

Clinical Outcomes After Medial Patellofemoral Ligament Reconstruction Using Transosseous Sutures Versus Suture Anchors

A Prospective Nonrandomized Controlled Trial

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Background: Patellar instability remains a challenging problem for orthopaedic surgeons. Recurrent patellar instability is traditionally treated with medial patellofemoral ligament (MPFL) reconstruction using a suture anchor or bone tunnel technique. Although the use of transosseous sutures was recently described for MPFL reconstruction, relevant clinical data have not been reported.

Purpose/Hypothesis: The purpose of this study was to compare a new transosseous suture fixation technique with the suture anchor technique for MPFL reconstruction. The hypothesis was that reconstruction with transosseous sutures would show similar clinical results to reconstruction with suture anchors.

Study Design: Cohort study; Level of evidence, 2.

Methods: There were 65 patients with recurrent lateral patellar dislocations from January 2014 to December 2016 who were included in this prospective nonrandomized controlled trial. In total, 31 patients underwent MPFL reconstruction with suture anchors at the patella site (suture anchor group), while the other 34 patients underwent MPFL reconstruction with transosseous sutures (transosseous suture group). The main outcome variable (patellar redislocation) was recorded at follow-up (range, 25–60 months). The International Knee Documentation Committee (IKDC) score, Kujala score, range of motion, congruence angle, patellar tilt, redislocation rate, and complications were collected preoperatively and/or postoperatively.

Results: No recurrent dislocations or other complications were observed in any of the patients. No significant differences were found at follow-up between the suture anchor and transosseous suture groups for subjective IKDC score, Kujala score, congruence angle, patellar tilt, redislocation rate, or range of motion.

Conclusion: This short-term study showed that after MPFL reconstruction (suture anchors or transosseous sutures), patellar stability could be restored. With the numbers available, no significant differences in outcome scores were observed between patients in the transosseous suture and suture anchor groups.

Keywords: medial patellofemoral ligament reconstruction; transosseous sutures; suture anchors

A recurrent lateral patellar dislocation is a rather common but challenging problem for orthopaedic surgeons.^{8,32,35} The medial patellofemoral ligament (MPFL) is the primary restraint for lateral patellar translation, and patients usually need MPFL reconstruction after recurrent lateral patellar dislocations.^{5,11,34} Numerous variations in the different surgical treatments for MPFL reconstruction, in

isolation or in combination with other surgical procedures, have been described in the literature, with studies reporting good to excellent outcomes.[‡]

For anatomic double-bundle MPFL reconstruction, the use of patellar fixation techniques is still controversial.^{15,17,29} Common fixation techniques for MPFL reconstruction at the patella include transosseous bone tunnels,^{4,21} suture anchors,^{3,22,37} and interference

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screws.^{12,29,35} However, the patellar tunnel techniques present a higher risk of postoperative patellar fractures, particularly for those that pass completely through the patella.^{19,25,26,31,33,36,39} Suture anchors are a reliable method to obtain stable fixation and are one of the most popular techniques for MPFL reconstruction, with good to excellent results reported in most patients.^{22,37} Suture anchor fixation was introduced to reduce the risk of patellar fractures.^{17,29}

The transosseous suture technique has been commonly used as an implant-free technique in the repair of patellar tendon or quadriceps tendon ruptures.¹⁶ The first description of transosseous sutures for MPFL reconstruction was reported in the English-language literature in 2007 by Brown and Ahmad¹ (for single-bundle MPFL reconstruction). However, over the past decade, no clinical studies have described the use of transosseous sutures for MPFL reconstruction with the double-bundle technique, and there are no clinical studies comparing the outcomes of different patellar fixation techniques.^{17,18,30} Our surgeons modified their operative technique in January 2014 to use transosseous sutures in the patella to reduce the risk of patellar fractures. Transosseous sutures can theoretically decrease the risk of patellar fractures by allowing the suture to be placed in a tunnel with a smaller diameter (2 mm) and removing the need to loop the tendon through larger diameter bone tunnels (~5 mm).

