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Novel techniques

A prospective randomized trial evaluating two different tensioning techniques for medial patellofemoral ligament reconstruction

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ABSTRACT

Background: In the literature, graft tension was mostly assessed under direct arthroscopy vision for a MPFL reconstruction. The purpose of this study was to prospectively assess the outcomes of MPFL reconstruction with graft tension of self-balance technique in comparison with arthroscopy-view technique.
Methods: Sixty patients with recurrent patellar dislocation were randomly divided into two groups to undergo MPFL reconstruction with graft tension either by the self-balance technique (SB group) or the arthroscopy-view technique (AV group). At a minimum of 24 months of follow up, patellar stability was evaluated with the apprehension test. Patellofemoral morphology was measured on an axial CT scan and knee function was evaluated using the Kujala and Lysholm scores.
Results: Twenty-three patients in the SB group and 25 patients in the AV group were followed for a minimum of 24 months. No recurrent dislocation or subluxation was reported. Apprehension signs remained in two patients in the SB group and in one patient in the AV group. The postoperative Kujala score for the SB group and AV group were 91.4 ± 5.1 and 90.3 ± 5.5, respectively, and the Lysholm score was 90.1 ± 6.4 and 88.4 ± 6.3, respectively, with no significant differences. On CT images, congruence angle, patellar tilt angle and lateral patellar angle were restored to the normal range.
Conclusions: At a minimum of 24 months of follow-up, graft tensioning using the self-balance technique yielded similar patellar stability and knee function compared with the arthroscopy-view procedure in the MPFL reconstruction. The self-balance technique as a simple procedure is recommended as a good alternative method for graft tensioning in the MPFL reconstruction.

1. Introduction

With the significant advances made in treatment methods for recurrent patellar dislocation over the past two decades, medial patellofemoral ligament (MPFL) reconstruction has become a popular procedure based on anatomical and biomechanical studies [1–3]. Besides the graft choice, proper tunnel position and different fixation techniques, appropriate graft tension is also one of the most important factors for a successful MPFL reconstruction [4]. Tightening the MPFL graft may create an overload of patellofemoral cartilage, restrict the range of motion and result in a postoperative loss of knee flexion [5,6]. With a loose reconstruction, in contrast, patellar instability can exist continuously, and patellar dislocation can even recur [5,7].

However, there is no optimal method of evaluating the graft tension during MPFL reconstruction; adjusting the intraoperative graft tension depends on the surgeon's subjectivity without an objective criterion. In the literature, the graft tension was mostly assessed by direct vision via the arthroscopy, and the patella was centered in the trochlear groove during the first 30° of flexion before the final graft fixation [8–10]. In our clinical practice, we found that graft tension could be self-balanced well during the range of extension–flexion movements of the knee without the direct arthroscopic view.

The purpose of this prospective randomized study was to assess the clinical outcomes of MPFL reconstruction with graft tension using the self-balance technique in comparison with the arthroscopy-view technique. The hypothesis was that the self-balance technique would yield similar clinical results in patellar stability and subjective knee function to the arthroscopy-view procedure.

2. Materials and methods

2.1. Study design and setting

This was a prospective randomized comparative trial. From March 2011 to July 2013, 60 patients with recurrent patellar dislocation who had experienced at least two episodes of patellar dislocation after at least three months of conservative treatment were randomly divided

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into two groups to undergo double-bundle MPFL reconstruction [1]. The patients were randomized using sealed envelopes. The graft tension was performed either with the self-balance technique (SB group) or the arthroscopy-view technique (AV group). All patients were subjected to the patellar apprehension test, with radiographs, CT and MRI scans. The patellar height was evaluated by the Insall–Salvati index on the lateral radiographs [11]. The tibial tuberosity to trochlear groove (TT-TG) distance was measured on CT scans [10].

The exclusion criteria were as follows: (1) previous surgery on the injured knee; (2) trochlear angle greater than 150°; (3) patella alta (Insall–Salvati index greater than 1.2); (4) patellofemoral chondral injuries of grade III or IV according to the Outerbridge classification; and (5) meniscal or tibial–femoral ligament injury requiring repair or reconstruction.

For patients with the TT-TG distance equal to or greater than 20 mm [12], the tibial tuberosity transfer was always performed before MPFL reconstruction in order to obtain a correct MPFL tension. These patients were also included in the current study.

All of the methods described were approved by the local ethics committee and all patients gave informed consent in the study.

2.2. Surgical technique

All surgeries were performed by the senior surgeon. The diagnosis of lateral patellar dislocation was confirmed under anesthesia. Arthroscopy was routinely performed to evaluate any intraarticular lesions and patellar tracking. Arthroscopic lateral release was performed for patients exhibiting tightness of lateral structures with a positive patellar tilt test under anesthesia [13]. The semitendinosus tendon autograft was harvested.

