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Results of anatomic gracilis MPFL reconstruction with precise tensioning

Olivier Carnesecchi [a,b,*], T. Neri [b], A. Di Iorio [b], F. Farizon [b], R. Philippot [a,b]

[a] Laboratory of Exercise Physiology (LPE EA 4338), Lyon University, Saint-Etienne, France
[b] Department of Orthopaedic Surgery, University Hospital Center of Saint-Etienne, France

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ABSTRACT

Background: The medial patellofemoral ligament (MPFL) is the most commonly injured structure in patients with objective patellar instability.
The objective of this study was to prospectively evaluate the clinical and radiographic results of MPFL reconstruction in 50 patients with chronic patellar instability.
Methods: Fifty patients with chronic patellar instability, aged 15–39 years, were included. The MPFL was reconstructed using a free gracilis autograft tendon. Two anchors were used for patellar fixation, and femoral fixation was achieved with an interference screw placed into a tunnel between the adductor tubercle and medial epicondyle. The graft was tensioned to 10 N with the knee in 30° flexion. IKDC and Kujala scores were assessed pre- and post-operatively. Patellar tilt was measured from CT scans with the quadriceps relaxed and contracted, both pre- and post-operatively.
Results: The follow-up period was 7 to 44 months (mean: 25 months, SD 10.3). The mean raw IKDC score increased from 51.5 preoperatively to 71.7 at last follow-up, the mean overall IKDC score increased from 38.5 to 61.7 and the Kujala score increased from 48.3 to 82.4. On CT scans, the mean patellar tilt went from 24° to 16.2° with the quadriceps relaxed and 27.7° to 18.1° in contraction. No recurrent dislocation was observed.
Conclusion: This technique of MPFL reconstruction provided significant improvements in IKDC and Kujala scores and significant reduction in patellar tilt. No recurrent dislocations were observed during the study period.
Level of evidence: Level IV

1. Introduction

Chronic patellar instability is defined by the existence of more than two episodes of true dislocation requiring manual reduction or one single episode of true dislocation followed by recurrent patellar subluxation episodes.

Besides the painful aspect of patellofemoral dislocation, cartilage damage can occur with every instability event thus predisposing patients to painful patellofemoral arthritis of the knee [1].

Conlan et al. [2] and Desio et al. [3] have studied the biomechanical behaviour of the medial patellofemoral ligament (MPFL) during knee flexion and demonstrated that this structure contributes 50 to 60% of the total restraining force of the medial patellar stabilizers.

According to Amis et al. [4], the MPFL maintains this tension throughout the initial 30° of knee flexion but with a small contribution beyond 90° of flexion as the patella is deeply engaged in the trochlear groove.

These studies have confirmed that the MPFL is the primary medial stabilizer of the patella during the first 30° of knee flexion, prior to the patella engaging in the trochlea. The MPFL restraining force then decreases gradually with knee flexion. The stabilizing action of the MPFL on the patella is determined by its favourable anisometry during the first 30° of knee flexion [4].

In a cadaveric study, Philippot et al. [5] showed that the favourable anisometry of the native MPFL depends on its femoral insertion, which is situated between the adductor tubercle and the medial epicondyle. In vitro studies [6] have confirmed the efficacy of MPFL reconstruction in the management of patellar instability when the patellar tilt angle is >20° on CT scan, associated or not with predisposing bone factors [7] such as patella alta or TT–TG (tibial tubercle–trochlear groove) distance > 20 mm.

Over the past few years, multiple techniques [8–19] have been described for the management of chronic patellar instability, including MPFL reconstruction, either as an isolated procedure, or combined with distal bone realignment. Several types of graft [3,8,10,11,13,19,20] and various graft fixation techniques [12,15,17] have been evaluated, but there is no scientific evidence to support one technique over another. Optimal graft tensioning is the most critical step in MPFL reconstruction as reported in the literature. In a recent cadaveric study, Philippot et al. [21] confirmed that 10 N of graft tension was

* Corresponding author at: Orthopaedic Surgery Department, Nord Hospital, 42270 Saint Priest en Jarez, France.
E-mail address: olivier.carnesecchi@gmail.com (O. Carnesecchi).

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considered optimal. This tension can significantly reduce patellar tilt and prevent hypercorrection and overconstrained graft on the medial patellofemoral compartment.

According to our hypothesis, anatomic MPFL reconstruction improves patellar stability and knee function thanks to a significant reduction in patellar tilt. Our main objective was to report the clinical and CT scan results of a prospective series of 50 MPFL reconstructions for patellar instability, respecting the biomechanical requirements of the native MPFL, with a minimum of six months follow-up for CT scan analysis and a mean 25 months follow-up for clinical evaluation.

2. Material and methods

The study was a prospective consecutive multi-operator study.

2.1. Population

All patiens who underwent MPFL reconstruction between January 2008 and January 2011 were included. The inclusion criteria were the following:

(1) Diagnosis of patellar instability, as evidenced by a history of two or more patellar dislocation events requiring manual reduction, or one single dislocation event followed by episodes of recurrent subluxation.
(2) CT scan demonstrating a lateral patellar tilt angle >20°.

