Reconstruction of the Medial Patellofemoral Ligament With Gracilis Tendon Autograft in Transverse Patellar Drill Holes

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Purpose: We present clinical results in a case series of 44 patients with medial patellofemoral ligament (MPFL) reconstruction with 12 to 32 months’ follow-up. Methods: Reconstruction was performed via gracilis tendon autograft looped through 2 transverse 4.5-mm drill holes in the patella and fixed at the natural MPFL insertion site on the medial femoral condyle with an interference screw. At follow-up, Kujala scores, Knee Injury and Osteoarthritis Outcome Scores, objective knee function, complications, and reoperations were assessed. Results: Only 1 patella redislocation was observed. Subluxation occurred in 3 patients, whereas 4 patients had chronic pain at follow-up, all of whom had cartilage injury at surgery. The Kujala knee function score improved overall from 46 points (range, 12 to 67 points) to 84 points (range, 62 to 100 points) at follow-up. Conclusions: MPFL reconstruction with double transverse patella drill holes and a gracilis tendon graft provides good postoperative patellar stability. Postoperative pain seems to be related to the degree of patellofemoral injury found at surgery. Level of Evidence: Level IV, therapeutic case series. Key Words: Medial patellofemoral ligament—Patellar instability—Ligament reconstruction.

Surgical treatments of patellar instability have been numerous and the clinical results variable.1,2 Recently, reconstruction of the medial patellofemoral ligament (MPFL) has been advocated as a surgical treatment for chronic patellar instability. Among the medial ligamentous retinacular structures (superficial medial patellar retinaculum, MPFL, and medial patellotibial and patellomeniscal ligaments), the MPFL is the primary medial restraining structure against lateralization of the patella and contributes up to 80% of the medial restraining forces to the patella.3,4 Biomechanical studies have found that the limited ability of the MPFL to elongate results in total rupture of the ligament in cases of full patellar dislocation.5 In addition, the healing capacity of the MPFL is often insufficient, which leads to increased medial laxity of the patellar retinacular structures.6,7

The aim of the MPFL reconstruction is to restore the medial tether of the patella. Numerous different techniques for MPFL reconstruction have been described. All techniques aim to supply tendon tissue from the medial aspect of the patella to the insertion site of the natural MPFL at the adductor tubercle of the medial femoral condyle to reconstruct the ligament. The described tendon sources are numerous: semitendinosus, gracilis, partial quadriceps, partial patella tendon, partial semimembranosus, vastus medialis retinaculum, and allografts or artificial tendons.8-20 The fixation of grafts is ensured by different techniques, such as patellar drill holes, sutures, suture anchors, and interference screws or staples at the femoral condyle. In general, the clinical results of MPFL reconstruction were successful in the previously mentioned studies. The procedure leads to good patellar stability, with rates of redislocation of only 0% to 10% (Table 1).

We describe the clinical results of a prospective
case series of 44 patients treated with MPFL reconstruction for chronic patellar instability via a surgical technique with gracilis tendon autograft fixed in patellar drill holes with an interference screw in the femoral condyle. The rationale for the transpatellar drill hole technique is to obtain an optimal graft fixation in the patella. We hypothesize that results are comparable to previously published data in studies with MPFL reconstruction.

**METHODS**

**Patients**

This study included 44 patients who were consecutively operated on. Patients underwent surgery from May 2003 to December 2005. Mean follow-up was 22 months (range, 12 to 32 months), and 45% of the patients had 2 years of follow-up or more. The patients’ median age was 22 years (range, 12 to 47 years). There were 15 male and 29 female patients. All patients had chronic patellar instability with a minimum of 2 total patellar dislocations. The median period of preoperative patellar instability was 7 years (range, 1 to 20 years). Eighteen patients had 1 previous patellar procedure, and eight had 2 previous procedures. These procedures were medial tibial tuberosity transfers, medial plication, lateral release, and MPFL reinsertion.

**Evaluation**

All patients with a minimum 1-year follow-up were seen for follow-up again in the fall of 2006. The median follow-up was 22 months, with a range from 12 to 36 months. Patients were evaluated by preoperative and follow-up Kujala scores. At follow-up, a subjective Knee Injury and Osteoarthritis Outcome Score (KOOS) profile was obtained. Clinical data included incidence of recurrent subluxation or dislocation. Any complications and reoperations were registered. The following objective measures were recorded at follow-up: pain along MPFL reconstruction, abnormal patellar movement, lateral patellar apprehension, range of motion, and muscle status. Persistent chronic pain was defined as a pain score of 0 or 3 in the pain subscale of the Kujala score.

