Medial quadriceps tendon femoral ligament reconstruction and medial patellofemoral ligament reconstruction have no significant differences in clinical outcomes for treatment of lateral patellar instability: a matched-cohort study

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Medial patellofemoral ligament
Medial quadriceps tendon-femoral ligament
Patellar instability
Tibial tubercle osteotomy
Return to sport
Return to work

ABSTRACT

Objectives: The purpose of this study was to compare clinical outcomes of medial quadriceps tendon-femoral ligament reconstruction (MQTFLR) and medial patellofemoral ligament reconstruction (MPFLR) among patients with recurrent lateral patellar instability.

Methods: A retrospective matched-cohort study was conducted involving patients who underwent MQTFLR or MPFLR with or without tibial tubercle osteotomy (TTO) from 2019 to 2021. Subjects were matched 1:1 on age, concomitant osteochondral allograft (OCA), concomitant TTO, and follow-up time. Measured outcomes included 90-day complications, Visual Analog Scale (VAS) knee pain, return to sport/work, Kujala score, Tegner score, and MPFL-Return to Sport after Injury (MPFL-RSI) score. Outcomes were compared between groups using Mann-Whitney U-test for continuous variables and Fisher's exact test for categorical variables. P-values < 0.05 were considered significant.

Results: Ten MQTFLR patients (mean age 28.7 years, 80% female, mean follow-up 19.7 months) and ten MPFLR patients (mean age 29.1 years, 90% female, mean follow-up 28.3 months) were included in the study. One MQTFLR patient (10%) and three MPFLR patients (30%) underwent reoperation for postoperative arthrofibrosis. Postoperative VAS resting pain was not significantly different between the groups (MQTFLR mean 1.1, MPFLR mean 0.6, p = 0.31). There were no significant differences in rates of recurrent subluxations (MQTFLR 10%, MPFLR 0%, p = 0.47), return to sport (MQTFLR 50%, MPFLR 75%, p = 0.61), return to work (MQTFLR 100%, MPFLR 88%, p = 1.00), or MPFL-RSI pass rate (MQTFLR 75% vs. MPFLR 38%, p = 0.31).

Conclusion: There were no significant differences in knee pain and function, return to work, and rates of recurrent patellar instability between patients who underwent MQTFLR versus MPFLR, though these results should be interpreted with caution given the small sample size and potential selection bias.

Level of Evidence: III.

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What are the new findings?

- There are no significant differences in knee pain, functional outcome scores, satisfaction, or rate of recurrent instability between patients who underwent primary medial quadriceps tendon-femoral ligament reconstruction versus patellar instability.
- There was a non-significant lower rate of arthrofibrosis among patients treated with MPFLR.
- Psychological readiness to return to sport, as measured by the Medial Patellofemoral Ligament-Return to Sport After Injury survey instrument, was non-significantly higher among patellar instability patients.

INTRODUCTION

Patellar instability is a common source of anterior knee pain and dysfunction among young athletes with a peak incidence at around 15–19 years of age in the United States [1]. Instability, which may present as recurrent patellar subluxations and/or dislocations, is often associated with insufficiency of the proximal medial patellar restraints (PMPRs) which consist of the medial patellofemoral ligament (MPFL) and the medial quadriceps tendon-femoral ligament (MQTFL) [2]. Reconstruction of either or both ligaments (MPFLR/MQTFLR) with allograft may prevent patellar instability, but key differences in the anatomy and surgical technique may contribute to differences in outcomes between the two procedures [3,4].

Comparative analyses of isolated MPFLR versus isolated MQTFLR have been conducted in cadaveric specimens, with some studies suggesting that the former may provide greater resistance to lateral patellar translation [5-7]. However, some systematic reviews have identified a small but significant risk of patellar fracture following MPFLR, with rates as high as 17% [8-10]. In contrast, MQTFLR may obviate this risk entirely by avoiding bony fixation of the graft to the patella [11]. Outcomes data on MQTFLR for patellar instability are sparse, but at least one retrospective series has identified high rates of symptom resolution, patient satisfaction, and return to physical activity following this procedure [12]. Given the paucity of comparative clinical studies on MQTFLR versus MPFLR, there is no consensus on which procedure yields superior outcomes among patellar instability patients in terms of symptom relief, return to sport, and return to work.

