Original Article

Patient-Reported Outcomes Following Medial Patellofemoral Reconstruction With Peroneus Longus Allografts Demonstrate Good Results

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Purpose: To evaluate the recurrent dislocation risk and patient-reported outcomes of peroneus longus allograft tissue for medial patellofemoral ligament (MPFL) reconstruction. **Methods:** Patients who underwent MPFL reconstruction with peroneus longus allograft at an academic center between 2008 and 2016 were identified. Record review and patient contact were used to identify any cases of recurrent patellar dislocation and collect patient-reported outcomes scores (Knee injury and Osteoarthritis Outcome Score [KOOS], Norwich Patellar Instability score, Marx activity scale). Patients with 1-year minimum follow-up were included. Outcomes were quantified and the proportion of patients reaching a previously defined patient acceptable symptom state (PASS) for patellar instability was determined. **Results:** Sixty-one patients (42 female and 19 male) underwent MPFL reconstruction with peroneus longus allograft during the study period. Forty-six patients (76%) with 1-year minimum follow up were contacted at a mean of 3.5 years postoperative. The mean age at time of surgery was 22 ± 7.2 years. Patient-reported outcomes data were available in 34 patients. Mean KOOS subscale scores were as follows: Symptoms 83.2 ± 19.1, Pain 85.2 ± 17.6, Activities of Daily Living 89.9 ± 14.8, Sports 75 ± 26.2, and Quality of Life 72.6 ± 25.7. The mean Norwich Patellar Instability score was 14.9% ± 17.4%. The mean Marx activity score was 6.0 ± 5.2. No recurrent dislocations were noted during the study period. Sixty-three percent of patients who underwent isolated MPFL reconstruction met PASS thresholds in at least 4 of 5 KOOS subscales. **Conclusions:** The use of a peroneus longus allograft in MPFL reconstruction in conjunction with other indicated procedures results in a low re-dislocation risk and a high proportion of patients meeting PASS criteria for patient-reported outcome scores 3 to 4 years postoperatively. **Level of Evidence:** IV, case series.

Patellar dislocations are relatively common knee injuries,[1] often leading to substantial morbidity and a decline in activity level.[2] When this injury occurs, a medial patellofemoral ligament (MPFL) injury occurs in greater than 95% of individuals.[3] The MPFL is the primary soft-tissue restraint to lateral patellar translation, and MPFL injuries decrease the force required to laterally dislocate the patella.[4-6] Patellar instability can impact participation in sports and other leisure activities, with far-reaching health implications.[7]

First-time patellar dislocations frequently are treated nonoperatively with bracing, effusion control, and physical therapy[6-9]; however, recurrent instability can occur.[2] In patients with recurrent episodes of instability, surgical treatment is indicated to restore knee stability and function. In many patients with recurrent instability, isolated MPFL reconstruction has been shown to be an effective procedure in reducing recurrence risk and instability symptoms.[10-15] In some cases with more severe patellofemoral malalignment, patella alta, or trochlear dysplasia, additional bony procedures may be indicated.[6]

While the results of isolated MPFL reconstruction are generally good in appropriately selected patients,

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multiple grafts have been described, and there are limited data to suggest the superiority of any particular graft type.[16-20] Recent work has demonstrated similar outcomes of autograft and allograft tissue for MPFL reconstruction[11,20]; however, most published series of allograft tissue use hamstring allograft tissue. Although other allograft options including peroneus longus have been described, published outcomes are lacking.[21] A recent biomechanical study demonstrated that and peroneus longus tendon exhibited noninferior initial biomechanical strength and stiffness characteristics compared with tibialis anterior allograft tendon.[22] Therefore, similar clinical outcomes after MPFL reconstruction using peroneus longus tendon are anticipated. An outcome study of this graft type is important to demonstrate that clinical results match the anticipated positive results. The purpose of this study is to evaluate the recurrent dislocation risk and patient-reported outcomes of peroneus longus allograft tissue for MPFL reconstruction. We hypothesized that MPFL reconstruction with peroneus longus allograft would result in a low recurrent dislocation risk and good patient-reported outcomes.

Methods

Patients and Follow-up

Following institutional review board approval (The Ohio State University; 2015H0446), a search of medical records using Current Procedural Terminology codes and operative report review was undertaken to identify patients who underwent MPFL reconstruction with a peroneus longus allograft by 2 sports medicine fellowship—trained orthopaedic surgeons (R.A.M. and D.C.F.) between January 2008, and December 2016. All patients who underwent MPFL reconstruction with peroneus longus allograft during this period were eligible for study inclusion.

