Medial Collateral Ligament Reconstruction With Autograft Versus Allograft

A Systematic Review

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Background: Medial collateral ligament (MCL) reconstruction (MCLR) is performed after failed nonoperative treatment or high-grade MCL injury with associated valgus instability.

Purpose: To evaluate clinical outcomes after MCLR with autograft versus allograft.

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

Methods: A systematic review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The authors conducted a search of the PubMed, CINAHL, EMBASE, and Cochrane databases to identify studies comparing outcomes of MCLR with autograft versus allograft. Studies were included if they evaluated clinical outcomes after MCLR using autograft and/or allograft. Any study that included concomitant knee ligament injury other than the anterior cruciate ligament injury was excluded. A quality assessment was performed using the modified Coleman Methodology Score.

Results: The initial search identified 746 studies, 17 of which met the inclusion criteria and were included in this review. The studies included 307 patients: 151 (49.2%) patients received autografts, and 156 (50.8%) received allografts. The most used autograft was the semitendinosus tendon (136 grafts; 90.1% of specified allografts), and the only allograft used was the Achilles tendon (110 grafts; 100% of specified autografts). The mean follow-up of the studies was 25.6 months. Postoperative pain (Lysholm scores) ranged from 82.9 to 94.8 in patients receiving autografts and 87.5 to 93 in patients receiving allografts. Postoperative range of motion was full in 8 of 15 (53.3%) patients receiving autografts compared with 82 of 93 (88.2%) patients receiving allografts. Five of the 151 (3.3%) patients who had MCLR with autografts had complications such as infection, instability, and prominent screws. Two of the 156 (1.3%) MCLRs with allografts developed complications of prominent screws and nonhealing incisions.

Conclusion: MCLR with either autografts or allografts leads to improved patient-reported, radiographic, and clinical outcomes. Patient-reported postoperative pain was similar in patients receiving either graft type. Other outcomes were difficult to compare between graft types because of nonstandardized reporting and a lack of pre- and postoperative measurements. Therefore, there is no evidence of significantly improved outcomes in the use of either autograft or allograft with MCLR.

Keywords: allograft; autograft; medial collateral ligament; medial collateral ligament reconstruction

The medial collateral ligament (MCL) is one of the most commonly injured ligaments in the knee. This injury often occurs in combination with anterior cruciate ligament (ACL) tears and medial meniscal tears, colloquially known as an "unhappy triad." Isolated MCL injuries are less common. MCL injuries often occur in sports that involve repetitive valgus knee movements (eg, football, ice hockey, skiing). In the United States, the incidence of MCL injury is 0.24/1000 people or 74,000 injuries annually.[17] The rate of injury is different between sexes, with women having a higher rate of MCL injury in high school, while men have a higher rate in college.

Most MCL tears are initially treated nonoperatively; however, depending on the severity of the injury, nonoperative treatment may result in chronic valgus instability of the knee.[4] Numerous factors, including patient age and activity level, are considered when determining the most appropriate treatment for MCL tears. In addition, the location of the MCL injury has a substantial effect on outcomes. In cases of failed nonoperative treatment or

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avulsion of the tibial attachment of the MCL, MCL reconstruction (MCLR) should be considered.[4] Rupture of the tibial attachment of the MCL has a poor outcome with nonsurgical treatment, while rupture of the femoral attachment of the MCL typically has a better outcome.[2,11] In 2006, Halinen et al[8] evaluated outcomes after complete ACL rupture and grade III MCL rupture from sports injury, traffic accidents, or falls in 47 male and female patients. The authors found that nonoperative and operative treatments of MCL injury led to equally good results after ACL reconstruction (ACLR) in the same patients.

Achilles, semitendinosus, peroneus longus, or tibialis posterior tendon autografts and Achilles tendon allografts are the most frequently used grafts for MCLR. This has caused orthopaedic surgeons to use various grafts for MCLR with minimal understanding of the postoperative outcomes for their selections. This study aimed to evaluate clinical outcomes after MCLR with autografts versus allografts. The authors hypothesized that there would be no significant differences in outcomes based on graft type.