The purpose of this study was to compare clinical outcomes of MQTFLR and MPFLR among patients with recurrent patellar instability. The specific aims were to (1) compare rates of complications and reoperations, (2) compare patient-reported knee pain and functional outcomes, and (3) compare rates of return to sport and work. The hypothesis was that there would be no significant difference in pain, function, return to sport, or return to work outcomes between the two procedures since both techniques have been shown to provide adequate resistance to lateral patellar translation in cadaveric models. However, it was also hypothesized that there would be lower rates of complications such as iatrogenic patellar fracture and arthrofibrosis among MQTFLR patients since the procedure does not involve bony fixation to the patella.

METHODS

Study design

A single-center, multisurgeon retrospective comparative cohort study was conducted.

Ethical approval

Ethical approval for this study was obtained from the New York University Langone Health institutional review board (approval #19-01430).

Cohort selection and matching

Patients who underwent MQTFLR with allograft for treatment of patellar instability from January 2019 to December 2021 at a single urban academic medical center were identified through a retrospective review of electronic medical records. Although the indications for MQTFLR are the same as for MPFLR, MQTFLR is more commonly performed at the study institution during patellar stabilization procedures that involve concomitant osteochondral allografting (OCA), arthroplasty, or other “bony” interventions on the patella that may increase the risk for fracture. MQTFLR was not performed at the study institution prior to 2019. An initial search of the electronic medical record system was performed using CPT codes 27,405, 27,420, 27,422, 27,424, 27,425, 27,427, and 27,429, and subjects were individually screened for inclusion in the cohort. Inclusion criteria were (1) diagnosis of lateral patellar instability, (2) MQTFLR with or without anteromedialization by tibial tubercle osteotomy (TTO), (3) skeletally mature at the time of surgery, and (4) minimum follow-up of 10 months. Exclusion criteria were prior MQTFLR or MPFLR or concomitant MPFLR.

The MPFLR group was also identified retrospectively using the same CPT codes as for the MQTFLR cohort. Subjects in this cohort underwent MPFLR with allograft at the study institution for treatment of patellar instability. Inclusion and exclusion criteria were the same as for the MQTFLR cohort. MQTFLR and MPFLR cohorts were matched 1:1 by age (to within 7 years), concomitant OCA, concomitant TTO, and follow-up time (to within 5 months).

Diagnosis of lateral patellar instability

The diagnosis of lateral patellar instability was made on the basis of patient history, physical exam, and radiographic findings. Presenting symptoms included anterior knee pain, at least one acute patellar dislocation episode (either traumatic or atraumatic), and/or more commonly recurrent symptomatic patellar subluxation and/or dislocation episodes. Physical exam findings included tenderness to palpation over the MPFL, ≥2 quadrants of passive patellar translation, positive patellar apprehension test (i.e. discomfort or apprehension with forced lateral patellar translation), and/or positive J sign. Radiographic evidence of patellar instability on magnetic resonance imaging (MRI) scans included, but was not limited to, bone bruising about the medial patella facet and lateral femoral condyle, MPFL attenuation or disruption, increased tibial tubercle-to-trochlear groove (TT-TG) distance, and patellofemoral chondral damage with or without a loose chondral body.