The purpose of this study was to report the outcomes of this new transosseous suture technique compared with those of traditional suture anchors at the patella during MPFL reconstruction. We hypothesized that the transosseous suture technique would yield similar clinical results in patellar stability to the suture anchor technique in our study patients.

METHODS

Patient Population

After receiving approval from a local institutional review board, we enrolled 65 patients who met the study inclusion and exclusion criteria, out of 75 consecutive patients who underwent MPFL reconstruction at our hospital from January 2014 to December 2016. Our team provided booklets to patients with patellar instability, informing them of their options and obligations preoperatively (such as participating in follow-up), when they were not as yet familiar with their diagnosis. The doctors presented the available options involved in choosing the treatments, including the decision role, decision context, alternatives, risks, and benefits. The inclusion criteria were symptomatic patients who had experienced a minimum of 2 lateral patellar dislocations and

episodes of recurrent subluxation. The exclusion criteria were (1) the need for a tibial tubercle osteotomy, with a tibial tuberosity–trochlear groove (TT-TG) distance >20 mm (the TT-TG distance is a direct measure of the extensor mechanism during valgus alignment calculated from a computed tomography [CT] scan); (2) active infections; (3) malalignment; (4) severe trochlear dysplasia (Dejour types B-D); (5) patellofemoral chondral injuries of grade III or IV; (6) patella alta (Insall-Salvati ratio >1.2); (7) skeletally immature patients; and (8) previous surgery on the affected knee.

Informed consent was obtained from each patient enrolled in this study. The enrolled patients were nonrandomly assigned to a suture anchor group (n = 31) and a transosseous suture group (n = 34) based on a shared decision between the patients and doctors.

All patients were evaluated at a minimum follow-up of 24 months. All of the operative procedures were performed by a senior surgeon (H.Z.). The follow-up evaluations were performed through clinic visits. All patients completed standardized outcome questionnaires at 3, 6, 9, 12, and 24 months and then annually.

Surgical Procedure

We used the gracilis tendon for MPFL reconstruction at our institution. Arthroscopic surgery was routinely performed to address any intra-articular lesions in the knee. Lateral retinacular release was performed arthroscopically if the patellar tilt test was positive on preoperative examination. Under arthroscopic guidance, the lateral retinaculum was divided from the superolateral corner of the patella to the lateral border of the patellar tendon approximately 1 cm above the joint line. The patellar tilt test was considered negative if the patella could be everted to neutral.

Transosseous Suture Technique

The transosseous suture technique was initially introduced for the repair of patellar tendon or quadriceps tendon ruptures,¹⁶ and we applied this technique to MPFL reconstruction. Figure 1 illustrates the MPFL reconstruction procedure with transosseous sutures. Using a 2- to 3-cm medial parapatellar incision, the medial side of the patella was exposed. One bony trough was made in the proximal two-thirds of the medial border of the patella with nucleus forceps. For the transosseous suture technique (Figure 1, A and B), a small eyelet-passing pin that was 2 mm in diameter was used to create 3 tunnels to allow the sutures to be passed through and tied on the opposite side of the patella from the MPFL graft. First, the upper tunnel was placed near the junction of the proximal and middle thirds of the

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Ethical approval for this study was obtained from the First Affiliated Hospital of China Medical University (2017-114-2).