METHODS

This systematic review was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.[18] Two independent reviewers (N.B., J.B.) searched the PubMed, CINAHL, EMBASE, and Cochrane databases from June 1 to June 25, 2022, to identify studies comparing outcomes of MCLR with autografts versus allografts. The search phrase used was "medial collateral ligament reconstruction autograft allograft." Studies were included if they reported outcomes of human MCLR with autografts or allografts. The exclusion criteria were non-English publications without an English translation, studies on patients with concomitant knee ligament injury other than ACL tears, studies with unclear surgical techniques, and conference abstracts. Data extraction was performed independently and reviewed by a third author (M.M.). In cases of disagreement, the same reviewer made the final decision. The same two independent reviewers performed a quality assessment using the modified Coleman Methodology Score (mCMS) and the risk-of-bias assessment using the risk of bias in nonrandomized studies of interventions and the Cochrane Collaboration tools.

Reporting Outcomes

The following outcomes were assessed: follow-up; patient-reported outcomes—pain was measured by Lysholm scores and postoperative function by International Knee Documentation Committee scores; graft survivorship; operative time; costs; radiographic analysis; return to activity; and complications—such as stiffness, valgus instability, flexion deficit, infection, and misalignment.

Study Methodology Assessment

The mCMS was used to evaluate the quality of the study methodology.[13] The mCMS has a score ranging from 0 to 100 based on the number of patients, follow-up time, description of surgical technique, study type, diagnostic description, description of postoperative rehabilitation, outcome criteria, outcome assessment, and subject selection process. Scores ranging from 85 to 100 are excellent, 70 to 84 are good, 55 to 69 are fair, and <55 are poor. No cluster modification was utilized in this assessment.

RESULTS

The initial search identified 746 studies, and 222 duplicates were removed. After a review of titles and abstracts, 452 studies were removed, and 72 full-text studies were reviewed, 17 of which met the inclusion criteria and were included in this review (Figure 1). The studies included 307 patients, 108 (58.7%) men and 76 (41.3%) women. The remaining breakdown is unknown because 6 studies did not include sex (n = 123). A total of 102 (33.2%) patients (11 studies) underwent MCLR alone, and 205 (66.8%) patients (12 studies) underwent MCLR and primary (183 patients, 59.6%; 11 studies) or revision (22 patients, 7.2%; 2 studies) ACLR. Finally, 151 patients (49.2%) received autografts, and 156 (50.8%) received allografts. The mean follow-up of the studies was 25.6 months (Table 1).

Graft Selection

The semitendinosus tendon was the most common autograft used for MCLR (136; 90.1%). The only allograft used was the Achilles tendon (110; 100%). LaPrade et al[10] conducted a clinical trial and randomly assigned 29 patients to MCLR using semitendinosus autografts or

