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Medial Patellofemoral Ligament Reconstruction with Semi-Patellar Tunnel Fixation: Surgical Technique and Mid-Term Follow-Up

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Background: The present study aimed to describe a new safe and economical technique for medial patellofemoral ligament (MPFL) reconstruction with satisfactory clinical outcomes, and present the results of a four-year follow-up.





Material/Methods: Thirty-two patients with recurrent patella dislocation, who underwent MPFL reconstruction with two semi-patellar tunnels and hardware-free patellar fixation between 2011 and 2013, were included in the study. Patella stability was tested by an apprehension test preoperatively and at follow-up. Knee function was evaluated using the Kujala score, Lysholm score, and Crosby-Insall grading system. Patellar congruence angle and patellar tilt angle were measured using an axial computed tomography scan. Furthermore, objective feelings of patients and complications were recorded.

Results: Thirty knees (30 patients) were followed for a minimum of 48 months. The apprehension test was positive in all patients preoperatively, but negative at follow-up. Kujala and Lysholm scores increased from 58.9 ± 9.6 to 92.0 ± 4.8 ($p < 0.001$) and 53.3 ± 5.6 to 91.6 ± 3.5 ($p < 0.001$), respectively, at the last follow-up. Seventeen patients were graded as excellent and 13 were graded as good by the Crosby-Insall grading system. The patellar congruence angle and patellar tilt angle also improved significantly. No patient experienced patellar re-dislocation, subluxation, or patella fracture. Most patients (93%) were satisfied with the surgery.

Conclusions: MPFL reconstruction with two semi-patellar tunnels and hardware-free patellar fixation was described and the study observations indicated it was a safe and economical surgical procedure for recurrent patella dislocation with satisfactory results. It could be an alternative surgery method for patients with patella recurrent dislocation.

MeSH Keywords: **Patella • Patellar Dislocation • Patellofemoral Joint**

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Background

The medial patellofemoral ligament (MPFL), which contributes 60% of soft tissue force restraint to lateral patella translation, plays an important role in patella stability [1]. MPFL has been found to be ruptured or injured during patella lateral dislocation, a finding supported by magnetic resonance imaging (MRI) studies and anatomic research [2,3]. The conservative treatment of patella dislocation can result in high re-dislocation occurrence rates, poor treatment effects, and patellofemoral osteoarthritis [4-6]. Therefore, MPFL reconstruction has become the preferred treatment, especially for patients with recurrent patella dislocation who have normal bony anatomy and alignment [7-11].

The understanding of the anatomy and function of MPFL has developed over time [1,12-14]. Kang et al. [13] did a series of research studies on the anatomy of the MPFL and proposed the concept of two functional bundles of the MPFL: an inferior straight bundle and a superior oblique bundle. In addition, Wang et al. [15] did a retrospective study and showed that patients treated with anatomical double-bundle MPFL reconstruction had better clinically and radiologically outcomes than patients treated with single-bundle isometric reconstruction.

A number of articles have described techniques of MPFL reconstruction, with variations based on the various methods used for patella fixation. Common fixations are suture anchor fixation, interference screw fixation and bone tunnel fixation [16-20]. Two suture anchors or interference screws are used in the patellar fixation, which adds substantial cost. Bone tunnel fixation is more economical with no screw application but with serious complications such as patella fracture [16,17]. Thus we developed MPFL reconstruction with two semi-patellar tunnels and hardware-free patellar fixation for safety and cost-savings for patients.

The purpose of the present study was to describe the new surgical procedure, present its preliminary results, and discuss the feasibility of its clinical application. Significantly improved subjective clinical outcomes and radiological improvements, including Kujala and Lysholm scores, patella tilt angle, and patella congruence angle, were hypothesized.

Material and Methods

Study design and patients

The study was a prospective, noncomparative, and interventional case series. Thirty-two consecutive patients with recurrent patella dislocation, who underwent isolated MPFL reconstruction from June 2011 to March 2013, were included in this study.

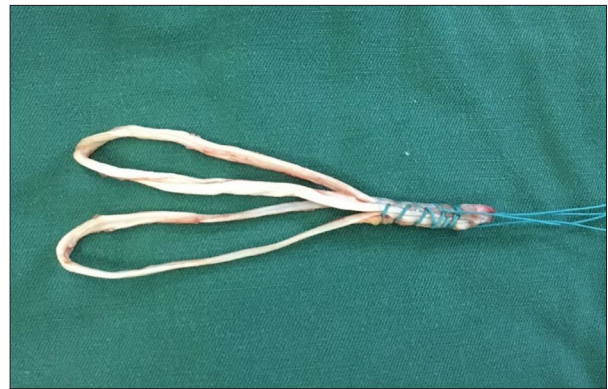


Figure 1. The preparation of the autografts.

