CASE SERIES

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Arthroscopic Medial Patellofemoral Ligament Reconstruction with a Double Suspension Technique

Özgür Başal[1], Recep Dinçer[2]

[1]*Emsey Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Turkey*
[2]*Süleyman Demirel University Training and Research Hospital, Department of Orthopedics and Traumatology, Isparta, Turkey*

Abstract

Surgical treatment of recurrent patella dislocations is difficult, and combined techniques are required in most cases. To overcome this issue, we present the preliminary results of a novel alternative fixation technique for the medial patellofemoral ligament (MPFL) reconstruction with using a looped semitendinosus tendon autograft. Between January 2018 and January 2020, five cases with isolated MPFL injury were treated with a double-suspension technique. The double suspension technique describes the fixation of the semitendinosus autograft into the single femoral and patellar tunnels using the adjustable and fixed loop-button technique arthroscopically. Tips and tendon fixation with a double suspension technique are described here in cases applied with MPFL reconstruction using semitendinosus autograft with this technique. An evaluation was made of five patients with an average age of 25 (range 18-33) years, followed up for a mean of 16.8 months. There was a statistically significant improvement in all patient-reported outcomes from baseline to the final follow-up examination. In the clinical outcomes, the mean modified Lysholm knee score increased significantly from 48 preoperatively to 95.2 at the final follow-up examination ($p<0.001$). All cases returned to their daily activities and amateur sports in an average of 4 ± 0.2 (4-6) months. Anatomic MPFL reconstruction with a double-suspension technique provides biomechanical stability closest to the tensile strength of the natural MPFL. The reconstruction of this ligament forms the main leg of the treatment. Although several different methods have been described, failure and complications are seen as related to technique inadequacies.

Keywords: MPFL, recurrent patellar instability, suspension device, reconstruction, knee ligaments

INTRODUCTION

Patellar instability and recurrent patellar dislocation are common problems seen, particularly in the younger age group (1,2). This term defines pain, blockage, and clinical twisting due to the deterioration of the static and dynamic knee extensor mechanism. It is striking that of more than a hundred surgical techniques described in the literature, patella instability has been reported to be the second most common pathology (3,4). Nevertheless, a definitive, acceptable treatment protocol has not been adopted (1-4). It is reported that 15-44% of the acute dislocation cases, which are treated with conservative approaches, have recurrent patellar instability (1-4).

The medial patellofemoral ligament (MPFL), as a primary stabilizer of the patella, contributes 40-80% of the total medial restraining force (2,3,5). Although surgical techniques and treatment principles show differences, the basic rationale is to provide patellofemoral joint congruence. In patients where there is no MPFL integrity or if present it is loose, repair of this ligament does not generally give a successful result and there is a need for reconstruction. Other accompanying anatomic defects (malrotation, tight lateral retinaculum, shallow trochlear groove, etc.) are included in the treatment with additional procedures (2). Previous cadaver studies and experimental research have focused on two basic points (3,4). The first is that if the femoral attachment site is incorrectly planned, failure is inevitable. The

Address for Correspondence: Özgür Başal, Emsey Hospital, Clinic of Orthopedics and Traumatology, İstanbul, Turkey
Phone: +90 541 304 83 38 **E-mail:** basalozgur@gmail.com **ORCID ID:** orcid.org/0000-0001-5403-0043

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other point is which technique can be used in the fixation of the tendon graft on the femur and patella.

The femoral attachment of MPFL is supero-posterior to the medial femoral epicondyle and just distal to the adductor tubercle (4). The Schöttle point is 1 mm anterior to the posterior cortex extension line, 2.5 mm distal to the posterior origin of the medial femoral condyle, and proximal to the posterior point of the Blumensaat line on the lateral radiograph (2). It has been reported that the patella width is 55.8±5.8 mm, length is 34.3±3.8 mm and the thickness is 22.4±2.3 mm (6,7). The MPFL is attached to one-third of the upper part, i.e., the superomedial, of the patella. These landmarks must be well known for a successful anatomic reconstruction of the MPFL.

The fixation technique made to the femur and patella and the tendon graft tension are of great importance in clinical success. The double suspension device described in this paper is a technique that can be applied extremely easily and allows potential complications to be reduced to a minimum.