Indications for concomitant procedures

Anteromedialization TTO was indicated for patients with TT-TG distance ≥18 mm with the goal of reducing the TT-TG distance to 12 mm. OCA was indicated for patients of age <50 years who presented with symptoms of knee pain, swelling, and/or catching; were physically active with participating in high demand sports/activities; and had a full-
thickness chondral defect of diameter 15–35 mm. Lateral retinaculum release or lengthening was indicated for patients with positive patella tilt test (i.e. inability to rotate the lateral border of the patella more than 5 mm) indicating an excessively tight lateral retinaculum, and all releases were performed using open technique. Trochleoplasty with the Peterson grooveplasty technique [13] was indicated for patients with Dejour type B or D trochlear dysplasia and supratrochlear spur >5 mm.

Surgical technique for MQTFLR reconstruction

All MQTFLR procedures were performed under general anesthesia with a saphenous nerve-adductor canal regional block. With the patient in supine position, the involved knee was examined under anesthesia to assess the integrity of the cruciate and collateral ligaments, the extent of lateral patellar translation on patellar glide test, and the presence of J-sign on flexion. The limb was then exsanguinated and a tourniquet was inflated around the proximal thigh for the duration of the procedure.

Diagnostic knee arthroscopy was performed prior to any open procedures. Standard anterolateral and anteromedial portals were placed. The arthroscope was first advanced into the patellofemoral compartment to confirm lateral patellar tracking under direct visualization and to identify any patellar or trochlear chondral defects. The scope was then advanced into the medial and lateral compartments to assess for any meniscal, chondral, or ligamentous pathology. Any loose bodies in the medial and lateral gutters were removed using a grasper and shaver.

Following arthroscopy, the open portion of the procedure commenced. The main incision was made starting at the superior border of the patella extending distally to four fingerbreadths below the tibial tubercle. Lateral retinaculum release or lengthening (if indicated) was performed beginning at the lateral aspect of the patellar tendon extending up to the superior border of the patella while avoiding injury to the vastus lateralis tendon and lateral meniscus. TTO (if indicated) was performed using a technique previously described by Markus et al. [14]. To summarize briefly, a guide pin was inserted into the tibial tubercle perpendicular to the posterior tibia, an osteotomy cutting block was then mounted to this guide pin onto the medial aspect of the tubercle, the cut was made using a sagittal saw at a 45° or 60° angle, the tubercle was fixed using two 5.0 mm cortical screws inserted using lag technique, and screw positioning was confirmed using intraoperative fluoroscopy. OCA for patellofemoral compartment lesions (if indicated) was performed using a lateral parapatellar arthroscopy approach, orthotopic graft harvested from the donor patella/trochlea, and press fit technique to seat the graft plug in the defect site [15,16].

After completing all concomitant procedures, the MQTFLR was performed. All reconstructions were performed using frozen allografts. Allograft was used instead of autograft as the former has the advantage of avoiding donor-site morbidity and is associated with lower rates of recurrent patellar instability and redislocations in several systematic reviews [17, 18]. Based on surgeon preference, a doubled semitendinosus or tibialis anterior allograft was prepared on the back table. An incision was made medial to the patella and down to the medial retinaculum. The vastus medialis oblique (VMO) was elevated and the adductor longus tendon inserting onto the adductor tubercle was identified. A guide pin was placed at the distal anterior aspect of the adductor tubercle (the anatomic origin of the MQTFL), which was then over-reamed to create a socket. The femoral end of the graft was passed into this socket and secured with an interference screw. The tendinous end of the graft was passed under the VMO, then up through a slit in the VMO tendon, then down through a slit in the quadriceps tendon. The graft was tensioned at 30°–60° of knee flexion to avoid over-tensioning. Flat-braided sutures were used to secure the tendinous end of the graft. The patella was confirmed to be tracking centrally with firm endpoint and ≤2 quadrants of lateral translation at 30° of flexion and without J-sign before commencing closure.

