MPFL reconstruction using a quadriceps tendon graft☆☆
Part 2: Operative technique and short term clinical results

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Abstract

Background: We describe the preliminary clinical results of a new operative technique for MPFL reconstruction using a strip of quadriceps tendon (QT).

Methods: Patients: 17 patients (7 male, 10 female; mean age 21.5 years ± 3.9) have been operated on with this technique. All patients were evaluated clinically, radiologically and with subjective questionnaires (Tegner-, Lysholm-, Kujala Score) pre-operatively and post-operatively at 6 and 12 months (m).

Surgical technique: A 10 to 12 mm wide, 3 mm thick and 8 to 10 cm long strip from the central aspect of quadriceps tendon is harvested subcutaneously. The tendon strip is then dissected distally on the patella, left attached, diverged 90° medially underneath the medial prepatellar tissue and fixed with 2 sutures. The graft is fixed in 20° of knee flexion with a bioabsorbable interference screw.

Results: Lysholm score at 6 m was 81.9 ± 11.7 and at 12 m 88.1 ± 10.9, Kujala score at 12 m was 89.2 ± 7.1 and Tegner Score was 4.9 ± 2.0 (6 m) and 5.0 ± 1.9 (12 m). Two patients had a positive apprehension test at 12 months. There was no re-dislocation during the follow-up period.

Conclusion: MPFL reconstruction with a strip of QT harvested in a minimal invasive technique was found to be associated with good short term clinical results. We think that this technique presents a valuable alternative to common hamstring techniques for primary MPFL reconstruction in children and adults, as well as for MPFL revision surgery.

Level of evidence: IV, prospective case series.

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1. Introduction

The Medial Patellofemoral Ligament (MPFL) represents the primary soft-tissue restraint to lateral patellar dislocation close to knee extension [1–5]. Rupture of the MPFL has been reported in 95 to 100% of patients with acute patellar dislocation [1,3,6–8]. Therefore, recently reconstruction of the MPFL for the treatment of patellar instability has captured more attention.

Several surgical techniques with promising clinical results have been described; most of them involve using hamstring tendons as the graft [9–19]. The majority of these techniques utilize bone tunnels and/or anchors for graft fixation on the patella [10,13,14,17–20]. Complications, however, such as implant breakage, patellar fractures through bone tunnels and loss of motion have also been described [5,21,22].

Anatomically, the MPFL is flat band-like structured. There are few reports on MPFL reconstruction using a strip of quadriceps tendon [23–26]. The gross morphological appearance of such a quadriceps tendon strip more closely resembles the natural MPFL than a hamstring construct. A human cadaveric study investigated the biomechanical characteristics of a 3 mm thick and 10 mm wide quadriceps tendon strip and found that they are similar to the natural MPFL, with respect to maximum load to failure, yield load and stiffness [27]. Despite these potential biomechanical advantages of QT MPFL reconstruction, the cosmetic appearance of longitudinal scars over the thigh as well as the technical difficulties harvesting a uniform 2–3 mm strip of the QT have most likely prevented a widespread use of these techniques.

The purpose of this study is to describe the short term results of a new minimally invasive MPFL reconstruction technique using the QT [28]. We hypothesized that MPFL reconstruction with a QT in a minimal invasive technique is feasible and leads to good clinical short term results.
2. Methods

All patients were evaluated clinically (ROM, apprehension test) and with subjective questionnaires (Tegner-, Lysholm Score) pre-operatively and post-operatively at 6 and 12 months. At the 12 month follow-up (FU) Kujala Score was added. Wilcoxon’s Matched-Pairs Test with 95% confidence intervals was used to compare pre-operative to 6 and 12 month results.

All patients were asked if they would undergo this operation again and if they were satisfied with their cosmetic outcome.

Radiological evaluation included MRI and AP and lateral radiographs pre-operative and AP and lateral radiographs at 12 months.

