Surgical Technique

Medial patellofemoral ligament double-bundle reconstruction using a double L-shaped medial patellar tunnel

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Abstract: Patellar instability is a common clinical problem encountered in orthopaedics. Double-bundle medial patellofemoral ligament (MPFL) reconstruction has become the most popular technique in MPFL reconstructions. However, the optimal method for graft fixation onto the patella remains controversial. In this article, we propose a new technique for double-bundle MPFL reconstruction using a custom-designed instrument. By using a Swan sagittal aimer to drill sagittal tunnels, two L-shaped tunnels are created. Double-bundle reconstruction is then performed. This technique makes the procedure more controllable, while retaining characteristics of an anatomic double-bundle MPFL reconstruction. We believe the technique of MPFL double-bundle reconstruction using a double L-shaped medial patellar tunnel is a new approach that is able to achieve stable and satisfactory results.

Keywords: Patellar instability; medial patellofemoral ligament reconstruction (MPFL reconstruction); double-bundle reconstruction

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Introduction

Patellar instability is a common clinical problem encountered in orthopaedics. The medial patellofemoral ligament (MPFL) is the main passive stabilizer of the patellofemoral joint, providing about 50% to 60% of the resistance in lateral patellar subluxation (1,2). As such, it is invariably damaged during lateral patellar dislocation (3,4). MPFL reconstruction has become one of the standard treatments for stabilizing the patella after lateral dislocation. However, there are numerous variations with regards to graft choice, patellar fixation, femoral fixation, graft tension and the amount of knee flexion at the time of fixation (5-7). With further understanding of the MPFL anatomy, the double-bundle MPFL reconstruction has become the most popular technique of fixation on the patella as it best mimics the dynamics of the native MPFL. Most techniques describe graft fixation via one or two patellar bone tunnels (8-11). More recently, interference screws, suture anchors and docking fixation techniques have also been described with satisfactory results (3,12-14). However, the complication rate remains high regardless of the chosen technique (7). Complications include patellar fractures, ongoing knee pain and implant irritation. The optimal method for graft fixation onto the patella remains controversial. In this article, we propose a new technique for double-bundle MPFL reconstruction using a custom-designed instrument.

Surgical techniques

The proposed procedure can be performed under spinal or general anaesthesia. The patient should be placed supine with a thigh tourniquet. A diagnostic knee arthroscopy should be first performed where loose body removal or lateral retinacular release can be performed if necessary. A 4 cm longitudinal incision should then be made along the medial border of the proximal three-quarter length of the patella. The medial 10–15 mm of the patella should be exposed by subperiosteal dissection with a No.15 scalpel. The dissection should be extended medially and dorsally around the patella through the retinaculum and native MPFL, stopping after the transverse fibres of the native MPFL have been cut. The capsule should be left intact.

The location for the two coronal patella tunnels should be marked on the medial border of the patella about 2 mm proximal to the upper two quadrant lines (*Figure 1*). Using an 8 mm offset Coco coronal guider (*Figure 2A*), two 2 mm guide pins should be drilled transversely into the patella at the previously marked tunnel sites (*Figure 2B*). The coronal tunnel should be drilled over the guide pin to a depth of 12 mm with a 4 mm Cici cannulated depth-limiting drill bit (*Figure 3A,B*). A Swan sagittal aimer (*Figure 4A*) should be introduced into the coronal tunnels and two 4 mm diameter sagittal tunnels should then be drilled from the anterior patella cortex to intersect the coronal tunnels (*Figure 4B*). Two L-shaped tunnels should have now been created (*Figure 5*). The two whipstitched ends of a 22 cm long semitendinosus allograft should then be introduced via the anterior aperture and pulled out medially through the patella with the aid of a No.2 PDS suture (Johnson & Johnson) to form a tendon loop (*Figure 6*).

