Autograft Versus Allograft for Medial Patellofemoral Ligament Reconstruction

A Systematic Review

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Background: Patients with recurrent lateral patellar dislocations are often treated with reconstruction of the medial patellofemoral ligament (MPFL).

Purpose: To perform a systematic review to evaluate clinical outcomes and the risk of recurrent patellar dislocation after MPFL reconstruction (MPFLR) with autograft versus allograft.

Study Design: Systematic review; Level of evidence, 4.

Methods: The authors conducted a search of PubMed, the Cochrane Library, and Embase to identify studies comparing outcomes of MPFLR with autograft versus allograft. The inclusion criteria were full-text studies that directly compared clinical outcomes and/or risk of recurrent patellar instability between patients undergoing MPFLR with autograft versus allograft. A quality assessment was performed using the modified Coleman Methodology Score, and risk-of-bias assessment was performed using the Risk Of Bias In Non-randomized Studies–of Interventions and the Cochrane Collaboration tools.

Results: Seven studies (1 evidence level 2, 3 level 3, 3 level 4) that met inclusion criteria were identified and included a total of 150 patients who underwent MPFLR with autograft and 193 with MPFLR with allograft. One study found a significantly higher failure rate among patients with autograft, and another study found a trend toward a significantly higher failure rate among patients with autograft. One study demonstrated no significant difference between postoperative tibial tubercle–trochlear groove distance (measured on magnetic resonance imaging scans) in failed versus successful grafts. One study found that patellar tilt angle improved significantly from preoperatively to postoperatively ($P < .001$) but there was no difference between the groups. Kujala scores significantly improved for both autograft and allograft groups across studies. Two studies found significant differences in postoperative Kujala scores between the 2 groups, 1 of which found better scores in the allograft group ($P = .0032$) and another in which scores were better in the autograft group ($P = .02$).

Conclusion: Patients undergoing MPFLR with either autograft or allograft can expect to experience improvement in clinical outcomes. Subjective outcomes improved to a similar degree in both groups. Graft failure was more frequently observed in patients with autograft. Allograft may be a better option for MPFLR owing to lower failure rate.

Keywords: allograft; autograft; medial patellofemoral ligament; MPFL reconstruction; patellar instability

The medial patellofemoral ligament (MPFL) acts as the primary restraint to lateral translation of the patella, with the medial patellotibial ligament and medial patellomeniscal ligament acting as secondary stabilizers.[15] Injury to the MPFL occurs in nearly 100% of cases of lateral patellar dislocation.[17] First-time dislocations are often treated nonoperatively,[17,21] while patients evaluated with recurrent lateral patellar dislocation/subluxation events are often indicated for MPFL reconstruction (MPFLR)/repair. Recent literature has suggested improved outcomes and decreased recurrence in patients undergoing MPFLR.[19] Graft choice is often considered an important decision in the reconstruction of other knee ligaments such as the anterior (ACL)[2,11,13] or posterior (PCL)[3,20] cruciate ligament. However, graft choice in MPFLR has not received the same level of attention in the literature. The purpose of this study was to perform a systematic review to evaluate clinical outcomes and the risk of recurrent patellar dislocation after MPFLR with autograft versus allograft. The authors

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hypothesized that there would be no significant differences in outcomes based on graft type.

METHODS

This systematic review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines using a PRISMA checklist. Two independent reviewers (M.J.K., G.M.A.) searched PubMed, Embase, and the Cochrane Library up to September 9, 2020. The electronic search phrase used was "medial patellofemoral ligament reconstruction autograft allograft." A total of 54 studies were reviewed by title and/or abstract to determine study eligibility based on inclusion criteria. In cases of disagreement, a third reviewer (M.K.M.) made the final decision. The inclusion criteria were full-text studies that directly compared clinical outcomes and/or risk of recurrent patellar instability events between patients undergoing MPFLR with autograft versus allograft. Exclusion criteria included (1) studies without direct comparison between graft types, (2) conference abstracts, and (3) non–English language studies without an English translation. Data extraction from each included study was performed independently (G.M.A.) and then reviewed by a second author (M.J.K.). No funding was used for this study.

