

Indian Journal of ORTHOPAEDICS

Volume 46 | Issue 4 | July - August 2012

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Reconstruction of medial patellofemoral ligament for chronic patellar instability

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ABSTRACT

Background: Disruption of the capsule, medial patellar retinaculum, and/or vastus medialis obliquus has been associated with recurrent patellar instability. Biomechanical studies have shown that the medial patellofemoral ligament (MPFL) is the main restraint against lateral patella displacement and reconstruction of the MPFL has become an accepted surgical technique to restore patellofemoral stability in patients having recurrent patellar dislocation. We report a prospective series of patients of chronic patellar instability treated by reconstruction of medial patellofemoral ligament.

Materials and Methods: Twelve patients (15 knees) with recurrent dislocation of patella, were operated between January 2006 and December 2008. All patients had generalised ligament laxity with none had severe grade of patella alta or trochlear dysplasia. The MPFL was reconstructed with doubled semitendinosus tendon. Patients were followed up with subjective criteria, patellar inclination angle, and Kujala score.

Results: The mean duration of followup after the operative procedures was an average of 42 months (range 24–60 months). 10 knees showed excellent results, 3 knees gave good results, and 2 knees had a fair result. The average patellar inclination angle decreased from 34.3° to 18.6°. The average preoperative Kujala functional score was 44.8 and the average postoperative score was 91.9.

Conclusion: MPFL reconstruction using the semitendinosus tendon gives good results in patients with chronic patellar instability without predisposing factors like severe patella alta and high-grade trochlear dysplasia, and for revision cases.

Key words: Hamstring tendon, medial patellofemoral ligament, patellofemoral instability

INTRODUCTION

The patellofemoral joint has a low degree of congruency. Stability depends on (1) bony structures – patellar and trochlear shape and (2) soft tissue structures – quadriceps muscle, in particular, the vastus medialis obliquus, lateral retinaculum, medial retinaculum, medial patellofemoral ligament (MPFL), and medial patello-tibial ligament.¹ The major restraints in the initial knee flexion (<30°) are the soft tissue structures, but after 30°, patellar stability depends on bony anatomy.² Major instability factors as described by Dejour are patellar tilt, tibial tubercle–

trochlear groove distance (Q-angle quantification by CT scan), patella alta, and trochlear dysplasia.³ The secondary instability factors are excessive external femoral rotation, excessive external tibial rotation, genu recurvatum, and genu valgum. These instability factors predispose to injury of the MPFL which is the major soft tissue restraint which contributes an average 53% of the total force that prevents lateral displacement of distal knee extensor mechanism.⁴

The MPFL is a distinct soft tissue structure within the medial retinaculum, which originates from saddle between the adductor tubercle and epicondyle and inserts at the superior two-thirds of medial border of patella, typically at the location where the perimeter of the patella becomes more vertical. It is approximately 55 mm long and its width ranges from 3 to 30 mm. This ligament is most taut in full extension, with the quadriceps contracted, and assists in guiding the patella into the trochlea during the early stages of flexion. The common attachment of the tendon of the vastus medialis muscle and the ligament to the superiomedial patella suggests that there may be a dynamic element for stability. Patellar tracking is significantly affected by a lateral force in the absence of the MPFL, but returns to normal following reconstruction.⁵ In nearly all

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Access this article online	
Quick Response Code:	Website: www.ijoonline.com
	DOI: 10.4103/0019-5413.97259

patella dislocations, there is damage to the MPFL.^{6,7} 70% is damaged at the patellar insertion while the remaining is damaged at the femoral origin. In all, however, there is also interstitial damage.^{6,7} MPFL reconstruction is most helpful for patients who have recurrent patellar dislocations associated with hyperelasticity and for patients who have obligatory patellar dislocations. Both of these scenarios are associated with incompetent medial retinacular tissue.⁸

Nonoperative management is the recommended option following primary patellar dislocation.^{9,10} Conservative management focuses on exercises to strengthen the quadriceps, and especially the vastus medialis, to prevent further instability. If the dislocation recurs operative intervention is considered, with the aim of restoring the soft tissue anatomy to normal. Proximal or distal realignment procedures have long been selected as treatment for recurrent patellar dislocation, but associated knee osteoarthritis in these non-anatomical surgeries leads to poor results.¹¹⁻¹⁴ Hence, a, medial patellofemoral ligament reconstruction, an anatomical reconstruction, has started in recent years. We conducted a prospective, study of reconstruction of medial patello femoral ligament for chronic patellar instability patients.