All remaining incisions and arthroscopy sites were closed in standard fashion. If TTO was performed, bone void filler was placed at the osteotomy site and allowed to dry before closing the arthroscopy.
were employed prior to injury, their preinjury level of work intensity was classified using the Association for Work Design, Business Organization and Business Development (REFA) classification of workload in which class 0 corresponds to the lowest level of intensity (work without load such as desk work) and class 4 corresponds to the highest level of intensity (work involving carrying loads of more than 50 kg) [21]. Secondary outcomes included incidence of 90-day complications (ex. surgical site infections, arthrofibrosis) and reoperations (ex. lysis of adhesions, graft revision). All subjects were surveyed via email using the REDCap data collection software (Vanderbilt University, Nashville, TN, USA), and clinical data were extracted from their medical records [22,23].

### Statistical analysis

Clinical characteristics and outcomes between the MQTFLR and MPFLR cohorts were compared using Mann-Whitney U-test for continuous variables and Fisher’s exact test for categorical variables. P-values less than 0.05 were considered significant. All analyses were performed in SAS Studio version 9.4 (SAS Institute, Cary, NC, USA).

### RESULTS

#### Patient demographics and operative characteristics

Fourteen patients were initially identified as having undergone MQTFLR procedures at the study institution from January 2019 to December 2021. Three patients were excluded due to insufficient follow-up time and one patient was excluded due to loss to follow-up. The final MQTFLR cohort comprised 10 patients (Table 1) who were of mean age 28.7 years (range 19–52) at the time of surgery, were majority female (8 patients; 80%), and had a mean follow-up time of 24.0 months (range 10–45).

Ten patients who underwent MPFLR were matched to the MQTFLR cohort (Table 1). The MPFLR cohort was of mean age 29.1 years (range 16–51) at the time of surgery, were majority female (9 patients; 90%), and had mean follow-up time of 19.7 months (range 10–34). There were no significant differences between the MQTFLR and MPFLR cohorts in matched characteristics: age (p = 0.74), concomitant OCA (p = 1.00), concomitant TTO (p = 1.00), and follow-up time (p = 0.06). Therefore, matching was deemed successful.

There were no significant differences in other nonmatched demographic characteristics such as sex (p = 1.00) and BMI (p = 0.91). The MQTFLR group had a higher rate of prior surgeries on the index knee but this difference did not reach statistical significance (MQTFLR 70% vs. MPFLR 20%; p = 0.07).

With regard to intraoperative characteristics (Table 2), there was a significant difference between the cohorts in graft types used (p < 0.001) with 60% of MQTFLR patients receiving tibialis anterior allograft and 100% of MPFLR patients receiving gracilis allograft. All patients that received an OCA did so for a primary lesion of the patella. All primary chondral lesions were of Outerbridge grade IV. The one patient in the MQTFLR group that had a concomitant trochleoplasty had Dejour type B dysplasia and a TT-TG distance of 9 mm.

#### Complications and reoperations among the two cohorts are summarized in Table 3. The only complication noted was arthrofibrosis, and there were no reported cases of iatrogenic patellar fracture in either cohort. The rate of arthrofibrosis was higher in the MPFLR cohort compared to the MQTFLR cohort, though this difference did not reach statistical significance (MQTFLR 30% vs. MPFLR 10%, p = 0.58). All patients with arthrofibrosis underwent reoperation with manipulation under anesthesia (MUA) and/or arthroscopic lysis of adhesions within 3 months of the index procedure. No other reoperations were noted, including revisions of the primary MQTFLR or MPFLR graft.

Patient-reported outcomes are also summarized in Table 3. VAS pain levels at rest and with sports were low in both cohorts and did not differ

### Table 1

Demographics and prior medical history among patients undergoing medial quadriceps tendon-femoral ligament reconstruction (MQTFLR) versus medial patellofemoral ligament reconstruction (MPFLR).

