Original Article

Early Surgical Intervention Results in Better Patient-Reported Outcomes Than Delayed Treatment in Patients Undergoing Anterior Cruciate Ligament Reconstruction in the Presence of Concomitant Medial Collateral Ligament Injury

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Purpose: To investigate the influence of the timing of anterior cruciate ligament (ACL) reconstruction (ACLR) on patient-reported outcomes, comparing patients with and without concomitant medial collateral ligament (MCL) injury. **Methods:** This study included patients who underwent ACLR between September 2015 and October 2020. The inclusion criteria included patients for whom preoperative and postoperative patient-reported outcome measures were available and a follow-up period of at least 2 years. Patients who sustained grade 2 or 3 MCL injuries with ACL tears were compared with patients with no MCL injuries as a control. All patients underwent ACLR with either bone-tendon-bone autograft or bone-tendon-bone allograft. Patient-reported outcomes (International Knee Documentation Committee [IKDC] score, Lysholm score, and Knee Injury and Osteoarthritis Outcome Score [KOOS]) were recorded, and outcomes were analyzed by sex and time from index injury. A stratified linear mixed-effects regression analysis was conducted. **Results:** A total of 253 eligible patients with 2-year outcomes were enrolled. Patients with combined ACL-MCL injuries had lower IKDC scores ($\beta = -6.1$ vs $\beta = -8.3$, $P = .003$), KOOS Quality of Life values ($\beta = -9.3$ vs $\beta = -11$, $P = .004$), and KOOS Sport values ($\beta = -12$ vs $\beta = -13$, $P = .08$) if surgery was performed more than 6 weeks after the index injury. Patients with isolated ACL injuries showed lower KOOS Activities of Daily Living values ($\beta = -2.4$, $P = .045$) if surgery was performed at between 3 and 6 months. Among patients with combined ACL-MCL injuries, autograft was found to have worse IKDC scores ($\beta = -11$ [95% confidence interval (CI), −18 to −4.2]; $P = .002$), Lysholm scores ($\beta = -9.2$ [95% CI, −15 to −3.1]; $P = .004$), KOOS Quality of Life values ($\beta = -11$ [95% CI, −20 to −1.6]; $P = .023$), KOOS Pain values ($\beta = -5.1$ [95% CI, −10 to −0.03]; $P = .049$), KOOS Symptoms values ($\beta = -7.6$ [95% CI, −10 to −0.03]; $P = .02$), and KOOS Sport values ($\beta = -21$ [95% CI, −32 to −10]; $P < .001$) than allograft. **Conclusions:** Patients undergoing ACLR with grade 2 or 3 MCL injuries have improved patient-reported outcomes if surgery is performed within 6 weeks from the time of injury. In this cohort, allografts resulted in better outcome scores compared with autografts. **Level of Evidence:** Level III, retrospective cohort study.

With over 200,000 surgical procedures performed annually in the United States, anterior cruciate ligament (ACL) reconstruction (ACLR) has become the standard of care for restoring the native biomechanics of the knee and reducing the risk of further injury to the meniscus and articular cartilage after an ACL tear.[1,2] Despite advancements in surgical techniques and rehabilitation protocols, ACL injuries can substantially impact a patient's long-term functional capacity and ability to return to preinjury activity levels.[3-5] Thus, identifying factors that optimize postoperative outcomes and reduce the risk of subsequent injury is crucial to enhancing patient outcomes.

Numerous studies have identified various factors as influencers of postoperative outcomes after ACLR, such as age, body mass index (BMI), graft type, and preoperative patient-reported outcome measures (PROMs).[6-8]

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Additionally, the timing of surgery has garnered attention as a critical consideration in ACLR. However, optimal timing remains a controversial topic.[9-15] Advocates of early surgery argue its potential to reduce the risk of secondary injuries, including meniscal and articular cartilage damage.[16,17] In contrast, proponents of delayed surgery suggest potential benefits such as improved quadriceps strength and a reduced risk of arthrofibrosis.[18,19] However, despite the focus on surgical timing and postoperative outcomes, the impact a concomitant medial collateral ligament (MCL) injury has on the optimal timing of surgery is poorly understood.