After making a three centimeter longitudinal incision along the proximal medial patellar border, the retinaculum and periosteum of the medial patellar rim were incised longitudinally and elevated off the bone. A superficial longitudinally bony sulcus at the proximal half of the medial patellar rim was created using a rongeur. Two metal suture anchors (Linvatec, Largo, FL) with a diameter of five millimeter, carrying two No. 2 Fiberwire sutures, were then seated close to the superomedial corner and the midpoint of the medial patellar border. The middle of the graft was placed in the bony sulcus with two limbs close to two anchors and fixed by tying two sutures from the inferior and superior suture anchors. The retinaculum and periosteum were sutured on top of the graft for additional fixation.

With a one centimeter incision above the MPFL femoral insertion, the MPFL femoral origin resided in the saddle between the adductor tubercle and medial epicondyle. A Beath pin was placed at this point and then drilled in a slightly anterior and superior direction to avoid posterior penetration of the femoral condyle. A seven millimeter reamer was used to drill a tunnel over the guide pin to a depth of 30 mm. Then a soft tissue tunnel was created by blunt dissection from the medial patellar border to the medial epicondyle, deep to the medial retinaculum but superficial to the synovium and the two free ends were passed through the soft tissue tunnel.

With appropriate length preserved, the two free ends of the graft were sutured with a whip-stitch technique using No. 2 non-resorbable suture of about 20 mm and pulled into the femoral tunnel tightly. The graft was tensioned and patellar tracking was monitored under arthroscopic direct vision via the anterolateral portal. When the patella was stabilized into the femoral groove at about 30° of knee flexion, the graft was then fixed with a 7 × 25 mm interference screw. Patellar stability and tracking were checked again throughout the range of knee motion, especially in early knee flexion angle.

For the self-balance technique, the two free ends of the graft were first pulled into the femoral tunnel tightly and then left to be free of any pulling force. Through several cycles of extension–flexion movement from knee extension to nearly 90° of knee flexion, the graft tension was maintained with the friction force between the femoral bone tunnel and the sutured ends of graft within the tunnel [14]. Then the graft was secured with a 7 × 25 mm interference screw at about 30° of knee flexion.

For a TT-TG distance equal to or greater than 20 mm, the tibial tuberosity transfer with the Elmslie–Trillat technique was added before the MPFL reconstruction for the correct alignment [15].

2.3. Postoperative rehabilitation

The rehabilitation protocol was the same in both groups. The quadriceps setting and straight leg raising exercises following the surgery were encouraged. Static partial weight bearing was permitted with a simple knee brace in extension. Range of motion exercise and walking with weight bearing on two crutches were also initiated from the second day after surgery and gradually progressed. Knee flexion of 90° was achieved at the fourth week and 120° was restricted at the sixth week. For the Elmslie–Trillat procedure, partial weight bearing was delayed to four weeks and full bearing was at eight weeks. Functional activities including walking, jogging and running were introduced at three months, and six months were needed for patients to return to normal sports activities.

2.4. Clinical evaluations

In the follow-up, the patellar stability was evaluated with the apprehension test divided into three groups as stability, subluxation and redislocation [16]. The stability was not with a positive apprehension test. The subluxation indicated the existence with a positive apprehension test and signs of subluxation but without a recurrence, while the redislocation was with a total loss of congruence of patella and trochlea. On the axial patellofemoral CT scans with 30° of knee flexion, congruence angle, patellar tilt angle and lateral patellar angle were measured according to the method described by Kujala et al. [17]. In addition, the Kujala and Lysholm scores were used for subjective knee function.

2.5. Statistical analysis

Before the investigation, the sample size was estimated using the Kujala scores as the primary variable. A power calculation was performed with a P-value of 0.05 ($\alpha = 0.05$), a power ($1 - \beta$) of 0.9, and an estimated difference of 10 between the groups. This yielded an estimated sample size of 23 patients per group. The statistical analysis was performed with SPSS 13.0 software (SPSS Inc., Chicago, Illinois). The Kolmogorov–Smirnov test was used to assess the normality of the variances. The t-test was for the parametric variances, and the Mann–Whitney U test and chi-square test were for non-parametric variances. Significance was set at $P \leq 0.05$.

3. Results

The consort flow diagram was followed as shown in Figure 1. Seven patients were excluded: four patients for having a trochlear angle greater than 150°, two patients for grade IV articular cartilage injury, one patient for previous surgery and five patients were lost in the follow-up. After a minimum of 24 months of follow-up, 23 patients in the SB group and 25 patients in the AV group were analyzed for the present study (Table 1). All the follow-ups were completed by the other senior surgeon.

During the MPFL reconstruction, combined surgeries such as lateral release and tibial tuberosity transfer were present, as shown in Table 2, without significant difference between the groups.

At final follow-up, no patients suffered from patellar redislocation or subluxation. Apprehension signs remained in three patients. Three patients demonstrated restricted knee flexion of less than 90° at three months postoperatively and regained a full range of motion after manipulation under anesthesia and physical therapy (Table 3).

Significant knee function improvement, as assessed by the Kujala and Lysholm scores, was recorded at follow-up, but there was no significant difference between the groups (Table 4).

The CT measurement results of the congruence angle, patellar tilt angle and lateral patellar angle were similar in both groups before operation. At final follow-up, these three angles returned to the normal range, without significant difference between the groups (Table 5).