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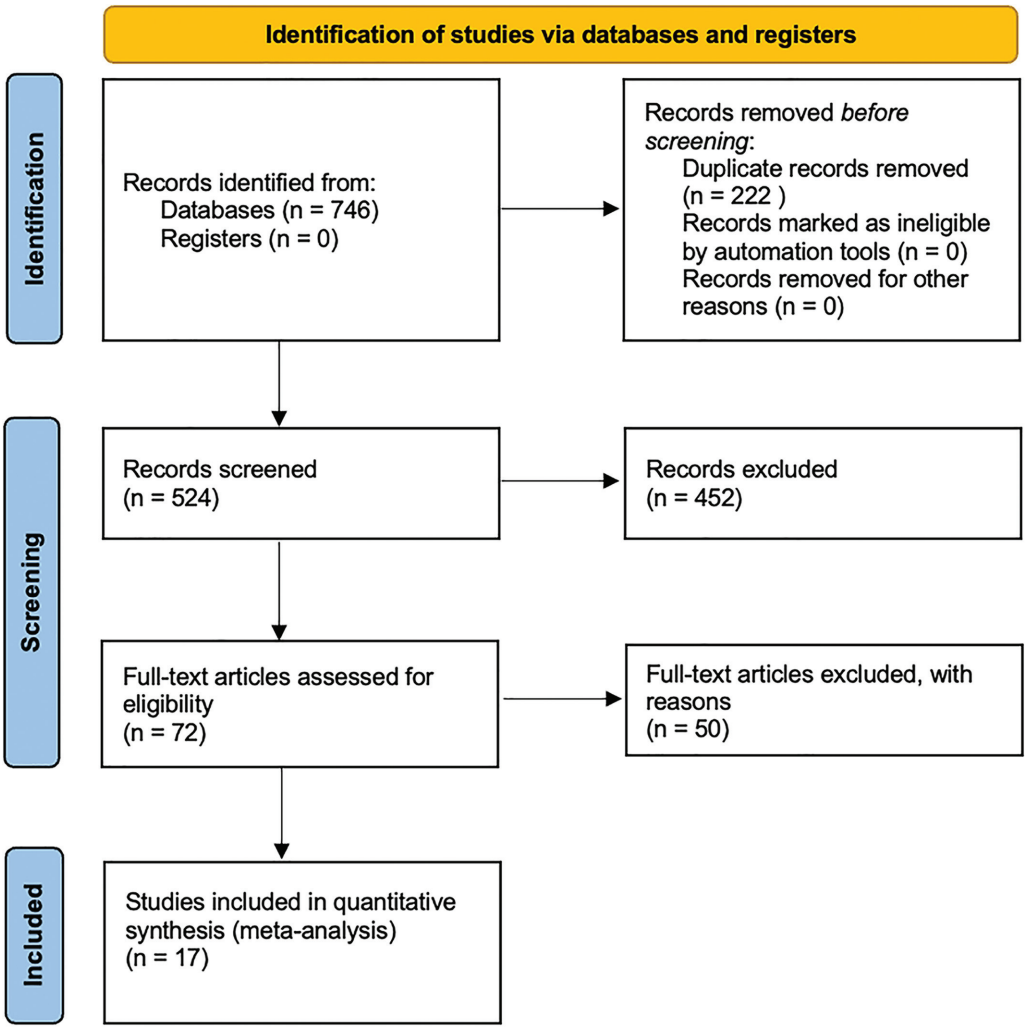

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram.

MCL repair.[10] No other studies reported graft selection criteria.

Clinical/Radiologic Analysis

Authors reported pre- and postoperative medial joint opening with valgus stress radiographically or by clinical comparison with the contralateral, healthy knee, referred to as side-to-side difference (Table 2). Preoperative valgus stress radiographs measured the side-to-side difference in the medial joint widening means ranging from 3.42 to 10.4 mm.[7,10,12,21] The mean side-to-side difference in medial joint opening on valgus stress radiographs after MCLR with autografts ranged across studies from 0.19 to 0.5 mm.[9,10] After MCLR with allografts, the mean side-to-side difference in medial joint opening on valgus stress radiographs was 0.625 mm in a 2013 study by Liu et al.[12] Dong et al[7] reported that the side-to-side difference in medial joint opening on radiographs decreased from 10.1 ± 0.5 mm to 2.9 ± 1.2 mm after MCLR with allografts. The authors compared postoperative medial joint opening to the contralateral, healthy knee in studies with no radiographic measurements. Four allograft studies evaluated medial joint opening with valgus stress compared with the healthy knee.[14,19,22,24] A study by Zhang et al[24] in 2014 using allografts for MCLR reported increased medial joint opening with valgus stress compared with the healthy knee in 1 of the 21 (4.7%) patients. In 2011, Marx and Hetsroni[14] reported medial joint opening with valgus stress of 3 to 5 mm in 3 (18.8%) patients and 5 + mm in 2 of 12 (16.6%) patients after MCLR with allografts. In 2004, Peters et al[19] reported 25° of medial joint opening with valgus stress in 1 of the 2 (50%) patients after MCLR with allografts.