MATERIALS AND METHODS

Twelve patients (15 knees) with recurrent dislocation of patella were operated between January 2006 and December 2008. All patients had generalised ligament laxity with none had severe grade of patella alta or trochlear dysplasia. Inclusion criteria were dislocating patella with history more than three episodes, failed previously operated cases, low-grade trochlear dysplasia, and mild patella alta. Exclusion criteria were pediatric patients less than 16 years, acute dislocations, high-grade trochlear dysplasia [tibial tuberosity–trochlear groove (TT–TG) distance >20 mm], high-grade patella alta (>1.35 CatonDeschamp's index), patients with patellofemoral arthritis, and dislocations associated with other ligament injuries with or without osteochondral fractures needing fixation.

Preoperative evaluation specifically consisted of dynamic patellar tracking, patella height, and possible patellofemoral osteoarthritis. The patellofemoral morphology study included routine X-ray of the knee anteroposterior, lateral and skyline views, before the operation and at followup. Preoperative CT scan was done for axial section at 0°, 10°, 15°, and 30° flexion of the knee for measuring TT–TG¹⁵ distance and patellar inclination angle.¹⁶ TT–TG is the quantitative indicator of Q-angle. CatonDeschamp's index was used to evaluate patella alta.¹⁷

There were eight females and four males. Out of them 3

female patients were having bilateral patella involvement. Six patients were already operated for unilateral instability. Three patients underwent for lateral release and medial plication procedure, one had only lateral release, and two had Elmslie-Trillat procedure before reporting to us. The mean age of the patients was 29.2 years (range 18-41 years). The average period between dislocation and surgery was 11.8 years. All our patients were having generalized ligament laxity as assessed by revised Brighton's criteria¹⁸ which included nine tests. Each positive test was counted as 1 point, giving a maximum of 9 points. Brighton score of five or more positive tests was considered positive for generalized joint hypermobility. The nine tests included: Passive apposition of right and left thumb to flexor aspect of forearm, passive dorsiflexion of right and left little finger >90°, passive hyperextension of right and left elbow >10°, passive hyperextension of right and left knee >10°, and forward flexion of the trunk with knees straight so that palms of hands rest easily on the floor. Two patients had low-grade patella alta and one patient had type A trochlear dysplasia.³ Associated intra-articular pathologic finding in one patient who had a loose body was addressed [Table 1].

Patellofemoral function was evaluated with the Kujala functional score before surgery and at the time of the final followup. Additional surgeries to an MPFL reconstruction considered were lateral retinacular release when there was tight lateral retinaculum, a tibial tubercle transfer in cases of trochlea–tubercle malalignment (TT–TG distance >20 mm), and severe patella alta (>1.35 CatonDeschamp's index).¹⁷ Surgical outcome was assessed by three methods: The patient's opinion (subjective: excellent, good, fair, or poor), patellar inclination angle, and Kujala patellofemoral score.¹⁹ 15 knee were operated and all were followed up and reported. The mean duration of followup of 15 knees (12 patients) after the operative procedures was an average period of 42 months (range 24–60 months).

Operative procedure

We used gracilis tendon in first four cases²⁰ later on in rest we used semitendinosus graft. Three cm long incision was made over the semitendinosus tendon, over the medial edge of the patella, and over the medial femoral epicondyle. The semitendinosus tendon was harvested with a routine technique.²¹ An incision was made over the medial edge of the patella into the second fascial layer of the knee. Dissecting scissors are now used to tunnel between the 2nd and 3rd fascial layers, aiming toward the medial epicondyle where the second fascial layer is also opened. A guide wire was inserted at the medial femoral condyle in between epicondyle and adductor tubercle. In the proximal third of the medial edge of the patella, two 3 mm drill holes were made approximately 10–12 mm apart. These drill holes should be on the edge of the patella and should not violate chondral surface and

