MPFL Reconstruction for Recurrent Patella Dislocation: A New Surgical Technique and Review of the Literature

Authors A. Panagopoulos, L. van Niekerk, I. K. Triantafillopoulos

Affiliation Orthopaedics and Trauma, Centre for Sports Injury Surgery, Friarage and Duchess of Kent Military Hospitals, Northallerton, United Kingdom

Key words
- traumatic patella dislocation
- patella instability
- MPFL reconstruction

Abstract

Recurrent dislocation, subluxation and functional instability due to patellofemoral pain might be present in 30% to 60% of patients managed nonoperatively for posttraumatic patella instability. Disruption of the capsule, medial patella retinaculum and/or vastus medialis obliquus have been associated with recurrent patella instability but recently the medial patellofemoral ligament (MPFL) has been recognised as the most important ligamentous stabiliser preventing lateral dislocation of the patella. Many nonanatomical surgical techniques for the treatment of recurrent patellar dislocation have been described in the literature. These procedures alter the premorbid patella mechanics by several principles, including the release of tight lateral ligaments, tensioning of loose medial structures and distal realignment of the extensor mechanism or a combination of these. Very few address the principle site of pathology in patella dislocation, i.e., the torn MPFL. The outcomes are inconsistent and many studies have reported recurrent dislocations and patellofemoral pain and arthritis in up to 40%. We describe a simple technique of MPFL reconstruction using a single hamstring tendon graft which is passed through the medial intermuscular septum at the adductor's magnus insertion and is fixed to the superomedial pole of the patella. A comprehensive review of the existing techniques of MPFL reconstruction using semitendinosus tendon autografts is also provided.

Introduction

Recurrent dislocation, subluxation and functional instability due to patellofemoral pain might be present in 30% to 60% of patients managed nonoperatively for posttraumatic patella instability [7,11,22,28]. Maenpaa and Lehto [29] reported the clinical results of 100 patients with primary acute patella dislocations treated with various nonoperative techniques. At an average 13-year follow-up, 44% re-dislocated. A further 19% had ongoing patellofemoral pain and subluxation leading to an overall 63% of patients reporting unsatisfactory results over a substantial follow-up period.

A patella dislocation is often reported as occurring when twisting or turning at speed in sports requiring such manoeuvres. A "pop" is felt and swelling will usually occur. Without clarifying finer details of the history of the injury with the patient, the examiner may think the patient is reporting an injury to an ACL! In the UK, initial management of a first time patella dislocation is nonoperative. When a pattern of instability establishes itself however, high physical demand patients will question continued management with physiotherapy and avoidance of provocative activities. Clinical examination and imaging may reveal contributing factors to the patellofemoral joint instability such as generalised ligamentous laxity, patellofemoral joint dysplasia, excessive femoral anteversion and external tibial torsion.

Disruption of the capsule, medial patella retinaculum and/or vastus medialis obliquus [17,53] have been associated with recurrent patella instability but recently the medial patellofemoral ligament (MPFL) has been recognised as the most important ligamentous stabiliser preventing lateral dislocation of the patella [12,23]. Nomura [34] reported a high incidence of MPFL rupture or insufficiency in both acute (18/19 knees) and chronic (49/49) cases with patella dislocation.

As the role of MPFL in lateral translation of the patella has been established over the last decade [5,14], numerous anatomic [4,17,20,23,31,35,37,40,41,44,47,49,52] and clinical [2,8,13,15,16,18,

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Correspondence
Dr. Andreas Panagopoulos, MD, PhD, Senior Clinical Fellow
Centre for Sports Injury Surgery, Friarage and Duchess of Kent Military Hospitals
Orthopaedics and Trauma
North Yorkshire, UK
DL6 1JG Northallerton
United Kingdom
or
25 Martiou 1
26504 Kato Kastritsi
Patras, Greece
Phone: + 30 69 44 36 36 24
Fax: + 30 26 10 46 40 33
andpan21@gmail.com