No preoperative range of motion measurements were reported; however, 7 studies reported postoperative range of motion (Table 3). Most patients regained full range of motion postoperatively, regardless of graft type.

TABLE 1
Study Characteristics and Graft Type with Outcomes[a]

Authors	Level of Evidence	Patients (Auto/Allo), n	Sex		Age, y	Follow-up, mo	MCL Injury Grade	Concomitant Injury?	Autograft Type	Allograft Type	Outcomes
			Male	Female							
Alm et al[1]	3	17 (17/0)	10	7	31.3 ± 12	28.8 ± 9	8 grade 2; 9 grade 3	17 revision ACL	Hamstring tendon (2), gracilis (3), quadriceps (12)		Tegner, Lysholm, Pain
Aparicio et al[2]	4	14 (0/14)			29	19.6		14 primary ACL		Achilles	Lysholm, IKDC, return to activity
Barrett et al[3]	4	12 (0/12)			30 (15-51)	40 (28-87)	3	1 MCL only 11 primary ACL		Achilles	ROM, IKDC, KOOS, Marx
Dong et al[6]	4	56 (0/56)	33	23	36 (18-60)	33 (15-47)		27 MCL only 29 primary ACL			EKMO, AMRI, IKDC, ROM
Kitamura et al[9]	4	16 (16/0)			28.6 (16-60)	(12-150)	3	16 Primary ACL	Semitendinosus		ROM, Lysholm, IKDC, Medial joint opening
LaPrade et al[10]	1	29 (29/0)	16	13	32 (23-40)	12	3	5 MCL only 24 primary ACL	Semitendinosus		Valgus stress test, pain, Lysholm, Tegner, IKDC, Satisfaction
Lind et al[11]	4	47 (47/0)			33 (14-62)	24	Grade 3 or 4	13 MCL only 34 primary ACL	Ipsilateral semitendinosus		IKDC, KOOS
Liu et al[12]	4	4 (0/4)	3	1	36.5 (16-33)	30 (24-36)		2 MCL only 2 primary ACL		Achilles	Medial laxity, IKDC, Lysholm
Marx and Hetsroni[14]	3	12 (0/12)	6	6	34 (19-60)	36 (24-61)	2+ and 3+	7 Primary ACL 5 revision ACL		Achilles	ROM, Valgus instability, IKDC, Lysholm, KOOS, ADL, QOL, Marx, Tegner, Sport/Rec
Mounasamy et al [15]	4	1 (0/1)	1		74	6		1 MCL Only			ROM
Nardin et al [16]	4	28 (0/28)			29.5	19.6		28 primary ACL		Achilles	Lysholm, IKDC
Peters et al [19]	4	2 (0/2)	2		(34-56)	24		2 MCL only		Achilles	ROM, valgus stress test, AKSS
Wang et al [20]	4	17 (17/0)	4	13	63 (55-72)	51 (36-72)		17 MCL only	Semitendinosus		AKSS, Pain
Wierer et al [21]	4	1 (1/0)	0	1	60	24		1 MCL only	Semitendinosus		Valgus and varus instability, Lysholm, Oxford, Tegner, VAS, ROM
Yazdi et al[22]	4	6 (0/6)			32 (26-38)	19 (12-27)		6 primary ACL		Achilles	Valgus instability, return to activity, Lysholm, IKDC
Yoshiya et al[23]	4	24 (24/0)	20	4	28 (16-54)	27 (24-48)		2 MCL only 12 primary ACL	Semitendinosus, gracilis		Symptoms, ROM, medial joint opening, stability
Zhang et al [24]	3	21 (0/21)	13	8	32 (19-62)	18.5 (7-29)				Achilles	Valgus stress test, ROM, Lysholm, IKDC

[a]ACL, anterior cruciate ligament; ADL, Activities of Daily Living; AKSS, American Knee Society Score, Allo, allograft; AMRI, anteromedial rotatory instability; Auto, autograft; EKMO, excessive knee medial opening; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; MCL, medial collateral ligament; QOL, Quality of Life; ROM, range of motion; Sport/Rec, Sport and Recreation; VAS, visual analog scale.

