CLINICAL ARTICLE

Medial Patellar Retinaculum Plasty Versus Medial Capsule Reefing for Patellar Subluxation in Adult

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Objective: The purpose of this study was to evaluate the clinical and functional results of surgical treatment for patellar subluxation.

Methods: A retrospective study was undertaken between October 2004 and April 2009 of 78 cases of patellar subluxation: 40 cases with medial capsule reefing, of which 15 cases had the combination of lateral retinacular release (Group A); and 38 cases with medial patellar retinaculum plasty, of which 12 cases had the combination of lateral retinacular release (Group B). All patients had CT scans available for reviewing congruence angle (CA) with knee flexion at 30 degrees. In addition, knee function was evaluated using the Kujala score and subjective questionnaires.

Results: Patients were followed up for a mean 60 months (33–87 months). The Kujala score improved significantly from 78.3 ± 1.0 to 88.3 ± 1.6 in Group A and from 77.8 ± 0.9 to 91.2 ± 1.7 in Group B ($P < 0.05$). Postoperatively, the CA on CT scan had a statistical difference between the two groups ($P < 0.05$). The subjective questionnaire revealed a significant difference ($P < 0.05$), including 12 excellent, 20 good and eight fair in Group A, and 25 excellent, and 13 good in Group B.

Conclusion: The medial retinaculum plasty was better than medial capsule reefing in improving the subjective effects and decreasing the patellar subluxation rate.

Key words: Adult; Arthroscopy; Medial capsule; Medial patellar retinaculum; Patellar subluxation

Introduction

The function of the patellofemoral joint is normally maintained by a complex cooperation between soft tissues and bony structures¹. The etiologies that predispose patients to patellar subluxation and patellar dislocation were believed to be genu valgum, hypoplasia of the lateral femoral condyle, patella alta, contracture of the lateral patellar soft tissues, ligament laxity, a laterally located tibial tubercle, abnormal attachment of the iliotibial tract and vastus medialis insufficiency². Patients with radiologic signs indicative of a predisposition for patellar subluxation were excluded. Medial capsule reefing has been the main traditional method for strengthening medial retinaculum to treat patellar subluxation. However, Scuderi

et al. reported that 17.7% of patients with patellar subluxation had recurrent subluxation after medial capsule reefing³. In recent years, medial patellofemoral ligament (MPFL) reconstruction has been considered an important operation for patellar instability because there was a low rate of recurrence and good clinical outcome after MPFL reconstruction. But the main indication of medial patellofemoral ligament reconstruction was that medial patellofemoral ligament has been extreme injury or flabby^{4–6}. For patients of patellar subluxation, without mild injury of medial patellofemoral ligament, medial patellofemoral ligament reconstruction may not be necessary for such patients. Therefore, we summarized the anatomical and biomechanical study of the knee, combined with the

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advantages of traditional medial retinaculum reefing and medial patellofemoral ligament reconstruction, devising a new proximal realignment procedure—medial patellar retinaculum plasty. The present study aimed to compare the clinical results of medial capsule reefing and medial patellar retinaculum plasty.

Materials and Methods

Indications and Exclusion Criteria

Based on the judgment criteria of Merchant *et al.*⁷ and Schutzer *et al.*⁸, congruence angle (CA) of more than 16 degrees was judged to be patellar subluxation. The surgical indication and exclusion criteria and the patients' backgrounds were basically the same. The surgical indications were as follows: (i) at least 3 months of non-surgical treatment, there was still chronic anterior knee pain; (ii) less than grade II degeneration of articular cartilage; (iii) CT scan displayed patellar subluxation; and (iv) patellar lateral shift (PLS) not exceeding 1.5 cm with a hard end point by the Apprehension test.

Exclusion criteria were as follows: (i) Q angle greater than 20°; (ii) trochlear angle greater than 150°; (iii) tibial tuberosity-trochlear groove (TTTG) distance greater than 15 mm; (iv) patella alta (Insall-Salvati index greater than 1.2); (v) with patellar dysplasia grade IV and V (Wiberg classification); (vi) concomitant knee cruciate ligament or collateral ligament injury; (vii) rheumatoid arthritis, osteonecrosis with cartilage damage greater than grade II; (viii) acute knee injury; (ix) patellar dislocation; and (x) MRI shows: MPFL injury at the femoral attachment site.