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19,21,30,36,38,46,50] studies have advocated either direct repair or reconstruction of the ligament. Despite the fact that there is still disagreement regarding the origin, insertion and isometry of the MPFL ligament [4,15,37,47,49] as well as in terms of graft selection (semitendinosus, quadriceps, artificial), type of reconstruction and fixation methods, several authors have reported a low rate of recurrence and good clinical outcome after MPFL repair or reconstruction.
We present a relatively simple surgical technique of MPFL reconstruction using a semitendinosus tendon autograft maintaining its distal insertion and passed through the medial intermuscular septum and fixed to the superomedial pole of the patella.
Surgical management of traumatic patella dislocation may have gained wider acceptance had it not been for our poor understanding of the pathoanatomy of the injury. A variety of surgical techniques in small numbers of patients with mixed results have been reported including distal patella realignment, lateral release, proximal realignment and combinations of the above. Many of these procedures attempt to correct perceived anatomical predisposing factors, others involve a simple repair of pathological tissue and some techniques attempt to do both. It is therefore not surprising that many of these procedures carry a significant morbidity of their own thereby dissuading most orthopaedic surgeons on the wisdom of their routine use in this very common knee injury. We feel that a prerequisite of successful surgical management of traumatic patella instability is a surgical technique that does not significantly alter the patient's premorbid anatomy but focuses solely on the restoration of damaged tissue. Procedures aimed at correction of anatomical variants can potentially lead to complications related to over constraint and multidirectional instability. A comprehensive review of the existing techniques of MPFL reconstruction using semitendinosus tendon autograft is also presented.

Surgical Technique

Preoperatively, patients are evaluated with a thorough history of the initial injury and subsequent episodes of dislocation/subluxation. A history of an injury requiring medical assistance for reduction of the dislocation or management with initial symptoms after the index injury is sought. We then record subsequent episodes of instability, as well as ongoing symptoms of apprehension, pain and reduction of level of physical activity. On clinical examination, we note patella tracking, alignment and apprehension on manual tilt and displacement of the patella. We survey our patients for signs of generalised ligamentous laxity and we check for any rotational variants of the lower limb that may predispose to altered patellofemoral joint mechanics. Radiographs are made principally to exclude bony injury of the patella and lateral femoral condyle that may occur during traumatic dislocation but also to record joint congruity (**Fig. 1**). MRI imaging assists in identifying chondral injury and soft tissue disruption/attenuation associated with this injury. Finally, evaluation under general anaesthesia is used to compare patella tilt, displacement, general joint stability and patellofemoral crepitus with the contralateral side.
Arthroscopy is begun with the use of pneumatic tourniquet on the thigh inflated to 300 mmHg. The orientation and tracking of the patella are recorded from the anteromedial portal site (**Fig. 2**). Unstable cartilage lesions, usually at the medial patellar facet and/or lateral edge of femoral trochlea, are debrided if present (**Fig. 3**). Limited synovectomy and treatment of meniscal lesions is performed at this time, whereas concomitant ligament pathology and cartilage defects are documented for possible separate intervention.
Through a separate anteromedial incision on the proximal tibia, the semitendinosus tendon is harvested, as one would do for ACL reconstruction. Care is taken to preserve a strong distal attachment of the tendon to the proximal tibia. The proximal end of the tendon is whip-sutured with Ethibond No. 2 (Ethicon, Edinburgh, United Kingdom) sutures. A rough estimation of the essential tendon length for the reconstruction is confirmed

Fig. 1 Increased lateral tilt at 30 degrees of knee flexion on plain X-rays, MPFL rupture at its patella insertion on MRI scan (arrow) and extreme lateral translation with the patient under general anaesthesia.