TABLE 2
Findings on Medial Joint Opening with Autograft and Allograft[a]

Study	Graft	Preop, Mean (SD), mm	Postop, Mean (SD), mm
LaPrade et al[10]	Semitendinosus autograft	3.42 (0.55) side-to-side difference	0.19 (0.67) side-to-side difference
Weirer et al[21]		10 side-to-side difference	
Kitamura et al[9]			8.5 (1.6) in postop knee 8.0 (1.2) in healthy, opposite knee 0.5 side-to-side difference
Yazdi et al[22]	Achilles allograft		No difference between postop and healthy knee
Zhang et al[24]			Negative in 20/21 patients
Liu et al[12]		6.95 side-to-side difference	0.625 side-to-side difference
Marx and Hetsroni[14]			11 pt no difference between postop and healthy knee 3 pt 3-5 mm 2 pt 5+ mm
Peters et al[19]			1 pt stable, 1 pt 25° valgus opening
Dong et al[7]		10.1 side-to-side difference	2.9 side-to-side difference

[a]Postop, postoperative; Preop, preoperative.

TABLE 3
Postoperative Knee Range of Motion[a]

Study	Graft	Postoperative ROM
Weirer et al[21]	Semitendinosus autograft	1 pt 0°-130°
Kitamura et al[9]		8 pt full ROM
		1 pt 3°-6° loss of extension
		5 pt >6° loss of extension
Marx and Hetsroni[14]	Allograft	12 pt full ROM
		1 pt 15° loss of extension
Mounasamy et al[15]		1 pt 5°-90°
Peters et al[19]		1 pt 0°-125°
		1 pt 0°-110°
Zhang et al[24]		20 pt full ROM
		1 pt 0°-15°
Dong et al[6]		50 pt full ROM
		4 pt > 6° loss of extension
		2 pt >25° loss of flexion

[a]ROM, range of motion.

TABLE 4
Patient-Reported Outcomes After MCLR[a]

		Lysholm		Tegner		AKSS	
Study	Graft	Preop	Postop	Preop	Postop	Preop	Postop
Alm et al[1]	Gracilis autograft		82.9		5.6		
LaPrade et al[10]	Semitendinosus autograft	67	90	4.0	5.5		
Weirer et al.[21]		27	86	2	4.1		
Kitamura et al[9]			94.8				
Wang et al[20]							172.4
Yadzi et al[22]	Achilles allograft		92				
Zhang et al[24]		45.4	87.5				
Aparicio et al[2]			93				
Marx and Hetsroni[14]					5.6		
Peters et al[19]						79	158.5
Nardin et al[16]			93				

[a]AKSS, American Knee Society Score; MCLR, medial collateral ligament reconstruction; Postop, postoperative; Preop, preoperative.

Patient-Reported Outcomes

Table 4 shows mean patient-reported outcomes per study, including Lysholm and Tegner scores and the American Knee Society Score (AKSS). After MCLR with autografts, Lysholm scores ranged from 82.9 to 94.8. After MCLR with allografts, Lysholm scores ranged from 87.5 to 93. Tegner scores after reconstruction with autografts ranged from 4.1 to 5.6, and after reconstruction with allografts, they were 5.6. The AKSS after reconstruction with autografts was 172.4, and it was 158.5 after allografts.

Cost Analysis and Operation Time

Cost analysis and operation time were not reported in any of the studies.

