MEDIAL PATELLOFEMORAL LIGAMENT RECONSTRUCTION

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Introduction

Patellar dislocation is a complete displacement of the patella from the trochlear groove of the femur. It nearly always involves a lateral displacement and commonly occurs during sports [1, 2]. The incidence is roughly 6 per 100,000, although it is considerably higher in children and adolescents aged between 10 and 19 years with an incidence of 31 per 100,000 [1–3]. At this age, females have a 33% increased prevalence compared to males [3, 4]. Patellar instability typically occurs in patients with several anatomic risk factors, including both soft-tissue and osseous abnormalities [3–5].

Despite being a common pathology, relatively easy to diagnose, with well known risk factors, and over 100 operative techniques, patellar dislocations were mainly treated nonoperatively till the last fifteen years [5–7]. Traditionally, patients were treated nonoperatively following a first-time patellar dislocation, although the rate of recurrence may be as high as 50% [1, 2, 6]. In the 21st century, a new anatomic structure, medial patellofemoral ligament (MPFL), crucial for patellofemoral stability was determined [4–6, 8]. Patellar dislocation leads to the ligament rupture, resulting in weakened medial retinaculum and redislocation. This structure is injured in almost 95% of all patellar dislocations and it happens to be a risk factor for redislocation [4–6, 8, 9].

Advances in the understanding of the biomechanical importance of the MPFL have led to an increase in repair and reconstruction of this structure. This has resulted in the development of multiple techniques for MPFL reconstruction using different types of grafts and varying rehabilitation protocols [1, 4, 5, 8, 9]. The surgical technique with the best results and least complications still needs to be determined.

Due to the fact that the above mentioned surgical techniques are performed in very few hospitals in the...
northern province of Serbia (Vojvodina), the aim of this study was to describe different operative techniques for the MPFL reconstruction, point to their advantages and disadvantages, analyze our first short-term results, and compare them with others.

**Material and Methods**

The surgical procedures of MPFL reconstruction were performed in the General Hospital Subotica in 15 patients. Eleven patients (73.3%) were female, and the average age was 18 years (range, 13 - 24). The results were evaluated using preoperative and postoperative radiographic diagnostics and physical examinations, including: patellar apprehension test, lateral glide and patellar tilt test, as well as Lysholm score [10]. The average follow-up period was 14 months (12 – 16 months). The participants gave data about their postoperative symptoms and return to non-restricted activities.

Two operative techniques were used. The first used gracilis tendon as a substitute for the MPFL (6 patients), the other a quadriceps tendon (9 reconstructions). The surgeries were indicated in patients with recurrent patellar dislocation with: torn MPFL, minor or moderate trochlear dysplasia, and no serious cartilage damage (Outerbridge grades 3 or 4) established by X-ray, magnetic resonance imaging or previous arthroscopic findings [9, 11]. Both techniques have similar phases: arthroscopy, graft harvesting and preparation, patellar attachment, femoral attachment (tunnel), graft passage and fixation.