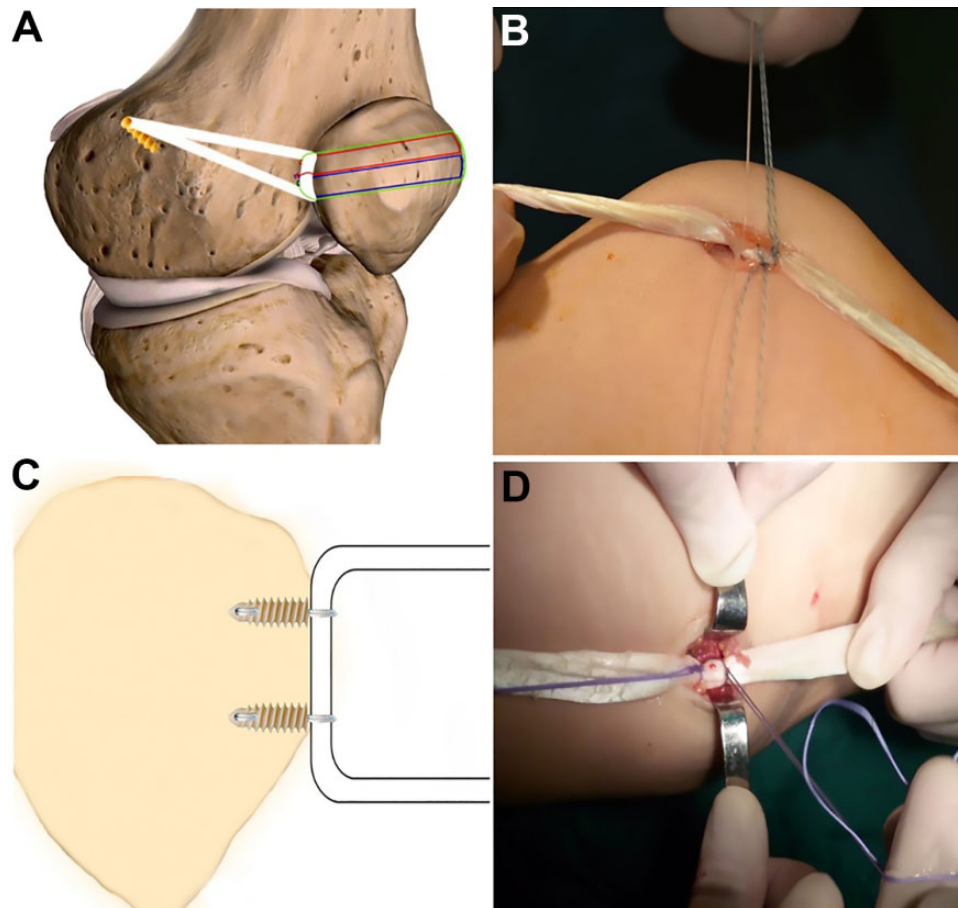


Figure 1. (A, B) Double-bundle medial patellofemoral ligament (MPFL) reconstruction with transosseous sutures. (C, D) Double-bundle MPFL reconstruction with suture anchors.

proximal patella, and the inferior tunnel was placed at the proximal two-thirds of the medial border of the patella. The central tunnel was drilled last. The tunnels were optimally created parallel to each other, taking care not to disrupt the articular surface or anterior cortex of the patella. Three No. 2 FiberWire sutures (Arthrex) were then laterally passed through the 3 patellar tunnels with a small eyelet-passing pin. Next, two No. 2 FiberWire sutures were passed through the central tunnel. The suture was then pulled through the upper tunnel; this process was repeated for the other suture and the lower tunnel. The third suture was then passed through the upper tunnel and lower tunnel. After this, the central portion of the autograft was attached to the bony trough and fixed with the sutures that were tied to the patella. The 2 sutures in the central tunnel were first fixed, and then the sutures in both the upper patellar tunnel and the lower patellar tunnel were tightened. This process was repeated for the 2 sutures in the lower tunnel and the 2 sutures in the upper tunnel.

Suture Anchor Technique

We performed the traditional suture anchor fixation technique for MPFL reconstruction as previously described by

Song et al.³⁷ Using a 2- to 3-cm medial parapatellar incision, the medial margin of each patella was exposed. A bleeding bony trough (~2 cm proximal to distal, 5 mm anterior to posterior, and 5 mm deep into the bone) was made with nucleus forceps or a rongeur on the medial patellar surface. The central portion of the autograft was then attached to the bony trough and fixed with two 2.9-mm single-loaded suture anchors (Osteoraptor; Smith & Nephew), each of which was single loaded with a No. 2 suture. There was a 1-cm bony bridge between the 2 suture anchors on the superior two-thirds of the patella (Figure 1, C and D).