Surgical Indications

Surgical management of patellar instability was offered to patients with recurrent lateral patellar instability. MPFL reconstruction was performed in all cases, with additional procedures performed at surgeon discretion following discussion with the patient. General indications for associated procedures were as follows. Lateral retinacular release or lengthening was performed in patients in whom the patellar could not be everted to the level of the horizon on physical examination under anesthesia. Tibial tubercle osteotomy (TTO) was considered in patients with patellar maltracking manifested as a large j-sign[23] and in those with patellar apprehension that persisted deep into knee flexion (greater than 60 to 70°[24]). Anteromedialization TTO was performed in such patients if the tibial tubercle—trochlear groove (TT-TG) distance was greater than 16 to 20 mm and distalization TTO was performed in the setting of patella alta with a Caton—Deschamps Index greater than 1.20 to 1.30.

Surgical Procedure and Rehabilitation

A diagnostic arthroscopy was performed in each case to identify and treat any intra-articular pathology. If indicated, TTO was then performed to anteromedialize and/or distalize the tubercle as dictated by patient anatomy. Any lateral-sided procedures such as lateral retinacular lengthening or release were then performed via an open approach based on intraoperative evaluation of patellar eversion.

MPFL reconstruction was then performed via an open approach. Following an incision over the medial patellar border, the interval just superficial to the capsular layer was identified and bluntly dissected to the adductor tubercle. A second incision was made over the adductor tubercle and a suture was passed through the resultant soft tissue tunnel for graft passage. Two anchors were placed on the medial patellar border with fluoroscopic guidance to ensure placement in the proximal half of the patella, and a shallow bone trough was created between the anchors. A femoral tunnel 7 mm in diameter was then placed anatomically on the saddle between the adductor tubercle and medial epicondyle following fluoroscopic confirmation that the location corresponded with Schottle's point[25] (Fig 1) and confirmation of relative isometry. The tunnel was drilled proximally and anteriorly to a maximal depth without violating the opposite cortex. No patients with open physes that required adjustment of tunnel trajectory underwent MPFL reconstruction with peroneus longus grafts in this period. The peroneus longus allograft was prepared by trimming and whip-stitching the 2 free ends such that they could pass together through the 7-mm femoral tunnel. This generally resulted in a graft diameter of approximately 5 mm. The graft was attached to the patella in its center with the 2 previously placed anchors and the free ends were passed through the soft-tissue tunnel and docked into the femoral tunnel. Fixation was performed at 60 to 75° of knee flexion with an interference screw and no graft tension.

Postoperative rehabilitation varied depending on whether a concomitant TTO was performed. In the case of isolated MPFL reconstruction, immediate weight-bearing with crutches was allowed with progression to unassisted gait when quadriceps control and strength were sufficient that the patient could walk without a limp. Jogging was allowed at 3 months with return to sports between 4 and 6 months postoperatively. In the case of TTO, weight-bearing was limited for 4 to 6 weeks postoperatively with a hinged knee brace on and locked in extension while ambulating. Full weight-bearing was allowed at 4 to 6 weeks, and the brace

Fig 1. Lateral fluoroscopic image demonstrating identification of the starting point of the MPFL femoral tunnel according to the technique of Shottle et al.[25] (MPFL, medial patellofemoral ligament.)

was discontinued at 8 weeks. High-impact activities such as running were limited for 6 months postoperatively and until well healed osteotomy site was noted on plain films.

Data Collection

Chart review was completed and demographic, surgical, and follow-up data were extracted including patient age, sex, body mass index, radiographic parameters, associated surgical procedures, and any subsequent patellar instability or patellofemoral surgery. Radiographic measures included the Caton–Deschamps Index[26] to assess patellar height and assessment of trochlear dysplasia according to Dejour[27] and measurement of the TT-TG distance on magnetic resonance imaging.[28] These measurements were performed by a single sports medicine fellowship–trained orthopaedic surgeon (R.A.M.) based on the published methods previously.

Patients were subsequently contacted by mail and/or telephone and asked about recurrent patellar dislocation episodes and surgery. Patients also were asked to complete outcome scores including the Knee Injury and Osteoarthritis Outcome Score (KOOS),[29] the Norwich Patellar Instability score,[9] and the Marx activity score.[30]

Statistics

Summary statistics were calculated. These included mean and standard deviations for normally distributed, continuous variables and proportions for categorical variables. Patient acceptable symptoms state (PASS) criteria are established to identify the score above which patients with a given condition are satisfied with their symptoms. The PASS is specific to each outcome score as well as to individual patient populations. A recently published study developed PASS thresholds for each KOOS subscale for patients 1 year following isolated MPFL reconstruction.[31] Proportions of patients meeting established PASS criteria were calculated.[31] All calculations were performed using Microsoft Excel (Redmond, WA).