The fixation methods most preferred in MPFL reconstruction have been compared in the literature (3-5,8,9). According to biomechanical studies, the through-tunnel tendon graft method with femoral fixation at the lateral condyle has been reported to be the fixation closest to MPFL tensile strength (2,6,10). Although tensile tests have not been made biomechanically of the technique described in this paper, it is technically similar to the through-tunnel tendon graft method.

The aim of this study was to describe the double suspension technique for MPFL reconstruction with a looped semitendinosus tendon autograft using a double suspension device to secure the graft to the patella and the femur.

CASE PRESENTATION

Methods

Five patients who presented at our clinic with recurrent patellar instability due to an isolated MPFL injury were treated with this novel technique between January 2018 and January 2020. The average age at surgery was 25 years (range, 18 to 33 years). Of the patients, 3 were male and 2 were female. In addition to physical examination, all the patients diagnosed with MPFL injuries underwent magnetic resonance imaging (MRI). All patients had traumatic dislocation and instability (three contact sports injuries, one falling from a height, and one case suffering from a traffic accident). All the cases included in the study were isolated MPFL ruptures without any previous knee surgery. Patients with concomitant ligament injury, misalignment requiring osteotomy, and previous knee surgery were excluded, as were patients with neurological deficit. Informed consent was obtained from all the patients. All procedures were performed by a single senior surgeon. All cases were operated after a failed conservative treatment. Surgery was performed under a tourniquet with the patient in the supine position under spinal anesthesia. The operated knee was immobilized in a full extension brace, and crutches were used for 3 weeks postoperatively to protect the graft. All the patients were rehabilitated according to the defined program in the same rehabilitation unit. Range of motion exercises were started immediately after the removal of the drain with the aim of achieving 90° of knee flexion within 3 weeks. Partial weight-bearing was permitted after 3 weeks and gradually increased to full weight-bearing by the sixth postoperative week. Squatting was not allowed until 6 weeks, and sports activity was restricted for 4 to 6 months postoperatively. All cases were evaluated according to return to sports criteria by an independent physiotherapy specialist after a minimum of 4 months. Patients were asked for a follow-up at intervals of 2 or 3 weeks until the 12th week. At the final follow-up, Lysholm knee scoring was used to evaluate clinical outcomes.

Surgical Technique

The procedure is applied under tourniquet with the patient in a supine position. The arthroscopic knee was examined under spinal anesthesia and intra-articular pathologies were noted. The table height was adjusted to be able to obtain an image with C-arm fluoroscopy.

Graft Preparation

To obtain the semitendinosus tendon graft, a cut was made 2-3 cm from the center of the medial border of the tibia and the tibial tubercle and the sartorial fascia was palpated. After determination of the location of the tendons, the fascia was opened parallel to the tendon below the gracilis tendon. The thicker semitendinosus tendon was suspended by marking with no 2 high-strength non-absorbable suture (Ethicon, Somerville, NJ, USA), and was cut from the tibia attachment point. The obtained graft was cleaned with a tendon stripper. After passing into the fixed button suspension device, the tendon was folded in two and the proximal and distal ends were sutured together with the Krakow technique.

The thickness of the double layer tendon graft obtained was measured and recorded (generally 5-6.5 mm in diameter). The folded graft should be at least 9 cm in length and ≥5 mm in diameter. If the obtained graft is of insufficient diameter, a 4-leg tendon graft can be obtained by including the gracilis tendon. If

the graft thickness is ≥6.5 mm, it will be greater than the diameter of the patellar tunnel, and the tendon must be thinned, or two separate divergent patellar tunnels must be opened. It must be kept in mind that a tendon diameter thicker than 6.5 mm can cause iatrogenic patella fracture.

Fixation of the Tendon Graft

Entering the joint from the anteromedial and anterolateral portals, the MPFL patellar attachment site was checked. While the lateral retinaculum is routinely loosened in chronic cases, it can be protected in acute ruptures. Other intra-articular pathologies and the patellofemoral joint were evaluated. Under fluoroscopy guidance, a guidewire was placed for the patellar and femoral tunnels. When opening the patellar tunnel, the tunnel depth was determined by calculating the turning distance for the fixed-length system, and the distance planned for tendon placement in the tunnel was marked with a pen. Using the fixed-button CL Ultra (Smith & Nephew), the prepared tendon graft was fixed first to the patella (Figure 1). The site of the femoral tunnel marked with the guidewire under fluoroscopy was opened with a 1.5 cm cut. With a blunt end obturator, the tendon graft was advanced over the capsule from the medial patella towards the femur attachment site (over the joint capsule and below the medial retinaculum).