Femoral Fixation

In both techniques, femoral tunnel positioning and fixation were the same. A femoral tunnel was drilled at the anatomic position through a 2- to 3-cm skin incision that was made along the adductor magnus tendon. The femoral tunnel was anatomically placed at the femoral attachment of the native ligament, as described by Schöttle et al,³⁵ from a true lateral knee view with a mobile radiographic machine (Mobilett XP Hybrid; Siemens). Then, a space was created with blunt dissection using a curved clamp between layers 2 (vastus medialis obliquus) and 3 (capsule), and 2 free ends

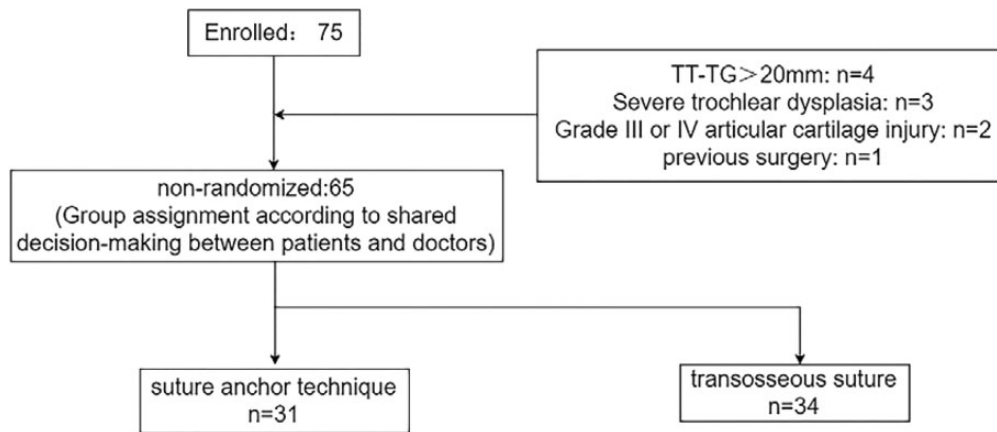


Figure 2. Patient flowchart using the CONSORT (Consolidated Standards of Reporting Trials) diagram. MPFL, medial patellofemoral ligament; TT-TG, tibial tubercle–trochlear groove.

were passed through this soft tissue tunnel from the patellar incision to the femoral incision. When the patella was stabilized in the femoral groove at 30° of knee flexion, the graft was tensioned with a bioabsorbable interference screw (Milagro; DePuy Mitek).

Rehabilitation

All patients underwent the same rehabilitation protocol. Patients were allowed full weightbearing with the leg locked in extension, and the brace was removed at night for 2 weeks. During the first 2 weeks, the brace was unlocked to allow passive range of motion (ROM) from 0° to 60°. From 2 to 4 weeks, the patients were allowed 0° to 90° of ROM. After 6 weeks, the patients were encouraged to reach full ROM. Partial weightbearing was allowed at 4 weeks with a hinged brace, and full weightbearing was allowed at 6 weeks if quadriceps strength had recovered. Return to sports was not allowed until approximately 12 months after surgery.

Outcome Measures

Evaluations were performed at 3, 6, 9, 12, and 24 months, and a final follow-up examination had been performed on all patients by February 2019 at the latest. We informed all patients of the follow-up time via WeChat and telephone, ensuring that every patient attended the follow-up on time. No patient was lost to follow-up. All patients were evaluated both preoperatively and postoperatively using the Kujala score and International Knee Documentation Committee (IKDC) score. We used CT scans to measure the same features on both preoperative and postoperative imaging (congruence angle and patellar tilt). Clinical data also included recurrent subluxations or dislocations at follow-up for all patients. ROM and complications (such as patellar fractures, infections, etc) were postoperatively assessed as well. The follow-up evaluations were performed by a single experienced examiner (M.Y.) who was not involved in the treatment of these patients.