Reporting Outcomes

Outcomes assessed included graft survivorship, complications (redislocation, subluxation, stiffness, instability, etc), operative time, costs, radiographic analysis (tibial tubercle–trochlear groove [TT-TG] distance, postoperative patellar tilt angle), return to activity, and patient-reported outcomes (Knee injury and Osteoarthritis Outcome Score [KOOS], Marx activity, Norwich Patellar Instability, Kujala, Lysholm, and Tegner scores).

Study Methodology Assessment

The modified Coleman Methodology Score (mCMS)[5] was used to evaluate study methodology quality. The mCMS has a scaled potential score ranging from 0 to 100. Scores ranging from 85 to 100 are excellent, 70 to 84 are good, 55 to 69 are fair, and <55 are poor. Risk of bias for the 6 nonrandomized[4,7,8,14,23,24] studies was assessed according to the Risk Of Bias In Non-randomized Studies–of Interventions (ROBINS-I[25]) tool, which incorporates an assessment of bias due to confounding, selection of participants, deviations from intended interventions, completeness of outcome data, selection of outcomes reported, and other sources of bias. For the remaining randomized study,[16] risk of bias was assessed according to the Cochrane Collaboration risk-of-bias tool (Version 2).[9] The "template for completion" (provided at http://sites.google.com/site/riskofbiastool/welcome/rob-2-0-tool?) was followed for guidance. No cluster modification was utilized in this assessment.[9]

Statistical Analysis

An average was calculated for numerical characteristics (age, interval from time of injury to surgery, follow-up time). Fisher exact test was used for comparison of failure rate between the autograft and allograft groups. A cost analysis was reported from a single included study[8]; no separate cost analyses were performed.

RESULTS

Seven studies[4,7,8,14,16,23,24] met all criteria and were included in this systematic review (Figure 1). The studies included 150 patients who underwent MPFLR with autograft and 193 with allograft (Table 1). The most commonly used autograft was gracilis, and the most commonly used allograft was semitendinosus-gracilis (Table 2). Of note, some of the studies[4,23,24] were listed as case series (level 4 evidence) but did perform a subanalysis comparing outcomes of patients with autograft versus allograft.

Graft Selection

Two studies[4,16] randomized patients to receive autograft or allograft. Kumar et al[14] allowed patients and their families to make a choice between autograft or allograft after discussion of risks and benefits. Four studies[7,8,23,24] did not describe how patients were allocated to receive autograft or allograft.

Methodologic Quality Assessment and Risk of Bias

Table 3 shows the mCMS values from the 7 included studies. Four studies[7,14,16,24] received a good score, and 3 studies[4,8,23] received a poor score.

The results of the methodologic quality assessment of the 6 nonrandomized studies[4,7,8,14,23,24] using the ROBINS-I risk-of-bias tool are presented in Figure 2. All studies

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showed a moderate risk of bias due to confounding, as there were no prognostic variables that predicted baseline intervention and no patients who switched between interventions during the study period. No studies excluded eligible patients or used variable follow-up times based on intervention (low risk of bias), no studies deviated from the intended intervention (low risk of bias), and all studies clearly classified treatment type (low risk of bias). One study[24] using blinded outcome assessors showed no systematic differences in the care provided between treatment groups (low risk of bias), while 5 studies[4,7,8,14,23] used nonblinded but identical postoperative protocols (moderate risk of bias). No studies showed bias due to missing data (low risk of bias). All 6 studies used physicians not blinded to the treatment group (serious risk of bias). Finally, no studies showed bias due to selective reporting (low risk of bias).

