Arthroscopic medial patellofemoral ligament reconstruction for recurrent patellar dislocation: short-term clinical results

Yong Huang1,2, Yuan Yang1, Mingjin Zhong1, Fan Su1, Jian Xu1, Zhenhan Deng1, Kang Chen1, Wenzhe Feng1, Wei Lu1, Weimin Zhu1,2*

1Department of Sports Medicine, the First Affiliated Hospital of Shenzhen University, Shenzhen Second People's Hospital, Shenzhen 518035, Guangdong, China
2School of Medicine, Shenzhen University, Shenzhen 518035, Guangdong, China

These authors contributed equally: Yong Huang and Yuan Yang.

Corresponding Author:
Weimin Zhu, Department of Sports Medicine, the First Affiliated Hospital of Shenzhen University, Shenzhen Second People's Hospital, Shenzhen 518035, Guangdong, China, e-mail: szhzwm@email.sz u.edu.cn

Abstract

The present study aimed to introduce a novel technique to reconstruct medial patellofemoral ligament (MPFL) via arthroscopy for recurrent patellar dislocation. A retrospective review of a prospectively collected registry was undertaken. A total of 34 patients (35 knees) who underwent arthroscopic reconstruction of MPFL from December 2017 to August 2019 were identified. Kujala score, Tegner score, Lyscholm score, patellar tilt, and congruence angle were recorded preoperatively and postoperatively. The occurrences of patient satisfaction, complications, and recurrent dislocation were recorded. The cohort consisted of both genders equally, and the mean age was 21.0±7.8 years, the mean body mass index was 22.5±3.5, and the mean follow-up time was 21.8±5.6 months. The patellar tilt decreased from 46.4±19.3° to 12.5±16.9° (P < 0.001), the congruence angle decreased from 46.4±19.3° to 12.5±16.9° (P < 0.001), Kujala score improved from 55.1±4 to 88.7±4.4 (P < 0.001); Tegner score improved from 1.3±0.4 to 3.7±1.1 (P < 0.001), and Lyscholm score improved from 55.5±3.9 to 89.1±4.8 (P < 0.001). Among them, 30 (88.2%) patients fully recovered to normal pain-free daily life, 24 patients (70.6%) returned to sports, 32 patients were satisfied with surgery, and no redislocations were encountered. MPFL reconstruction via arthroscopy improves the knee joint function in patients with recurrent patellar dislocation and is a safe and effective surgical treatment for recurrent patellar dislocation.

Key words: Patellar dislocation; Medial patellofemoral ligament; Arthroscopy;
Recurrent patellar dislocation is a common disease of the knee joint and usually leads to pain, edema, limited activity, and reduces the patients’ quality of life\(^1\). The incidence of recurrent patellar dislocation is 2.29/100,000 person-years\(^2\), dislocations most commonly occur among teenagers, especially female\(^3\,4\). Many factors can result in patellar dislocation, medial patellofemoral ligament (MPFL) rupture, lateral retinacular tightness, femoral trochlear dysplasia, increased Q angle and patella alta\(^5\,8\). Recurrent patellar dislocation is often multifactorial and therefore, the diagnosis and treatment become challenging.

Furthermore, MPFL is the most important static structure that maintains the medial stability of patella\(^10\). A previous biomechanical study suggested that MPFL contributes to maintaining patellar stability of 50–60% in knee flexion within 0–30° range\(^11\,13\). A magnetic resonance imaging (MRI) study showed that 98.6% of patients with acute patellar dislocation had MPFL rupture\(^14\). Therefore, MPFL reconstruction has become the gold standard for the treatment of recurrent patellar dislocation. Femoral trochlear dysplasia is an major risk factor for recurrent patellar dislocation\(^5\,6,9,15,16\). Severe femoral trochlear needs to be corrected by trochleoplasty. Increased tibial tubercle-trochlear groove (TT-TG) distance is another risk factor for patellar dislocation\(^7,17\). Increased TT-TG distance leads to abnormal patella track and increases the risk of patellar dislocation risk. When the TT-TG distance is >20 mm, the abnormality needs to be treated with anteromedial tibial tubercle transfer. In addition, lateral retinaculum release significantly reduces the pressure on the lateral side of the patellofemoral joint\(^18,19\).