<table>
<thead>
<tr>
<th>Variable</th>
<th>MQTFLR (n = 10)</th>
<th>MPFLR (n = 10)</th>
<th>P-valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>28.7 ± 10.6</td>
<td>29.1 ± 10.6</td>
<td>0.74</td>
</tr>
<tr>
<td>Sex</td>
<td>Male: 2 (20%)</td>
<td>Male: 1 (10%)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Female: 8 (80%)</td>
<td>Female: 9 (90%)</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>26.5 ± 5.5</td>
<td>26.4 ± 5.1</td>
<td>0.91</td>
</tr>
<tr>
<td>Race</td>
<td>White: 5 (50%)</td>
<td>White: 6 (60%)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Black: 3 (30%)</td>
<td>Black: 3 (30%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>APE: 2 (20%)</td>
<td>APE: 1 (10%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other: 1 (10%)</td>
<td>Other: 0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Smoking history</td>
<td>Never: 10 (100%)</td>
<td>Never: 9 (90%)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Former: 0 (0%)</td>
<td>Former: 1 (10%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current: 0 (0%)</td>
<td>Current: 0 (0%)</td>
<td></td>
</tr>
<tr>
<td>ASA physical status classification</td>
<td>E: 5 (50%)</td>
<td>E: 6 (60%)</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>I: 5 (50%)</td>
<td>I: 4 (40%)</td>
<td></td>
</tr>
<tr>
<td>Laterality of index knee</td>
<td>Left: 7 (70%)</td>
<td>Left: 4 (40%)</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Right: 3 (30%)</td>
<td>Right: 6 (60%)</td>
<td></td>
</tr>
<tr>
<td>Traumatic onset of instability symptoms</td>
<td>4 (40%)</td>
<td>4 (40%)</td>
<td>1.00</td>
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<tr>
<td>Prior index knee surgery</td>
<td>7 (70%)</td>
<td>2 (20%)</td>
<td>0.07</td>
</tr>
<tr>
<td>Chondroplasty</td>
<td>5 (50%)</td>
<td>1 (10%)</td>
<td>0.14</td>
</tr>
<tr>
<td>Loose body removal</td>
<td>3 (30%)</td>
<td>1 (10%)</td>
<td>0.58</td>
</tr>
<tr>
<td>Partial lateral meniscectomy</td>
<td>1 (10%)</td>
<td>0 (0%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Lateral retinaculum release</td>
<td>1 (10%)</td>
<td>1 (10%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Preoperative TT-TG distance</td>
<td>13.8 ± 7.2</td>
<td>18.9 ± 5.0</td>
<td>0.10</td>
</tr>
<tr>
<td>Dejour classification of trochlear dysplasia</td>
<td>A: 4 (40%)</td>
<td>A: 5 (50%)</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>B: 5 (50%)</td>
<td>B: 4 (40%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C: 0 (0%)</td>
<td>C: 0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Follow-up time (months)</td>
<td>19.7 ± 8.7</td>
<td>28.3 ± 9.9</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Abbreviations: BMI — body mass index, API — Asian/Pacific Islander, ASA — American Society of Anesthesiologists, TT-TG — tibial tubercle to trochlear groove.

* Continuous variables are reported with mean ± standard deviation, categorical variables are reported with count (%).

b P-value for inter-group comparison of variables with Mann-Whitney U test (for continuous variables) or Fisher’s exact test (for categorical variables).
significantly between MQTFLR and MPFLR patients ($p > 0.05$). Patient satisfaction was similar between cohorts ($p = 0.44$) and a similar number of patients in both cohorts stated they would undergo the same surgery again ($p = 1.00$). Kujala and MPFL-RSI scores did not significantly differ between the cohorts ($p > 0.05$). However, twice as many patients in the MQTFLR cohort obtained a passing score on the MPFL-RSI survey compared to the MPFLR cohort, though this difference was not statistically significant (MQTFLR 75% vs. MPFLR 38%, $p = 0.31$). Both cohorts had similar pre-injury Tegner scores ($p = 1.00$), preoperative Tegner scores ($p = 0.73$), and postoperative Tegner scores ($p = 0.70$). In both cohorts, a majority of patients improved over their preoperative baseline score but failed to achieve their pre-injury baseline score. Recurrent
patients in either cohort reported dislocation episodes after surgery.