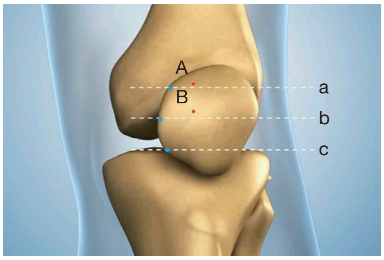

Figure 1 Schematic drawing of the position of the two coronal tunnel apertures. Lines a, b and c are quadrant lines. Point A and B are 2 mm proximal to the lines a and b, respectively.

With the knee in 30° of flexion, a 2 cm incision should be made from the medial femoral epicondyle to the adductor tubercle. A 2 mm guide pin should be placed at the ridge between the medial femoral epicondyle and adductor tubercle. An interval between the second layer (MPFL) and the third layer (capsule) should be developed using a long curvilinear clamp. The whipstitched tendon ends should be pulled through this interval and rolled onto the guide pin. An isometric test should be performed by taking the knee through a range of motion. Once the location of the guide pin is found to be acceptable, the guide pin should be drilled through to the lateral epicondyle of the femur (*Figure 7A*). A 30 mm long femoral tunnel should be created using a 7 mm

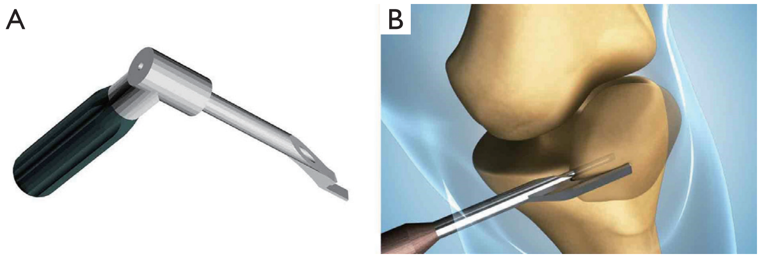

Figure 2 Coco coronal guider. (A) Schematic drawing of an 8 mm offset Coco coronal guider. (B) The Coco coronal guider rests against the medial cortex of the patella with its guide arm contacting the anterior cortex.

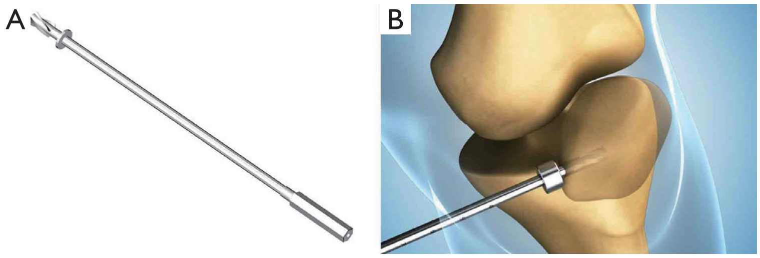

Figure 3 Drilling of the coronal tunnels. (A) Schematic drawing of a 4 mm Cici cannulated depth-limiting drill bit. (B) The drill bit drills over the guide pin to a depth of 12 mm.

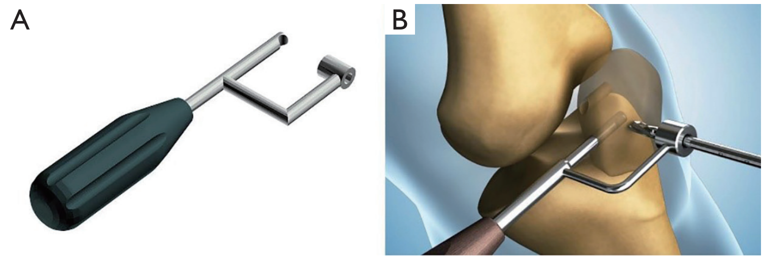

Figure 4 Drilling of the sagittal tunnels. (A) Schematic drawing of a Swan sagittal aimer. (B) Two 4 mm diameter sagittal tunnels are drilled from the anterior patella cortex to intersect the coronal tunnels.