2.1. Surgical technique

Patients were positioned to allow free knee motion between 0° and 120°. The knee was draped to allow fluoroscopy during the procedure. In 90° of knee flexion a 2.5–3 cm transverse skin incision was placed over the superomedial pole of the patella. The prepatellar bursa was incised longitudinally and the quadriceps tendon then carefully exposed. A long Langenbeck retractor was introduced and the quadriceps tendon subcutaneously exposed proximal to the patella. A double knife of 10 or 12 mm (KARL STORZ, Tuttlingen, Germany) width was then introduced starting over the middle of the superior patella border and pushed up to a minimum of 8 cm (marked on the instrument). The thickness of the graft was then determined by a 3 mm tendon separator (KARL STORZ, Tuttlingen, Germany) proximal to the same mark (minimum 8 cm) (Fig. 1ab). Finally the tendon strip was cut subcutaneously by a special tendon cutter (KARL STORZ, Tuttlingen, Germany) (Fig. 2ab). The graft was left attached distally and the free proximal end anchored with a resorbable suture whip stitch. Distally the longitudinal cuts were continued with a surgical knife towards the patella and over the patellar surface in the chosen width (10 or 12 mm); lateral for 2 cm and medial for 1 cm, on the anterior surface of the patella. The quadriceps tendon strip was then subperiostally elevated from the surface of the patella. The proximal 1.5 cm of the medial patellar border was exposed. From the medial patellar border the prepatellar tissue was elevated laterally creating a tunnel reaching the medial edge of the graft. This was performed with a periosteal elevator. A surgical clamp was introduced into the tunnel from medial to lateral and the graft passed through the tunnel. The graft was then secured to the retinaculum tissue on the medial patellar edge by 2.0 resorbable sutures (Fig. 3ab). A 1.5 cm skin incision was then made over the adductor tubercle. Starting at the patella a curved clamp was used to create a tunnel in the space between the vastus medialis and the joint capsule. A suture loop was then pulled through the tunnel. This loop was used to pull the graft towards the femoral insertion. Under fluoroscopic guidance a 2.4 mm guide pin was drilled into the insertion of the MPFL and overreamed with a 6–8 × 28 mm bioabsorbable interference screw at 20° of knee flexion with the lateral patellar border flush with the lateral border of the trochlear groove.

2.2. Postoperative treatment

A knee brace with ROM 0–90° was used for 6 weeks during postoperative rehabilitation. The patients were mobilized with 20 kg partial weight bearing for 3 weeks. Full weight bearing was started thereafter. Passive ROM exercises to a maximum of 90° were initiated immediately postoperative. Stationary cycling was started 6 weeks postop. Full return to pivoting sports was allowed between 4 and 5 months after the operation.

Fig. 1. A tendon separator (2 or 3 mm) (KARL STORZ, Tuttlingen, Germany) is introduced and advanced proximally to approx. 8 cm. (a. operative procedure; b. cadaveric preparation).

Fig. 2. The tendon strip is cut at the desired length (8–10 cm) using a tendon cutter (KARL STORZ, Tuttlingen, Germany) (a. operative procedure; b. cadaveric preparation).
2.3. Patients

Only patients with more than two patellar dislocations, a TT–TG < 20 mm [19], patellofemoral chondromalacia > ICRS grade IIIB [29] and closed growth plates were included in the study.

In a consecutive case series 17 patients (seven male, 10 female; mean age 21.5 years ± 3.9; BMI 22.6 ± 3.9) have been operated on by two surgeons with isolated MPFL reconstruction using QT between March 2011 and November 2012.

3. Results

The mean TT–TG measured on MRI [32] was 12.7 mm ± 3.2 (9.2 to 17 mm). Eight patients (47.0%) had two, seven patients (41.2%) had three and two (11.8%) patients four dislocations prior to surgery.

Three patients (17.6%) had chondromalacia grade IIIA on the medial aspect of the patella, six patients (35.3%) had grade II, and eight patients (47.1%) had normal cartilage by arthroscopic appearance. Seven patients (41.2%) had a normal trochlea and nine patients (52.9%) had trochlear dysplasia Type A and one patient (5.9%) Type B according to Dejour [33].

All patients had equal side to side knee motion (one female patient was considered hypermobile with bilateral knee hyperextension of 15°, none of the other patients presented knee hyperextension greater than 5°). All patients presented a positive apprehension test on the injured side.

Average operating time (including arthroscopy) was 46 min ± 12 min. There were no post-operative complications in this series.

At 6 months post-operative four patients (23.5%) and at 12 months two patients (11.8%) had a positive apprehension test. At 6 months FU six patients (35.3%) had a knee flexion deficit of 10° compared to the opposite knee. At 12 months all but one patient (flexion deficit of 10°) (94.1%) had equal side to side knee motion.

Lysholm score improved significantly (p < 0.05) from pre-operative to 6 months and also significantly (p < 0.05) between 6 and 12 months FU. The changes in Tegner score were not significant (p > 0.05) over time (Table 1).

Kujala score at 12 months was 89.2 ± 7.1. During the 12 month follow-up period none of the patients had a re-dislocation.

Table 1

<table>
<thead>
<tr>
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<th>Pre-operative</th>
<th>6 months</th>
<th>12 months</th>
</tr>
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<tbody>
<tr>
<td>Lysholm Score</td>
<td>69.5 ± 10.3</td>
<td>81.9 ± 11.7</td>
<td>88.1 ± 10.9</td>
</tr>
<tr>
<td>Tegner Score</td>
<td>4.8 ± 2.4</td>
<td>4.9 ± 2.0</td>
<td>5.0 ± 1.9</td>
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4. Discussion

MPFL reconstruction using a strip of QT harvested subcutaneously in the described technique has been found feasible and to be associated with good short term clinical and cosmetic results.