Table 1: Clinical details of the patients

S.no.	Name	Age / Sex	Rt..	Lt.	Predisposing factors	Previous surgeries	Additional surgery performed	Follow-up	Patellar inclination angle		Score	
									Pre-op.	Post-op.	Pre-op.	Post-op.
1	BT	21 / M	Rt.		Lax Joints	————		15° Flexion restriction	24°	15°	43	88
2	SD	36 / F		Lt.	Lax Joints	Lateral release, Medial plication	————	Once feeling of patella Subluxation	40°	18°	44	90
3	SD	36 / F	Rt.		Lax Joints	Elmslie Trillat	————	————	38°	20°	46	92
4	LI	25 / F	Rt.		Lax Joints Patella Alta 1.28	Lateral release	————	5° flexion restriction	36°	17°	45	92
5	RA	27 / F	Rt.		Lax Joints	————	————		30°	15°	46	95
6	RA	27 / F		Lt.	Lax Joints	————	————		28°	17°	44	95
7	KR	41 / M	Rt.		Lax Joints	Lateral release, Medial plication	Loose body removal		42°	23°	42	92
8	JI	21 / F		Lt.	Lax Joints	————	————		36°	20°	46	92
9	JI	21 / F	Rt.		Lax Joints	————	————		35°	19°	46	94
10	SA	41 / F	Rt.		Lax Joints Trochlear Dysplasia type 'A'	————	————	Anterior knee pain	43°	24°	43	88
11	HA	30 / F		Lt.	Lax Joints	Elmslie Trillat	Lateral release		23°	16°	46	92
12	MH	25 / M	Rt.		Lax Joints	————	————		30°	19°	48	95
13	PA	18 / F		Lt.	Lax Joints	Lateral release, Medial plication	————		33°	17°	44	91
14	MR	30 / M	Rt.		Lax Joints Patella Alta 1.26	————	————	10° Flexion restriction anterior knee pain	36°	16°	46	88
15	NA	18 / F		Lt.	Lax Joints	————	Lateral release		40°	24°	43	94

anterior cortex. A tape was then placed around the guide wire at the medial epicondyle, taking it from there, between the 2nd and 3rd fascial layers, to the drill holes at the medial edge of the patella. With the knee in full extension, while strongly pulling proximally with a bone hook on the distal patella in the direction of the anterior superior iliac spine (ASIS), the slack in the tape is taken up. The tape was then clamped with an artery forceps on the surface of the patella. The stability of the patella, compared to the opposite knee as well as the lengthening pattern of the tape, was observed. At the correct femoral insertion point, the patella should be stable in full extension and the tension in the tape should be at maximum in full extension and progressively become lax with flexion. If this tension pattern was not observed, the position of the guide pin on the femur should be changed. Moving the guide pin more proximal would decrease the tension in extension and increase the tension in flexion. Conversely, moving the guide pin more distal would increase the tension in extension and decrease the tension in flexion. The ideal position was where the tape was maximally tight in extension and became more lax in flexion. When satisfied with the tensioning pattern, over-drill the guide wire in the epicondyle with a 5-mm cannulated drill. Place a 5-mm bone anchor in this drill hole in the femoral condyle and attach the loop of the double semitendinosus tendon to it [Figure 1].

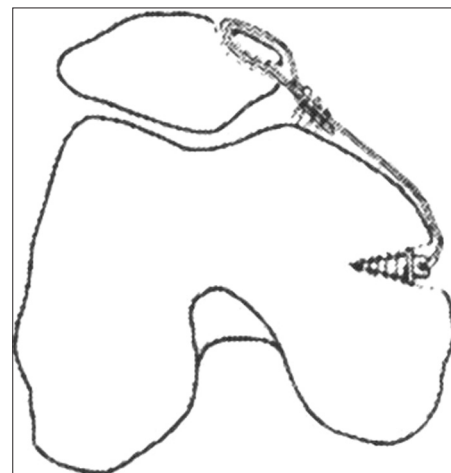


Figure 1: A line diagram showing MPFL ligament reconstruct – Bone anchor in femoral condyle and bone tunnel made in medial patellar edge