Return to sport rates were comparable between athletes in both cohorts, with 50% of MQTFLR patients and 75% of MPFLR patients returning to sport (p = 0.61). However, among those who returned to sport, only 50% of MQTFLR patients and 33% of MPFLR patients returned to the pre-injury level. Of the patients who returned to sport, 80% achieved passing MPFL-RII scores. Of the patients who failed to return to sport, only 50% achieved passing MPFL-RII scores. By contrast, return to work rates were high in both cohorts with 80% of MQTFLR patients and 80% of MPFLR patients returning to work after surgery (p = 1.00).

**DISCUSSION**

This study aimed to compare clinical outcomes of MQTFLR and MPFLR among patients with recurrent patellar instability. The analysis found no significant differences in knee pain, functional outcome scores, satisfaction, or rate of recurrent instability between patients who underwent primary MQTFLR versus MPFLR. In addition, there were no reported cases of patellar fracture in either group. However, the study did find a slightly higher rate of arthrofibrosis in the MPFLR group compared to the MQTFLR group, though this difference did not reach statistical significance. In addition, while return to sport and work outcomes were similar between the two cohorts, a higher percentage of athletes in the MQTFLR group achieved a passing score on the MPFL-RII survey indicating psychological “readiness” to return to sport.

From a biomechanical standpoint, reconstruction of the MQTFL may potentially offer certain advantages over reconstruction of the MPFL, given that the former is a more dynamic stabilizer of the patella and may reduce abnormal loading of the patellofemoral compartment [7]. The intricate anatomy of the medial soft-tissue stabilizers of the patella, collectively referred to as the medial patellofemoral complex (MPFC), was first described by Warren and Marshall in 1979 [24]. The MPFC comprises both MPFL and MQTFL and the distal medial patellar restraints (DMPRs), the medial patellofemoral ligament (MPTL) and medial patello-meniscal ligament (MPML). While it is well-understood that the MPFL serves as the primary restraint to lateral patellar translation from 0 to 70° of knee flexion, biomechanical studies have established that other structures of the MPFC also play crucial roles in resisting patellar displacement [25,26]. Unlike the MPFL, which has a static insertion on the superomedial aspect of the patella, the MQTFL inserts on the undersurface of the distal quadriceps tendon and is thus a more dynamic stabilizer than the MPFL. This was further demonstrated by Sanchis-Alfonso et al. who conducted a finite element model analysis comparing a “static” reconstruction of the MPFL to a “dynamic” reconstruction of the MQTFL. The group found that while the reconstructed MQTFL behaved similarly to the reconstructed MPFL from 0 to 30° of knee flexion, the former technique was associated with lower peak patellar contact pressures following MQTFLR compared to MPFLR. Given the mixed results in cadaveric models, the viability of MQTFLR as an equivalent alternative to MPFLR and the relative indications for either procedure remains a source of controversy in the orthopedics literature.

Despite the possible biomechanical differences between the MQTFLR and MPFLR techniques, both cohorts in the present study demonstrated comparable postoperative outcomes in terms of knee symptoms and satisfaction including no difference in recurrent instability. However, it should be noted that the rate of postoperative recurrent instability remained considerable at 20% in both cohorts. While outcomes after MPFLR have been well-characterized in the literature [10,14,29,30], outcomes data on MQTFLR are comparatively scarce. In the largest series to date, Barden et al. [12] reported excellent outcomes in 28 patients (29 knees) at mean 38-month follow-up after MQTFLR. Among the patients in their cohort that were at least 2 years out from surgery, 86.3% reported that they were free of instability symptoms and none reported recurrent dislocations. Other outcomes have been reported in the context of combined MQTFLR and MPFLR procedures (i.e. PMPR reconstruction). Spang et al. [4] found positive outcomes in 25 child and adolescent patients (27 knees) who underwent combined MQTFLR and MPFLR with the cohort reporting a mean Kujala score of 85.3 (standard deviation 13.9) and 11% rate of recurrent instability at mean 2-year follow-up. The available evidence, in combination with the present study’s findings, suggests that MQTFLR may serve as a comparable alternative to MPFL with regard to preventing further instability and relieving knee symptoms.