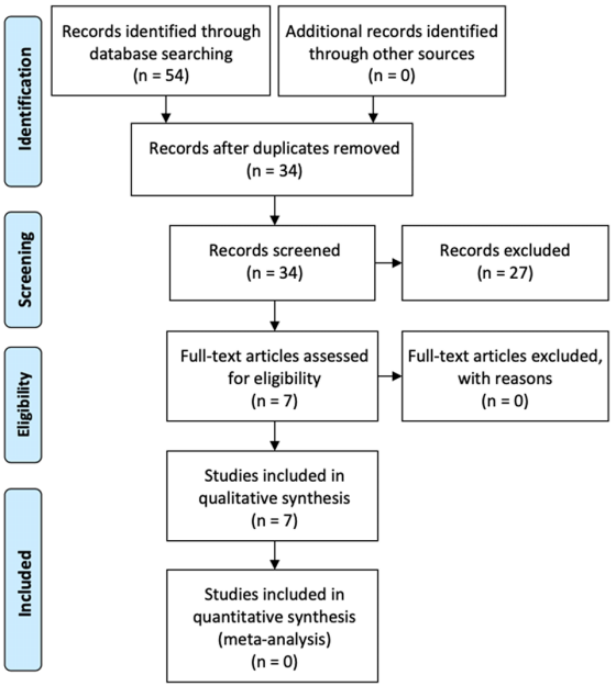

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram.

The remaining 1 randomized study[16] was assessed for methodologic quality using the Cochrane Collaboration risk-of-bias tool. Sequence generation and allocation were adequately reported (low risk of bias), although blinding of the outcome assessor or patient was not described (moderate risk of bias). One study[7] reported a significant loss to follow-up (76%) at the latest follow-up (high risk of bias). Otherwise, there was no significant loss to follow-up, selective reporting, or incomplete outcome data (low risk of bias).

In 4 studies,[4,8,14,23] 100% of included patients were evaluated at the final follow-up. Of 115 MPFLRs (37 autograft, 78 allograft) assessed by Flanigan et al,[7] 76% (30 autograft, 57 allograft) were evaluated at the final follow-up, and patient-reported outcome scores were completed by 50 patients (19 autograft, 31 allograft). Matuszewski et al[16] enrolled 47 patients and randomized 44 patients, all of whom were evaluated at the final follow-up. Steiner et al[24] identified 36 eligible patients; 1 died of an unrelated accident and another sustained a traumatic rupture to her medial collateral ligament during follow-up, leaving 34 patients who were evaluated at the final follow-up.

Clinical Comparisons

No significant differences in outcomes after MPFLR using autograft or allograft were found across studies in terms of patient sex, age at reconstruction, body mass index, acute versus chronic dislocation, side of operation, and duration of symptoms.

Surgical Techniques

Diagnostic arthroscopy was performed before MPFLR in all studies. Kumar et al[14] performed a tibial tubercle transfer

TABLE 1
Study Characteristics[a]

Lead Author (Year)	LOE	Patients (Auto/Allo), n	Patient Sex	Patient Age at Surgery, y[b]	Follow-up Time[b]
Flanigan (2020)[7]	3	87 (30/57)	Auto: 11 F, 5 M Allo: 26 F, 11 M	Auto: 23.5 ± 9.4 Allo: 25.8 ± 8.6	4.1 (1-10) y[c]
Hendawi (2019)[8]	3	56 (21/35)	Auto: 17 F, 4 M Allo: 24 F, 11 M	Auto: 15.3 Allo: 16	NR
Matuszewski (2018)[16]	2	44 (22/22)	Auto: 15 F, 7 M Allo: 12 F, 10 M	Auto: 15 (13-16) Allo: 15 (13-17)	24 mo[c]
Kumar (2018)[14]	3	59 (23/36)	Auto: 16 F, 7 M Allo: 22 F, 14 M	Auto: 14.9 ± 2 Allo: 15.3 ± 1.5	Auto: 5.7 ± 2.1 y Allo: 3.1 ± 1.1 y
Calvo Rodríguez (2015)[4]	4	28 (13/15)	Auto: 9 F, 4 M Allo: 6 F, 9 M	Auto: 21 (15-29) Allo: 22 (16-38)	Auto: 17 (15-29) mo Allo: 42 (29-80) mo
Slenker (2013)[23]	4	35 (12/23)	23 F, 12 M[c]	20.6 (14-42)[c]	21 (12-25) mo[c]
Steiner (2006)[24]	4	34 (29/5)	22 F, 12 M[c]	27[c]	66.5 (24-130) mo[c]