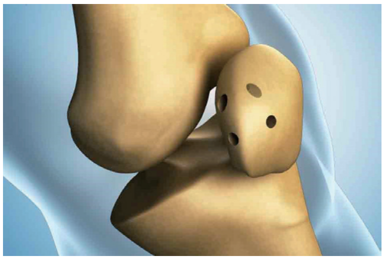

Figure 5 Two L-shaped tunnels are created on the medial side of the patella.

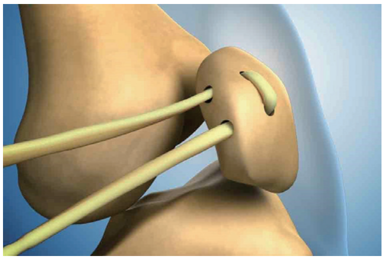

Figure 6 The two free ends of the allograft are inserted via the sagittal tunnels and pulled out medially, thereby forming a tendon loop around the patella.

diameter cannulated drill bit (*Figure 7B*). A 4.5 mm tunnel should then be drilled over the guide pin in its entirety (*Figure 7C*). Both whipstitched ends of the graft should then be passed into the femoral tunnel using a Beath pin (*Figure 8A*). While pulling tension on the braided sutures laterally, the patella should be able to be laterally displaced about 10 mm from the centre position. The allograft should then be fixed within the femoral tunnel with a 7 mm interference screw (*Figure 8B*). The native MPFL should be sutured to the graft and the medial retinaculum closed over the graft. The wounds should be closed in a standard fashion.

Discussion

In recent years, awareness of MPFL injuries has increased significantly. As a result, numerus laboratory and clinical studies have been conducted in order to better understand the MPFL anatomy and biomechanical characteristics. Studies have shown that the MPFLs attachment to the patella is fan-shaped, attaching from the superior patellar pole to the midpoint of the patella (15,16). Kang *et al.* (17) described a functional double-bundle concept that included an ascending superior-oblique bundle for dynamic stability and a horizontalis inferior-straight bundle that provides static strength. As such, a double-bundle MPFL reconstruction best recreates the original MPFL anatomy by providing both static and dynamic patella stability. Biomechanical studies have shown that double-bundle MPFL reconstructions can better recreate the anatomy of the native ligament by evenly distributing stress on the patella (18,19). Wang *et al.* (20) compared single and double-bundle MPFL reconstructions and concluded that the double-bundle technique was superior, especially in the long-term.

Numerous methods of fixation in double-bundle MPFL reconstructions have been described. Traditionally, tunnel-based techniques were believed to be superior. The transverse bone tunnel technique where the tendon passes medially to laterally within the bone tunnels, while the tendon loop sits laterally and the free ends medially, has been a well-established option for surgeons (9,21-23). Panni *et al.* (24) proposed a technique with diverging transpatellar tunnels to more closely mimic the course of the inferior-straight and superior-oblique bundles. All of these techniques describe the formation of a tendon loop around the patella, which means a much longer graft is required. As a result, the semitendinosus tendon is most commonly chosen in transpatellar fixations. Some researchers have proposed oblique bone tunnels to avoid the disadvantages

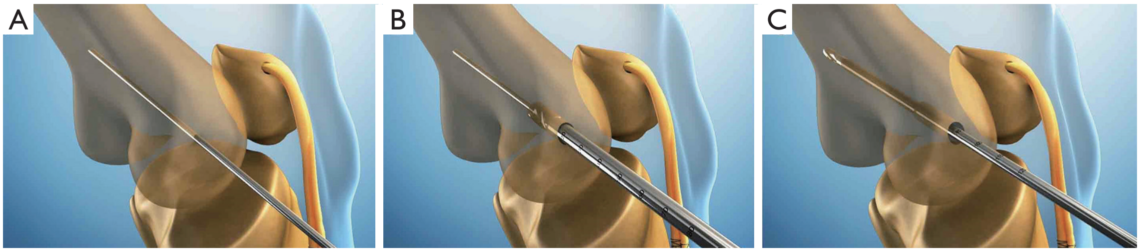

Figure 7 Drilling of the femoral tunnel. (A) A guide pin is drilled through the lateral femoral cortex at the ridge between the medial femoral epicondyle and adductor tubercle. (B) A 7 mm diameter tunnel is drilled over the guide pin to a depth of 30 mm. (C) A 4.5 mm tunnel is then drilled over the length of the guide pin.