The double semitendinosus tendon was brought between the 2nd and 3rd fascial layers to the drill holes in the patella. Tensioning was done with the knee in full extension, while strongly pulling proximally with a bone hook on the distal patella in the direction of the ASIS. Tension on the semitendinosus tendon is only enough to remove the slack and the free ends are then temporary tied to themselves with a suture loop. This maneuver

prevents over tensioning of the reconstructed MPFL. Over tensioning of the ligament can lead to an extensor lag when the tension in this reconstructed ligament is more than that in the patellar tendon with quadriceps contraction and active knee extension. After tensioning, the medial and lateral movement of the operated patella should be similar to that of the contralateral patella. Once the tensioning was satisfactory, the free ends of the folded back tendon were sutured onto themselves and the surrounding soft tissue with a non-absorbable material.

In the last 11 cases, we modified the previous technique, using single incision and semitendinosus tendon since our patients were of average built with ligament laxity [Figures 2 and 3]. A 6–7 cm vertical incision was made between adductor tubercle and medial border of the patella. A horizontal incision was made over the medial retinacular structures till the third layer, taking precaution

to avoid entering the joint. Patellar end was fixed with 2.8-mm FASTak titanium anchor on the medial border of patella at the junction of upper and middle thirds, typically where the perimeter of patella becomes more vertical. Then, guide pin was inserted on medial femoral epicondyle and isometricity was tested with the anchor thread itself. Then, femoral tunnel of 7 mm width was made using beath pin from the chosen point. Care had to be taken such that femoral tunnel length was larger by at least by 1 cm than the graft construct so that femoral end could be fixed with traction by pull-out sutures of beath pin. Soft-threaded 7-mm titanium screw or biodegradable screw (1 mm larger than the tunnel width) could be used for femoral end fixation at knee flexion between 20° and 60°. Knee flexion angle depended on which position the patella engages in the groove. During fixation, traction force of 2 N was applied to the pull-out sutures. Previously incised retinacular tissues were sutured, which would be covering reconstructed graft.

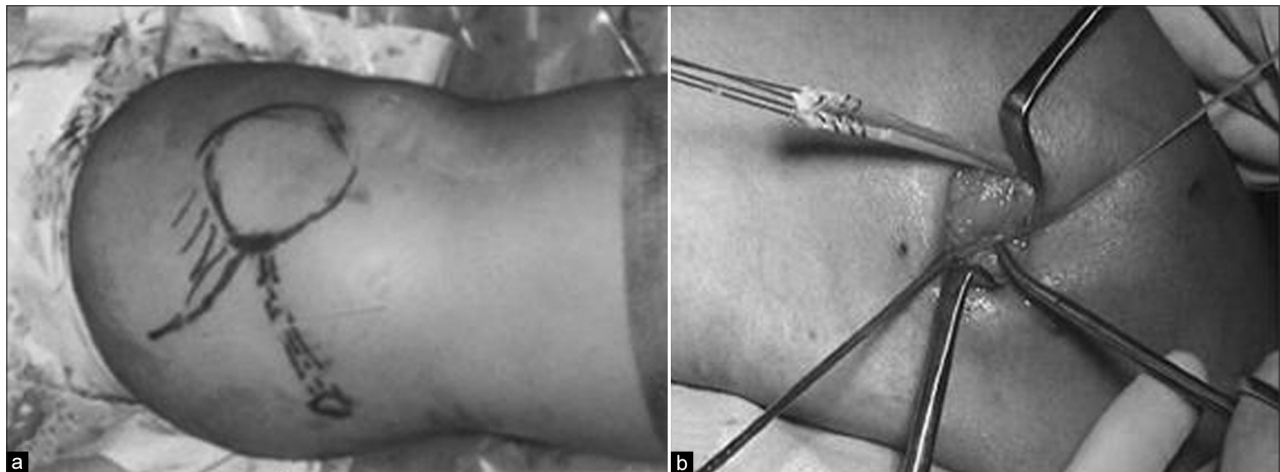


Figure 2: Preoperative photographs showing (a) Surface anatomy of MPFL. (b) Finding the isometric point on medial femoral condyle