Recent studies have shown that isolated MPFL reconstruction exhibits satisfactory clinical outcomes on patients with femoral trochlear dysplasia, abnormal TT-TG distance, and Caton index\(^20\,21\). A large number of surgical techniques have been used to treat recurrent patellar dislocation. At present, the surgical treatment usually uses open incisions to establish the patella and femoral bones tunnel for MPFL reconstruction, which has disadvantages such as large surgical incisions, slow recovery, and obvious postoperative wound scars. Arthroscopy is used to loosen the lateral retinaculum and treat the intraarticular cartilage damage, reducing the surgical incisions and achieving early recovery\(^24\). Gao et al.\(^25\) made a window through the joint capsule under arthroscopy to expose the inner edge of the patella and reconstruct the MPFL patella insertion. The insertion of the femoral tunnel needs to be located by C-arm fluoroscopy, which has the disadvantages of the prolonged operation time, inaccurate positioning, and exposure of patients and medical staff to ionizing radiation. In the present study,
accurate positioning was achieved by locating the MPFL femoral insertion by arthroscopy, and the MPFL femoral tunnel was reconstructed via arthroscopy.

Therefore, the purpose of this study was to evaluate the short-term clinical outcomes of MPFL reconstruction under arthroscopy in the treatment of recurrent patellar dislocation. Herein, we hypothesized that MPFL reconstruction under arthroscopy achieves good clinical outcomes and significantly improves the Kujala score, Tegner score and Lysholm score, as well as the postoperative patella tilt and congruence angle.

**Results**

The cohort was followed up for an average of 21.8±5.6 (13–32) months, and the last follow-up time point was September 2020. The average TT-TG distance measured by CT before the operation was 17.7±4. At the last follow-up, no further dislocation was found in the patient. Table 1 summarizes the

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<th>Table 1 Patient Demographics</th>
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<td>Number of knees</td>
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<td>Follow-up rate, %</td>
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<tr>
<td>Mean age at surgery, years</td>
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<tr>
<td>BMI, kg/m²</td>
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<tr>
<td>Gender (F/M), n</td>
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<tr>
<td>Side (L/R), n</td>
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<tr>
<td>Follow-up period, months</td>
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<td>TT-TG, cm</td>
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Values are shown as mean ± SD unless otherwise indicated.
demographic characteristics. At the last follow-up, the patella tilt angle decreased from 25.5±11° before surgery to 6.7±6° after surgery (P < 0.001). The patellofemoral fit angle decreased from 46.4±19.3° before the operation to 12.5±16.9° after the operation (P < 0.001). The Kujala score rose from 55.1±4 before surgery to 88.7±4.4 after the surgery. The Tegner score increased from 1.3±0.4 before surgery to 3.7±1.1 after the surgery. The average Lyscholm score increased from 55.5±3.9 before surgery to 89.1±4.8 after the surgery. All scores have been significantly improved (P < 0.001, Table 2). A total of

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<th>Table 2 Patient-reported Outcome</th>
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<td></td>
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Clinical scores

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<tr>
<th></th>
<th>Preoperative</th>
<th>Follow-up</th>
<th>P</th>
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<tr>
<td>Kujala</td>
<td>55.1±4</td>
<td>88.7±4.4</td>
<td>&lt;0.001</td>
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<tr>
<td>Tegner</td>
<td>1.3±0.4</td>
<td>3.7±1.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lyscholm</td>
<td>55.5±3.9</td>
<td>89.1±4.8</td>
<td>&lt;0.001</td>
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Radiological evaluation