Combined ACL-MCL injuries constitute the most common presentation of multiligamentous knee injuries.[20] The ACL serves as the primary stabilizer, guarding against anterior tibial translation and rotatory knee instability, whereas the MCL plays a crucial role in stabilizing the knee against valgus stress.[21,22] When both ligaments are injured together, studies have shown a substantial increase in valgus motion, predisposing patients to potential complications, including osteoarthritis and lateral meniscal damage.[23,24] Additionally, the absence of the ACL, a secondary stabilizer against valgus stress, may hinder the healing response of the MCL due to increased valgus laxity.[23] Although surgical versus nonsurgical management of concomitant MCL injury has been heavily debated within the literature,[25-27] this challenging clinical scenario also necessitates careful consideration of surgical timing.

The purpose of this study was to investigate the influence of the timing of ACLR on patient-reported outcomes, comparing patients with and without concomitant MCL injury. The hypothesis of this study was that patients undergoing early ACLR with concomitant MCL injury would have improved patient-reported outcomes compared with those undergoing delayed reconstruction.

Methods

After obtaining approval from the institutional review board (No. 2016P001873), we conducted a retrospective review of all patients who underwent primary ACLR surgery performed by the senior author (P.D.A.) between September 2015 and October 2020 in the Surgical Outcome Systems registry (Arthrex, Naples, FL) and electronically provided preoperative and postoperative patient-reported outcome surveys. The study inclusion criteria encompassed patients who underwent primary ACLR surgery for either an isolated ACL tear or an ACL tear combined with a grade 2 or 3 MCL injury that did not require surgical management (as assessed on preoperative magnetic resonance imaging and confirmed by laxity on physical examination), who had available preoperative and postoperative PROMs, and who were followed up for at least 2 years after surgery. The exclusion criteria included patients who underwent prior knee ligament reconstruction, those with a concomitant grade 3 posterior cruciate ligament and/or lateral collateral ligament tear, or those younger than 15 years. Patients with a grade 1 MCL injury, which is generally not considered clinically significant, were also excluded from the analysis. This decision was made because the inclusion of grade 1 MCL injuries may have introduced unnecessary variability. The senior author most commonly treats grade 3 MCL injuries nonoperatively unless a retracted distal MCL tear is found, which was not the case in this cohort. The surgeon's preoperative preference was for patients to be able to extend the knee to neutral and approximately 130° of flexion prior to surgery. Once adequate motion was achieved, patients signed consent forms for surgery. The timing from injury to surgery was influenced by multiple factors, including late presentation to the office, missed diagnosis, and lack of initial investigation.

Variables and Outcomes

Demographic variables including age, sex, race, ethnicity, and BMI were collected, along with injury and surgical details such as concomitant MCL injury graded on magnetic resonance imaging, graft type, time between injury and surgery, and PROM scores. The decision on graft type was influenced by a shared decision-making process, with allografts generally being recommended for patients aged 40 years and older with a lower activity/risk profile. To improve clinical interpretability of the results, the variable of time between injury and surgery was categorized into 4 groups based on the following intervals: less than 6 weeks, between 1.5 and 2 months, between 2 and 3 months, and more than 6 months. The boundaries of the intervals were determined by plotting the distribution of the data and clinical experience of typical time frames observed in practice. These intervals were decided prior to the analysis. The 6- to 8-week window, in particular, was included to reflect a critical period for recovery based on input from the investigator team healthcare providers.

The PROMs investigated in this study were obtained from a prospectively maintained institutional registry and included the International Knee Documentation Committee (IKDC) score; Lysholm score; and Knee Injury and Osteoarthritis Outcome Score (KOOS) component scores, including Pain, Sports and Recreational Activities (Sport), Quality of Life (QOL), Activities of Daily Living (ADL), and Symptoms. These PROMs were administered preoperatively and at postoperative intervals of 3 months, 6 months, 1 year, and 2 years.