Complications and Treatment Failures

Of the 307 total patients, 7 (2.3%) had complications, and 1 (0.3%) experienced treatment failure, which was defined as persistent severe instability or symptoms requiring revision (Table 5). Five of the 151 (3.3%) MCLRs with autografts had complications. Three (2%) patients had pain or mild instability during light activity.[22] One (0.7%) patient after autograft MCLR suffered septic arthritis in the early postoperative period, and 1 (0.7%) patient required screw removal because of the pain.[11] Two of the 156 (1.3%) MCLRs with allografts developed complications. One (0.6%) patient had painful prominent tibial hardware requiring removal, and 1 (0.6%) patient had a nonhealing incision (Table 6).[3,24] In addition, there was 1 treatment failure in which a patient who underwent MCLR with Achilles allograft required a total knee arthroplasty at 1

TABLE 5
Complications after MCLR Using Autografts or Allografts[a]

Author	Complications	Failures	Autograft or Allograft
Alm et al[1]		0/17 (0)	Autograft
Aparicio et al[2]		0/14 (0)	Allograft
Barrett et al[3]	1/12 (8.33) painful prominent tibial hardware requiring removal	1/12 (8.33)	Allograft
Dong et al[7]		0/56 (0)	Allograft
Kitamura et al[9]		0/16 (0)	Autograft
LaPrade et al[10]		0/29 (0)	Autograft
Lind et al[11]	2/47 septic arthritis and screw renivak	2/47 (4.2)	Autograft
Liu et al[12]		0/4 (0)	Allograft
Marx and Hetsroni[14]		0/12 (0)	Allograft
Mounasamy et al[15]		0/1 (0)	Allograft
Nardin et al [16]		0/28 (0)	Allograft
Peters et al[19]		0/2 (0)	Allograft
Wang et al[20]		0/17 (0)	Autograft
Wierer et al[21]		0/1 (0)	Autograft
Yazdi et al[22]		0/6 (0)	Allograft
Yoshiya et al[23]	3/27 (11.1) with pain or mild instability during light activity	0/24 (0)	Autograft
Zhang et al[24]	1/21 (4.76) nonhealing incision	0/21 (0)	Allograft

[a]Data are presented as n/N (%). MCLR, medial collateral ligament reconstruction.

TABLE 6
Total Number of Complications and Failures Using Autografts Versus Allografts[a]

Participants	Number	Percentage
Total	307	N/A
Total autograft	151	N/A
Total allograft	156	N/A
Total with no complications	300	97.7
Total with complications	7	2.3
Autograft with no complications	146	96.7
Autograft with complications	5	3.3
Allograft with no complications	156	98.7
Allograft with complications	2	1.3
Total failures	1	0.3
Autograft failures	0	0
Allograft failures	1	0.6

[a]N/A, not applicable.

year postoperatively secondary to persistent valgus instability and posttraumatic arthritis.[3]

Methodologic Assessment and Risk of Bias

Table 7 shows the mCMS for the 17 included studies. Six studies received a fair score and 11 studies received a poor score. No studies were rated as good or excellent. All studies were retrospective cohort studies. Most studies had small sample sizes, did not describe postoperative rehabilitation, and did not include a general health measure. The operating surgeon measured most patient outcomes.

TABLE 7
Modified Coleman Methodology Score

Authors	Score
Alm et al[1]	64 (fair)
Aparicio et al [2]	52 (poor)
Chen et al[4]	34 (poor)
DeLong and Waterman[5]	40 (poor)
Dong et al[7]	64 (fair)
Kitamura et al[9]	30 (poor)
LaPrade et al[10]	66 (fair)
Liu et al[12]	32 (poor)
Marx and Hetsroni[14]	61 (fair)
Mounasamy et al[15]	44 (poor)
Nardin et al[16]	37 (poor)
Peters et al[19]	54 (poor)
Wang et al[20]	67 (fair)
Wierer et al[21]	52 (poor)
Yazdi et al[22]	62 (fair)
Yoshiya et al[23]	22 (poor)
Zhang et al[24]	47 (poor)

Clinical Comparisons

There was too much variability to determine whether patient sex, age, laterality, duration of preoperative symptoms, or body mass index had a statistically significant effect on outcomes after MCLR using autografts or allografts. Marx and Hetsroni[14] included 12 cases that underwent MCLR using autografts or allografts and simultaneous primary or revision ACLR. Both patients (2/12; 16.7%) had inferior functional scores and did not

return to preinjury activity, while 10 of the patients who underwent only MCLR (10/12; 83.3%) returned to preinjury levels.