[a]Allo, allograft; Auto, autograft; F, female; LOE, level of evidence; M, male; NR, not reported.
[b]Reported as mean ± SD or mean (range).
[c]Reported as a sum/mean of both autograft and allograft groups.

TABLE 2
Graft Type and Study Outcomes[a]

Lead Author (Year)	Autograft Type	Allograft Type	Outcomes
Flanigan (2020)[7]	Hamstring	Soft tissue tendon	Recurrent dislocation, recurrent subjective instability, patient-reported outcomes (KOOS, Marx activity, and Norwich Patellar Instability scores)
Hendawi (2019)[8]	Gracilis	Gracilis	Graft survivorship, Kujala scores, operative time, costs, graft size, TT-TG distance
Matuszewski (2018)[16]	Gracilis	Tensor fascia lata	Kujala scores, postoperative patellar tilt angle
Kumar (2018)[14]	Gracilis	S/G	Return to normal activity, complications (incidence of re-dislocation or subluxation, stiffness, other), Kujala scores
Calvo Rodríguez (2015)[4]	S/G	Semitendinosus, AT, BQ, gracilis, HFEHL, peroneal	Graft-related morbidity, Kujala scores, associated complications
Slenker (2013)[23]	Hamstring	Soft tissue tendon	Kujala scores, recurrence of patellar instability, return to sports, activity level, postoperative MRI
Steiner (2006)[24]	AM, BQ	BP	Kujala, Lysholm, and Tegner scores

[a]AM, adductor magnus; AT, tibialis anterior tendon; BP, bone–patellar tendon; BQ, bone–quadriceps tendon; HFEHL, hybrid of flexor and extensor hallucis longus; KOOS, Knee injury and Osteoarthritis Outcome Score; MRI, magnetic resonance imaging; S/G, semitendinosus-gracilis; TT-TG, tibial tubercle–trochlear groove.

TABLE 3
Modified Coleman Methodology Score

Lead Author (Year)	Score
Flanigan (2020)[7]	71
Hendawi (2019)[8]	64
Matuszewski (2018)[16]	81
Kumar (2018)[14]	70
Calvo Rodríguez (2015)[4]	63
Slenker (2013)[23]	65
Steiner (2006)[24]	75

before diagnostic arthroscopy in patients with a TT-TG distance >20 mm to a corrected distance of 10 mm. Flanigan et al[7] made a longitudinal incision medial to the patella and an accessory medial incision over the adductor tubercle with placement of a passing suture. Two anchors were placed along the medial edge of the patella, and the graft was secured to the femur using an interference screw and to the patella using anchors.[7] Calvo Rodríguez et al[4] used a double femoral and patellar incision; they then introduced a periostotome from the patellar to femoral incision to leave a retinacular tunnel through which a loop suture was passed to subsequently introduce the graft. Kumar et al initially shuttled the graft tails from the femur to the patella via 2 suture anchors, but this then evolved to interference screw fixation at both the femur and the patella. Others[8,16,23,24] performed tunnel drilling in the patella. Femoral fixation of the grafts was performed using an interference screw,[4,7,8,14] a titanium anchor,[16,23] a knotless suture anchor,[23] and a cancellous lag screw.[24] Slenker et al[23] used an EndoButton (Smith & Nephew) for patellar fixation initially, although the authors ultimately changed techniques because of pain and irritation using this implant. Flanigan et al added a tibial tubercle osteotomy on an individual basis without specifying their criteria, and Matuszewski et al[16] treated 6 patients (3 with autograft, 3 with allograft) with microfracture because of grade 2 cartilage damage on the patella. Autograft and allograft sources varied among studies (Table 2). Two studies[4,14] reported using nonirradiated allografts; all other studies[7,8,16,23,24] did not specify allograft preparation techniques.