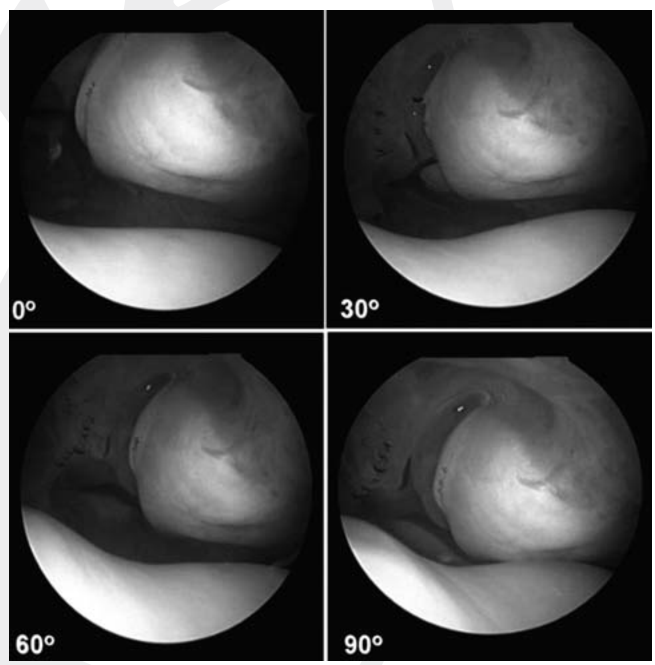

Fig. 2 Arthroscopic evaluation of patellar tracking prior to MPFL reconstruction. The patella is laterally subluxed through a 0 to 90 degrees range of motion.

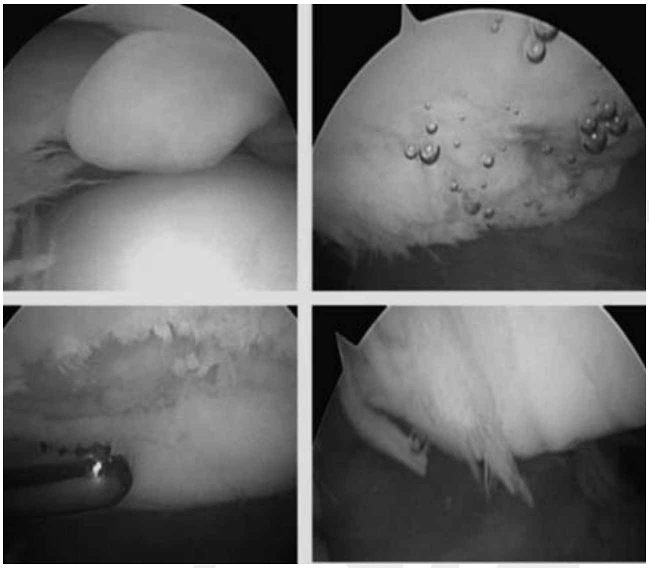

Fig. 3 Loose bodies and various cartilage injuries in patients with patella instability.

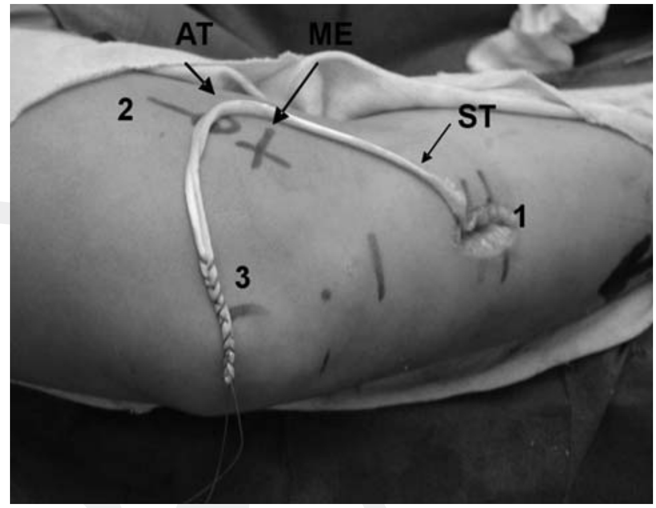

Fig. 4 Initial estimation of adequate graft length for the MPFL reconstruction. ST = semitendinosus autograft, ME = medial epicondyle, AT = adductor's tubercle.