1. The first operative technique requires: gracilis muscle tendon, two anchors and one screw [9]. The gracilis tendon was harvested with stripper by palpating pes anserinus junction, as the size and strength has been shown to be sufficient for MPFL reconstruction (4 – 5 mm in diameter). A minimum graft length was 18 cm, whipstitched 10 mm at both ends. Afterwards, a 2 cm skin incision was performed from the superomedial corner, extending the medial edge of the patella. Under fluoroscopic guidance, two transverse tunnels were made in the upper third of the patella. The tunnels were drilled parallel to one another, 1 cm apart. We used a 2.4 mm drill for a guide pin in a transverse fashion across the patella to a minimum depth of 25 mm. Over-drilling was performed with a 4.5 mm cannulated reamer to a depth of 25 mm. The graft was fixed to the patella by passing the tails of the graft ends through the eyelets of 4.75 mm SwiveLock™ anchors and pushed into the drill holes until the eyelet was fully seated. Then, femoral insertion was prepared, because the proper position of the femoral insertion of the MPFL is crucial to maintain proper biomechanics of the patellofemoral (PF) joint. Profile X-rays were used for femoral insertion (Figure 1) [12]. The template can help to establish the position of the guide pin. The insertion point was approximately 1 mm anterior to the posterior cortex extension line, 2.5 mm distal to the posterior articular border of the medial femoral condyle, and proximal to the level of the posterior point of Blumensaat’s line. A 2.4 mm guide pin was drilled and the femur was over-drilled with a 6 mm cannulated reamer. The graft was passed between the second and third layers of the medial side of a knee by identifying the space between the vastus medialis and the capsule. The graft was looped through the passing suture and the suture was pulled from the patellar origin to the insertion point at the medial femoral epicondyle. A 1.1 mm guide wire was placed into the drill hole next to the femoral guide wire to facilitate insertion of the 6 mm x 23 mm bio-interference screw. The graft was inserted into the socket with equal tension on both graft bundles (Figure 2). The best isometry was achieved when the graft indicated constant tension. That happens when the screw is placed into the femur and the knee is at 30˚ of flexion. The MPFL isometry may be provisionally evaluated at this time by maintaining adequate tension on the graft and cycling the knee through the range of motion. The final step is closure of the wound and positioning the brace on the knee joint in extension.

2. The second surgical technique [11] differs from the first only in harvesting a different graft,
part of a quadriceps tendon. It is technically easier and cheaper, because it requires only one screw. The incision is made over the tendon. A 10 to 12 mm wide, 3 mm thick and 8 to 10 cm long strip from the central aspect of quadriceps tendon is harvested subcutaneously. The tendon strip is then dissected distally on the patella, left attached, diverged 90° medially underneath the medial prepatellar tissue and fixed with 2 sutures. The graft is passed through a tunnel and fixed at 20° of knee flexion with a bioabsorbable interference screw (Figure 3). The wound is closed with an intradermal suture.

Antibiotic prophylaxis and the same rehabilitation protocol were used in both groups. Thromboprophylaxis was not used. The above techniques offer immediate, stable fixation and allow active quadriceps exercises at postoperative day one. A postoperative brace locked at 0˚ - 90˚ of flexion should be worn for a period of 4 weeks. Weight-bearing is limited to partial weight-bearing crutch ambulation until wound healing is complete and at that point it can be increased according to the pain tolerance of the patient. Full range of motion is allowed after 6 weeks with light jogging or cycling [9, 11]. The results are marked with a statistical significance level of p < 0.0001.

Open epiphyseal plates, high grade trochlear dysplasia, tibial tubercle–to trochlear groove (TT-TG) distance greater than 20 mm and serious cartilage lesions (grade 3 or 4) are limited for performing MPFL reconstruction alone [9, 11]. These conditions were also exclusion criteria of our study. Patients who had additional procedures, like anteromedialization of the tibial tubercle and other knee operations, or did not comply with the rehabilitation protocol were also excluded from the study. The patients with habitual or first dislocations were not included in the study.

Results

In our study, the patellar dislocation was mostly caused by sport injury (6 patients; 40%). The second reason was a non-serious trauma during daily activities with a little force; in our study this mechanism occurred in 5 cases (33.3%). Three patients fell from height (20%), and one injury (6.6%) was sustained in a traffic accident.

The participants reported from 3 to 20 patellar dislocations before undergoing surgery (8 on average).

No significant difference was registered between the affected side: 8 left and 7 right knees were operated.

There were no patients with limited range of motion or infection.

Postoperative X-rays showed correct position of graft tunnel(s) in all cases.

One surgical complication was registered, anchor breakage in the gracilis tendon group, without need for revision extraction. In the same group there was only one bad result due to the development of high grade PF arthrosis.

In the second group, where MPFL was substituted by quadriceps tendon, the main disadvantage was a big scar without functional loss.