Patients and Methods

From October 2004 to April 2009, we operated on 78 consecutive patients with patellar subluxation. With permission of the ethics committee of the Third Hospital of Hebei Medical University, randomization was based on the year of

birth (even/odd). There were 40 cases with medial capsule reefing, of which 15 cases had the combination of lateral retinacular release (Group A); and 38 cases with medial patellar retinaculum plasty, of which 12 cases had the combination of lateral retinacular release (Group B). Clinical manifestations showed all patients had anterior knee pain, heavier when squatting or walking upstairs and downstairs, 20 of them also had giving-way. CT scan was performed with the measurement of TTTG distance, CA, patellar tilt angle (PTA) and PLS. The knee function was assessed with the Kujala score and with a subjective questionnaire. There were no differences in preoperative data between the two groups. (Table 1)

Surgical Technique

With the patient lying supine and under subarachnoid anesthesia, arthroscopy was first carried out to assess and address any possible chondral lesions and concomitant pathology.

In Group A, 10 patients had patellar articular cartilage lesions of grade I, eight patients had patellar articular cartilage lesions of grade II and 10 patients had lateral femoral condyle lesions of grade II. The force directed medial shift of the patella less than a quarter the width of the patella indicated an overtension of the lateral retinaculum structure, and a lateral retinaculum release (LRR) was then performed arthroscopically⁹. After removing the arthroscope, an anteromedial incision was made on the patella, and then we dissected the subcutaneous tissue and deep fascia in turn that would expose the quadriceps muscle, the medial retinaculum of the patella, and the patellar tendon. We dissected the medial retinaculum and medial capsule thoroughly from the patellar tendon to the junction point of the vastus medialis and vastus intermedius, and then sutured the imbrication of the medial capsule to the patella temporarily. Through the evaluation of activity of the patella by hand, we observed the congruence of the patellofemoral joint with the knee at complete extension and the

TABLE 1 Comparison of patients' demographics in two groups

Indexes	Group A (n = 40)	Group B (n = 38)	t (χ^2 [95%CI])	P-values
Gender(M/F)	16/24	15/23	0.002	0.962
Age	28 (21–35)	29 (21–37)	−0.848 (−2.845, 1.148)	0.399
X-ray				
Insall index	1.03 ± 0.05	1.07 ± 0.06	−3.345 (−0.064, −0.016)	0.069
Q angle (°)	14.2 ± 1.3	14.4 ± 1.1	−0.739 (−0.739, 0.339)	0.057
CT scan				
TT–TG (mm)	12.1 ± 0.8	12.2 ± 0.6	−1.631 (−0.592, 0.059)	0.107
CA (°)	19.3 ± 1.1	19.4 ± 1.2	−0.276 (−0.547, 0.414)	0.784
PTA (°)	14.5 ± 1.1	14.3 ± 1.1	0.710 (−0.320, 0.675)	0.564
TA (°)	135.5 ± 3.3	134.4 ± 3.2	1.546 (−3.305, 2.262)	0.757
PLS (mm)	12.5 ± 1.1	12.6 ± 1.1	−0.402 (−0.595, 0.395)	0.700
Kujala score	78.3 ± 1.0	77.8 ± 0.9	0.027 (−0.441, 0.453)	0.979

CA, congruence angle; CI, confidence interval; PLS, patellar lateral shift; PTA, patellar tilt angle; TA, trochlear angle; TT-TG, tibial tuberosity-trochlear groove distance.

tracking of the patella during a flex motion through arthroscope. Based on the tracking of the patella, the tension of the medial capsule was adjusted and then sutured with PDS-1 sutures.

In Group B, there was I° patellar articular cartilage lesion in eight cases, II° patellar articular cartilage lesion in eight cases, II° lateral femoral condyle lesion in four cases. The force directed medial shift of the patella less than a quarter the width of the patella indicated an overtension of the lateral retinaculum structure, and a lateral retinaculum release (LRR) was then performed arthroscopically⁹. After removing the arthroscope, an anteromedial incision was made on the patella, and then we dissected the subcutaneous tissue and deep fascia in turn, which exposed the vastus medialis, the medial retinaculum of the patella, and the patellar tendon. A longitudinal dissection was made following the medial border of the patella to dissect the vastus medialis and medial retinaculum, and then a transverse dissection was made along the junction of the vastus medialis and medial retinaculum to the medial femoral condyle with the aim of dividing both of them. We pulled the medial retinaculum proximally and laterally to near the upper pole of the patella with temporary fixation, then we pulled the vastus medialis distally and laterally to near the middle line of the patella with temporary fixation. Through the evaluation of activity of the patella by hand, we observed the congruence of the patellofemoral joint with the knee at complete extension and the tracking of the patella during a flex motion through an arthroscope (Fig. 1). Based on the tracking of the patella, the tension of the medial retinaculum and vastus medialis was adjusted and then sutured. Finally, the two overlapping tissues were sutured with PDS-1 sutures (Fig. 2).