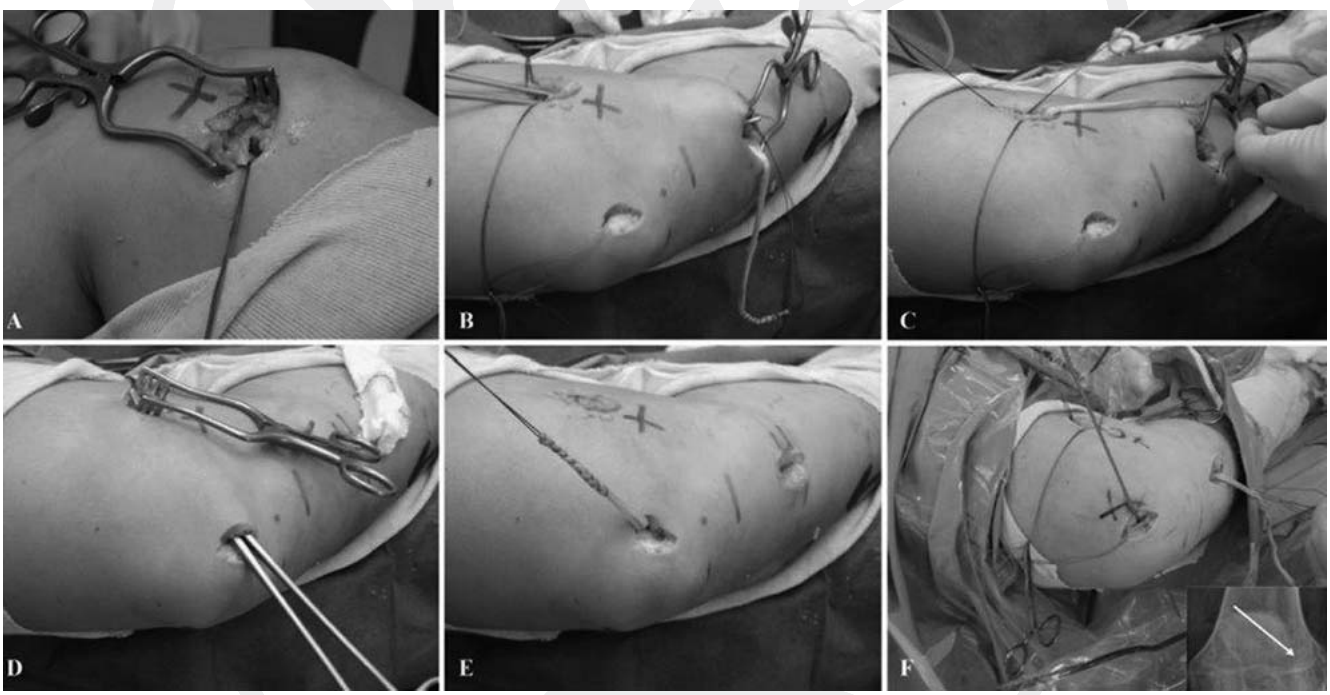

Fig. 5 A to **F** Surgical technique: **A** incision at the AT and passage of an Ethibond No. 2 loop through the adductor's tendon, close to its insertion, **B** retrieval of the ST autograft using a cholocystectomy obturator, **C** passage of the tendon through the superficial and deep fibres of the medial collateral ligament, **D** passage of the tendon through the medial patellar retinaculum, **E** retrieval of the tendon and **F** direction of the patellar tunnel (in another case).

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(**Fig. 4**). The standard template of the Biotenodesis® screwdriver (Arthrex Ltd., Sheffield, UK) is used to determine tendon diameter that should be smaller or loosely the same size as the proposed patella tunnel.

A second incision is then made, starting at the adductor tubercle (AT) in line with the posterior margin of the vastus medialis obliquus (VMO) and extended proximally by 2 – 3 cm. Using blunt dissection, to avoid damage to the saphenous nerve, the insertion of the hamstring portion of the adductor magnus and medial intermuscular septum (MIS) are identified. A curved haemostatic clip is passed through the MIS beneath the adductor magnus tendon as close as possible to its insertion; a loop of Ethibond No. 2 suture is passed through this route and secured (**Fig. 5 A**). The MIS will act as a pulley for the rerouted semitendinosus tendon.

A third incision is made at the superomedial corner of the patella. A length of 1.5 – 2 cm provides more than adequate exposure. The overlying soft tissue is sharply dissected, exposing patella bone over a 1-cm wide area. Careful dissection between the deep and superficial layers of the medial patella retinaculum will lead to the MIS. A leader suture can be placed in this passage for tendon retrieval and passage.