The inclusion criterion for isolated MPFL reconstruction was symptomatic patients who had experienced at least two episodes of patella dislocation and failed a course of conservative treatment (at least three months); and MPFL rupture was shown in MRI. The exclusion criteria for isolated MPFL reconstruction were as follows: osteoarthritis > grade 1 according to Kellgren and Lawrence [21]; focal cartilage defects > grade 3 according to Outerbridge [22]; trochlear dysplasia > grade B according to Dejour [23]; tibial tuberosity-trochlear groove distance (TT-TG) >20 mm [24]; patellar height: Insall-Salvati index >1.2 [25]; Q-angle >20° [26]; and knee cruciate ligaments and medial collateral ligament injury.

Patellofemoral cartilage condition was observed by arthroscopy. Trochlear morphology and TT-TG distance were measured on computed tomography (CT) scan. Q-angle and patellar height were evaluated by weight-bearing anterior-posterior and lateral views of knee x-ray radiographs, respectively. Kujala and Lysholm scores and apprehension test were also used to evaluate the patients before surgery [4,27].

Informed consents were obtained from all individual participants included in the study. All of the methods were approved by the local ethics committee.

Surgery technique

The surgeries were completed by one experienced senior surgeon. Autologous semi-tendinosus tendon was harvested and divided longitudinally into two equal grafts. Then the two grafts were folded from the middle point and the four free ends were whip stitched together about 25 mm with No. 1 Ethicon non-absorbable sutures (Figure 1).

A guide pin with 2.0-mm diameter with an eyelet was inserted from the site superoposterior to the medial femoral epicondyle and distal to the adductor tubercle to the lateral cortex of the femur [28,29]. Then a longitudinal skin incision with length to 10 mm was made over the femoral insertion site

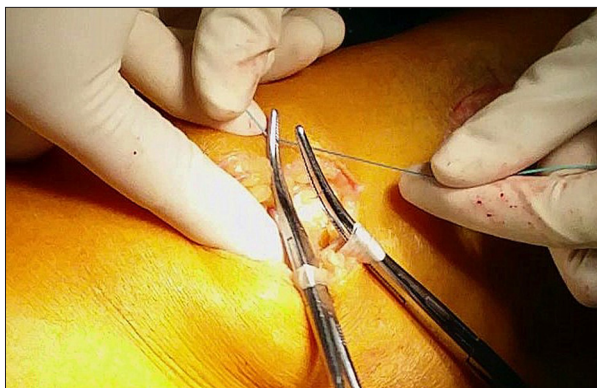


Figure 2. The two autografts were separated for double-bundle MPFL reconstruction.

and subcutaneous tissue was dissected to expose the cortical bone. A femoral tunnel of a depth of 25 mm was drilled over the guide pin by a cannulated reamer with a diameter of 7 mm. The whip stitched portions of the two grafts were pulled into the femoral tunnel by their No. 1 Ethicon nonabsorbable sutures and guide pin. After adjustment, the whip stitched portions of the grafts were fixed with a bioabsorbable interference screw measuring 6×10 mm², with the sutures in the femoral tunnel under tension.

A longitudinal incision was made from the upper inner corner to the center of the medial edge of the patella. Two folded ends of the grafts were pulled out to the medial patella margin through the subcutaneous fascial layers (Figure 2). Subsequently, the folded ends were separated for the double-bundle of MPFL and were passed through by two No. 2 nonabsorbable Fiberwire. A guide pin with 2.0-mm diameter was transversely inserted from the midpoint of the medial edge of the patella to the lateral border. A semi-patellar tunnel with a length of 20 mm was drilled by a cannulated reamer with a diameter of 4.0 mm under the guidance of the guide pin. After that, one folded end was pulled into the semi-patellar tunnel. A guide pin with 2.0-mm diameter was inserted from the upper inner corner of the patella to the lateral border transversely. A 20-mm long semi-patellar tunnel and another folded end were pulled into the tunnel by the same procedures.