Our patients did not experience recurrent postoperative episodes of dislocation or subluxation. By the final follow-up, clinical tests for patellar instability had disappeared in all patients.

A significant improvement was registered in patients’ daily activities (instability, pain, swelling, weight-bearing, kneeling, squatting, climbing stairs) by Lysholm score (from 71.0 ± 10 points preoperatively to 95.5 ± 4.5 postoperatively, p < 0.0001).

There was no statistical difference in: range of motion, size of thigh muscles and postoperative Lysholm score between the groups (average 95.70 in quadriceps tendon and 95.25 in gracilis tendon group).

The return to unrestricted daily activities occurred in 14 of 15 patients. Only one patient did not return to competitive sport. Patients resumed full activity at 11 - 15 weeks after the surgery (after 3 months on average).

Discussion

The MPFL tear has been considered the “essential lesion” for patellar dislocations [4–6, 8, 9]. It represents a passive medial structure of a knee that prevents lateral patellar displacement during the initial degree of a knee flexion. The MPFL is most tightened at 20° - 30° of flexion and it plays an impor-
The average length of the MPFL is 65.2 mm (from 56.8 to 77.8 mm). The width ranges between 5 – 12 mm, 8.8 mm on average [5, 6, 13]. The insertion of MPFL is 10.6 ± 2.9 mm wide in femur, near adductor tubercle, distal to insertion of adductor magnus tendon, and just below medial epicondyle. Distal fibers of MPFL are inserted to proximal two thirds of patella, and proximal fibers to vastus intermediacy tendon. The MPFL is related only to a bundle of fibers that has a junction on patella, so Tanaka et al. [14] recommended the term “medial patellofemoral complex”, that would contain the fibers that are inserted to other anatomic structures, but functionally influence medial patellar stabilization. The confirmed causes of PF instability are: improper position of bone structures of lower extremity (patella alta, trochlear or patellar dysplasia, misalignment of the leg, rotational deformities of femur and tibia), as well as soft tissue disorders (atrophy of vastus medialis obliquus muscle, medial retinaculum laxity, overtightened lateral retinaculum and MPFL injury) [5, 6, 12, 14].

The first episode of patellar dislocation is common among young, physically active persons, most often in female teenage population [3, 4, 15]. Our results confirm that MPFL rupture happens most often in the second decade of life, and the incidence among females is almost three times higher than in males. After the initial injury, MPFL is ruptured resulting in patellar instability. Its femoral insertion is most often injured, but rupture can be placed also in patellar insertion or in the middle parts of ligament. The recurrent dislocation usually happens without a strong force and reduces spontaneously [3, 4, 15]. Repeated episodes of patellar dislocation result in PF pain, degenerative arthritis, and impairment of the activities of daily living. The history of many former dislocations, clinical examination and X-rays are mostly sufficient for accurate diagnosis. We used additional MRI diagnostics for: PF cartilage damage, trochlear morphology, measurement of TT-TG distance, present loose bodies and combined meniscal and ligament injuries, although MRI is today a standard method used worldwide for preoperative evaluation of knee structures [3, 4, 15].

Controversy persists as to whether first-line treatment of acute patellar dislocation should be conservative or surgical [15]. Almost a half of later injuries happen recurrently despite conservative treatment, leading to recommendation of surgical management of acute patellar dislocation, especially in patients with femoral avulsion of the MPFL [15]. On the other hand, the only prospective and randomized study to our knowledge [7] showed that surgical treatment did not show a demonstrable improvement in medium-term (7-year) outcomes over conservative treatment. No studies have demonstrated the efficacy of bracing and physical therapy in the treatment of acute patellar dislocations [4]. However, the aim of treatment is to decrease swelling, promote muscular strength, and increase the range of motion of the knee. Immobilization in extension may help the medial structures to heal, but stiffness may be a problem with this treatment [16].