Table 1. Demographics

Sex	
Male	19 (31%)
Female	42 (69%)
Age, y	22.0 ± 7.2
BMI	27.8 ± 732
Caton–Deschamps Index	1.20 ± 0.15
TT-TG distance, mm	17.1 ± 4.3
Trochlear dysplasia	
None	18 (29%)
Dejour A	38 (60%)
Dejour B	7 (11%)
Dejour C or C	0 (0%)

BMI, body mass index; TT-TG, tibial tubercle–trochlear groove.

Results

A total of 63 knees in 61 patients were treated for recurrent patellar instability with a primary MPFL reconstruction during the study period. The study population was young and majority female (Table 1). The population included 30 knees (47%) with patella alta, 12 knees (21%) with a TT-TG distance greater than 20 mm, and 45 knees (71%) with trochlear dysplasia (Table 1). Concomitant procedures included 1 partial medial meniscectomy, 19 partial lateral meniscectomies, 1 lateral meniscus repair, 16 tibial tubercle osteotomies, 10 lateral retinacular lengthenings, 12 lateral retinacular releases, one lateral retinacular repair, 18 loose body removals, 16 microfractures, and 23 chondroplasties.

Of the 61 patients (63 MPFL reconstructions) eligible for study inclusion, 46 patients (48 reconstructions) with minimum 12-month follow-up (76%) were available for follow-up at a mean of 3.5 years (range 1.0-6.7 years) postoperative. During the follow-up period, no episodes of recurrent patellar dislocation were noted, but subjective postoperative patellar subluxation was reported by 12 patients (25%).

Patient-reported outcomes data were available in 34 patients (36 MPFL reconstructions; 57%) at a mean of 4.1 years (range 1.2-6.7 years) following surgery. The mean Norwich Patellar Instability score was 14.9% ± 17.4%. The mean KOOS subscales were Symptoms: 83.2 ± 19.1, Pain: 85.2 ± 17.6, Activities of Daily Living: 89.9 ± 14.8, Sport/Recreation Function: 75 ± 26.2, and Knee-Related Quality of Life: 72.6 ±

Table 2. Postoperative Patient-Reported Outcomes

	Overall	Isolated MPFLR N = 25	MPFLR + TTO N = 11	Significance
KOOS Symptoms	83.2 ± 19.1	84.3 ± 17.5	80.3 ± 23.5	$P = .57$
KOOS Pain	85.2 ± 17.6	84.8 ± 16.4	85.5 ± 21.4	$P = .91$
KOOS ADL	89.9 ± 14.8	90.1 ± 14.6	88.5 ± 15.9	$P = .75$
KOOS Sport	75.0 ± 26.2	77.3 ± 28.2	70.9 ± 23.6	$P = .52$
KOOS QoL	72.6 ± 25.7	76.6 ± 24.9	63.6 ± 27.5	$P = .20$
Norwich Patellar Instability Score	14.9% ± 17.4%	13.3% ± 16.6%	16.9% ± 20.0%	$P = .56$
Marx Activity Score	6.0 ± 5.2	7.1 ± 5.4	3.7 ± 4.4	$P = .076$

ADL, Activities of Daily Living; KOOS, Knee injury and Osteoarthritis Outcome Score; MPFLR, medial patellofemoral ligament reconstruction; QoL, Quality of Life; TTO, tibial tubercle osteotomy.

25.7. The mean Marx activity score was 6.0 ± 5.2 (Table 2).

Using established PASS thresholds, we found that the percentage of patients who underwent isolated MPFL reconstruction who achieved the PASS threshold for each KOOS subscale was 71% for Symptoms, 63% for Pain, 38% for Activities of Daily Living , 67% for Sport/Recreation Function, and 83% for Quality of Life (Table 3). Sixty-three percent of patients who underwent isolated MPFL reconstruction met PASS thresholds in at least 4 of 5 KOOS subscales.

Discussion

The primary finding of this study is that MPFL reconstruction with peroneus longus allograft in conjunction with other indicated procedures results in a low dislocation risk and a high proportion of patients meeting PASS criteria for patient-reported outcome scores in patients with recurrent patellar instability. Previous work has demonstrated allograft to be a viable alternative to autograft tissue for MPFL reconstruction. In a recent systematic review comparing outcomes of autograft and allograft MPFL reconstruction, Hendawi et al.[32] found that in a pediatric population the autograft group had longer operative times, greater risk of graft failure, and lower patient-reported outcomes. Other recent work in adults found no increased risk of recurrent instability or poorer patient-reported outcomes with allograft tissue.[20] Allograft use avoids graft-site morbidity and preserves autograft tissue for potential future intra-articular procedures where such grafts have been shown to be superior.