DISCUSSION

The present study aimed to review outcomes after MCLR with autografts versus allografts. Based on the findings of this review, patients undergoing MCLR experienced improved outcomes regardless of graft choice. The mean preoperative radiographic measurements of the side-to-side difference in medial joint opening under valgus stress ranged from 3.42 to 10.1 mm.[10,12,21] After surgery, the mean autograft radiographic measurements of the side-to-side difference in medial joint opening under valgus stress ranged from 0.19 to 0.5 mm.[9,10] The mean postoperative allograft radiographic measurement of the side-to-side difference in medial joint opening under valgus stress was 0.625 to 2.9 mm.[7,12] Patients had a similar range of motion, and patient-recorded outcomes such as the Lysholm score, Tegner score, and AKSS after MCLR with either graft. Five of the 151 (3.3%) MCLRs with autografts had complications, and 2 of the 156 (1.3%) MCLRs with allografts developed complications. We could not find data suggesting that MCLR with autografts or allografts has a significant difference in cost or operative time.

Previous studies have compared the outcomes of autografts versus allografts for the reconstruction of other knee ligaments, such as the ACL and posterior cruciate ligament.[1,7,9,15,17] ACLR studies have shown superior outcomes with autografts, including lower graft rupture rates, lower levels of knee laxity, lower revision rates, and improved patient-reported outcomes, particularly among younger patients (age <25 years).[7,9,15] However, posterior cruciate ligament reconstruction has demonstrated equivocal results with either graft type.

DeLong and Waterman[5] published a systematic review of surgical techniques and outcomes used in MCLR. The authors identified various surgical techniques and graft choices, with no technique demonstrating superior clinical outcomes. The only notable outcome was superior postoperative radiographic valgus stress measurements in anatomic double-bundle reconstruction compared with the anatomic single-bundle and nonanatomic reconstructions. The authors of this study commented on the difficulty in comparing outcomes due to nonstandardized outcome measures and confounding variables.

There are several limitations to this study. First, there was a lack of pre-and postoperative measurements in many studies, making direct comparison and meta-analysis difficult. Only valgus stress measurements, Lysholm, and Tegner scores were measured pre- and postoperatively in autograft and allograft patients. However, the preoperative Lysholm or Tegner score was only reported for 1 patient who underwent MCLR using autografts. In addition, the Lysholm, Tegner, and AKSS outcomes rely significantly on patient subjective pain, which can be difficult to compare between patients because of different pain tolerances. A variety of outcome measures were reported. Some studies reported valgus instability, others flexion and extension, and others malalignment. There was no control across studies regarding classifications and measurements. Many confounding variables affected the reliability of the study. These include varying surgeons, techniques, injury severity, patient age and general health, comorbidities, follow-up time, and postoperative rehabilitation. Outcome measurements were confounded by the load applied and the degree of knee flexion in which valgus stress radiographs were taken.

The mCMS assessment demonstrated a high level of bias in all the studies. Many studies had few patients, poor descriptions of surgical techniques, and no description of postoperative rehabilitation. Moreover, very few studies evaluated patients postoperatively with an investigator independent of the operating surgeon.

CONCLUSION

MCLR with either autograft or allograft leads to improved patient-reported, radiographic, and clinical outcomes. Patient-reported postoperative pain, measured by the Lysholm score, was similar in patients receiving either graft type. Other outcomes were difficult to compare between graft types because of nonstandardized reporting and lack of pre- and postoperative measurements.

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