Statistical Analysis

Baseline characteristics were reported using means, standard deviations, and proportions. Patients with isolated ACL tears were compared with patients with

combined ACL-MCL injuries using a 2-sample *t* test, the χ^2 test, or the Fisher test, as appropriate. Patient-reported outcome scores were compared at various time points between the 2 groups using linear mixed-effects regression models and calculation of estimated marginal means.

To understand individual variables' impact on PROMs within each cohort, a stratified linear mixed-effects regression analysis was conducted. This statistical method allows for the assessment of variable effects while accounting for both fixed effects (e.g., age, sex, and BMI) and random effects (e.g., variations within cohorts) across different strata or groups. To perform this analysis, patients were stratified into 2 cohorts based on the extent of MCL injury: (1) isolated ACL tears and (2) combined ACL-MCL injuries. The analysis examined the potential influence of age, sex, BMI, graft type, preoperative PROM scores, and time between injury and surgery on postoperative PROM scores. For each variable, the analysis yielded a β value, which represents the average change in postoperative PROM score per 1-unit increase in the variable while all other variables are held constant. To measure uncertainty, we calculated the confidence interval (CI), which represents the range of values within which we can be 95% confident that the true β value lies. Statistical significance was set at an α level of .05. All statistical analyses were performed using the R package (version 4.2.2; The R Foundation, Vienna, Austria).

Results

Demographic Variables and Outcome Measures

The initial cohort consisted of 611 patients who underwent primary ACLR. Of these patients, 38 were excluded because of prior knee ligament reconstruction, 84 were excluded because of non−grade 2 or 3 concurrent knee ligament injury to the MCL, and 236 were excluded because of incomplete preoperative or postoperative PROM data (Fig 1). The final cohort included 253 patients, comprising 163 (64%) with an isolated ACL tear and 90 (36%) with a combined ACL-MCL injury. The 2 cohorts had a similar mean age of approximately 33 years, with no statistically significant difference observed between the groups. There were no significant variations in terms of sex, race, ethnicity, or graft type between the cohorts. However, patients with combined ACL-MCL injuries underwent surgery significantly earlier than those with isolated ACL tears (2.5 months vs 12.9 months, $P < .05$). Table 1 provides a summary of the differences in demographic parameters stratified by the presence of a concomitant MCL tear. The PROMs showed several significant differences between the cohorts, mainly involving the preoperative