Statistical Analysis

Statistical analysis was performed using SPSS 18.0 (IBM). The Student *t* test was used to compare the preoperative and postoperative values of the congruence angle, ROM, TT-TG distance, and Insall-Salvati ratio between the suture anchor and transosseous suture groups. The Student *t* test was also used to compare the preoperative and postoperative Kujala and IKDC scores. A difference of 10 points on the subjective Kujala or IKDC score was deemed clinically relevant. Between-group differences in the rate of surgical site infections were assessed using the chi-square test with the Yates correction.

The Shapiro-Wilk test was used to assess the normality of variances. The chi-square test was used for nonparametric variances. Statistical significance was defined as $P < .05$.

RESULTS

The CONSORT (Consolidated Standards of Reporting Trials) flow diagram is shown in Figure 2. In total, 31 patients underwent MPFL reconstruction with suture anchors (suture anchor group; 8 of these patients also underwent lateral retinacular release), while the other 34 patients underwent MPFL reconstruction with transosseous sutures (transosseous suture group; 9 patients also underwent lateral retinacular release). Preoperatively, there were no significant differences in sex, age, TT-TG distance, Insall-Salvati ratio, or Kujala score between the 2 groups (Table 1). All patients were available for clinical follow-up. There were no recurrent dislocations in any patients in either the suture anchor or the transosseous suture group.

Clinical Scores

The mean outcome scores in both the suture anchor and the transosseous suture groups can be seen in Table 2. A significant improvement in knee function was recorded at follow-up compared with preoperative values in

TABLE 1
Demographic Data of Patients^a

	Transosseous Suture Group (n = 34)	Suture Anchor Group (n = 31)	<i>t</i> or Chi-Square Value	<i>P</i> Value
Age, y	28.15 ± 6.01	28.90 ± 5.68	<i>t</i> = 0.52	.61
Body mass index, kg/m ²	25.22 ± 2.10	25.20 ± 2.06	<i>t</i> = -0.03	.97
Sex, female/male, n	19/15	18/13	χ ² = 0.03	.86
TT-TG distance, mm	15.26 ± 2.19	15.19 ± 2.21	<i>t</i> = -0.13	.90
Insall-Salvati ratio	1.06 ± 0.09	1.07 ± 0.11	<i>t</i> = 0.47	.64
Follow-up, mo	44.65 ± 11.18	43.48 ± 9.66	<i>t</i> = -0.45	.66

^aData are reported as mean ± SD unless otherwise indicated. TT-TG, tibial tuberosity–trochlear groove.

TABLE 2
Outcome Scores^a

	Transosseous Suture Group	Suture Anchor Group	<i>t</i> Value	<i>P</i> Value
Kujala score				
Preoperative	55.13 ± 8.98	55.52 ± 8.75	0.18	.86
Final follow-up	88.90 ± 3.75	89.06 ± 3.37	-0.14	.89
<i>t</i> value	-18.01	-21.3		
<i>P</i> value	<.001	<.001		
IKDC score				
Preoperative	48.87 ± 9.10	47.94 ± 7.32	0.46	.65
Final follow-up	89.52 ± 4.69	87.68 ± 4.18	1.67	.10
<i>t</i> value	-23.88	-25.01		
<i>P</i> value	<.001	<.001		

^aData are reported as mean ± SD unless otherwise indicated. IKDC, International Knee Documentation Committee.

TABLE 3
Computed Tomography Findings^a

	Transosseous Suture Group	Suture Anchor Group	<i>t</i> Value	<i>P</i> Value
Congruence angle, deg				
Preoperative	21.03 ± 4.53	21.74 ± 4.09	-0.66	.51
Final follow-up	-6.61 ± 5.10	-6.94 ± 5.82	0.24	.81
<i>t</i> value	22.35	27.67		
<i>P</i> value	<.001	<.001		
Patellar tilt, deg				
Preoperative	22.35 ± 4.03	22.76 ± 3.62	-0.43	.67
Final follow-up	10.45 ± 3.10	9.79 ± 3.23	0.84	.41
<i>t</i> value	14.14	16.20		
<i>P</i> value	<.001	<.001		
Redislocation, %				
Final follow-up	0	0		

^aData are reported as mean ± SD unless otherwise indicated.

both groups, but there were no statistically significant differences in the Kujala or IKDC scores between the 2 groups.