Treatment Failures

Two studies[4,24] did not report on treatment failures. In the study by Slenker et al,[23] 3 patients (8.6%) reported a subluxation event postoperatively at an average of 14.7 months after surgery, although the authors did not specify graft type among these patients. All 3 patients were able to return to full athletic activities without requiring further intervention.[23] Of the 4 studies reporting treatment failure by specific graft type, there were 13 failures (8.7%) in the autograft group and 6 failures (3.1%) in the allograft group ($P = .032$) (Table 4). Hendawi et al[8] defined clinical failure as graft failure with recurrent instability and the need for revision MPFLR. The authors changed their graft type to allograft because of a high initial failure rate with autografts and subsequently reported 6 graft failures (28.6%) in the autograft group and none in the allograft group ($P = .0037$).[8] The average time to graft failure was 13.8 months.[8] Flanigan et al[7] found that recurrent dislocation occurred in 1 patient with autograft (3.3%) and 2 patients with allograft (3.5%); however, this was not statistically significant, and average time to graft failure was not reported. Kumar et al[14] defined failure as subsequent dislocation. The authors reported 6 graft failures (26.1%) in the autograft group and 3 graft failures (8.3%) in the allograft group ($P = .064$).[14] Matuszewski et al[16] reported a single redislocation in the allograft group after a traumatic event 1 month postoperatively; it was found that the femoral anchor had migrated from the bone.

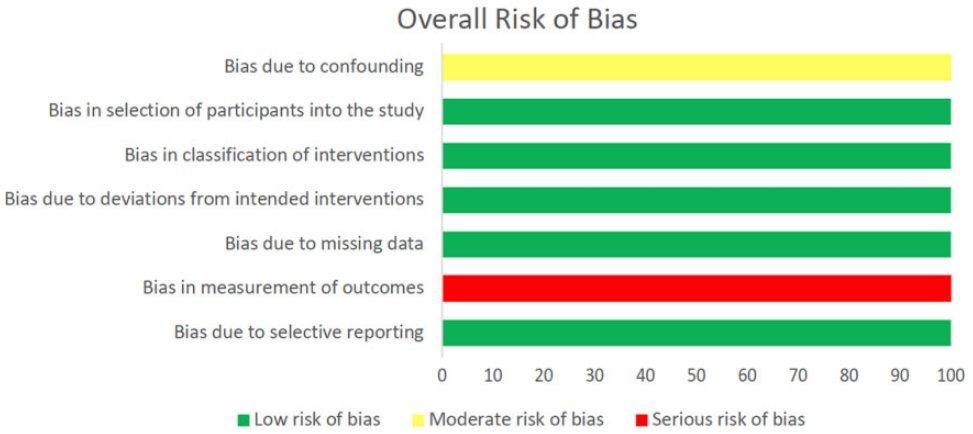

Figure 2. Risk of bias according to the ROBINS-I (Risk Of Bias In Non-randomized Studies–of Interventions) tool.

TABLE 4
Failure Rates[a]

Lead Author (Year)	Autograft	Allograft	*P* Value
Hendawi (2019)[8]	6/21 (28.6)	0/35	.0037
Matuszewski (2018)[16]	0/22	1/22 (4.5)	NR
Kumar (2018)[14]	6/23 (26.1)	3/36 (8.3)	.064
Flanigan (2020)[7]	1/30 (3.3)	2/57 (3.5)	ns
Overall failure rate, range, %	0-28.6	0-8.3	

[a]Data are presented as n/total (%) unless otherwise indicated. Three studies[4,23,24] did not report failure rate and/or did not specify graft type. NR, not reported; ns, not significant.