Operative treatment for patellar dislocation has been published since the early 1900s, initially with an open-wedge osteotomy of the lateral femoral condyle. Over the past century, more than 100 different surgical procedures have been described in the literature [1, 2, 8, 9, 11, 12, 17–20]. These procedures typically involve a combination of lateral release, medial imbrication, distal realignment, and anteromedialization of the tibial tubercle, but the so-called gold-standard treatment for patellar instability has yet to be defined. The isolated lateral release is the only procedure that has been shown to be ineffective [21]. Comparing medial repair with nonoperative treatment of acute patellar dislocation, there is also no significant difference between the results [7]. Indications for a trochleoplasty include at least three episodes of patellar dislocation with high-graded trochlear dysplasia [17, 18]. Several types of distal realignment have been described and an indication is TT-TG distance greater than 20 mm [17, 18]. A medial transfer of the tibial tubercle (Elmslie-Trillat procedure) [19] and anteromedialization of the tibial tubercle [20] were created many decades ago.

Nowadays, MPFL reconstruction is most commonly performed in recurrent patellar dislocation [1, 8, 9, 11, 12, 15]. Although this procedure is spreading worldwide, the surgical technique with the best results and least complications needs to be determined [1]. There is still no consensus with regard to the choice of graft, its tension, or static versus dynamic reconstruction [1, 2, 11, 17, 18]. Many tendons and other structures are suitable and used for grafts, such as: gracilis, quadriceps, adductor magnus, semitendinosus, tibialis anterior, fascia lata, patellar ligament, and artificial ligaments [8, 9, 11, 12, 22–30]. Most of surgical techniques use hamstring tendons as the graft of choice [9, 12, 23–29]. We used gracilis tendon autograft in one group of patients and quadriceps tendon in the other. Steiner et al. [26] recommended the use of bone-quadriceps tendon autograft or bone-patellar tendon allograft for severely dysplastic knees in which more strength was thought to be warranted. Farr and Schepsis [27] support the use of a doubled semitendinosus allograft, not for its strength but rather to reproduce the broad attachment site on the patella.

Medial patellofemoral ligament reconstruction provides good results in terms of preventing future dislocations [9, 11, 12, 22–30]. However, not all patients with recurrent instability may benefit from this procedure. Nomura and Inoue [8] found only fair re-
results in patients with preexisting chondromalacia patella. Thus, they recommended reconstruction only for patients without advanced changes in the patellar cartilage. We agree with this relative contraindication. Our good first results may be a consequence not only of excellent operative technique, but also careful patient selection. Our results and first outcomes are comparable with others considering scores and complications [8, 15, 22, 28–30], because the average postoperative Lysholm score in other studies ranges between 88 and 96 points [8, 15, 22] and our patients resumed full activity 3 months after the operation that is also comparable with other published results [9, 11, 22].

The complication rate of MPFL reconstruction is very low (usually below 5%) [9, 11, 22, 27]. The most frequent are: relaxation, patellar fracture, improper bone tunnels and size of the graft, overtension of the graft and implant breakage [15, 23, 25, 32–40]. All of mentioned techniques use bone tunnels and anchors for graft fixation on the patella. There are few reports on MPFL reconstruction using a strip of quadriceps tendon (QT) without anchors or bone tunnels in the patella because quadriceps tendon is naturally connected to it [11, 22, 33]. We used the same technique in the second group. Despite good clinical results, the cosmetic appearance of longitudinal scar over the thigh, as well as technical difficulties of harvesting a consistently appropriate strip of QT, have prevented widespread use of this technique. Although it is relatively easy to perform and cheap, in our opinion this is the only disadvantage of this technique. To overcome some of the aforementioned limitations, a new harvesting technique for the QT has been developed, that not only allows a constant graft harvesting with respect to width and thickness, but also necessitates a smaller skin incision of 2 cm in comparison to former 10 cm [22]. Two small tunnel technique that we used in the second group allows safe placing of a single-tendon graft, thus minimizing potential complications and patellar fracture [29, 40].