The results of the current study compare favorably to previously published series. A recent study by Mulliez et al.[33] evaluated the outcomes of gracilis autograft MPFL reconstruction with TTO added as indicated in a similar population to the current study. The reported KOOS Pain, Activities of Daily Living, and Symptom subscales range from 75 to 83 and KOOS Sport and knee−related Quality of Life subscales of 55 and 58, respectively. In a similar study using an algorithmic approach to the addition of TTO to MPFL reconstruction with semitendinosus allograft, Dragoo et al.[34] reported KOOS Pain, Activities of Daily Living, and Symptom subscales ranging from 65 to 80 and KOOS Sport and knee-related Quality of Life subscales of 49 and 46, respectively. The outcomes of the current study compare favorably with these results. The very low risk of recurrent patellar dislocation (0%) compares favorably with the 1% to 2% failure risk of both isolated MPFL reconstructions and several published series in which a tibial tubercle osteotomy was performed in addition to MPFL reconstruction.[35,36] Further, the results of this study are generally positive in term of the proportion of patients who met the PASS threshold in the majority of KOOS subscales for this study. The purpose of PASS is to define a threshold in which a patient-reported outcome corresponds to an acceptable state regarding knee satisfaction postoperatively. In each KOOS subscale except for Activities of Daily Living, at least 63% of patients exceed the PASS threshold.

Previous studies have compared the failure load and stiffness of the native MPFL with other graft options, including peroneus longus, semitendinosus, gracilis, and tibialis anterior. Duchman et al.[3] demonstrated greater lateral restraining force at increased displacement in MPFL reconstruction compared with the intact MPFL due to a much greater failure load and stiffness of the tibialis anterior allograft used in the study compared with the native MPFL. Previous work has shown

Table 3. KOOS Subscales and Percentage of Patients Meeting PASS After Isolated MPFLR

	Mean ± SD	PASS Threshold	Percentage Meeting PASS
KOOS Symptoms	84.3 ± 17.5	80.4	71%
KOOS Pain	84.8 ± 16.4	84.7	63%
KOOS ADL	90.1 ± 14.6	99.3	38%
KOOS Sport	77.3 ± 28.2	57.5	67%
KOOS QoL	76.6 ± 24.9	53.1	83%

ADL, Activities of Daily Living; KOOS, Knee injury and Osteoarthritis Outcome Score; MPFLR, medial patellofemoral ligament reconstruction; PASS, patient acceptable symptom state; QoL, Quality of Life; SD, standard deviation.

greater failure load and stiffness of both semitendinosus and gracilis tendon grafts[3] compared with the native MPFL.[37] Of interest, the study from Zhao and Hangfu[38] showed that the average failure load of the anterior half of peroneus longus tendon was similar to semitendinosus and superior to gracilis tendons. These demonstrate that all available grafts likely have sufficient strength for MPFL reconstruction. The good outcomes of peroneus longus in the current study suggest that the graft is not overly stiff as to cause over constraint.

Limitations

There are several limitations of the current study. One major limitation is that although 75% of patients were available for assessment of recurrent dislocation risk at a minimum of 1-year postoperatively, only 57% of eligible patients completed patient-reported outcome scores. This loss to follow-up may introduce selection bias into the collected data. Some outcomes data were collected by phone, which in some cases has been shown to potentially alter responses as compared to independent form completion.[39] The data were collected by an investigator who was not the surgeon to minimize this potential bias. Further, the study population and procedures performed and rehabilitation were quite heterogeneous. Although this heterogeneity complicates comparison of these outcomes with previous published work, it also makes these data broadly generalizable. Similarly, although all grafts were frozen and not terminally irradiated, specific graft details including size and donor age are not available in this cohort, limiting the ability to evaluate impacts of these factors on outcomes. These data demonstrate the effectiveness of peroneus long allograft in treating a large spectrum of patellofemoral instability pathology via MPFL reconstruction—with or without tibial tubercle osteotomy. Further, the study lacks a control group. Comparisons to MPFL reconstructions performed using other grafts in other populations do provide some context for the outcomes presented in this study, but potential differences in patient populations and surgical technique limit these comparisons. Finally, preoperative outcome scores are lacking in this cohort. Their absence limits the analysis to postoperative findings and precludes assessment of improvement over time as well as calculation of the proportion of patients who achieved minimum clinically important differences in terms of improvements of the outcome scores with surgery. Calculation of the proportion of patients achieving PASS mitigates but does not eliminate this limitation.

Conclusions

The use of a peroneus longus allograft in MPFL reconstruction in conjunction with other indicated procedures results in a low redislocation risk and a high proportion of patients meeting PASS criteria for patient-reported outcome scores 3 to 4 years postoperatively.

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