A standard guide pin with threading eye is drilled from the superomedial border of the patella to the infero-lateral pole (▶ Fig. 5 F). It is vital to pass this pin half way between the anterior and posterior boundaries of the patella to ensure that the intended bony tunnel will not transgress the patella cortex as this may lead to patella fracture. Equally, the intended tunnel should not breach the patella articular cartilage for obvious reasons. Depending on the width of the prepared end of the ST tendon, a 5.5 – 6-mm Biotenodesis® drill (Arthrex Ltd., Sheffield, UK) is introduced over the guide pin to create a tunnel from superomedial to infero-lateral boundaries of the patella.

The next step is the passage of the ST graft (▶ Fig. 5 B – E): The first step is passage of ST graft in the plane between pes anserinus and MCL to arrive at the anterior margin of the insertion of the hamstring portion of adductor magnus. The ST graft then passed from posterior to anterior through the MIS taking care not to ensnare subcutaneous branches of the saphenous nerve using the Ethibond loop. The ST graft is then passed between the two layers of the medial patellar retinaculum towards the incision on the superomedial margin of the patella. Finally, the tendon is passed through the patellar tunnel using the guide pin and suture.

The free end of the tendon is pulled by the surgeon from the lateral tunnel exit and the knee is put through a full range of motion (10 – 15 circles) to reduce residual laxity at the MIS pulley. With minimal tension on the graft and the patella fully engaged in the trochlea at 60° of knee flexion, the graft is secured to the patella usually with a 5.5-mm Biotenodesis® (Arthrex Ltd., Sheffield, UK) screw.

Second look arthroscopy is performed at this stage to assess the position of the patella in the trochlea, as well as the integrity of the reconstructed MPFL (▶ Fig. 6). The incisions are closed with absorbable sutures and a hinge knee brace is applied with the knee in full extension. The knee is protected in the brace for 6 weeks and the patient is instructed to partial weight-bear except when the brace is locked in full extension. Continuous passive motion of the knee is initiated by the first postoperative date. Knee flexion is limited to 45° for the first 3 postoperative weeks, progressed to 90° over the next three weeks. A simple neoprene patella brace is applied for another 4 – 6 weeks to aid in scar quality and patella proprioception. Further rehabilitation under the supervision of a physiotherapist aims to return the patient to their pre-morbid level of activity 16 – 20 weeks after surgery.

Discussion

Nonanatomic reconstruction and lateral release

Many nonanatomical surgical techniques for the treatment of recurrent patellar dislocation have been described in the literature [1, 3, 5, 6, 8 – 10, 32, 33]. These procedures alter the pre-morbid patella mechanics by several principles, including the release of tight lateral ligaments, tensioning of loose medial structures and distal realignment of the extensor mechanism or a combination of these. Very few address the principle site of pathology in patella dislocation, i.e., the torn MPFL [2, 34, 43, 46]. The outcomes are inconsistent and many studies have reported recurrent dislocations and patellofemoral pain and arthritis in up to 40 % [9, 26, 27, 32]. Isolated lateral retinacular release with or without division of the vastus lateralis tendon relies on the uncontrolled lengthening of uninjured tissue on the lateral side of the patella to counteract the effects of a damaged medial patella retinaculum and can lead to re-dislocation rates of up to 40 % [3]. The potential for creating a multidirectional instability of the patella is significant [24, 25, 39] even though this complication was not reported in the 20 subjects of Woods et al. [54].

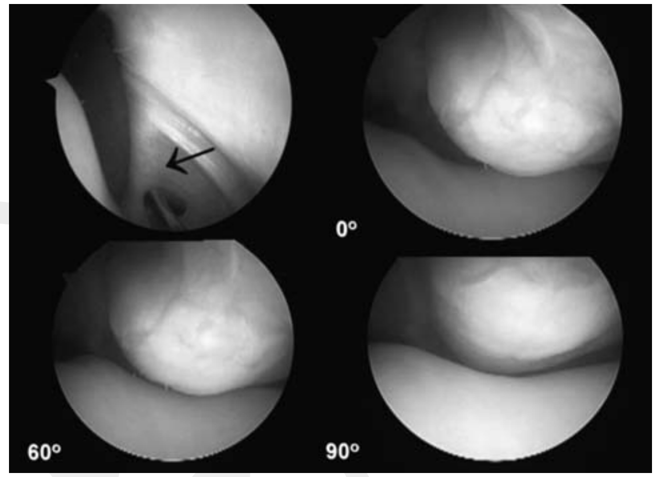

Fig. 6 Second look arthroscopy after the reconstruction showing the new MPFL ligament (black arrow) and centralisation of the patella through a 0 to 90 degrees range of motion.