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<th>Follow-up</th>
<th>P</th>
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<tr>
<td>Patellar tilt angle</td>
<td>25.5±11</td>
<td>6.7±6</td>
<td>&lt;0.001</td>
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<th>Congruence angle</th>
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<td>Redislocation, %</td>
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Subjective satisfaction, n (%)

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<th>Preoperative</th>
<th>Follow-up</th>
<th>P</th>
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<tr>
<td>Satisfaction</td>
<td>32(94)</td>
<td></td>
<td></td>
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<tr>
<td>Disatisfaction</td>
<td>2(6)</td>
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Values are shown as mean ± SD unless otherwise indicated

30 (88.2%) patients subjectively considered that they had completely returned to normal and painless daily life, and 32 (94%) patients were satisfied with the results of the surgery. Two patients subjectively thought that they still had knee instability, but there was no dislocation. Subsequently, 24 patients
resumed exercise after the operation, and 10 patients were afraid to resume exercise because of fear of dislocation again. One patient developed a subcutaneous hematoma due to no compression bandage after the operation. After the hematoma was cleared and bandaged again, no infection recurred. The knee joint function of the patient recovered satisfactorily. None of the patients experienced postoperative joint stiffness. All patients used allogeneic tendons, and none had tendon exclusion reactions. Postoperative CT showed accurate positioning of the bone canal (Figure 1A), while MRI showed good tendon healing 1 year after the operation (Figure 1B).

![Figure 1](A) Postoperative CT showed the position of MPFL tunnel; (B) MRI of MPFL at 1 year after the operation. MPFL medial patellofemoral ligament.

**Discussion**

This study is the first report of arthroscopic reconstruction of MPFL. The results showed that arthroscopic reconstruction of MPFL in the treatment of recurrent patellar dislocation could achieve satisfactory therapeutic effects in a short period. A total of 34 patients were followed up for an average of 21 months. None of the patients had re-patella dislocation. The preoperative and postoperative comparison showed that the knee joint function score, patella inclination angle, and fit angle were significantly improved.

After an acute dislocation of the patella, conservative treatment is usually given priority, including physical therapy and fixation of the patella support band. Some studies have found that the incidence of recurrence of patellar dislocation after acute patellar dislocation is 10–50%. Presently, a large number of studies have shown that after acute patellar dislocation, almost all patients have MPFL rupture. Therefore, MPFL needs to be reconstructed to maintain the stability of the patella. The MPFL reconstruction has become a routine operation for the treatment of dislocation of the patella. The
current clinical studies have shown that the single-bundle reconstruction of MPFL significantly improves the knee joint function in patients with patellar dislocation. The current surgical method requires two incisions: a small incision on the inside of the patella, and a large incision on the femoral side to expose the epicondyle and adductor tuberosity of the femur and locate the MPFL femoral side stop. Due to the large incision on the femoral side, the trauma is large and can easily cause joint stiffness. MPFL femoral stop point positioning methods are mainly Schchottle point and adductor-assisted positioning methods. Schottle point requires intraoperative fluoroscopy, which increases the risk of ionizing radiation for patients and doctors, and increases the operation time. The adductor-assisted positioning method locates by touching the adductor nodules on the body surface. When there are more soft tissues on the adductor nodules, the touch positioning is prone to deviation.

Next, we use the anteromedial approach to find the femoral endpoint under knee arthroscopy, which avoids intraoperative fluoroscopy positioning of ionizing radiation and large incisions, reduces surgical trauma, and accurately determines the position under direct vision.

Currently, arthroscopy application in the treatment of recurrent patellar dislocation is mainly for joint exploration, synovial cleansing, and lateral support band loosening. Gao et al. performed an MPFL patella side reconstruction under arthroscopy to reduce the patella side incision and avoid the damage to the knee extension device caused by surgical trauma. The current method of reconstructing MPFL under arthroscopy accurately locates the femoral stop of MPFL, reduces the femoral side incision, and is minimally invasive. In addition, there is no need to see through the C-arm, reducing radiation damage.

