Original Article Clinics in Orthopedic Surgery 2022;14:386-392 • https://doi.org/10.4055/cios21093

Results and Factors Affecting Clinical Efficacy of Medial Patellofemoral Ligament Reconstruction Using a Gracilis Tendon Suture Technique

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Background: This study evaluated the outcomes of medial patellofemoral ligament (MPFL) reconstruction using a gracilis tendon suture technique for patients with patellar instability. Potential factors affecting clinical efficacy were also evaluated.

Methods: This study included 22 patients diagnosed with patellar instability, who underwent MPFL reconstruction using a gracilis tendon. Their mean age was 21.5 years (range, 15–48 years), and the mean follow-up period was 26.8 months (range, 12–66 months). Clinical evaluation included the determination of Kujala, Lysholm, and Tegner scores. Radiographic evaluation included changes in congruence angle and arthritic changes in the patellofemoral joint. Additionally, patients were examined for any complications, including recurrent dislocation. Factors affecting clinical efficacy were also evaluated.

Results: All clinical scores improved at final follow-up. The mean congruence angle improved from 23.6° before surgery to –6.5° at final follow-up. Two of 15 patients developed osteoarthritic changes in the patellofemoral joint. Dislocation recurred in 2 patients with type C trochlear dysplasia, which showed a statistically significant association with recurrent dislocation when compared to type A and B dysplasia (p = 0.026). Kujala scores were significantly lower among patients with abnormal patellar tilts (p = 0.038), and Lysholm scores were significantly lower among patients with femoral internal rotation deformity (p = 0.024).

Conclusions: Satisfactory results were obtained after MPFL reconstruction using a gracilis tendon suture technique for patients with patellar instability. However, dislocation recurred in patients with type C trochlear dysplasia, and clinical efficacy was lower among patients with femoral internal rotation and patellar tilt.

Keywords: *Patellar instability, Medial patellofemoral ligament, Gracilis, Ligament reconstruction*

Patellar instability has several causes, including trochlear dysplasia, patella alta, and an excessive tibia tubercle-trochlear groove distance.[1-3] There is also a variety of treatment options.[4] However, there is controversy regarding the need to correct all predisposing factors of patellar instability and the complications of the procedures.

Recent studies have demonstrated that retinacular restraints could play a critical role in reversing patellofemoral instability and that most recurrent patellar dislocation is associated with medial patellofemoral ligament (MPFL) injury.[5,6] Even when MPFL injury is not the primary cause of patellofemoral instability, MPFL reconstruction is effective and may, by itself, prevent future lateral patellar dislocation.[7] However, a patellar fracture can occur due to a patellar tunnel created for MPFL reconstruction,[8] therefore, patellar fixation using soft-tissue suturing is useful for preventing patellar fractures. Good clinical outcomes were

Received June 14, 2021; Revised July 22, 2021;
Accepted July 23, 2021
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reported using soft-tissue suturing during MPFL reconstruction with gracilis autograft fixation without a bone tunnel.[9]

We hypothesized that MPFL reconstruction without bony procedures could be a good treatment option for patellar instability even though all causative factors for patellar instability could not be correctable. This study evaluated the outcomes and potential factors affecting the clinical efficacy of MPFL reconstruction using an autologous gracilis tendon suture technique for patients with patellar instability.

METHODS

This study was approved by the Institutional Review Board of Kyungpook National University Hospital (IRB No. KNUH 2019-10-011). The patient data were collected retrospectively. Owing to the retrospective design, the requirement for informed consent was waived.

Patients

Twenty-two patients (12 men and 10 women) who were diagnosed with patellar instability from July 2009 to July 2018 and underwent MPFL reconstruction using a gracilis tendon were included in this study. Their mean age was 21.5 years (range, 15–48 years), and the mean follow-up period was 26.8 months (range, 12–66 months). Lateral retinacular release was carried out in 15 cases, in which the tightness of the lateral retinaculum was maintained after MPFL reconstruction.

Surgical Procedure

Using arthroscopy, the sliding and tilting of the patella and the state of the cartilage were determined, and the presence of any loose bodies was also checked. Any identified lesions were treated before MPFL reconstruction. At 2 cm medial to the tibial tuberosity, the gracilis tendon was harvested using a tendon stripper, then a whip stitch was made at each end.