**Surgical Technique**

The gracilis tendon is harvested through a 2- to 3-cm incision over the pes anserinus. The anserinus bursa is opened, and the gracilis tendon is exposed and released with a tendon stripper. The gracilis tendon was used to minimize the effect on hamstring function and to have a tendon that could easily pass through the patellar drill holes. The tendon is fitted with No. 0 FiberWire nonabsorbable suture baseball stitches (Arthrex, Naples, FL) in each end. Then 2 incisions are made transversely on the medial and lateral aspects of the patella at the proximal one-third line. A small 1-cm incision on the lateral side and a 4- to 5-cm incision on the medial side are made from the medial patellar edge to the medial femoral epicondyle. Two transverse 4.5-mm drill holes are made through the patella over initially placed guidewires. The holes are placed in the proximal two thirds of the patella, 10 to 15 mm apart (Fig 1). Care is taken not to violate the chondral surface or the anterior cortex. Then the adductor tubercle is exposed and identified at the medial femoral condyle. The natural MPFL insertion point is just distal to the tubercle.

A K-wire is inserted at that point, and an isometry test is performed with looped No. 0 Vicryl sutures (Ethicon, Somerville, NJ) from the K-wire through the 2 patellar holes to test isometry through the motion arc. Excessive tension at flexion should be avoided and can be resolved by a slightly more distal placement of the condyle K-wire. When proper K-wire placement is achieved, a 7-mm drill hole is made at the femoral condyle.

The gracilis tendon is then passed through the patellar holes in a looped fashion (Fig 1). On the medial side, the free ends off the tendon are passed under the fascia to the femoral drill hole. The proximal tendon is

<table>
<thead>
<tr>
<th>Study</th>
<th>Graft</th>
<th>N</th>
<th>Follow-up</th>
<th>Redislocation</th>
<th>Kujala Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deie et al.17 (2005)</td>
<td>Semitendinosus transfer</td>
<td>39</td>
<td>5 yr</td>
<td>0%</td>
<td>92</td>
</tr>
<tr>
<td>Schöttle et al.15 (2005)</td>
<td>Semitendinosus autograft</td>
<td>15</td>
<td>4 yr</td>
<td>1/15</td>
<td>87</td>
</tr>
<tr>
<td>Steiner et al.16 (2006)</td>
<td>Adductor tendon autograft</td>
<td>34</td>
<td>2-10 yr</td>
<td>0%</td>
<td>90</td>
</tr>
<tr>
<td>Drez et al.12 (2001)</td>
<td>Various grafts</td>
<td>19</td>
<td>32 mo</td>
<td>1/19</td>
<td>88</td>
</tr>
</tbody>
</table>
passed through the vastus medialis aponeurosis midway toward the medial epicondyles to ensure optimized vastus medialis oblique muscle action. Both tendon ends are tightened into the femoral drill hole via a Beath pin pullout technique. The tension of the reconstruction is tested through the arc of motion, and the tendons are fixed in the femoral condyle with a bioresorbable interference screw. The tendons are tensioned at 45° of flexion so that the patella still can be lateralized manually 10 mm. It is important not to overconstrain the reconstruction, thereby creating chondral overload in flexion.

We supported the MPFL procedure with a medial tibial tuberosity transfer in patients who had significant trochlear dysplasia. A completely flattened trochlea (Dejour type B) or an absent or severely dysplastic medial femoral condyle (Dejour type C) indicated a medial tibial tuberosity transfer in our study. Radiographically, we used a sulcus angle greater than 160° as a sign of Dejour type B or C. In addition, pathologic Q-angles of more than 15° for male patients and more than 20° for female patients indicated tiberosity transfer. Q-angle was assessed with the lateral patellar edge aligned with the lateral femoral condyle. Tibial tuberosity transfer was always performed before MPFL reconstruction so as to obtain correct MPFL tensioning after the transfer of the tuberosity.

**Rehabilitation**

A DonJoy brace (DJO, Vista, CA) with 0° to 90° of motion was used for the first 2 weeks, with full weight-bearing on a straight knee. From 2 to 6 weeks, no brace was used, with an allowed range of motion of 0° to 90° and free weight-bearing during standing and walking. After 6 weeks, free activity was allowed. Controlled sports activities after 3 months and contact sports after 6 months were allowed.