After preparation of the femoral tunnel to an appropriate diameter and depth, the tendon legs were advanced along the tunnel by mounting them on the buttons and threads of the elevator system. After placement in the adjustable loop and button system of the Liftlix Button Ti (Tulpar, Turkey), the suspension threads (Figures 2, 3) were tightened in the correct axis until appropriate tension was achieved. Tendon tension was adjusted by pulling the tightening threads while the knee was in 30° flexion. To avoid excessive tension, the tendon was checked by placing the round bone between the tendon and the lateral condyle in the elevator. After fixation, the femur trochlea was examined arthroscopically.

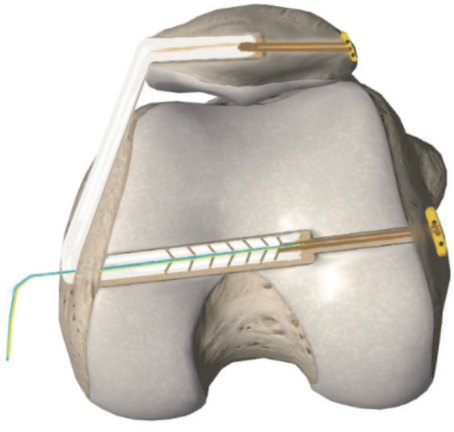

Figure 1. Illustration of double suspension technique

RESULTS

Three male and two female patients with an average age of 25 (range 18-33) were treated surgically after an acute knee injury. Time from injury to surgery was 7.6 weeks (range 6-10). Anatomic MPFL reconstruction with a double-suspension technique was achieved biomechanical stability closest to the tensile strength of the natural MPFL. The mean surgery time was 51 minutes (range 45-60). Clinical results were obtained in an average of 16.8 months (range 12 to 24) follow-up. Chondral damage was evaluated with MRI at the 6th month of surgery and graded according to the modified Outerbridge grading of chondromalacia. Of 5 patellae, three were graded II and two were graded as I according to the MRI. There was a statistically significant improvement in all patient-reported outcomes from baseline to the final follow-up examination. In the clinical outcomes, the mean modified Lysholm knee score increased significantly from 45.5 preoperatively to 95.2 at the final follow-up examination ($p<0.001$). A return to amateur sports at an average of 4±0.2 (4-6) months was achieved 100% (n=5) of the cases (Table 1).

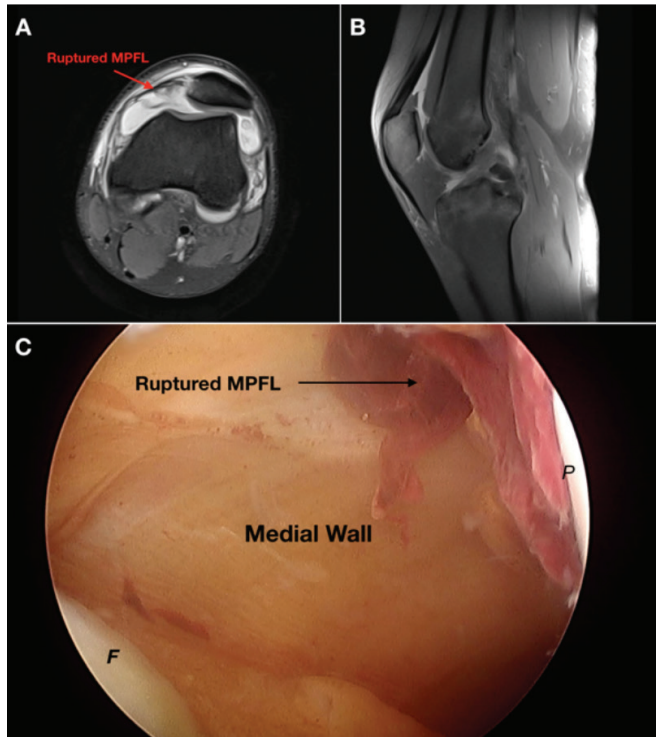

Figure 2. A) Axial MRI view of ruptured MPFL; B) Sagittal MRI view of injured knee and displaced patella; C) Arthroscopic view of ruptured MPFL and medial wall