Kumahashi et al. [15] reported 5% of complications that resulted in reoperation, such as removing an irritating titanium interference screw from the femoral side. Other authors used only bioabsorbable interference screws and reported 7–10% of cases of screw removal, due to screw protrusion or pain [23, 26]. Matthews and Schranz [25] reported even 28% of complications that needed reoperation. Five patients required a manipulation under anesthesia, because their flexion ability was less than 90° but subsequently regained a satisfactory range of motion. One patient developed a neuroma related to hamstring harvest, which was excised. Another patient underwent a washout for infection. Revisions after these procedures are mostly performed to relieve medial pain syndrome due to faulty placement of the femoral graft attachment, sometimes because improper gliding of patella in the trochlear groove, caused by the faulty position of graft and weakness of patellar stabilizers [12]. We avoided complications such as anchor penetration into the joint or pain regarding severe PF osteoarthritis or trochlear dysplasia by using intraoperative X-rays and careful patient selection.

Arnbjornsson et al. [16] evaluated patients with bilateral recurrent PF instability and compared the results of surgical treatment of one knee and conservative in the contralateral knee. At a mean of 14-year follow-up, 75% of the operated knees presented with degenerative changes compared to 29% in the conservatively managed knees [16]. Current techniques such as MPFL reconstruction, combined with less post-op immobilization and a more knowledgeable approach to postsurgical rehabilitation, could translate into surgical management with more encouraging long-term results. This is suggested by a few midterm studies. Nomura et al. [35, 36] reported (only) 12% of moderate PF osteoarthritis, 12 years after MPFL reconstruction. More discouraging is a study of Farr et al. [37] who used medialization of the tibial tubercle reporting severe cartilage lesions in 23% of patients. Those authors also reported worst radiographic results in patients treated late, suggesting that delayed surgical treatment, allowing recurrent patellar dislocation, may cause further chondral damage, as reported by other authors [37, 38]. There is no current evidence that surgical treatment of patellar instability prevents or delays early PF osteoarthritis [35–39]. Conclusions are similar to anterior cruciate ligament (ACL) reconstructions, considering prevention of cartilage damage, risk factors and outcomes [41–45]. It seems that patellar instability is very similar to instability of the knee joint. ACL is pointed as a key structure for femorotibial joint, as MPFL is in the patellofemoral joint. Risk factors, mechanisms of injury and anatomic junctions are well defined, so developed operative techniques must: achieve isometry, strength, prevent redislocations, minimize complications and improve patients’ quality of life [41–46]. In our opinion, the choice of graft and implants is not crucial for final outcome. Although it is reasonable to assume that achieving stability can prevent cartilage damage, there is still no evidence that structure reconstruction affects prevention of osteoarthrosis.

The main limitations of this research are: short follow up period, small number of patients, and lack of some modern instruments that would reduce the scars. This study showed a zero redislocation rate and patient outcome scores compatible with other reported MPFL reconstructions. Patient selection remains vitally important to ensure optimal surgical outcomes.

Our study opens many questions concerning the best time for surgery and surgical technique, the ideal choice of graft and its tensioning, and whether surgical treatment of patellar instability can prevent early osteoarthritis. Answers may be found by further investigations.

**Conclusion**

Recurrent patellar dislocation commonly occurs in young female athletes with risk factors. It is mostly caused by dysfunction of medial patella stabilizers, medial patellofemoral ligament in the first place, that is ruptured during the initial injury. Al-
most half of patients have recurrent dislocations after non-surgical treatment. There is no gold standard surgical procedure for patellar dislocation, because many anatomical and functional factors affect the final surgical outcome.

Reconstruction of the medial patellofemoral ligament with gracilis and quadriceps tendons can prevent postoperative episodes of dislocation if proper surgical technique is used and in careful patient selection.

This study showed that both reconstructive techniques provide acceptable results in the treatment of recurrent patellar dislocation in short-term follow up.

References