Postoperative Rehabilitation Program and Follow-Up

The postoperative rehabilitation program and follow-up of the two groups were basically the same. Quadriceps setting exercises and straight leg raising were encouraged from the day following surgery. Walking with partial weight bearing on two crutches and knee flex activities were also permitted as tolerated and gradually progressed from the day following surgery, until after one week, knee flexion up to 90° was obtained. After 2 weeks, full weight bearing was allowed, patients were advised to wear a knee pad to stabilize the patella during sports or rehabilitation exercises. Patients who achieved a sufficient range of motion, quadriceps strength and stability of the patella were allowed to begin normal daily living and jogging at one month and return to full sports activity at 3 months. During follow up, the patellofemoral joint was evaluated with CT scans and the knee function determined with the Kujala score and with a subjective questionnaire (Fig. 3).

Statistical Analysis

Statistical analysis was conducted with SPSS software. The differences between the two groups were analyzed with two-samples *t*-test. The subjective questionnaires were analyzed with the χ^2 test. A *P*-value of less than 0.05 was considered statistically significant.

Fig. 1 Picture showed arthroscopic appearance of patellar subluxation preoperatively (A). Fine congruence of patellofemoral joint with the knee at completely extension postoperatively (B). Patella was stabilized into the femoral trochlea with the knee at 10° flexion (C).

Fig. 2 Schematic diagram of operating procedure. (A) A longitudinal dissection was made following the medial border of the patella to dissect the vastus medialis and medial retinaculum, and then a transverse dissection was made along the junction of the vastus medialis and medial retinaculum to the medial femoral condyle with the aim of dividing both of them. (B) The vastus medialis and medial retinaculum were divided. (C) The medial retinaculum was pulled proximally and laterally to near the upper pole of the patella with fixation. (D) The vastus medialis was pulled distally and laterally to near the middle line of the patella with fixation, then the two overlapping tissues were sutured together.

Results

Patients were followed up for an average of 60 months (33–87 months). On CT scans, the CA had a statistically significant difference between the two groups at the latest follow up (Table 2). The Kujala score had significantly improved after surgery, from 78.3 ± 1.0 to 88.3 ± 1.6 in Group A and from 77.8 ± 0.9 to 91.2 ± 1.7 in Group B. The subjective

questionnaire revealed that there were 12 (30%) excellent results in Group A and 25 (65.7%) in Group B, eight (20%) patients in Group A and no (0%) patients in Group B answered fair. The Kujala score and PLS with the statistically significant differences between the two groups, and the subjective knee function in Group B was better than that in Group A (Table 2).

Fig. 3 A patient with subluxation of patella with left knee underwent the procedure of medial patellar retinaculum plasty. Difference was significant between preoperation (A) and postoperation (B) on CT scan.

Discussion

Patellar subluxation would change patellofemoral joint contact surface and contact stress including a local increase in stress and bounce of the patellofemoral joint. Patellar sub-

luxation for a long time would inevitably lead to degeneration of patellofemoral joint surface and cartilage lesion^{10,11}. When non-operative management of chronic patellar subluxation failed to provide symptomatic improvement, surgical intervention was commonly recommended¹²⁻¹⁵. The principle of treatment was to eliminate the factors leading to patellar subluxation and improve the soft tissue balance of the knee to prevent further cartilage lesion.

Patients with radiologic signs indicative of a predisposition for recurrent patellar subluxation were excluded; medial capsule reefing was the main traditional method by strengthening the power of the medial retinaculum to treat patellar subluxation. However, Scuderi *et al.* reported that 17.7% of patients with patellar subluxation had recurrent subluxation after medial capsule reefing³. In Group A, 40 cases with medial capsule reefing, until the latest follow-up, of which eight cases had a recurrence of patellar subluxation by measure of CA on a CT scan. This recurrence rate was similar to the data reported in the above literature. We considered the reason for the recurrence subluxation was that the strengthened power of the medial patella was not enough, so the tension of the medial capsule, which included the medial patellar ligament, were weakened as time went on. Then, laxity medial capsule had an adverse impact on the tracking of the patella.