**RESULTS**

Subjective patient assessment revealed that 80% of patients (35/44) felt that their knee function had improved in terms of activities of daily living and 37 of 44 patients indicated that their ability to perform recreational sports activities had improved. Of the patients, 64% (28/44) were completely pain-free when performing activities of daily living and 59% (26/44) were pain-free when performing sport activities. Four patients had persistent chronic pain. All of these patients had cartilage injury with an International Cartilage Repair Society grade of 3 or 4 to the patella or trochlea. In the 40 patients without chronic pain, similar severe cartilage injuries were found in only 20% (8/40). The Kujala knee function score improved overall from 46 points (range, 12 to 67 points) to 84 points (range, 62 to 100 points) at follow-up (Table 2). The mean Tegner activity score at follow-up was 4 (range, 1 to 9). Eight patients were performing competitive sports at follow-up.

One patient had a redislocation 6 months postoperatively. This patient was further treated with a brace and was not interested in additional surgical treatment. Three patients had a sensation of subluxation. Twelve patients had a tibial tuberosity transfer performed according to the criteria mentioned in the "Methods" section. All had trochlear dysplasia as the indication for the osteotomy, and furthermore, 3 of the patients had an excessive Q-angle. The Kujala and Tegner scores in
these patients were similar to those in patients without this additional procedure but with a tendency to lower scores in the patients with the combined procedure (Table 2).

Objective Patient Assessment

Palpable pain was found at the medial patellar edge in 43% of the patients (19/44) and at the medial femoral condyle in 50% (22/44). A positive apprehension sign with patellar lateralization was found in 41% of patients (18/44). Four patients had a loss of flexion of greater than 10°, with the greatest flexion loss being 25°.

Complications

There were 5 reoperations. In 1 patient the knee was forced into maximal flexion while he was under general anesthesia because his flexion ability was less than 90°. Three patients had the medial femoral condyle interference screw removed between 6 and 12 months postoperatively because of screw protrusion or pain at the screw position at the medial femoral condyle. A severe complication was seen in 1 patient with a transverse patellar fracture 6 weeks postoperatively. The fracture was caused by a surgical failure: 1 of the transverse drill holes had violated the anterior patellar cortex. The fracture occurred when the patient rose from a chair without support.

DISCUSSION

The optimal surgical treatment for chronic patellar instability is controversial. Numerous techniques have been used with varying success. Proximal realignment procedures, which cover medial capsule plication and lateral capsule release, have been investigated in a few studies. Scuderi et al.21 reported a low redislocation rate of 3% with isolated proximal realignment. A similar finding was reported by Aglietti et al.22 and Zeichen et al.23 Medial transfer of the tibial tuberosity, called distal realignment, has been used in isolation, with unsatisfactory results in approximately 20% to 25% of patients.24,25 However, in a study by Shelbourne et al.,26 a redislocation rate of 0% was found in 34 patients with patellar instability but 25% had persistent symptomatic instability. A combination of all 3 of the previously mentioned procedures, called the Roux procedure, has resulted in better redislocation rates of 5% to 10%.27-29

This study, which contained a large patient group with MPFL reconstruction, had a low redislocation rate of 2%. This is consistent with other MPFL reconstruction studies that report no redislocation or a very low incidence of redislocation after the procedure.8,9,11-14,16-20 Our follow-up Kujala score of 84 points is slightly lower than that in other studies using this score, ranging from 87 to 92 points (Table 1). One study had poorer outcomes in patients with cartilage damage at the time of surgery.8 We found a similar tendency, with 100% of patients with persistent chronic pain having grade 3 or 4 chondral lesions, whereas major chondral lesions were found in only 20% of the patients without persistent pain.