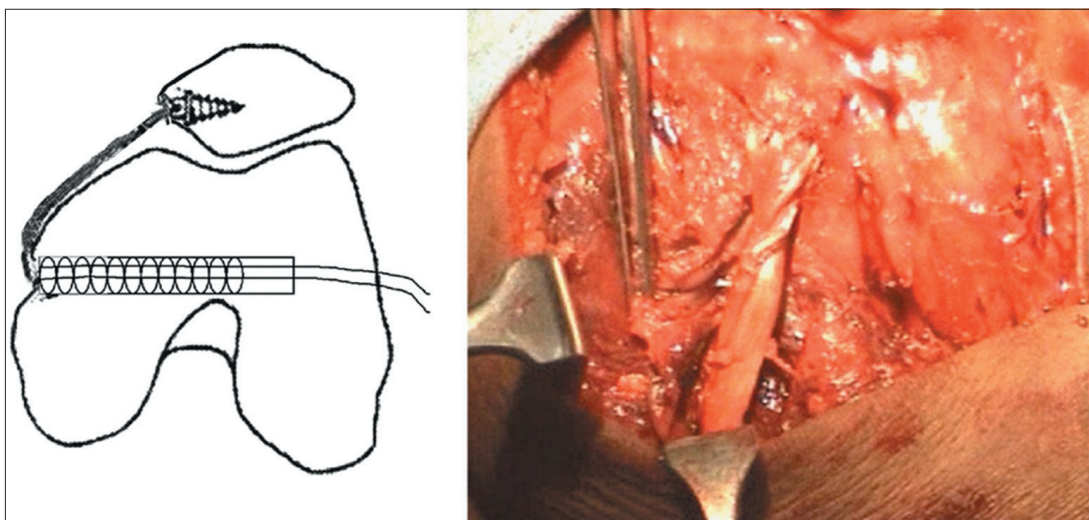


Figure 3: A line diagram and a peroperative photograph showing MPFL ligament reconstruct – FASTak anchor on patellar edge and Bio screw in femoral tunnel

Postoperative rehabilitation

Postoperative immediate full passive motion was encouraged once postoperative pain subsides. Active flexion and light isometric quadriceps exercises were also done. The knee was immobilized in extension in a knee immobilizer. The patient was allowed only partial weight bearing on crutches for the first 4 weeks and thereafter full weight bearing was allowed and intensive quadriceps rehabilitation started. Quadriceps rehabilitation is often prolonged and can take up to 6 months or even longer. Demanding activities like step climbing, fast walking, and jogging were allowed as soon as full quadriceps rehabilitation had been achieved.

RESULTS

In 13 knees, only MPFL reconstruction was done. Lateral release along with MPFL reconstruction was done in two knees which had tight lateral retinaculum [Table 1]. Tubercle transfer was not done in any patient.¹⁷ All patients were followed for an average period of 42 months (range 24–60 months). No dislocations have occurred, but two had apprehension test positive on examination. One patient had extensor lag of 5° and two had flexion restriction of 10° and 15°. Two patients had patellofemoral pain. Two patients had tenderness on patellar anchor fixation site on deep palpation. Subjectively, 10 knees showed excellent results, 3 knees gave good results, and 2 knees had fair results. The average patellar inclination angle decreased from 34.3° to 18.6° [Figure 4]. The average preoperative Kujala functional score was 44.8 and the average postoperative score was 91.9. There was a strong association of generalized ligamentous laxity with chronic patellar instability, as all our patients had generalized ligament laxity.

DISCUSSION

The reconstruction of the MPFL gives better results in recurrent patellar dislocations than with non-anatomical reconstruction, which would alter the biomechanics of the patellofemoral joint.^{22–25} Medial transfer of the tibial tubercle increases joint loading within the medial tibiofemoral compartment and the medial facet of the patellofemoral joint and induces variable changes within the lateral tibiofemoral compartment.¹¹ Proximal or distal realignment procedures leads to poor results due to associated knee osteoarthritides.^{12–14,25}

The importance of MPFL reconstruction has been described in cadaveric study done by Conlan.⁴ Avikainen *et al.* (1993).²⁶ described adductor magnus tenodesis to reconstruct the MPFL. Their report on 14 patients, 10 with acute and 4 with recurrent patellar dislocations, showed good results for 12 patients in a 7-year followup. Many

