Soft-Tissue Loop for Medial Patellofemoral Ligament Reconstruction

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Abstract: A patient with patellar instability frequently presents with anterior knee pain, patellar subluxation, or dislocation. Medial patellofemoral ligament (MPFL) has a key role for normal patella tracking and stability. Reconstruction of the MPFL using a hamstring graft is a commonly used procedure for the treatment of chronic lateral subluxation of patella. Anchor sutures and bony tunnels are used for the patellar attachment of the graft. This can be associated with complications such as patella fracture; besides, it does not produce an anatomical reconstruction for the native MPFL that can alter the direction of tension applied on the patella. To overcome these problems, a soft-tissue loop technique is used for MPFL reconstruction. During this procedure, a semitendinosus graft was passed through the prepatellar extensor retinaculum and secured with sutures. The free ends of the graft were then passed between the second and third layers of the medial patellofemoral retinaculum and fixed to a femoral tunnel on the medial femoral condyle with an interference screw. The desired amount of tension on the graft is achieved under direct vision of patella tracking arthroscopically. We found this method to be relatively safe and fast. It is more anatomical and can avoid the complications during the conventional bony procedures.

Patella instability is common in young patients with more predilection in females. Patellar instability frequently presents with anterior knee pain, patellar subluxation, or dislocation during childhood or adolescence. Patellofemoral joint is a joint with complex biomechanics that enables transmission of tensile forces generated by the quadriceps to the patellar ligament, and hence increases the lever arm of the knee extension mechanism. The stability of patellofemoral joint is contributed by static (bony, e.g., femoral trochlea, femoral condyle, patella shape and position) and dynamic (soft tissue, e.g., ligament laxity and muscle conditions) components. Any abnormality in 1 or both of these components will cause patellar instability symptoms. The medial patellofemoral ligament (MPFL) is the primary medial restraining structure with 80% contribution against lateralization of the patella.1,2

Nonoperative management is still recommended after the primary patella dislocation. However, if the dislocation recurs, surgical intervention is indicated to restore the medial tether of the patella. Recurrent instability has been reported to occur in 15% to 44% of patients after the initial event with increased incidence on successive events.3 A deficient MPFL is a necessary lesion that can lead to lateral patellar instability and recurrent dislocations of the patella. Therefore, MPFL reconstruction has become an accepted method for treating recurrent patellofemoral instability in the setting of normal alignment and deficient proximal medial restraints.4 In general standard operative procedures, the reconstructed MPFL is aimed to support tendon tissue from the medial edge of the patella to the adductor tubercle of the medial femoral condyle. The fixation of grafts, which is ensured by different techniques with patella drill holes, is the most popular.

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Fig 1. (A) Diagram of the right knee. The red line is the site for the medial patellofemoral retinaculum incision 2 cm medial to the medial margin of the patella; the green line is where to stop dissection at the prepatellar extensor fascia. (B) Right knee medial paramedian vertical skin incision and the underlying medial retinaculum incision through the first and second layers but not the third layer of joint capsule. (C) The dissection continued between the second and third layers with lifting up the prepatellar extensor retinaculum together with the periosteum.
Fig 2. (A) Demonstration of weaving of the semitendinosus graft through the prepatellar retinaculum, for a right knee starting from medial to lateral, from inside to outside through the medial retinaculum incision. Weaving continued laterally with a U turn at the mid patellar width and returned medially in the same manner. (B) The weaving starts from inside out through the medial retinaculum incision at the upper quadrant of the patella, piercing the extensor retinaculum at the midline and then returning back medially to pierce the medial retinaculum outside in to come out through the medial retinaculum incision. (C) In a right knee, making an incision for the femoral tunnel placement on the medial femoral condyle. The incision is between the medial femoral epicondyle and the adductor tubercle.
method besides the anchor suture. However, it was reported that a transverse patella drilled hole may cause a patella fracture either intraoperatively or during postoperative rehabilitation. The fracture was attributed to the violation of the anterior patellar cortex that occurred intraoperatively during drilling of the patellar tunnel. On the articular side, cartilage injury during a drill hole surgery can result in chronic anterior knee pain during the follow-up of some patients. Avulsion fracture of the superior pole of the patella could occur in excessive dissection at the superior aspect of the patella. Soft-tissue reconstruction was developed to overcome drawbacks of the previously described techniques.

Herewith we describe our soft-tissue loop technique to reconstruct the MPFL.