Sport-related outcomes were largely similar between the MQTFLR and MPFLR cohorts. However, while rates of return to sport and return to sport at the pre-injury level were not significantly different between the two groups, twice the number of athletes in the MQTFLR group achieved passing scores on the MPFL-RII survey compared to the MPFLR group. Hurley et al. [19] previously adapted the ACL-Return to Sport After Injury (ACL-RII) survey for use in MPFLR patients and found that patients who failed to return to sport also tended to exhibit poor psychological readiness for return to sport. The same finding held true in the present study. A majority of patients who did not return to sport following MQTFLR or MPFLR also had failing MPFL-RII scores. The higher rate of psychological readiness to return to sport in the MQTFLR group compared to the MPFLR group may be the result of preoperative differences in patellar instability symptom duration, level of sports participation, and psychosocial characteristics (e.g. lifestyle, personality type) and therefore unrelated to the procedure itself.

The study also found a somewhat higher rate of postoperative arthrofibrosis among the matched MPFLR controls compared to the MQTFLR group. Arthrofibrosis is a known sequela of knee injuries and ligamentous reconstruction procedures including MQTFLR and MPFLR [12,14]. Rates of arthrofibrosis following MPFLR have ranged from 0 to 20% in recent literature and while specific predictive factors have not been identified in this population, early mobilization and range of motion exercises are considered important for mitigating the risk of developing arthrofibrosis postoperatively [31]. A history of prior surgeries involving the index joint has been described as a potential risk factor for arthrofibrosis in the total knee arthroplasty literature [32], but this may not apply to the present study’s patient population since the MQTFLR cohort had a higher rate of prior index knee surgery compared to the MPFLR cohort. Tissue insult during surgery and implantation of hardware such as prostheses and screws have also been cited as potential causes of arthrofibrosis since these actions may trigger the release of inflammatory mediators within the joint space [33]. The patellar drilling and bony fixation unique to the MPFLR procedure could be a source of postoperative inflammation leading to higher rates of arthrofibrosis among MPFLR patients compared to MQTFLR patients. This discussion should be qualified by noting that (1) the difference in arthrofibrosis rates between the MQTFLR and MPFLR cohorts did not reach statistical significance, (2) the rate of arthrofibrosis in the MPFLR cohort is higher than most estimates reported in the literature, and (3) the analysis does not account for differences in postoperative mobilization between patients that may have increased or decreased the risk of developing arthrofibrosis.

There are several limitations of the study design. First, the study was retrospective in design which precluded the use of preoperative outcome scores and may have introduced selection bias into the analysis. Second, while the MPFLR controls were adequately matched to MQTFLR patients on most demographic characteristics, there remained significant differences in graft type and concomitant procedures between the groups that could have had a confounding effect on the analysis. Third, the small
Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Eric J. Strauss reports a relationship with American Orthopaedic Surgeons that includes: board membership. Eric J. Strauss reports a relationship with American Orthopaedic Association that includes: board membership. Michael J. Alaia reports a relationship with BodyCad that includes: consulting or advisory. Michael J. Alaia reports a relationship with Arthrex Inc that includes: consulting or advisory. Michael J. Alaia reports a relationship with DePuy Mitek Inc that includes: consulting or advisory. Michael J. Alaia reports a relationship with Orasco Inc that includes: funding grants and non-financial support. Michael J. Alaia reports a relationship with Springer that includes: funding grants. Kirk A. Campbell reports a relationship with American Academy of Orthopaedic Surgeons that includes: board membership. Kirk A. Campbell reports a relationship with Arthroscopy Association of North America that includes: board membership. Kirk A. Campbell reports a relationship with Stryker that includes: funding grants and non-financial support.

References