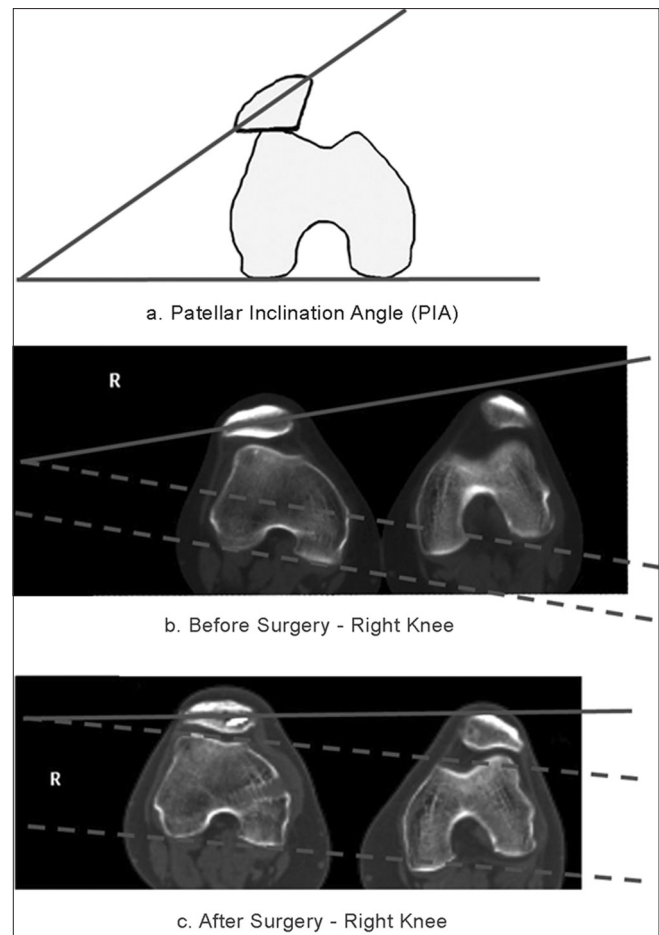


Figure 4: A line diagram (a) and Axial CT scan (b,c) showing the angle between the transverse axis of the patella and bicondylar axis (P/A)

other studies^{14,21,27–30} have been published concerning this specific MPFL reconstruction technique and have described many repair or reconstructive techniques of the MPFL. The association of definite knee osteoarthritis in MPFL reconstruction with or without lateral release was small in the long term followup.^{12–14,25}

Majority of patients with patellar dislocation, have ligamentous hyperlaxity, patella alta, and trochlear dysplasia.³¹ The generalized ligament laxity. Predisposed to an acute overload of the soft tissue stabilizers and rupture of the MPFL with patella dislocation. The TT–TG distance of all patients was less than 20 mm and CatonDeschamp's index was less than 1.35. Therefore, tibial tubercle realignment surgeries were not indicated in our patients, along with MPFL reconstruction. The principle of repair philosophy is to reconstruct the MPFL with stronger tissue than before and to compensate for the underlying predisposing pathology without changing the original position of the patella and its original conformity with its underlying trochlea.^{20,33,34} We avoided using imbrication method⁸ (MPFL plasty) of treating chronic patellar instability as most of our patients were having generalized ligament laxity and had been operated earlier.

The semitendinosus and gracilis hamstrings are commonly harvested as grafts for reconstructive procedures.³⁵ MPFL reconstruction with stiff graft can produce large increase in patellofemoral joint loading if small errors in graft length and/or attachment sites are present.³⁶ Several different methods have been described to reconstruct the MPFL with hamstring graft, and variation also occurs between patella tunnel placement and graft fixation methods. We used semitendinosus tendon as the gracilis tendon was very thin in most of our patients. We could perform surgery using single vertical incision placed in between adductor tubercle and medial border of patella, since our patients were of average built with ligament laxity. In last 11 knees, we used anchors at patellar side instead of making a tunnel in patella. Doubled hamstring tendon strands were tied to the anchor and further strengthened by suturing strands to the patellar periosteum. A study comparing the fixation of hamstring graft to the patella reported no difference between suturing to the patella periosteum and using a single tunnel to the center of the patella.²² for fixation of graft at femur K wire was drilled in the isometric point at the femur after placing an anchor at the medial border of patella. The isometricity for the femoral tunnel location was confirmed. Fixation of graft with femur was done with a screw, between 20° and 60° of knee flexion, depending on where the patella was engaging in the groove, while applying low tension pull over the graft (2 N). Overtensioning could be avoided by applying low loads (2 N) to MPFL reconstructions, which reestablished normal translation and patellofemoral contact.³⁷