F: Femur, P: Patella, MPFL: Medial patellofemoral ligament, MRI: Magnetic resonance imaging

DISCUSSION

Several techniques have been described for MPFL reconstruction. The major aim of all these techniques is to achieve a more anatomical reconstruction. Current fixation materials and the fixation methods used have been examined biomechanically in experimental models. According to tension tests, the graft resistance is highest when fixed along the tunnel. The results of clinical studies have shown that stabilization is provided with correct determination of the tendon attachment sites and tension that is neither too tight nor too loose. With the technique described in this paper, tendon tension is provided in a controlled manner. The elevator technique reduces to a minimum the possibility of tendon laxity or insufficient fixation.

The mean total length of the MPFL has been reported to be 58.8±4.7 mm, with a width of 12.0±3.1 mm and a thickness of 0.44±0.19 mm at the mid-point (4). The tensile force resistance of a natural MPFL is 208 N (10). The aim of MPFL reconstruction is to prevent this tensile force that causes dislocation. The methods most preferred for fixation of the tendon graft to the patella are anchor fixation, the docking technique, bone bridging, and transverse tunnel interference screw fixation. Of these techniques, the through-tunnel tendon graft method has been reported to have the closest tensile strength to that of the natural MPFL. Although the tunnel fixation technique with an interference screw seems to be superior in mechanical tests, the tendon is seen to slide back over the tendon. With the dual suspension method described in this paper, interference screw loosening is prevented and tension closest to the anatomy is provided.

Patellofemoral stability is a balance formed by dynamic and static structures working together. Failure in the first 30° of flexion of the knee occurs as instability. The femoral attachment point is of primary importance in providing a dynamic balance within this stability. The projection of this point in the coronal and sagittal planes should be identified with fluoroscopy (Table 2).

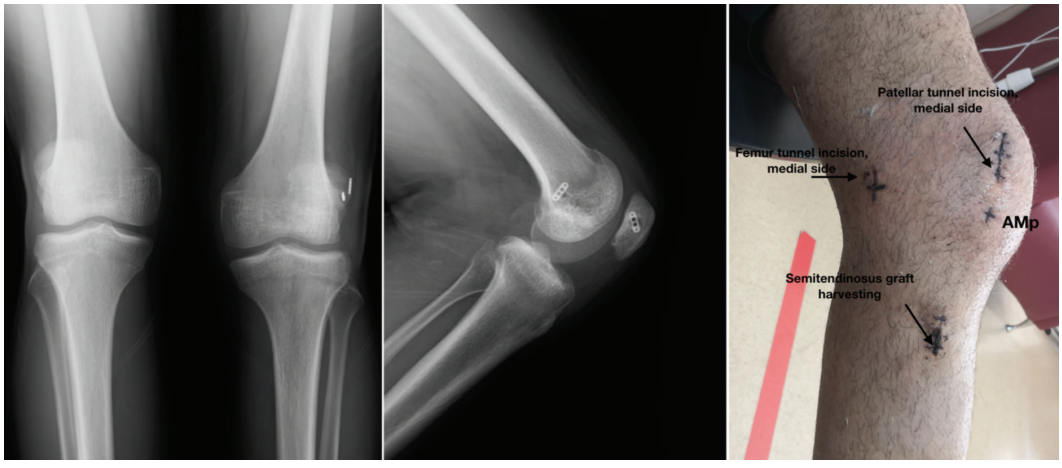

Figure 3. D. Postoperative X-ray image of suspension devices and tunnels, skin incisions of surgical technique from the medial aspect
AMp: Anteromedial portal

Table 1. Patient demographics, postoperative Lsyholm score, and subjective assessments

ID	Age	Gender	Side	Injury mechanism	TFIS (week)	Hospitalization	Duration of surgery (min)	Full recovery time (mo)	Follow-up (mo)	Lysholm knee score	Return to sports (mo)	Complication
1	22	M	L	Contact sports	6	4	45	3	12	96	4	Not
2	24	M	R	Fall from height	8	2	60	4	18	94	4	Not
3	28	F	R	Contact sports	8	2	45	3	24	94	6	Not
4	33	M	R	Contact sports	5	3	50	4	18	100	4	Joint effusion
5	18	F	L	Traffic accident	6	3	55	4	12	92	4	Not