**Surgical Technique**

The patient was positioned supine with the affected knee in 90° of flexion; a tourniquet was applied. After cleaning and draping, the semitendinosus tendon was harvested from the ipsilateral knee through a small incision over the pes anserinus area by using a closed loop tendon stripper (Smith and Nephew Endoscopy, Andover, MA). We prepared the tendon in the usual manner as in the cruciate ligament reconstruction. Both ends of the semitendinosus tendon were sutured with Ethibond 2 (Ethicon, Somerville, NJ). The graft size was identified and tension was applied at 10 pounds for 10 minutes.

Next, a diagnostic arthroscopy was performed to visualize the articular cartilage over both the medial and lateral facets of the patella. Osteochondral lesions can be associated with chronic instability of the patella and need to be addressed when found. The skin incision was made with 5-cm medial paramedian vertical incision with knee in flexion, and subcutaneous tissue was dissected to expose the prepatellar extensor retinaculum. The medial patellofemoral retinaculum was incised 2 cm from the medial edge of the patella in knee extension (Fig 1A). The medial retinaculum was incised through the first and second layers but stopped at the third layer just above the joint capsule (Fig 1B). From here dissection was continued between the second and third layers laterally until reaching the medial edge of the patella. Here we continued and lifted up the first and second layers together with the prepatellar extensor retinaculum and periosteum (Fig 1C). Dissection was ended at the mid patellar width.
Next, the free end of the prepared semitendinosus tendon was weaved in and out through the first and second layers using a curved tendon passer (TEKNO, Tuttlingen, Germany), starting from medial to lateral at the level of the superior quadrant of the patella (Video 1). The weaving was continued in and out through the prepatellar fascia and periosteum to the mid patellar width. After reaching at the mid patella, we made a “U” turn 90° down till the level of mid length of the patella and weaved back medially in the same manner (Fig 2 A and B). To prevent the graft from slippage, the tendon was sutured down to the prepatellar extensor retinaculum and periosteum at 4 corners geometrically using Ethibond 2 sutures (Ethicon) (Fig 3).

Another small incision was made over the femoral side of the MPFL. It was made between the medial femoral epicondyle and the adductor tubercle attachment of the MPFL. It was made between the second and third layers of the medial retinaculum from the medial retinaculum incision to the femoral tunnel incision. A guidewire was inserted 1 mm anterior to the posterior cortex extension line and 2.5 mm distal to the posterior origin of the medial femoral condyle in a lateral view. The tunnel size was determined by the size of the graft. Both free ends of the semitendinosus tendon were then shuttled through the second and third layers of the medial retinaculum toward the femoral tunnel (Fig 3B). Then, the graft was passed through the femoral tunnel with the aid of a guidewire. Under arthroscopic guidance, the amount of tension on the graft can be adjusted by direct vision of the patella tracking in the trochlear groove. A marker pen was used to mark the graft at the optimum amount of tension in the femoral tunnel. The graft was secured in position with a bioabsorbable interference screw (BIOSURE PK, Smith and Nephew Endoscopy). The screw size used was the same as the size of the femoral tunnel and was fixed in position with the knee in 20° of flexion. After surgery, the knee was kept on a functional brace with 0° to 30° of flexion. The patients were allowed for partial weight bearing with crutches. Physiotherapy and exercises of the knee started in 2 weeks after the removal of skin sutures. The brace was required to be removed in 6 weeks with full weight bearing (Table 1). We had an impressive result with this technique. There were no complications encountered during the surgery and all patients went back to the normal activity within 6 months after the MPFL reconstruction (Fig 4).

Discussion

There are many methods of MPFL reconstruction especially in the choice of fixation over patellar bone. The principle of treatment is to get back the stability of the patella and tracking well on the femoral trochlear groove during flexion. The advantage of this anatomical double-bundle reconstruction is that it replicates the native shape of the MPFL and also provides outstanding flexion and extension. This loop of reconstruction would also mimic the original level of MPFL attachment on the patella. It provides the starting point of vector of pull for the reconstructed MPFL nearer to the surface of the patella. It is different from the tunnel method that is in the centre of patellar thickness. The 4 corner stitches and the loop of the graft at the mid patellar extensor retinaculum will add a sufficient strength to the graft fixation on the patellar side. For the femoral side, we preferred to use a bony tunnel with interference screw fixation rather than using a soft-tissue repair as described by Pranjal. Using this technique will allow graft tensioning under direct observation of the patella tracking by the arthroscope, which can prevent the overconstrained problems of the graft. It is usually used