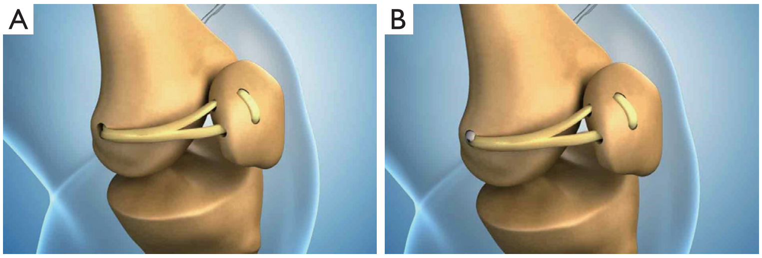

Figure 8 Allograft fixation. (A) The free ends of the allograft are passed through the femoral tunnel by a Beath pin. (B) The allograft is then fixed with a 7 mm interference screw at the femoral tunnel.

associated with long tunnels and the use of a gracilis tendon to reduce donor site morbidity (11,25,26). However, in practice, we found that creating bone tunnels that exited anteriorly without instrumentation required great surgical skill and risked chondral damage or patellar fracture. Other than oblique tunnels, Toritsuka *et al.* (27) advocated dual-tunnel MPFL reconstructions by fixing the sutures on the lateral side of the patella over the endo-button. This technique described using a 2.4 mm guide wire to make transverse transpatellar tunnels, and a 4.5 mm cannulated reamer to over-drill to a depth of 1 cm. Siebold *et al.* (28) proposed a similar technique that created a superficial longitudinal C-shaped bony sulcus at the insertion site of the MPFL and used transosseous sutures to complete the pass medially to laterally. As a result, bone loss is reduced, but this technique still requires two transpatellar bone tunnels which may increase the risk of patella fracture (29). A systematic review of complications associated with MPFL reconstructions concluded that transpatellar tunnels were associated with a higher risk of patella fracture (7). Parikh *et al.* (29) also suggested that avoiding bone tunnels that transverse the entire length of the patellar significantly decreases the risk of fracture. Furthermore, great care must be taken to avoid violating the anterior cortex or the chondral surface while preparing the tunnels.

To minimize the risk of patella fracture, several authors have used implants such as suture anchors for patellar fixation (14,20,30). Schöttle *et al.* (3) used a Swivel Lock (Arthrex) to achieve aperture fixation at the patella. Although clinical outcomes were satisfactory, the problems with implant irritation and a relatively higher rate of recurrent dislocation/subluxation and apprehension/hypermobility still remain (7). Tunnel fixation enables tendon-to-bone healing which can provide a much stronger attachment as compared to suture anchor fixation which can only provide contact healing. Biomechanical testing suggests that suture-anchor-based reconstructions are more likely to fail on the patella side, even soon after surgery (31).

In this article, we propose a novel technique that avoids the use of implants or complete transverse bone tunnels on the patellar side, while still retaining characteristics of an anatomic double-bundle MPFL reconstruction. Compared with a dual-tunnel reconstruction with aperture fixation (3), this technique avoids any possible implant irritation. In this technique, the contact area between the tendon and bone is also significantly higher, which is important for tendon-to-bone healing while not adding to the risk of patella fracture. The pulling-out strength on the patella was transferred onto the strong anterior cortex of the patella by forming a loop in the medial part of the patella. Wiesel had previously described a technique of making patella tunnels that exited anteriorly (32). However, none of these reports advocated a standard technique with corresponding instruments. In this article, we describe a modified technique with standard instruments to make the procedure more controllable. We believe this modification can achieve stable and satisfactory results.

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Footnote

Conflict of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/aoj.2019.11.02). LNS has a patent Instruments to make “L” shaped medial patellar tunnels in MPFL double bundle reconstruction issue. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient.

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