Medial reefing advances the VMO aponeurosis but fails to address injuries to the MPFL closer to the adductor tubercle [2, 43]. Potentially there may be a role for distal or medial displacement of the tibial tuberosity for conditions such as patella alta. There is however a dearth of scientific reports on the results of tuberosity transfer procedures when used in isolation. Carney et al. [9] recently reported on the 26-year results of the Roux-Elmslie-Trilatt procedure in 14 patients. This is a “3 in 1” procedure involving a lateral release, medial plication and tuberosity transfer with presumably a variable contribution of each subsection of the operation to the final result. Although the re-dislocation rate remained unchanged, there was deterioration in knee function between the 3- and 26-year review.

Biomechanics of the MPFL

Several biomechanical studies have shown that MPFL is the main checkrein in preventing lateral patellar dislocation providing up to 60 % of the total medial restraining force [4, 17, 23, 35, 41, 47]. Nomura [35] et al. have shown that isolated sectioning of the MPFL greatly increases the lateral shift of the patella during 20° to 90° of knee flexion, even with the other medial patellar stabilisers intact. MPFL reconstruction, however, can restore almost normal patellar tracking during 20° to 120° of knee flexion [23, 44]. MRI studies and immediate surgical exploration in knees with acute patellar dislocation have proven MPFL injury in up to 100 % of the cases [2, 34, 43, 46, 48].

Anatomy of the MPFL

Most investigators agree that the MPFL is a band like structure that runs from the medial margin of the patella to the medial femoral epicondyle showing great variation in length, thickness and quality. Reider et al. [42] reported that the MPFL was present in only 7 (35 %) of 20 dissected knees, but in most of the recent studies the MPFL was isolated in all [17, 20, 37, 41, 47, 52] or more

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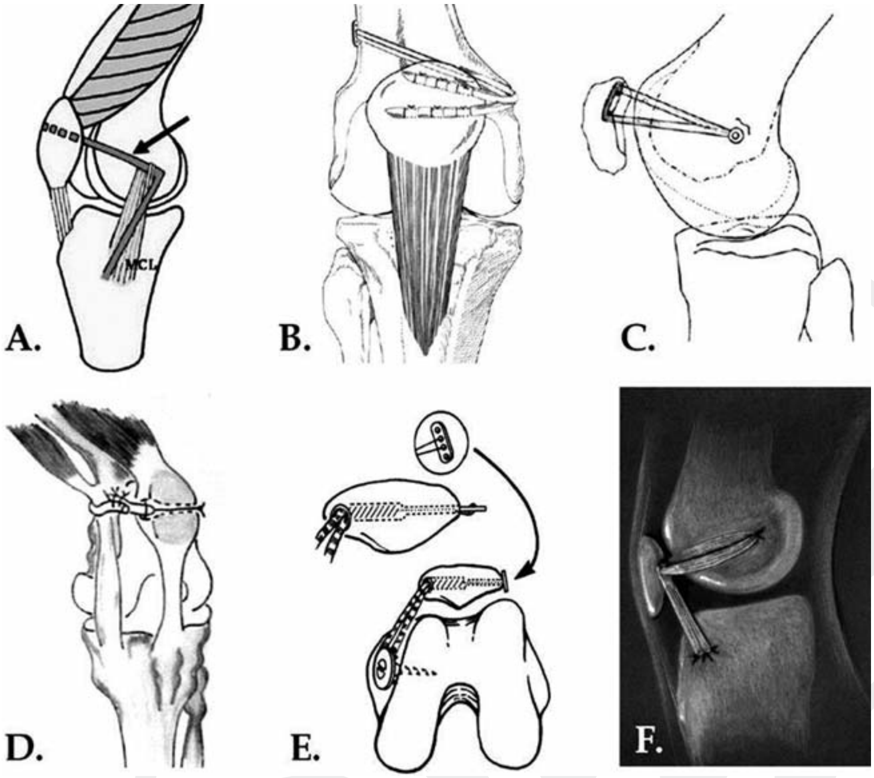