After pulling guide pins out of the patella, the grafts were fixed temporarily using two hemostats clamping the ends of Fiberwire sutures on the lateral side of the patella. The graft tension and patella tracking were assessed by arthroscopy and physical examination in the flexion at 0–60° of the knee. The four ends of the two No. 2 Fiberwire nonabsorbable sutures over the lateral bone bridge were fastened for fixation when tensing the folded ends of the grafts in 30° of knee flexion. Because biomechanical studies have shown that the MPFL has its maximal length and restraint against patella lateralization in 30° of flexion [12]. At last, routine wound closure was

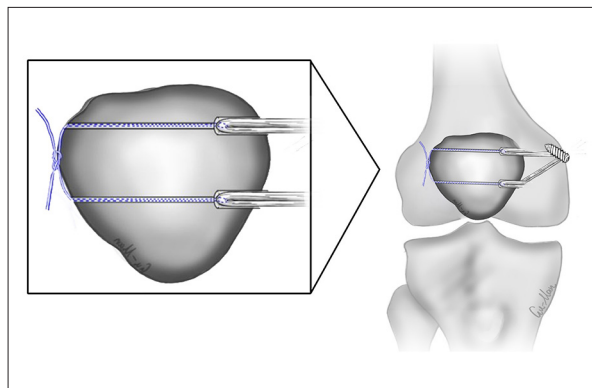


Figure 3. The schematic diagram of the MPFL reconstruction.

performed. The schematic diagram for the reconstruction is shown in Figure 3.

Postoperative care

The knee was immobilized for one week in an extended position. On the second day postoperatively, leg raising and quadriceps isometric strength exercises were started. At one week after surgery, a gradual range of motion was initiated with a hinged brace. Four week postoperatively, 90° of knee flexion was achieved. At six weeks after surgery, the brace was removed. Six weeks after surgery, full weight-bearing was allowed without a crutch. Three months after the surgery, the patients returned to performing normal daily activities. Contact sports were permitted six months after the surgery.

Clinical assessments

Knee function was evaluated using Kujala score, Lysholm scores and Crosby-Insall grading system [30]. Physical examinations were assessed using the apprehension test for lateral stability of the patella. Re-dislocation and fracture cases were also recorded. In addition, knee joint CT scans with 30° of knee flexion were performed to measure patella tilt angle and patella congruence angle preoperatively, six months postoperatively and annually thereafter. The subjective feelings of patients were recorded using questionnaire forms in the last follow-up. These values were recorded to the nearest 0.1.

Statistical analysis

The statistical analysis was performed using SPSS version 21.0 (SPSS, IL, USA). The preoperative and the most recent data from clinical and radiologic assessments were compared using the paired Student *t*-test. The level of significance was set at $p < 0.05$. The results were expressed as mean ± standard deviation.

Table 1. Patient characteristics.

Variable	N	Mean ±SD
Sex (M/F)	10/20	
Side (L/R)	14/16	
Cause of dislocation (trauma/others)	11/19	
Age for surgery (year)		25.0±6.9
Height (cm)		163.0±7.6
Weight (kg)		52.9±8.3
Month from first dislocation		18.9±14.1
Q-angle (degrees)		11.7±2.1
Insall-Salvati index		1.0±0.1
Sulcus angle (degrees)		136.7±6.7
TT-TG distance (mm)		14.3±2.7
Follow-up month		55.1±4.9

TT-TG distance – tibial tuberosity–trochlear groove distance.

Results

Two patients who underwent the procedure were unavailable for follow-up for more than 24 months (could not be connected via their telephone numbers), thereby leaving 30 patients (30 knees) in the study (10 males and 20 females). The average age was 25 years (range 16–35 years). The average follow-up time was 55 months (range 48–63 months). The basic patient characteristics are shown in Table 1.

At the last follow-up, the Kujala score increased from 58.9±9.6 to 92.0±4.8 ($p<0.001$) and the Lysholm score increased from

Table 2. Radiological and functional evaluations at the latest follow-up.

Measurement	Preoperative	Latest follow-up	P value
PCA	41.9±8.6	5.8±7.3	<0.001
PTA	32.3±8.6	12.8±3.4	<0.001
Kujala score	58.9±9.6	92±4.8	<0.001
Lysholm score	53.3±5.6	91.6±3.5	<0.001

PCA – patellar congruence angle; PTA – patellar tilt angle.

