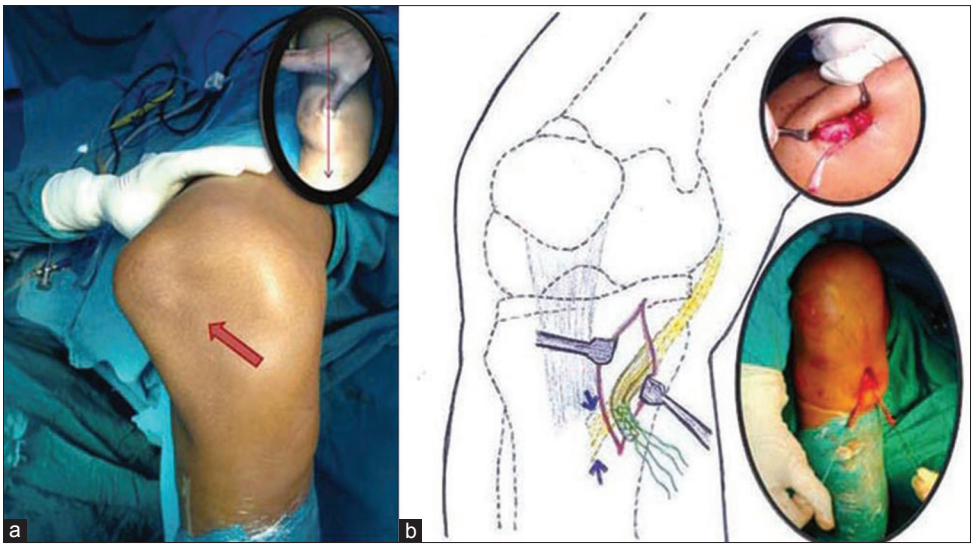

Figure 5: Clinical photograph showing (a) examination under anesthesia revealing marked lateral patella translation (b) Schematic diagram showing detachment of distal attachment of the graft (2 arrows)

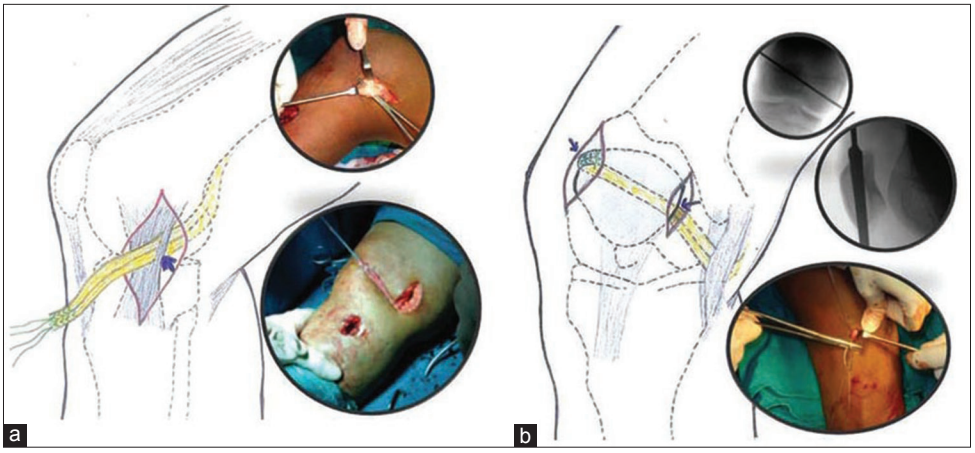

Figure 6: Schematic diagram showing medial collateral ligament pulley (b) Anchoring hamstrings to patella after passing through patellar tunnel

patellar tunnel medio-laterally with the patella reduced into the trochlea at 30° of knee flexion. The appropriate tension in graft was gained in this position; the grafts were then sutured to the fascia and periosteum over the patella [Figure 6(b)]. Before completing the procedure, the patellar tracking and stability was judged clinically and arthroscopically through the range of motion of the knee. Finally, the amount of lateral patellar translation was checked in full knee extension before all the incisions were closed.

Postoperatively, we recommended a knee brace locked in extension and weight bearing as tolerated with crutches until pain and swelling had resolved. Use of the brace was continued until the quadriceps strength returned to Grade 4 (usually first 2 weeks postoperatively). From 2nd to 6th week, early range of motion by use of physical therapy and continuous passive motion was prescribed. During this period full weight bearing with a hinged brace locked between 0° and 90° was advised. After 6 weeks, free activity was allowed without brace. Controlled sports activities after 3 months and contact sports after 6 months were allowed.

Discussion

The stability of the patellofemoral joint depends on numerous bony (shape of patella and trochlea, axis of knee joint) and soft tissue (vastus medialis obliqus [VMO], lateral retinaculum, medial retinaculum, MPFL, medial patellotibial ligament) factors.[5,6] There is damage to the MPFL in almost all cases of traumatic patellofemoral dislocation. MPFL provides 53–60% of total medial restraining force.[2]

The fibers of MPFL run transversely between medial patellar margin and the area between the adductor tubercle and medial epicondyle of the femur. The length of this ligament is

approximately 53–58 mm[7], width has been reported to range from 3 to 30 mm and mean tensile strength of 208 Newtons.[8]

Chronic retropatellar pain and recurrent patellar instability is seen in 40–70% of patients after acute patellar dislocation.[9] Most of the MPFL tears occur at the femoral attachment unlike our cases where three of our patients had a tear at the patellar attachment. MRI is useful in identifying the pathological changes associated with patellofemoral joint instability.[3,4,9] Numerous treatment methods have been advised for MPFL injuries. Conservative treatment has a 44% redislocation rate.[1] Many nonanatomical surgical techniques for the treatment of recurrent patellar dislocation have been described in literature such as arthroscopic lateral release with 25% poor results,[10] combined lateral release and arthroscopic medial plication with limited morbidity and high success rate.[11] Very few procedures address the principle site of pathology that is, the torn MPFL. The outcomes are inconsistent and many studies have reported recurrent dislocations, patellofemoral pain and arthritis in up to 40%.[12]