Fig. 7 A to **F** Current techniques of MPFL reconstruction using various types of semitendinosus autograft fixation according to: **A** Deie et al. [15, 16], **B** Mikashima et al. [30], **C** Schöttle et al. [46], **D** Ellera Gomes et al. [19], **E** Schock et al. [45] and **F** Drez et al. [18].

than 90% of the dissected knees [12]. There is disagreement on the ligament's femoral attachments. It is generally accepted that the lateral attachment of the MPFL is the superomedial portion of the patella, and the under-surface of vastus medialis muscle. It's femoral attachment, however, has been reported to be at the ME [4,17,23,41], at the AT [12,52], just distal to the AT [37], at the anterior part of the ME [20], at the posterior part of the ME [49], and at the MCL [15,16]. The range of these descriptions shows that the femoral attachment of MPFL is not a clearly identifiable feature, and probably the convergence of various structures and layers towards the ME makes it difficult to distinguish the MPFL origin. Nomura et al. [37] reported that the femoral attachment of MPFL is located just distal to the AT. Both Tuxøe et al. [52] and Smirk et al. [47] have reported that the femoral attachment is just distal to the AT and just proximal and more posterior to the ME.

MPFL reconstruction vs. repair

The recognition of MPFL as the main anatomic restraint for lateral patellar dislocation and the high failure rate of previously applied bony and soft tissue procedures led many surgeons to the immediate repair of medial patellar stabilisers after acute patellar dislocation [2,36] or to subsequent reconstruction of the MPFL in patients with recurrent patellar dislocations [13,15,16, 18,19,21,30,38,42,45,46,50]. Multiple techniques of MPFL reconstruction have been described in the literature, including advancement and plication of the ligament [21], reconstruction with a medial retinacular strip [13], quadriceps tendon graft [50], artificial mesh or polyester type ligament [36,38], and hamstring tendons (ST and/or gracilis) autografts [15,16,18,19, 30,45,46]. Steiner et al. aimed for an isometric reconstruction using a combination of adductor tendon, quadriceps-bone or bone-patellar tendon-bone in their cohort of patients with dysplasia [51]. The graft is usually placed at the superomedial border of the patella and is fixed with the knee in a flexed position that varies from 30° to 60° using heavy sutures, suture anchors, endobutton techniques and blinded-end or through out tunnels in the patella. The femoral fixation varies among authors and is accomplished with sutures, stitching of the folded tendon to itself, staples, screw and washer and interference screws.

MPFL reconstruction with hamstring autograft

To our knowledge, six techniques of MPFL reconstruction using hamstrings autograft have been described so far in the literature (**Fig. 7**). Drez et al. [18] has described a technique for reconstruction of both MPFL and MPTL (medial patellotibial ligament) in 19 patients using a folded ST/gracilis graft that is fixed to its centre portion in the patella with a bone anchor and the two limbs, which represent the two ligaments, were fixed at the AT (MPFL) and 1.5 cm distal to joint line in the tibia [MPTL]. Ellera Gomes et al. [19] reported a technique of MPFL reconstruction in 15 patients with patella instability. They passed the proximal end of a free ST graft through an osteoperiosteal tunnel under the adductor magnus at its distal femoral insertion and they folded the tendon over itself and fixed it with sutures. The other end was embedded in a 3.3-tunnel in the patella and fixed with sutures at the lateral retinaculum. Schöttle et al. [46] treated 12 patients with patella instability using a semitendinosus graft that was attached by two suture anchors at the superomedial border of the patella and a tendon to bone tunnel fixation by an interference screw at the adductor tubercle. Medialisation of the tibial tuberosity was additionally performed if the tuberosity-trochlear groove distance was more than 15 mm (8/12 patients). Shock et al. [45] has described a technique of MPFL reconstruction using a looped ST graft that is fixed with a washer just proximal to the MCL and with standard endobutton technique in the patella through a half blind-ended tunnel. The authors do not provide any information regarding clinical outcomes and rate of recurrence but they suggest that the procedure is indicated (1) in patients with recurrent lateral patellar dislocation and poor quality of the medial soft tissues, no definable MPFL and limited bony stability because of trochlear dysplasia, and (2) after failure of previous proximal- or proximal and distal-realignment procedures with ongoing medial laxity. Finally, Mikashima et al. [30] have recently reported on 24 patients with recurrent patella dislocation that underwent MPFL reconstruction using a ST graft that was fixed over a button on the femur and with two different techniques in the patella; either through a bone tunnel and then sutured to itself or directly sutured to the periosteal and fibrous tissue overlying the patella. Two patients sustained a patella fracture and one had persistent patella apprehension.