The contracture of the lateral retinaculum is one of the factors for the outward movement of the patella. By loosening the lateral retinaculum, the pressure on the lateral patella can be relieved and the dislocation of the patella corrected. Therefore, it has become an auxiliary surgery for the treatment of dislocation of the patella. However, a randomized controlled study by Malatray et al. concluded that for patients undergoing MPFL reconstruction for recurrent patellar dislocation, lateral retinaculum release is not required. Song et al. found that excessive loosening of the lateral retinaculum can leads to iatrogenic patella instability, especially for patients without lateral retinaculum contracture. Therefore, it is necessary to screen patients with contracture of the lateral support belt and then allow a moderate release. The lateral support band loosening under arthroscopy reduces surgical trauma, helps early recovery, and avoids excessive loosening.
The choice of graft is one of the main points of MPFL reconstruction. Flanigan et al.\textsuperscript{32} compared autologous and allogeneic tendons to reconstruct MPFL and demonstrated that allogeneic tendons did not increase the incidence of re-dislocation of the patella and had the same therapeutic effect as autologous tendons. Because MPFL is an extraarticular structure, it has a better ligament healing environment. Similarly, McNeilan et al.\textsuperscript{33} study showed that the clinical results of allogeneic tendon are similar to that of autologous tendon. Choosing allogeneic tendons can avoid pain and discomfort in the donor site and reduce trauma, which is conducive to early rehabilitation training\textsuperscript{34}.

In conclusion, arthroscopic reconstruction of MPFL can significantly improve the knee function of patients with recurrent patellar dislocation, and is a safe and effective surgical method for the treatment of recurrent patellar dislocation.

\section*{Methods}

\textbf{Patient selection.} A total of 34 patients with recurrent patellar dislocation, who underwent arthroscopic MPFL reconstruction from December 2017 to August 2019, were included in this study. The cohort included 17 males and 17 females, encompassing 35 knees; the mean age was 21.0±7.8 (range, 12–42)-years-old, and the mean follow-up was for 21.8±5.6 (13–32) months. The inclusion criteria were as follows: (1) patellar dislocation at least twice; (2) MPFL reconstruction by arthroscopy; (3) follow-up for >1 year. Subsequently, patients treated with combined tibial tuberosity transfer were excluded from the study. Moreover, this study was approved by the Hospital Ethics committee of the First Affiliated Hospital of Shenzhen University. All the participants had surrendered informed consent preoperatively. As for participants under the age of 18 years, informed consent had been obtained from a parent and/or legal guardian. All methods were carried out in accordance with relevant guidelines and regulations.

Kujala, Tegner, and Lyscholm scores were evaluated before the operation. The standard anterior lateral view of knee flexion at 30° and computed tomography (CT) examination of the knee joint was performed before the operation. TT-TG distance, patella tilt, and congruence angle were measured by CT. Knee joint MRI was performed before the surgery to confirm lateral dislocation of the patella and MFPL rupture. Then, the CT examination of the knee was performed to assess the bone tunnel position postoperatively.
**Surgical technique.** All procedures were performed by the same senior surgeon. First, the adductor tubercle and medial femoral condyle on the medial side of the femur were touched; then, the midpoint of the two was taken as the MPFL femoral insertion, the skin was marked, and the Kirschner wire was located(Figure 2A). A 0.5–1 cm incision was made on the upper inner edge of the patella to bluntly separate the soft tissue, exposing the upper inner edge of the patella. A 4.5-mm hole was drilled in the middle and upper third of the inner edge of the patella, following which an anchor was inserted; subsequently, the anchor tail was pulled to confirm that the anchor is stable(Figure 2B). The knee arthroscopy anterolateral and anteromedial approaches were applied to clean up the synovial tissue in the joint. The tension of MPFL was explored in the state of flexion and extension of the knee joint, followed by an arthroscopic exploration of patellofemoral joint matching(Figure 3A). Next, the cartilage damage of the patellofemoral joint was explored, freshening and microfracture operations were performed.