53.3±5.6 to 91.6±3.5 ($p<0.001$). According to the Crosby-Insall grading system, 17 patients were graded as excellent and 13 as good. The apprehension test was positive in all patients preoperatively, but negative at follow-up. No patient experienced patella re-dislocation or subluxation in the follow-up. No case of patella fracture was reported. The patellar congruence angle (41.9±8.6° to 5.8±7.3°, $p<0.001$) and the patellar tilt angle (32.3±8.6° to 12.8±3.4°, $p<0.001$) also improved significantly (Table 2). Most patients (93%) were satisfied with the surgery (Table 3).

Discussion

The present study showed that anatomical MPFL reconstruction with two semi-patellar tunnels and hardware-free fixation was a safe technique to treat patients with recurrent patella dislocation, which yielded satisfactory results. Thirty patients were involved in the study and achieved good clinical results at a mean follow-up of 55 months. The Kujala score was 92±4.8, Lysholm score was 91.6±3.5, patellar congruence angle was 5.8±7.3°, and patellar tilt angle was 12.8±3.4° at the last follow-up. In addition, no patient experienced patella re-dislocation or subluxation. No case of patella fracture was reported. Most patients (93%) were satisfied with the surgery.

Table 3. Subjective feeling questionnaire at the latest follow-up.

Question	Yes number	%
Are you satisfied with the outcome of the surgery?	28	93
Did the surgery improve your symptoms obviously?	30	100
Would you recommend this procedure to others?	22	73
Have you had a recurrence of your symptoms?	0	0
Have you resumed sport/maximal activities?	21	70
Do you feel anxious for patella re-dislocation after surgery?	5	16
Do you feel pain or uncomfortable in patella?	1	3
Do you feel pain or uncomfortable in the femur (place around interference screw)?	2	7
Do you feel pain or uncomfortable in the tibia (location where autografts were harvested)?	2	7
Compared with the contralateral knee, do you feel difficult in knee rotation, extension and flexion?	1	3

Two semi-patellar tunnels with 20 mm length were drilled under the guidance of the guide pin and filled with folded grafts, which had several advantages. Compared with bone tunnel fixation, semi-patellar tunnels caused less bone loss and were easy to control when drilling. Also, the risk of patella fracture decreased [16,17]. Compared with the suture anchor and interference screw fixation, the technique used in this study was not restricted by the diameter of the screws because metal screws were not used. In addition, postoperative complications such as postoperative pain caused by interference screws and anchor screws occurs frequently [31]. Hence, a lack of application of screws for patellar fixation in this study could result in fewer complications, as well as being less costly.

In a study reported by Hinterwimmer et al. [16], 19 patients received MPFL reconstruction with bone tunnel fixation and had follow-up at a mean of 16 ± 3 months; 89% of the patients were either satisfied or very satisfied with the overall outcome. The mean Kujala score was 92 ± 7 (range 69–100), and the median Tegner scale was 5 (range 3–7). Two patients could not flex the knee beyond 90° at six weeks postoperatively and one other patient suffered a displaced fracture three months postoperatively. In the study reported by Enderlein et al. [17], 224 patients received MPFL reconstruction with bone tunnel fixation and had follow-up from 12 to 60 months; the Kujala score improved from 62.5 to 80.4. Among them, seven patients (4.6%) had a re-dislocation, and 39% of patients experienced one or more episodes of subjective patellar instability. Song et al. [19] reported MPFL reconstruction with suture anchors fixation. Twenty patients had follow-up with a mean of 34.5 months, Kujala score was 90.9 ± 4.5 , and Lysholm score was

90.9 ± 5.9 at the last follow-up. The Kujala score and Lysholm score in this study were comparable or even superior to those in other studies reporting on the results of anatomical MPFL reconstruction. No patient in our study experienced patella re-dislocation or subluxation. No complication such as patella dislocation was reported. Thus, MPFL reconstruction in this study can be considered a safe surgical method.

The limitations of our study included the small sample size and a mid-term follow-up. A longer follow-up with a larger patient cohort is necessary to confirm the effectiveness and safety of this technique. Also, control groups are needed in the future to show the efficacy and superiority of the presented technique clinically. However, the main aim of this study was to describe a new technique for anatomical MPFL reconstruction and present its clinical results. The technique was thought to have several advantages compared with the current techniques, especially for safety and cost-saving.

Conclusions

Anatomical double-bundle MPFL reconstruction with two semi-patellar tunnels and hardware-free fixation was found to be a safe and economical method. Clinical and radiographic outcomes were satisfactory, which indicated it could be an alternative surgery for patients with patella recurrent dislocation.

Conflict of interest

None.

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