Most of the pre-mentioned techniques have shown acceptable results in the mean of subjective symptomatic improvement and low rate of recurrence in 85% to 93% of the involved cases. Despite preliminary success with MPFL reconstruction, no technique has been designed specifically to recreate the anatomy and the isometry of the native ligament. All the pre-mentioned techniques represent a "static" fixation of the MPFL ligament at the more recognised sites of its origin and insertion to the patella.

Deie et al. [15], in contrast had proposed a more "dynamic" technique of MPFL reconstruction for the treatment of habitual or recurrent dislocation of the patella in children (4 patients-6 knees, 2003) with the transfer of ST tendon to the patella using the posterior one-third of the femoral insertion of the MCL as a pulley. In 2005, the same authors [16] reported the midterm (minimum follow-up 5 years) results of their technique in 43 patients; the MPFL reconstruction was combined with lateral release and VMO advancement in 39 of them representing in fact a "3 to 1" procedure. Although the authors had no recurrence of dislocation after surgery, the lateral and medial shift ratio and the Insall-Salvati ratio remained abnormal.

Clinical relevance

During 2004 – 2005, 25 patients (19 men, 6 women; average age 26.9 years old) with posttraumatic patellar instability underwent MPFL reconstruction with the technique described above after a mean post-injury interval of 22.3 months. Clinical pre- and postoperative assessments included IKDC, Tegner, Lysholm and Kujala scores. ICRS documentation recorded the contribution of articular cartilage damage. At a mean follow-up period of 13 months, no cases of re-dislocation were recorded. The Tegner and IKDC scores averaged 4.2 and 46.9 pre-injury. Postoperatively they had improved to 7.7 and 86.5. The average postoperative Lyshom and Kujala scores were 87 and 89, respectively. One patient sustained a patella fracture; in our first 7 cases, we used a 7.5-mm blind-ended tunnel in the patella; after the modification of patella fixation, no cases of fracture have been recorded. These early results suggest that surgical reconstruction of the MPFL provides a favourable early outcome for the treatment of posttraumatic patellofemoral instability and will form the basis for longer follow-up in a larger cohort.

Conclusion

The reconstruction described by Deie and our own are the only anatomic and dynamic, if not isometric, reconstructions of the MPFL. We believe that MCL cannot play the role of pulley to the ST graft because of the orientation of its fibres parallel to the movement axis of the patella. In our own cadaveric study [40], the ST autograft split the MCL fibres during flexion and extension of the knee and MCL gradually became loose. However, our data showed that adductors tubercle represents a slightly less isometric point than the ME. Our modification of this technique utilises the MIS as pulley for the ST tendon. In support of the findings of Steiner et al. [51] and on the basis of current evidence, we do not believe there is a role for trochleoplasty or other bony and cartilage procedures even in the presence of dysplasia.

Our cadaveric study also confirmed the native MPFL to be a nonisometric structure. We therefore aim for a dynamic femoral fixation point close to the adductor tubercle that does not involve excessive soft tissue dissection or implantation or hardware at this prominent part of the femur that can lead to symptoms of it's own. By avoiding a static femoral fixation point and tensioning the graft at 60 – 90°, we hope to avoid any potential of overconstraint of the patellofemoral joint thereby making this reconstruction both safe and, from our preliminary data, effective. By not interfering with the pre-morbid anatomy, we hope to evaluate the results of reconstruction of the MPFL in isolation.

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