**Figure 2** (A) MPFL femoral insertion was marked on skin; (B) An anchor was inserted in the inner edge of the patella; (C) MPFL was fixed by anchor in the inner edge of the patella

**Figure 3** (A) Arthroscopic exploration of patellofemoral joint matching; (B) Arthroscopic exploration of patellofemoral joint matching again
were performed on the existing cartilage defects, and loose bodies cleaned up. Subsequently, the cruciate ligament and meniscus were explored before the corresponding treatment. A canal was fashioned under the skin through the anteromedial incision to the MPFL femoral incision as an arthroscopic approach to the MPFL femoral side. The MPFL canal was also made from the medial incision of the patella to the MPFL femur incision. Arthroscopy was conducted through the anterior medial approach of the knee joint in addition to the planer via the medial patella incision approach, some soft tissue was cleaned around the Kirschner wire, an operation gap was made, and the superficial medial collateral ligament, adductor tuberosity, medial femoral condyle, and MPFL were exposed(Figure 4A). Arthroscopy revealed that the MPFL femoral tunnel was positioned as the midpoint of the adductor tuberosity and the medial femoral condyle. Then, the guide pen was re-inserted at the positioning point under the mirror, and an isometric test conducted. A 1-cm incision was fashioned in the skin of the MPFL femoral incision, and a bone tunnel with a diameter of 6 mm and a depth of about 5 cm was drilled under the arthroscope. The allogeneic tendon was woven into a diameter of 6 mm as the MPFL graft, the fold anchor line was fixed on the inner side of the patella, and soft tissue was used to cover the reconstruction of the MPFL patella incision(Figure 2C). The MPFL graft is penetrated into the femoral side bone tunnel through a subcutaneous canal, the tendon is tightened at 30° of knee flexion, and the patellofemoral joint matching is monitored by arthroscopy within the range of motion of the knee joint, and the tension of the MPFL is adjusted (Figure 3B). The 6-mm interface screw fixes the MPFL femur incision (Figure 4B). The MPFL femoral side was pressed by elastic bandage compression bandage to prevent subcutaneous hematoma formation, and the cotton legs were fixed to prevent thrombosis in lower limbs.
**Figure 4** (A) MPFL femoral tunnel insetion. (B) Interface screw fixed the MPFL femur insetion. ME medial epicondyle, sMCL superficial medial collateral ligament, AT adductor tuberosity, AMT adductor muscle tendon

**Rehabilitation protocol.** The cotton leg was fixed for 3 days, and the wound was pressure-bandaged for 7 days. On day 1, after the surgery, ankle pump training and straight leg raising training were started. Knee flexion training started on day 4 after the surgery, and the knee flexion reached 90° within 2 weeks. The full range of knee motion was achieved within 2 months. Partial weight-bearing and full weight-bearing started at 2 weeks and 4 weeks after surgery, respectively. The knee brace was fixed for 3 months, which started to return to sports 6 months post-surgery.

**Statistical analysis.** The data were analyzed using SPSS19.0 and expressed as mean±standard deviation. The imaging evaluation and functional score were compared as the preoperative and postoperative differences by paired t-test. P < 0.05 indicated statistically significant difference.

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**Author contributions**

All authors had full access to the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Y.H. and W.M.Z. were responsible for conception and design. Y.H. and Y.Y. contributed to study retrieval and’drafed the manuscript. M.J.Z., F.S., J.X. and Z.H.D. contributed to data collection. K.C., and W.Z.F. performed data analyses. W.L. contributed to language editing. All the authors contributed to the interpretation of the data and critically reviewed the manuscript for publication.

**Competing interests**

The authors declare no competing interests.
Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

References