A longitudinal incision was made at the upper medial two-thirds of the patella. After making a submuscular tunnel at the lower area of the vastus medialis obliquus for passage of the graft tendon, an incision was made in the distal area of the adductor tubercle. Using a fluoroscopic guide, suture anchor fixation was performed at the isometric point, which was slightly anterior to an elongation of the posterior femoral cortex between the proximal origin of the medial condyle and the most posterior point of the Blumensaat's line (Fig. 1).[10] After suturing the graft tendon with the thread at the isometric point, the graft was passed through the submuscular tunnel and sutured at the patellar periosteum in a 45° flexed position (Fig. 2). Then, the lateral retinacular release was performed in 4 cases in which the tension of the lateral retinaculum remained.

Double-bundle reconstruction was performed in 17 cases with a congruence angle of > 16° and positive for lateral glide test, depending on the severity of subluxation. On the other hand, single-bundle reconstruction was performed in the other 5 cases. A suture was performed from the upper one-third of the patellar medial border to the patellar midportion in the single-bundle reconstruction. However, the suture was performed from the upper one-third and midpoint of the patellar medial border to the patellar midportion in the double-bundle reconstruction. The patellar lateral border was displaced to overlap the border of the lateral femoral condyle to identify the proper tension of the graft. The graft was sutured to hold one end of the graft tendon and patella. Lastly, patellar stability was confirmed in various angles, as well as the flexion and extension of the knee joint. In addition, patellar tracking was checked by arthroscopic evaluation.

Rehabilitation

Patients performed quadriceps setting exercises in a splint for 2 weeks after surgery. Motion exercises were initiated with an aim of attaining 90° flexion for 6 weeks after surgery with partial weight-bearing. Then, full weight-bear-

Fig. 1. Using a fluoroscopic guide, suture anchor fixation was performed at the isometric point, which was slightly anterior to an elongation of the posterior femoral cortex between the proximal origin of the medial condyle and the most posterior point of the Blumensaat's line, as suggested by Schottle et al.[10]

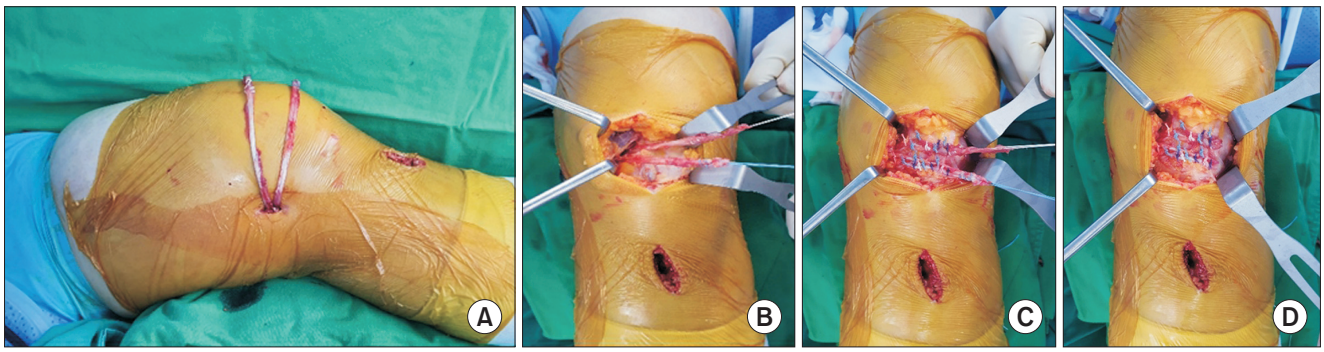

Fig. 2. (A) The graft tendon was sutured with the thread of the anchor at the isometric point. (B) The graft was passed through the submuscular tunnel. (C) The graft was sutured at the patellar periosteum in a 45° flexed position. (D) Reconstructed medial patellofemoral ligament.

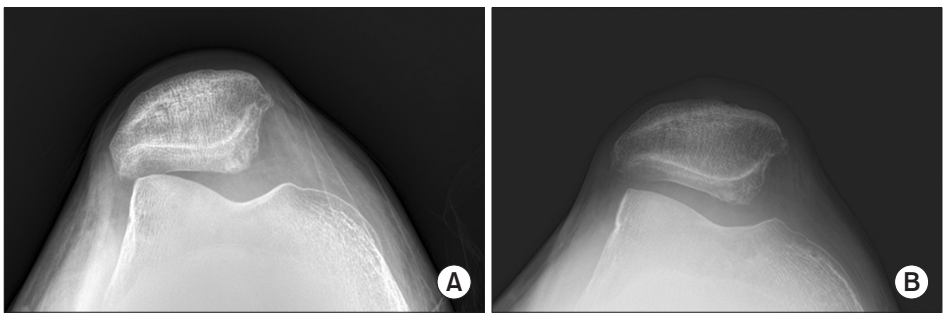

Fig. 3. Preoperative and follow-up radiographs. (A) Preoperative Merchant view showing a subluxated patella. (B) Follow-up Merchant view showing a nondislocated patella.

ing, full range of motion, and open kinetic chain exercises were allowed. The knee brace was worn for 3 months after surgery. Light sports were permitted 3 months postoperatively, and all sports were permitted 6 months postoperatively, depending on the recovery of muscle power.