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<th>Table 1. Key Points of the Soft-Tissue Loop Surgical Technique</th>
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<td>1. Position the patient supine; use a lateral and heel supports to position the knee at 90° during the surgery.</td>
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<td>2. Perform a diagnostic arthroscopy to assess the patellofemoral tracking; any associated osteochondral lesions or loose bodies need to be addressed when found.</td>
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<td>3. Make the skin incision when the knee in flexion, whereas the medial retinaculum incision is made when the knee in the extension position.</td>
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<td>4. The medial retinaculum incision is through the first and second layers but not the third layer, just above the joint capsule. Identify the interval between these 2 layers and proceed with dissection laterally lifting up the prepatellar extensor retinaculum and periosteum until reaching the mid patellar width.</td>
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<td>5. Use the curved tendon passer for weaving of the graft through the prepatellar extensor retinaculum. Starting from inside out for the upper bundle and ending outside in for the lower bundle. Both ends of the graft should end within the medial retinaculum incision.</td>
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<td>6. Suture the graft to the prepatellar extensor retinaculum and periosteum at 4 corners geometrically.</td>
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<td>7. For the femoral attachment of the graft, make a small skin incision between the medial femoral epicondyle and the adductor tubercle while the knee in 90° of flexion. Use the image intensifier to identify the Schottle radiological landmark.</td>
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<td>8. The size of the tunnel is the same size of the 2-bundle graft.</td>
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<td>9. Make a blunt dissection between the second and third layers of the medial retinaculum from the medial retinaculum incision to the femoral tunnel incision.</td>
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<td>10. Use a shuttle suture to pass the free ends of the graft to the femoral tunnel.</td>
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<td>11. Under arthroscopic guidance, adjust the tension on the graft to the desired point by direct vision of the patella tracking in the trochlear groove. Mark the graft at the femoral tunnel inlet.</td>
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<td>12. Secure the graft in situ using a bioabsorbable interference screw at the same size of the tunnel and the knee in 20° of flexion.</td>
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Table 2. Pros and Cons of the Soft-Tissue Loop Technique

1. The soft-tissue loop technique is an anatomical double-bundle reconstruction of the MPFL. The 2 bundles of the graft will replicate the upper and lower borders of the native shape of the MPFL.
2. This loop of reconstruction would mimic the original level of MPFL attachment on the patella. It provides the starting point of vector of pull for the reconstructed MPFL nearer to the surface of the patella. It is different from the tunnel method that is in the centre of patellar thickness.
3. This method can avoid the complications arising from other bony procedures such as drilling patellar tunnels and anchor sutures.
4. The use of this technique will allow an optimal graft tensioning under direct arthroscopic observation of the patella tracking at the trochlear groove, which can prevent the overconstrained problems of the graft.
5. The soft-tissue loop reconstruction is less rigid compared with the all bony procedures, which is another reason to reduce the over-constraining of the patella at the medial femoral condyle.
6. It is a minimal invasive technique with 3 small incisions and less tissue dissection. It will preserve the integrity of the joint capsule and the normal anatomical structures of the knee.
7. The remnants of the native MPFL is not disturbed by the graft placement. So it can be used as an augmentation for the partially torn ligaments. This will preserve the proprioceptive feedback impulse to prevent farther patella dislocations.
8. Because of the minimal soft-tissue dissection, the patients are more compliant with the postoperative physiotherapy with early recovery and better outcome.
9. This technique can be used safely in skeletally immature patients by directing the tunnel anteroinferiorly.
10. The strength of repair is dependent on the weaving of the graft, the loop, and suturing of the graft to the prepatellar extensor retinaculum and periosteum. This will provide sufficient strength in the early postoperative stages, but the ultimate strength of repair will be gained after complete healing of the soft tissue.

MPFL, medial patellofemoral ligament.
in adult patients, but it is still feasible in immature skeleton by directing the tunnel anteroinferiorly to avoid the physeal plate (Table 2).

Isolated MPFL reconstruction surgery takes only less than 1 hour to perform and it is all about soft-tissue procedures. It can be performed as a minimal invasive technique with 3 small incisions. Bony structure and its integrity remain intact, and these can avoid any bony procedure complication that can cause a disaster like the fracture of the patella.

Conclusions

We found that this method is relatively safe, fast, and easy to perform compared with the other conventional bony procedures. It can avoid the fracture of the patella or cartilage injury during drilling of the patella. It can also be a first procedure to consider for lateral subluxation of the patella before proceeding to any other advanced soft-tissue and bony-salvage procedures.

References