Two of our patients with preoperative patella femoral chondral changes had persisting anterior knee pain. Three patients had minimal end-stage movement restrictions, might be attributed to overtightening of the graft or faulty patellar, femoral attachment points. In Fernandez *et al.*'s study, all patients (30 knees) ended up with a full range of motion, except one patient whose flexion was limited to 120°.³⁸ Placing the reconstruction more proximal will result in a reconstructed MPFL that is lax in extension and tight in flexion; this might cause loss of knee flexion and creates excessive pressure on the medial patella.³⁶ Conversely, placing the reconstruction distally will result in an overtight MPFL in extension and a lax ligament in flexion; this might result in an extensor lag as the tension in the reconstructed ligament might be more than that in the patellar tendon, with maximum quadriceps contraction. Graft length change patterns depend principally on femoral graft attachment point. The least change was with a point more distal on the patella and more proximal on the femur.²⁷

Underlying pathologies such as severe dysplastic trochlea, abnormal TT–TG, patella alta, and hyperlaxity result in a greater reliance upon the reconstructed MPFL for patellar

stability.^{3,39} When subjected to severe stress, the graft, which is stronger and stiffer than the original MPFL, will cause a fracture through the medial edge of the patella. This weak area results from the previous drill holes, which act as stress risers.⁴⁰ As our patients were of thin built, we avoided making tunnel in our later cases by fixing the graft to patella, using anchor. Stress over the anchor was shared by suturing the graft with periosteum of patella. In two of our cases, we did lateral release instead of the preferred lateral lengthening,⁴¹ where we found the abnormal tilt with tight lateral retinaculum. On followup of these two patients, there was no medial instability. The creation of iatrogenic medial instability of the patella is uncommon but not rare after lateral retinacular release.^{42,43} Release of the lateral retinaculum in the presence of patellar instability causes further destabilization of an unstable joint.^{44,45} Instead of releasing, lengthening is preferred. Larson and associates⁴¹ described a method of lateral retinacular lengthening that helps avoid the potential complication of medial patellar subluxation.

Schöttle *et al.* reported that the mean Kujala score improved significantly from 55.0 to 85.7 points in his study.⁴⁶ Reconstruction of the MPFL was done with gracilis tendon autograft in transverse patellar drill holes by Christiansen *et al.* In this study, knee function score improved overall from 46 points (range 12–67 points) to 84 points (range 62–100 points) at followup.⁴⁷ In Mikashima *et al.*'s²² study, the mean Kujala score was 95.2 postoperatively. These results are comparable with our outcome. Average patellar inclination angle in our study was 34.6°. Dejour has reported that 83% of objective patellar instability group had patellar tilt angle more than 20°.³ All our patellar instability patients had patellar inclination angle more than 20°. MPFL reconstruction provides excellent long term pain relief and functional return in patients with patellar instability with normal femoral trochlear anatomy. In addition, MPFL reconstruction stabilizes the patella with low-grade femoral trochlear dysplasia also.^{46,48} But in high-grade trochlear dysplasia, MPFL reconstruction should be coupled with trochleoplasty. There is a strong association of generalized ligamentous laxity with chronic patellar instability, as all our patients had generalized ligament laxity.

Limitation of study

The sample size is small. It is difficult to correlate the results between the primary MPFL reconstruction cases and the secondary ones as the previous different procedures further fractionize the study group into statistically small sample.

CONCLUSION

MPFL reconstruction using the semitendinosus tendon gives

good results in patients with recurrent patellar instability and is an effective procedure for primary cases without predisposing factors like high-grade trochlear dysplasia and severe patella alta, and for revision cases.

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How to cite this article: Reddy KR, Mishra CB. Reconstruction of medial patellofemoral ligament for chronic patellar instability. *Indian J Orthop* 2012;46:447-54.

Source of Support: Nil, **Conflict of Interest:** None.

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