M: Male, F: Female, R: Right, L: Left, TFIS: Time from injury to surgery, mo: Month

Table 2. Pearls of double suspension technique for MPFL reconstruction
1. If the tunnel opened in the patella is wider than 6.3 mm in diameter, the patella will not be resistant to axial loading on the patella. The tunnel length opened for the suspension button must be measured carefully and the tunnel depth appropriate to the tendon diameter must not be less than half the patella width (mean 20±4 mm). 2. The entry site of the guidewire to be placed for the femoral tunnel should be marked with fluoroscopy. 3. Excessive tension of the tendon graft must be avoided. A bone elevator should be inserted between the tendon graft and the lateral femur to avoid loading excessive tension on the tendon graft when pulling on the zip suture. 4. It is recommended that the length of the femoral tunnel prepared for the adjustable loop device is 5 mm longer than the length of the interference screw. 5. The graft tensioning and patellar tracking must be evaluated arthroscopically.
MPFL: Medial patellofemoral ligament

Complications such as chondral damage, arthrofibrosis, hemarthrosis, recurrent instability, and patella fracture may be seen after MPFL reconstruction. The selection of grafts is known not to have any effect on the development of complications. In this study, we preferred a semitendinosus autograft. The mean diameter of the semitendinosus tendon has been reported to be 6.29±0.61 mm in a non-sports group and 6.35±0.6 mm in a sports group (11). Over-tension or laxity in the graft and incorrect determination of the femoral fixation site are the primary reasons for complications. Therefore, to avoid potential complications, an appropriate tunnel diameter should be determined, the tunnel diameter should be expanded to a sufficient depth, and these should be confirmed with fluoroscopy.

Suspension systems are the most frequently used fixation methods in cruciate ligament reconstruction. The two different designs of adjustable loop and fixed length loop are usually used. In comparisons of these two techniques, fixation with the fixed-length device has been shown to be superior in mechanical tests (9). In adjustable suspension devices, suture slippage can occur as a result of over-loading. Prolongation of this suspension causes clinical laxity. Nakagawa et al. (12) described suspension devices in MPFL reconstruction. However, in the technique described in that study, a double tunnel was described for patellar fixation and no reference was made to the risk of loosening due to cyclic loading of the suspension system. In mechanical tests, adjustable length fixing devices experience a clinically significant increase in loop elongation during cyclic testing (9). This elongation can be partially adjusted with sutures, causing a shift in the length of the loop. The suspension loop technique applied for MPFL reconstruction in this study was applied as a fixed-length loop for the patella and as the adjustable loop technique for femoral fixation. The aim of this was to reduce to a minimum the loosening that can occur as a result of cyclic loading on the patella. Appropriate graft tension is provided with the adjustable suspension system benefiting from the femoral tunnel length in femur fixation. In addition to the adjustable loop device, to reduce to a minimum the sliding back of the tendon graft and loop loosening, fixation from the medial is strengthened with an interference screw.

Aperture fixation techniques (anchor suture, interference screw fixation, docking technique, etc.) are known to have insufficient tensile resistance strength compared to the transverse tunnel technique. However, there are no mechanical tests available as yet which compare the double tunnel and single tunnel techniques.

The advantages of the technique are that it allows the surgeon to easily adjust the tendon graft tension and there is no risk of suture slippage. However, there is a need for support of these results with clinical case series. Negative aspects of the technique are that mechanical tests have not yet been conducted and mid-term follow-up results have not yet been obtained.

CONCLUSION

Our preliminary results show that the double suspension technique is an easy and effective method for MPFL reconstruction. Anatomic MPFL reconstruction with double-suspension technique provides biomechanical stability closest to the tensile strength of the natural MPFL. This technique, which can be easily applied, can be recommended in the treatment of chronic or acute patellar instability.

Ethics

Informed Consent: An informed consent was obtained from all patients.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Ö.B., Concept: Ö.B., R.D., Design: Ö.B., R.D., Data Collection or Processing: Ö.B., Analysis or Interpretation: Ö.B., Literature Search: Ö.B., R.D., Writing: Ö.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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