The principle of reconstruction is to reconstruct MPFL with a thicker and stronger tissue than before so as to compensate for underlying predisposing factors that are not corrected and to create a favorable anisometry.[13,14] The reconstruct should also have optimal length and elasticity.[15] Medial patellofemoral ligament reconstruction techniques have used various grafts for reconstruction including hamstring tendons, adductor magnus tendon, quadriceps tendon, iliotibial band and synthetic graft. However, ideal graft and technique for reconstruction are as yet undetermined. Of all the grafts, hamstrings exhibit similar elasticity to MPFL.[16] The mean diameter for gracilis tendon is 1.5 ± 0.2 mm and semitendinosus tendon is 2.2 ± 0.3 mm, these values vary depending on height, weight, BMI and gender of the patient.[17] Mean tensile strength of one gracilis strand is 837 Newtons and one semitendinosus strand is 1060 Newtons.[15] The exact figures for tensile strength in an individual hamstring tendon with an intact belly have not been quoted in literature and might not be as high as that in the isolated tendinous part. Reconstruction of MPFL restores normal orientation of VMO.[4] Loss of tension in MPFL results in lateral patellar dislocation and over tightening results in patellofemoral joint arthritis.[18,19]

Medial patellofemoral ligament reconstruction procedures can be broadly classified into two types based on the fixation techniques that is, static and dynamic. In static reconstruction on either side graft is fixed rigidly at isometric points of parent MPFL with staples or interference screws or anchors in bony tunnels, whereas in dynamic reconstructs the graft is secured to soft tissue at isometric points either on one or both sides with sutures.[16] The advantage of dynamic reconstructs over static ones are, greater chances of accommodation in length all through the range of motion of knee thus bringing down the peak pressure on patellofemoral joint during flexion.[16] The drawbacks of dynamic reconstruction are a weak anchorage leading to chances of failure and other complications of their own depending on the procedure.

To our knowledge, there are only five published studies of dynamic MPFL reconstruction that is, soft tissue anchorage of one or both sides of the reconstruct of which two are cadaveric studies. Deie *et al*.[20] in his series used single hamstring graft without disturbing its distal attachment for reconstruction by passing it through posterior one-third of superficial part of MCL at its proximal attachment, patellar attachment was secured by fixing the graft into the tunnel at level of superiomedial pole of the patella with a biotenodesis screw. Fink *et al*.[21] used quadriceps tendon after stripping its proximal attachment at desirable length, the graft is then fixed on femoral isometric point with an interference screw after dissecting the tendon distally over the patella keeping it attached to the patella and rotating it 90° medially underneath the medial prepatellar tissue. Panagopoulos *et al*.[12] in his series used similar technique used by Deie *et al*. but used medial intermuscular septum at the adductor magnus insertion at pulley on the femoral side instead of MCL. Ochid *et al*.[22] used the same technique used by Deie *et al*. in cadaveric knees prior to being used by Deie *et al*. in human studies, he was also an author in publishing the human studies along with Deie *et al*., Amis *et al*.[16] in his cadaveric studies used free hamstring graft and secured it on either side to soft tissue that is, fascia and periosteum at isometric points of parent MPFL.

Graft anchorage and viability play an important role in reconstruction. Fixation on the patellar side by suturing to fibrous tissue and periosteum over patella and fixing to a bony tunnel in the patella are the most commonly used techniques.[23]

The outcome criteria by Crosby and Insall[24] were used for all our cases keeping in mind its ability to assess patients with recurrent patellar dislocation and patient's subjective assessment of outcome. We also used Kujala questionnaire[25] to assess patient outcomes as this questionnaire is a detailed subjective assessment for patellofemoral disorders.

In this series, strong hamstring tendons (both gracialis and semitendinosis) are used in a dynamic fashion. By preserving the proximal attachments other major issues such as viability, anisomery and optimal tension in various positions through the range of motion can be achieved which finally judge the final outcome. Their close proximity to the knee, optimal length and diameter, similar elastic properties to parent MPFL[15] and minimal donor site morbidity made hamstrings our ideal choice for reconstruction. Posterior one-third of superficial MCL at its femoral attachment is used as pulley for rerouting to achieve isometric femoral

attachment that was earlier well documented by Ochid *et al*. in both his cadaveric and human studies.[20,22] Graft is anchored to the dorsal patellar periosteum on the lateral side after passing it through an oblique medio-lateral patellar tunnel making our anchorage firm, implant free and isometric to parent MPFL on patellar side.

Our rehabilitation protocol was designed keeping in mind tendon to bone tunnel healing. The initial graft to fascia suturing heals in 2–3 weeks[23] hence knee range of motion exercises are started. The bone to tendon incorporation starts at 2 weeks, takes reasonable good loads at 12 weeks and is completed by 26 weeks.[26] In our cases, sports activities were allowed at 3 months and activities resembling contact sports causing greater loads on patellofemoral joint were started at 6 months so as not to compromise graft anchorage.

To conclude that preliminary results indicate that MPFL reconstruction using an autologous hamstring graft is a simple, implant free, cost effective procedure with little associated donor site morbidity and good preliminary outcomes; it greatly helps in preventing further episodes of patellar subluxations or dislocations and in improving quality of life. Further clinical studies are needed to confirm these early results.

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Conflicts of interest
There are no conflicts of interest.

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