Patients requiring tibial tubercle osteotomy were included.

Patients with symptomatic patellofemoral syndrome without a history of dislocation or instability were excluded.

A total of 50 MPFL reconstructions were performed. The mean age at surgery was 23 years (range, 15 to 39). Twenty-one males and 29 females were included.

Nine knees had already undergone patellar stabilization surgery: there were seven cases of tibial tubercle transfer, one medial retention plasty (retinaculum medial plication) and one vastus medialis myoplasty (Insall procedure).

2.2. Clinical evaluation

All patients were evaluated pre- and post-operatively using the International Knee Documentation Committee (IKDC) and Kujala scores [22]. In addition, all patients underwent a standard and comparative knee examination including testing for lateral patellar apprehension (Smillie test) and patellar hypermobility at 0° and 30° of knee flexion.

2.3. Radiographic evaluation

Radiographic evaluation was performed preoperatively and at six postoperative months, corresponding to the time of patellar stabilization.

Patellar height was assessed using the Caton–Deschamps index and trochlear dysplasia was classified according to Dejour et al. [23].

Radiographic measurement of patellar tilt was carried out using the Laurin and Merchant angles [24] and Maldague classification [25]. The Maldague classification was used to evaluate patellar tilt on a lateral view with the knee in extension. According to the amount of patellar tilt, three stages were described: 1 = absence of lateral patellar tilt, 2 = eccentric patella, and 3 = sub-dislocation of the patella.

Femoral tunnel positioning, which determines graft isometry, was also studied on a lateral radiograph using the landmark established by Schöttle [26] as a reference.

A CT scan analysis was also performed preoperatively and at six months to investigate the TT–TG distance and tilt of the patella with the quadriceps relaxed and contracted.

2.4. Statistical analysis

Statistical analysis was performed by means of the SPSS statistics® software, using Student's t-test. Significance was set at $p < 0.05$. A post-hoc power calculation of our primary outcome measurement was performed, and all inferential statistical tests were presented with 95% confidence intervals based on a non-normal distribution.

2.5. Surgical technique

Our technique aimed at achieving a favourable graft anisometry by positioning the femoral tunnel between the adductor tubercle and the medial epicondyle [5] and tensioning the graft at 10 Newtons (N).

Arthroscopy was performed only when osteochondral damage or an intra-articular loose body was suspected. The gracilis tendon was classically harvested and half-folded. A non-absorbable traction suture was placed on the loop portion of the graft. A seven millimeters diameter and 30 mm length blind femoral tunnel was positioned 10 mm distal to the adductor tubercle and 10 mm posterior to the medial femoral epicondyle according to the criteria described by Philippot et al. [5]. The traction suture was then passed through the eye of the passing pin for graft positioning into the femoral tunnel without fixation.

On the patellar side, the superficial retinaculum was incised and lifted for insertion of two patellar fixation anchors. The first anchor was positioned at the upper pole of the patella and the second one at the upper third/middle third junction. The two strands of the graft were passed under the superficial retinaculum in an extra-articular fashion and fixed to the two patellar anchors. A 10 N traction was applied to the graft at 30° of knee flexion by means of a dynamometer fixed to the traction suture. Fixation into the femoral tunnel was performed using a 7 mm × 20 mm bioabsorbable interference screw.

2.6. Postoperative rehabilitation

Immediate postoperative weight-bearing was allowed without requiring the use of a splint, and patients were discharged on the third postoperative day when a minimum of 90° of knee flexion could be achieved. During physical therapy and exercises, emphasis was directed towards restoring maximum flexion within the limits of pain. Patients were seen at 45 days to assess knee flexion. Return to sporting activities was allowed at four months. Repeat CT scans were obtained at six months postoperatively.

3. Results

3.1. Clinical results

Preoperative clinical examination was systematically conducted for subjective assessment of patellar instability with the patient's subjective sensation of instability and patellar apprehension sign. The mean follow-up of this study was 25 months (range, seven to 44). Only two patients underwent arthroscopy for excision of a chondral fragment. In these two cases, it was an avulsion of a chondral fragment from the lateral side of the femoral trochlea. As shown in Table 1, there was a significant improvement in the mean IKDC score, the overall IKDC score and the mean Kujala score ($p < 0.001$). The Smillie apprehension test was positive in 44 patients (88%) preoperatively versus 0 patients postoperatively ($p < 0.001$).

Lateral patellar hypermobility was found preoperatively in 40 cases (80%) with the knee in extension and in 28 cases with the knee flexed to 30° (56%). Postoperatively, there were five cases of residual hypermobility in extension and no cases in flexion. Postoperatively, four patients reported abnormal patellar tracking such as patellar

Table 1
Results of functional scores pre- and postoperatively.

Score	Pre-operative	Last follow-up	Difference	95% CI
Mean IKDC	51.5	71.7	+20.2*	28.15–12.27
Mean overall IKDC	38.5	61.7	+23.2*	31.16–15.28
Mean Kujala score	48.3	82.4	+34.1*	42.05–26.17

* $p < 0.05$.