CT Findings

The mean congruence angle in both the suture anchor and the transosseous suture groups can be seen in Table 3. There were no statistically significant differences between the 2 groups at follow-up. The postoperative

ROM and congruence angle were equivalent in the contralateral extremity in all patients at follow-up. No patients experienced redislocations in either group at follow-up (Table 3).

Other Complications

There were no other surgical complications, including infections, patellar fractures, or wound problems, at final follow-up.

DISCUSSION

The primary purpose of this study was to compare the clinical outcomes between transosseous sutures and suture anchors in MPFL reconstruction. With the current number of patients, the principal finding of this study was that clinical and stability results of MPFL reconstruction with transosseous sutures were not statistically different from those of MPFL reconstruction with suture anchors.

Biomechanical properties are a possible difference in the characteristics of the 2 surgical techniques (suture anchors vs transosseous sutures). Transosseous suture fixation (2 tunnels and 2 sutures) was shown to provide an adequate strength of fixation in MPFL reconstruction in a biomechanical study reported by Lenschow et al.¹⁷ Those authors compared MPFL reconstruction using transosseous sutures and suture anchors in a cadaveric model. They reported that the maximum load to failure of transosseous sutures (539.5 ± 159.6 N) was stronger than that of the normal MPFL and those of other fixation techniques (titanium suture anchor: 401.5 ± 96.1 N; interference screw fixation: 416.0 ± 101.7 N; medial bone bridge: 146.7 ± 79.6 N; and transpatellar tunnel: 354.4 ± 136.8 N).¹⁷

In the present study, no patellar fractures and no recurrent dislocations were reported in patients who underwent the suture anchor or transosseous suture techniques. The suture anchor and transosseous suture techniques were both shown to be safe for patellar fixation in MPFL reconstruction. To the best of our knowledge, this is the first report in the English literature that compares MPFL reconstruction with a transosseous suture technique and a suture anchor technique. A remarkable advantage of the transosseous suture technique for MPFL reconstruction is the cost, as this technique does not require implants. The resulting cost is far lower than that of the suture anchor technique or that of other devices, such as suspension buttons, biodegradable screws, and metallic anchors.

Limitations

The limitations of the study include the following: (1) This study was a prospective nonrandomized controlled study. The nonrandomly assigned nature of the study obviously does introduce the potential for selection bias. However, a double-blind randomized controlled trial may not be suitable for many patients in China because of the medical risk.^{27,40} Most patients may not trust doctors when choosing to participate in double-blind randomized controlled trials. Intolerance against doctors is a global phenomenon, but China seems to lead the world in violence against doctors, reflecting deteriorating relations between medical staff and their patients.^{27,40} The patient's family structure, disease awareness, and hospitalization model under the traditional Chinese social background seriously affect the doctor-patient relationship and decision making. Shared decision making between doctors and patients plays an important role in alleviating the pressure of doctors' decision making and improving doctor-patient relationships.^{9,10,38} In patients with chronic patellar instability,

patellar fixation techniques in MPFL reconstruction are still controversial, thus to determine that a treatment is suitable for an individual patient, we think that there is a strong need for communication between the patient and doctor. (2) The follow-up period was relatively short, and further studies will be needed to confirm the long-term efficacy of this technique in repairing patellofemoral instability. (3) We tried to focus on isolated MPFL reconstruction without any additional bony procedures because of the clinical complexity of recurrent patellar dislocations, which could limit the generalizability of the results of MPFL reconstruction; thus, bony risk factors, such as an increased TT-TG distance or trochlear dysplasia, were not included in this study. (4) The small sample size may have affected our finding that there was no difference in outcomes between the transosseous suture and suture anchor groups.

CONCLUSION

The use of the transosseous suture technique or suture anchor technique in MPFL reconstruction for recurrent lateral patellar instability achieved good clinical outcomes during a minimum follow-up of 24 months. The transosseous suture technique represents a reliable and reproducible alternative for MPFL reconstruction.

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