Evaluation Methods

Clinical evaluation included the determination of Kujala, Lysholm, and Tegner scores. Radiographic evaluation included assessing changes in congruence angle and arthritic changes in the patellofemoral joint using the Merchant view (Fig. 3). Additionally, patients were examined for any complications, including recurrent dislocation. Factors affecting clinical efficacy were also evaluated. The investigated factors include age, sex, number of bundles, history of previous dislocation, previous arthritic changes in the patellofemoral joint, valgus deformity, genu recurvatum, sulcus angle, trochlear dysplasia, tibia tubercle-trochlea groove (TT-TG) distance, femur rotation, patellar tilt, and patella alta.

Among these, the sulcus angle was measured using the Merchant view radiographs and considered abnormal when greater than 150°,[11] and trochlear dysplasia was divided into four types according to the classification described by Dejour using three-dimensional reconstruction computed tomography (CT).[12] Axial CT views were used for the evaluation of TT-TG distance, femoral rotation, and patellar tilt. TT-TG was considered abnormal when greater than 20 mm.[13] The normal femoral rotation was defined as 10.89° ± 8.7°.[13] Abnormal patellar tilt was defined as values over 20°, and patella alta was defined as the Insall-Salvati index greater than 1.2.[14]

Statistical Analyses

The Wilcoxon signed-rank test was used to compare preoperative and postoperative values. The relationship of several factors with the results including complications and osteoarthritic change was analyzed using the chi-square test and Fisher's exact test, whereas the relationship of the factors with clinical scores was analyzed using the Mann-Whitney and Kruskal-Wallis test. Statistical significance was assumed at p-values < 0.05. All statistical analyses were performed using IBM SPSS ver. 21.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The mean congruence angle improved from 23.6° ± 15.9° (range, 2.4°–58.2°) before surgery to −6.5° ± 5.7° (range, −1.6° to 3.6°) at the final follow-up (p < 0.001). The mean

Kujala score improved from 46.9 ± 10.4 (range, 31–68) to 81.7 ± 6.4 (range, 70–98) at the final follow-up ($p < 0.001$); the mean Lysholm score improved from 50.3 ± 13.1 (range, 41–59) to 77.8 ± 7.3 (range, 71–100) ($p < 0.001$); and the mean Tegner score improved from 2.5 ± 0.5 (range, 2–3) to 4.3 ± 0.5 (range, 4–5) ($p < 0.001$) (Table 1). Two of the 15 patients developed osteoarthritic changes in the patellofemoral joint at 15 and 36 months postoperatively. Moreover, dislocation recurred in 2 patients.

Both patients with recurrent patellar dislocation had type C trochlear dysplasia (4 patients), which demonstrated a significantly higher incidence of recurrence than type A trochlear dysplasia (7 patients) and type B trochlear dysplasia (11 patients) ($p = 0.026$). Other factors did not affect recurrent dislocation (Table 2).

Kujala scores were significantly lower among patients with abnormal patellar tilts ($p = 0.038$). Lysholm scores were significantly lower among patients with femoral internal rotation deformity ($p = 0.024$). Other factors did not affect the postoperative Kujala and Lysholm scores. Postoperative arthritic changes in the patellofemoral joint and Tegner activity scores were not affected by all investigated factors.

DISCUSSION

In the present study, satisfactory clinical outcomes were achieved by MPFL reconstruction using an autologous gracilis tendon without bony procedures for patellar instability. However, patients who had type C trochlear dysplasia tended to experience recurrent patellar dislocation, and patients with femoral internal rotation and abnormal

Table 1. Clinical Outcomes

Characteristic	Preoperative	Postoperative	*p*-value
Congruence angle (°)	23.6 ± 15.9	–6.5 ± 5.7	< 0.001
Kujala score	46.9 ±10.4	81.7 ± 6.4	< 0.001
Lysholm score	50.3 ± 13.1	77.8 ± 7.3	< 0.001
Tegner activity score	2.5 ± 0.5	4.3 ± 0.5	< 0.001

Values are presented as mean ± standard deviation.