Stability of the patella depended on the soft tissue system around the patella. The soft tissue system was divided into static structure and dynamic structure. Anatomic and biomechanical study showed that the MPFL was an important structure as a passive check rein at 20° of flexion, providing 53% to 67% of the medial soft tissue restraint to prevent lateral displacement of the patella and control its tracking^{16,17}. Medial patellofemoral ligament laxity will reduce the power of restraining lateral patellar translation, then result in lateral displacement of the patella. Long-term bad congruence of the patellofemoral joint may cause laxity of the medial patellar retinaculum, especially laxity of the medial patellofemoral ligament¹⁸. We separated the medial retinaculum from the vastus medialis by a transverse dissection along the junction of them, the medial retinaculum including the MPFL were then advanced proximally and laterally to near the upper pole of the patella with fixation, enabling us to shorten the lengths of MPFL and medial retinaculum, so as to increase the tension of the medial retinaculum. We also sutured the overlapping tissues (medial retinaculum included MPFL and vastus medialis, which were divided), so as to increase the thickness of medial retinaculum and MPFL, then further increased the tension of them, so that would avoid the power of medial retinaculum and MPFL more and more weaken as time went on. That could strengthen the static stability of medial patella effectively.

Vastus medialis was an important dynamic structure in preventing patella lateral translation. Goh *et al.* found medial stability to be reduced by 30% when the vastus medialis obliquus (VMO) was relaxed at 20° of knee flexion and also increased the load on the lateral facet¹⁹. The vastus medialis obliquus was the first part of the quadriceps to weaken and the last to recover when function is inhibited²⁰. So, restoring

TABLE 2 Follow-up results of knee function

Indexes	Group A (n = 40)	Group B (n = 38)	t (χ^2 [95%CI])	P-values
CT scan				
CA (°)	3.7 ± 3.3	2.7 ± 2.3	6.182 (1.189,2.318)	0.000
PTA (°)	8.5 ± 1.1	8.8 ± 1.1	-1.206 (-0.795,0.195)	0.700
PLS (°)	10.5 ± 2.3	9.1 ± 1.3	3.737 (0.748,2.457)	0.001
Kujala score	88.3 ± 1.6	91.2 ± 1.7	-7.510 (-3.605,-2.094)	0.000
Subjective questionnaire (n [%])			8.840	0.012
Excellent	12 (30%)	25 (65.7%)	—	—
Good	20 (50%)	13 (34.3%)	—	—
Fair	8 (20%)	0 (0%)	—	—

CA, congruence angle; CI, confidence interval; PLS, patellar lateral shift; PTA, patellar tilt angle.

and strengthening the function of the vastus medialis was very important for the patients who had patellar subluxation, even for the patients of patellar dislocation. Panagiotopoulos *et al.* revealed the location of the strong “meshing” fibers from the VMO to the MPFL close to its patellar insertion²¹. By shortening of the “meshing” fibers, the VMO “dynamizes” the MPFL, so medial patellofemoral ligament provides both static and dynamic stability for the patella. We pulled the lower border of the vastus medialis distally and laterally to near the middle line of the patella, strengthening the dynamic stability of the medial patella to effectively combat the power of lateral translation. Vastus medialis obliquus over the medial retinaculum was further strengthened as we “reconstructed” the static function of the MPFL and medial patellar retinaculum. We also strengthened the “meshing” structure of the anatomy, so as to gain a strengthening of the joint dynamic-static stability structure. The medial patellar retinaculum plasty was

performed in 38 patients, Kujala score from 77.8 ± 0.9 to 91.2 ± 1.7 , CA from 19.4 ± 1.2 to 2.7 ± 2.3 . Compared with medial capsule reefing, the Kujala score and PLS with the statistically significant differences between the two groups, and the subjective knee function in Group B was better than that in Group A.

Medial patellar retinaculum plasty, and vastus medialis obliquus overlap with the medial retinaculum, further strengthening and “reconstructing” the static function of the MPFL and medial patellar retinaculum. This also restored the “meshing” structure of them on the anatomy, so as to strengthen the functions of dynamic-static stability structure for patella. Compared with the medial capsule reefing, medial patellar retinaculum plasty effectively strengthened the power of the soft tissues of the medial patella, and restored the anatomic morphology of the soft tissues of medial patella, also providing the anatomic basis for the stability of the patella.

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