Complications

Calvo Rodríguez et al[4] reported that 1 patient with autograft required revision surgery to replace a patellar anchor within the first 48 hours postoperatively, and 1 patient with allograft had a patellar fracture 3 months postoperatively as a result of direct trauma. None of the patients in this study experienced recurrent instability, and there were no cases of postoperative infection during the follow-up period.[4] Matuszewski et al[16] reported a wound infection in the allograft group in the region of the femoral attachment of the graft. Slenker et al[23] reported on 3 patients who underwent reoperation for elective implant removal because of pain and irritation caused by the EndoButton (Smith & Nephew), although the authors did not specify graft type among these patients.[23] Steiner et al[24] reported that 2 patients required reoperation, 1 because of evacuation of a hematoma on postoperative day 8 and the other who underwent graft advancement after loosening in a motor vehicle accident 5 months postoperatively. Three additional patients desired elective removal of a prominent or painful screw at the medial epicondyle. The authors did not specify graft types among these patients.[24]

Radiologic Analysis

Hendawi et al[8] assessed the postoperative TT-TG distance using magnetic resonance imaging measurements and found no difference in grafts that failed compared with those that were successful. Matuszewski et al[16] compared differences in patellar tilt angle between the autograft and allograft groups using postoperative Merchant view radiographs. Patellar tilt angle improved significantly in both groups, from 29.9° to 10.4° in the autograft group ($P < .001$) and from 21.3° to 9.4° in the allograft group ($P < .001$), with no significant difference between groups.[16]

Cost Analysis and Operation Time

Hendawi et al[8] reported an average operating time of 37.2 minutes longer in patients with autograft ($P = .0002$), correlating with a cost increase of $445. The average cost of each gracilis allograft was estimated as US $1058.[8] When factoring in reoperation costs, allograft procedures were less expensive than autograft surgeries.[8] Matuszewski et al[16] reported a median operative time of 95 minutes in patients with allograft and 115 minutes in patients with autograft.

Patient-Reported Outcomes

Flanigan et al[7] reported no significant difference in patient-reported outcomes (KOOS, Marx activity, and Norwich Patellar Instability scores) between patients with autograft and allograft. In 4 studies,[4,16,23,24] Kujala scores significantly improved postoperatively in both autograft and allograft groups, with no significant differences between the 2 groups (Table 5). Kumar et al[14] found that postoperative Kujala scores were significantly better in the autograft group ($P = .02$), while Hendawi et al[8] found that postoperative Kujala scores were significantly better in the allograft group ($P = .0032$). Steiner et al[24] evaluated pre- and postoperative Lysholm and Tegner scores after MPFLR. The authors found statistically significant ($P < .001$) improvements in both Lysholm (from 52.4 to 92.1) and Tegner (from 3.1 to 5.1) scores, with no significant differences between groups.

TABLE 5
Kujala Scores[a]

Lead Author (Year)	Preoperative Score (Allograft, Autograft)	Postoperative Score (Allograft, Autograft)
Hendawi (2019)[8]	—	92.1, 80.3
Matuszewski (2018)[16]	73.91, 70.77	94.5, 94.32
Kumar (2018)[14]	—	92.7, 97.4
Calvo Rodríguez (2015)[4]	60.2, 53.8	92.6, 89.2
Slenker (2013)[23]	49.0[b]	89.6, 89.5
Steiner (2006)[24]	53.3[b]	90.7[b]

[a]Scores are reported as means. Dashes indicate there was no preoperative mean reported.
[b]Reported as overall mean among all patients.