There are only few previous reports on MPFL reconstruction using a strip of quadriceps tendon without anchors or bone tunnels in the patella [23,24,26,34]. In these techniques an approximately 6 cm to 8 cm longitudinal incision from the superior pole of the patellar extending proximally is used. While Noyes and Albright [34] harvest an 8 × 70 mm full thickness graft from the medial aspect of the QT leaving it attached at the superomedial border of the patella, Steensen et al. [26] and Goyal [23] dissect a partial thickness graft of 10 to 12 mm in width from the central part of the QT. The tendon strip is diverged 90° medially over the prepatellar tissue and fixed on the medial femoral condyle with transosseous sutures [26], titanium interference screws [23] or pulled through a puncture hole in the medial retinaculum distal to the insertion of the VMO and superficial to the distal aspect of the medial epicondyle, folded over on itself and sutured to the medial intermuscular septum and the medial retinaculum [34].

In the technique of Steensen et al. [26] and Goyal [23] the location of the attachment of the QT strip is in the midpatellar area anterior instead of the preferred medial border of the patella.

Therefore, we have adapted the technique of Macura and Veselko [24] who are undermining the tissue on the medial aspect of the patella and diverging the QT strip 90° underneath it instead of simply diverting it superficially [28]. This results not only in an insertion site on the medial aspect of the patella (the graft is fixed with two sutures at the original MPFL insertion), but may also improve graft to bone healing. Careful dissection has to be used not to peel off the QT strip from the bony patellar surface. This did not happen in our series but has been experienced in our early anatomical dissections. In this case bone anchors may be used to fix the QT strip to the medial aspect of the patella (free QT graft) or if the graft is long enough it can be looped through the prepatellar tissue and sutured on to itself.

The technique of Noyes and Albright [34] is by definition not an MPFL reconstruction, but a reinforcement of the medial retinaculum with a QT graft.

Up to now, hamstring grafts are far more common for MPFL reconstruction than quadriceps tendon techniques. These procedures
document a high rate of success for the patients with patellofemoral instability [9,18,35]. Clinically, the Kujala scores improved from 49.7 ± 9.7 to 90.8 ± 3.7 and Lysholm scores from 57.7 ± 9.7 to 89.8 ± 3.1 at an average FU of 4.7 ± 2.8. These results are comparable to our findings, however with much shorter follow-up.

Still, there are failures of these procedures. Patellofemoral pathology is extremely complex and only few of its aspects can be solved by MPFL reconstruction. We had two patients with persisting apprehension test and one patient who would not undergo this operation again.

On the other hand, there are complications which are associated with the MPFL reconstruction itself. Recently, Shah et al. [5] in a systematic review on MPFL reconstruction (all except one paper in this review used hamstring grafts) documented an overall complication rate of 26.1% (164 complications in 26.1% of knees). In this series 22 knees had residual flexion loss of which nine underwent manipulation under anesthesia. Most likely there are two major reasons attributed to this problem: 1. Incorrect placement of the femoral insertion may result not only in patellofemoral hyperpressure but also eventually in loss of flexion [21,22,36] and 2. Higher stiffness of the reconstruction compared to the natural MPFL. In a biomechanical study of Lenschow et al. [37] it was found that the stiffness of hamstring constructs is about 3 × higher compared to the native MPFL whereas the stiffness of a QT construct is similar to the native MPFL [27].

Four patients in the systematic review of MPFL failures [5] sustained a patellar fracture through transpatellar bone tunnels. All the previously described QT techniques [24,26,34] as well as our technique avoid implants or bone tunnels in the patella. This makes QT also an ideal transplant for revision MPFL surgery, where preexisting tunnels or hardware are present in the patella. Weidner et al. [38] presented a case of MPFL reconstruction following patellar instability after total knee replacement. In order to avoid implants or bone tunnels which might have interfered with a resurfaced patella the authors used our described technique with good clinical outcome.

Our study has several limitations. The most obvious are the low number of cases and the short term of follow-up. All our patients are followed up prospectively and longer term follow-up will be presented in the future.

MPFL reconstruction with a strip of QT harvested in a minimal invasive technique was found to be associated with good short term clinical results. We think that this technique presents a valuable alternative to common hamstring techniques for primary MPFL reconstruction in children and adults, as well as for MPFL revision surgery.

Conflict of interest statement

Two of the authors are consultant for Karl Storz. Additionally, one receives product royalties from Karl Storz.

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References


Fig. 4. Cosmetic appearance of scars following minimal invasive QT harvest.