The usage of additional procedures combined with MPFL reconstruction is controversial. We used medial tibial tuberosity transfer in patients who had pathologic Q-angles of more than 15° for male patients and more than 20° for female patients. Also, significant trochlear dysplasia with a completely flattened trochlea (Dejour type B) or an absent or severely dysplastic medial femoral condyle (Dejour type C) also indicated a medial tibial tuberosity transfer in our study. The dysplasia was thought to lead to excessive load on the MPFL reconstruction, and tibial tuberosity transfer would, in theory, reduce the load to the reconstruction. One study, however, did not find poorer results in patients with dysplasia when performing

### Table 2. Results of KOOS, Kujala, and Tegner Activity Scores

<table>
<thead>
<tr>
<th></th>
<th>Overall (N = 44)</th>
<th>MPFL Reconstruction (n = 32)</th>
<th>MPFL Reconstruction and Tibial Tuberosity Transfer (n = 12)</th>
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</thead>
<tbody>
<tr>
<td>KOOS, mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptoms</td>
<td>73 (15)</td>
<td>75 (13)</td>
<td>66 (21)</td>
</tr>
<tr>
<td>Pain</td>
<td>90 (9)</td>
<td>91 (8)</td>
<td>87 (13)</td>
</tr>
<tr>
<td>Activities of daily living</td>
<td>84 (12)</td>
<td>85 (11)</td>
<td>78 (16)</td>
</tr>
<tr>
<td>Sports and recreation</td>
<td>80 (10)</td>
<td>81 (9)</td>
<td>78 (13)</td>
</tr>
<tr>
<td>Quality of life</td>
<td>80 (10)</td>
<td>81 (9)</td>
<td>78 (13)</td>
</tr>
<tr>
<td>Kujala score [median (range)]</td>
<td>84 (62-100)</td>
<td>88 (68-100)</td>
<td>83 (62-100)</td>
</tr>
<tr>
<td>Tegner activity score [median (range)]</td>
<td>4 (0-9)</td>
<td>4 (1-8)</td>
<td>4 (0-9)</td>
</tr>
</tbody>
</table>

NOTE. The KOOS score contains 5 subscores ranging from 0 to 100, with 100 being the best score. The subscores are symptoms, pain, activities of daily living, sports and recreation, and quality of life. The Kujala score ranges from 0 to 100, with 100 being the best score. The Tegner activity score ranges from 0 to 10, with 10 being the best score.
isolated MPFL reconstruction. This could indicate that the additional procedure might be unnecessary.\(^{16}\) In the study by Schöttle et al.,\(^{13}\) a tibial tuberosity transfer was performed when the distance between the center of the trochlear sulcus and tibial tuberosity was greater than 15 mm. However, so far, no studies have indicated any need for additional procedures combined with MPFL reconstruction in cases of increased Q-angles or dysplasia.

Positive apprehension and pain with palpation were seen in 50% of the patients. The change in anatomy at the medial aspect of the patella as a result of the reconstruction, as well as the fact that several patients had undergone previous surgeries, is considered to be the reason for these findings.

We had 2 types of complications that resulted in reoperations. A major complication was a patellar fracture in an obese patient, resulting from a surgical error where a drill hole affected the anterior patella cortex. A concern with our technique is the risk of patellar fracture as a result of cortical weakening after creation of drill holes. Therefore our technique requires careful placement of the drill holes in the patella.

A patellar fracture was described in another study in which patella drill holes were used for graft fixation.\(^{9}\) In that study a drill canal diameter in the patella of 7 mm was used and violation of the anterior cortex was thought to be the cause of the patellar fracture. In our study 3 of 44 patients needed screw removal because of local inflammation. In a study by Steiner et al.,\(^{16}\) 10% of patients needed screw removal because of a prominent or painful screw. Screw placement at the medial femoral condyles is susceptible to development of inflammation probably as a result of the extensive mobility of the soft tissues during knee motion or accumulation of small fragments of the biocomposite screw under the fascia during screw resorption.

This study is limited by investigating the short-term clinical results after MPFL reconstruction. The mean follow-up was 22 months, but 45% of the patients had more than 2 years’ follow-up. However, at the time of the mean follow-up, patients typically have returned to the highest level of activity possible and remaining surgical morbidity does not improve significantly more over time. In addition, our material is a prospective patient series including all operated patients at our clinic. This results in a heterogeneous group with respect to the degree of patellofemoral dysplasia and previous surgeries. However, this heterogeneity gives an indication of clinical results with MPFL reconstruction in the typical chronic patellar instability patient population.

**CONCLUSIONS**

Early results with MPFL reconstruction with gracilis tendon in patellar drill holes show a low redislocation rate of 2% and medial hardware problems in approximately 7% of patients. The procedure is not able to eliminate apprehension and pain at the medial aspect of the patella. More persistent postoperative pain with activity is a problem that is related to patellofemoral chondral lesions.

**REFERENCES**

16. Steiner TM, Torga-Spak R, Teige RA. Medial patellofemoral