Table 2. Relationship of Preoperative Factors with Clinical Efficacy (*p*-value)

Variable	Recurrent dislocation	Arthritic change in patellofemoral joint	Kujala score	Lysholm score	Tegner score
Age	1.000	0.544	0.214	0.785	1.000
Sex	1.000	0.571	0.174	0.545	1.000
Number of bundle	1.000	1.000	0.937	0.780	1.000
History of previous dislocation	0.481	1.000	0.374	0.408	1.000
Previous arthritic change in the patellofemoral joint	1.000	1.000	0.972	0.640	0.350
Valgus deformity	1.000	0.527	0.430	0.251	1.000
Genu recurvatum	0.476	0.214	0.156	0.789	1.000
Sulcus angle	1.000	1.000	0.844	0.576	0.274
Trochlear dysplasia	0.026	0.073	0.106	0.679	0.231
Tibia tubercle–trochlea groove distance	1.000	0.227	0.178	0.332	0.145
Femur rotation	1.000	0.532	0.164	0.024	0.121
Patellar tilt	0.481	0.169	0.038	0.658	1.000
Patellar alta	0.156	1.000	0.401	0.475	1.000

patellar tilt had lower clinical scores.

The MPFL is the primary soft-tissue stabilizer preventing lateral patellar translation for the initial 30° of knee flexion,[15] and MPFL injury is recognized in most patients with recurrent patellar dislocation.[5,6] In situations where a trochlear dysplasia or patella alta exists, the MPFL may play an even greater role as a biomechanical restraint than when the trochlear groove and patellar height are normal.[16] Even when MPFL injury is not the primary cause of patellar instability, MPFL reconstruction is effective for stabilizing the knee and may prevent lateral patellar dislocation alone.[7] Good clinical results were obtained by MPFL reconstruction alone in this study, without correction of trochlear dysplasia or osteotomy of the tibial tuberosity. Furthermore, lateral retinacular release is widely performed before MPFL reconstruction. However, in this study, MPFL reconstruction was done first, and the lateral retinacular release was performed if the tightness of the lateral retinaculum was maintained, which could be an advantage because performing the unnecessary release of the lateral retinaculum is no longer needed.

Various methods exist for achieving fixation of the graft tendon to the femur and patella, including sutures, spiked washers, staples, interference screws, suture anchors, and suture fixation using a docking technique.[8,10,17-20] Complications, including pain caused by implants, are reported in up to 57% of patients.[19,21] Patellar and femoral tunnels can cause patellar and adductor tubercle fractures.[8,17,21] The patellar fracture was reported even when a suture anchor was used.[22] However, such complications were prevented in the present study by suturing the graft onto the soft tissues, as well as onto the periosteum of the patella. Moreover, even though a fixation material was not used, the soft-tissue fixation was also advantageous because a bone tunnel or suture anchor can result in fractures or continuous pain after surgery.

Various graft materials for MPFL reconstruction have been also reported, including autologous gracilis tendon,[23] semitendinosus tendon,[18] patellar tendon,[24] quadriceps tendon,[25] tibialis anterior allograft,[26] and synthetic ligament.[27] These materials are stronger than the native MPFL, which has a mean tensile strength and stiffness of 208 N and 8 N/mm, respectively.[15] Graft tendons for MPFL reconstruction must be of similar stiffness as the native MPFL, but greater strength is more advisable.[28] However, the currently used graft tendon materials are much stronger and stiffer than the native MPFL. Mountney et al.[29] reported problems associated with patellar alignment due to overtensioning when a hamstring graft was used. The gracilis tendon was employed in this study because of resemblance to the MPFL.[30]

The ideal conditions for MPFL reconstruction are known to include type A trochlear dysplasia type A or normal trochlea, no trochlear spur, a tubercle-sulcus angle between 0° and 10° valgus, and a patella alta measurement < 1.4 (Insall-Salvati ratio).[28] The satisfactory outcomes in this study could be obtained using MPFL reconstruction without a bony procedure, such as tibia tubercle osteotomy or trochleoplasty, even though there was no ideal indication for MPFL reconstruction alone. However, two cases of recurrent dislocation occurred in patients with type C trochlear dysplasia, and the patients with internal rotation of the femur or severe patellar tilt had lower clinical scores. MPFL reconstruction with additional procedures for correcting bony deformities should be considered for such patients.

The limitations of this study include its retrospective study design and small sample size. Additionally, the study lacks a control group for comparison with the treatment group. Thus, large-scale comparative studies are warranted. Satisfactory outcomes were obtained with MPFL reconstruction using a gracilis tendon for patients with patellar instability. However, dislocation recurred in patients with type C trochlear dysplasia, and patients with femoral internal rotation deformity or severe patellar tilt had lower clinical scores.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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