DISCUSSION

Based on the findings of this review, patients undergoing MPFLR experienced improved outcomes regardless of graft choice. However, graft failure occurred in 13 of 150 patients with autograft (8.7%) and 6 of 193 patients with allograft (3.1%), which we found to be statistically significant. In terms of quality assessment, 4 of the 7 studies received a good score and 3 studies received a poor score. All studies showed a moderate risk of bias due to confounding and serious risk of bias in measurement of outcomes.

Previous studies have compared outcomes of autograft versus allograft for reconstruction of other knee ligaments, such as the ACL and PCL.[3,11,13,18] ACL reconstruction studies have shown superior outcomes with autograft, including lower rates of graft rupture, lower levels of knee laxity, lower revision rates, and improved patient-reported outcomes, particularly among younger patients (age, <25 years).[11,13,18] On the other hand, PCL reconstruction has demonstrated similar results regardless of graft type.[3] Interestingly, we found a significantly higher failure rate after MPFLR with autograft. The location of the MPFL being intra-articular but extrasynovial may lend itself to a more similar graft environment to the PCL than the ACL.

Hendawi et al[8] attributed the significantly higher failure rate among patients with autograft to smaller graft size (mean, 5.29 mm for autograft and 5.7 mm for allograft; $P = .0009$), underlying hypermobility and joint laxity in patients undergoing autograft reconstruction, and human or technical error, as allograft reconstructions were done later in the study period than autograft reconstructions. Since most autografts were gracilis and most allografts were semitendinosus, it may be suggested that larger graft size should be considered when using autografts for MPFLR. It is possible that some of these patients had ligamentous laxity and would be predisposed to failure with autograft tissue. Kumar et al[14] also attributed increased failure rates in the autograft group to a longer follow-up period, although this was not statistically significant. There was no significant difference between autograft and allograft groups in terms of radiographic analysis (TT-TG distance, postoperative patellar tilt angle), return to activity, and patient-reported outcomes. Only 1 study[8] demonstrated superiority of one graft over the other. Hendawi et al reported significantly improved patient-reported outcomes in patients with allograft, as well as decreased cost and lower failure rate, supporting the use of allograft over autograft. Kumar et al reported significantly higher mean postoperative Kujala scores in patients with autograft ($P = .02$), although the clinical importance is unclear, as there was no difference in return to activity, pain scores, and failure rate between the 2 groups.

In summary, we found that graft failure occurred more frequently in patients with autograft, with similar improvement in subjective outcomes among both groups. We therefore recommend that MPFLR be performed with allograft because of the advantages of its lower failure rate, shorter operative times, and decreased donor-site morbidity.[10] The use of autograft is not without complications, with studies on ACL reconstruction reporting donor-site complications with various graft types, such as patellar fracture after bone–patellar tendon–bone harvest[6,12] and weakness of terminal knee flexion after hamstring harvest.[1,22]

The limitations of this study should be noted. Only 7 studies were included in this systematic review, many of which were retrospective comparative studies with no level 1 studies included. Methodologic assessment showed heterogeneity and poor overall quality of the studies, making meta-analysis impossible. Additionally, autograft and allograft types varied across studies, there was heterogeneity among surgical technique and definition of treatment failure, data were not presented uniformly, and there was a lack of reported follow-up times. Moreover, reported rates of follow-up may not be reflective of the true attrition rates, as several studies[4,8,14,23] required follow-up times as a criterion for inclusion. One study[8] shifted all patients to allograft after a high initial failure rate noted in patients with autograft. Given this deliberate choice to perform one technique over another, the outcomes may be due to a learning curve. Finally, graft selection was not randomized across studies.

CONCLUSION

Patients undergoing MPFLR with either autograft or allograft can expect to experience improvement in clinical outcomes. Graft failure was more frequently observed in patients with autograft. Subjective outcomes improved to a similar degree in both groups. Allograft may be a better option for MPFLR because of its lower failure rate, although further high-quality studies, such as prospective randomized controlled trials, are needed to confirm these findings.

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