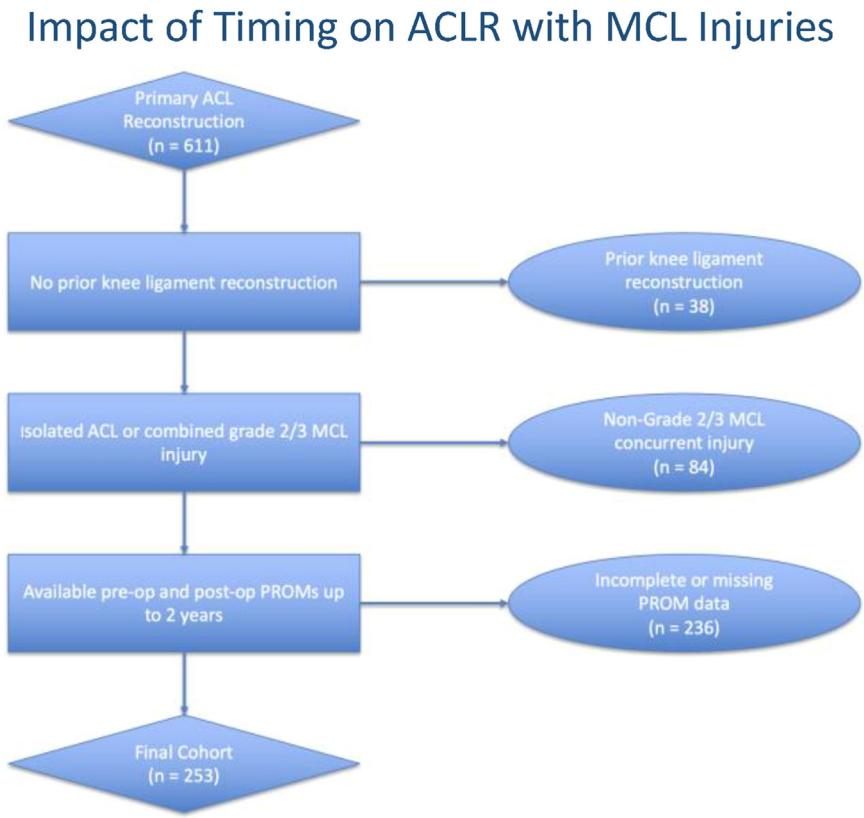

Fig 1. Flowchart outlining selection process for final patient cohort. (ACL, anterior cruciate ligament; MCL, medial collateral ligament; post-op, postoperative; pre-op, preoperative; PROM, patient-reported outcome measure.)

Table 1. Patient Demographic Characteristics Stratified by Presence of Concomitant MCL Injury

Characteristic	Patients, n	ACL Without Grade 2-3 MCL Tear (n = 163)	ACL With Grade 2-3 MCL Tear (n = 90)	*P* Value*
Age, mean (SD), yr	252	33.6 (13.7)	33.4 (12.4)	.99
Sex	253			.3
Female		82 (50)	52 (58)	
Male		81 (50)	38 (42)	
Race	241			>.99
Asian		9 (5.9)	7 (8.0)	
Black or African American		7 (4.6)	3 (3.4)	
Other		1 (0.7)	1 (1.1)	
Patient declined to specify		1 (0.7)	0 (0)	
White		135 (88)	77 (88)	
Ethnicity	225			.15
Hispanic or Latino		3 (2.1)	5 (6.0)	
Not Hispanic or Latino		139 (98)	78 (94)	
Graft type	253			.4
Allograft		67 (41)	32 (36)	
Autograft		96 (59)	58 (64)	
BMI, mean (SD)	253	24.7 (3.8)	25.0 (4.0)	.7
Time between injury and surgery, mo	252			.006
Mean (SD), mo		12.9 (47.5)	2.5 (1.7)	
<1 mo		22 (14)	13 (14)	
1-1.5 mo		25 (15)	19 (21)	
1.6-2 mo		50 (31)	36 (40)	
2-3 mo		31 (19)	16 (18)	
>3 mo		34 (21)	6 (6.7)	
Unknown		1	0	

NOTE. Data are presented as number (percent) unless otherwise indicated.
ACL, anterior cruciate ligament; BMI, body mass index; MCL, medial collateral ligament; SD, standard deviation.
*Welch 2-sample *t* test, Pearson χ^2test, or Fisher exact test.

measures. Preoperatively, the combined ACL-MCL injury cohort exhibited significantly lower values for the IKDC score (49.6 vs 54.3, $P < .05$), KOOS Sport (32.5 vs 40.7, $P < .05$), and KOOS Quality of Life (30.4 vs 35.5, $P < .05$) compared with the isolated ACL tear group. At 3 months postoperatively, the combined ACL-MCL injury cohort showed significantly lower KOOS Symptoms values (73.3 vs 77.5, $P < .05$). No significant differences in any PROMs were observed at the 6-month, 1-year, or 2-year postoperative assessments. Table 2 presents a comprehensive summary of all PROMs at various time points, stratified by the presence of a concurrent MCL injury.

Mixed-Effects Regression Analysis

Stratified mixed-effects regression analysis revealed several significant associations between patient-specific variables and postoperative PROM scores in both cohorts (Table 3). Regarding demographic variables, in the combined ACL-MCL injury cohort, older age at treatment was significantly associated with worse IKDC scores ($\beta = -0.33$ [95% CI, −0.58 to −0.08]; $P = .011$) and KOOS Pain values ($\beta = 0.2$ [95% CI, −0.40 to −0.01]; $P = .043$), whereas sex and BMI revealed no significant associations. In the isolated ACL tear cohort, no significant associations were revealed between age and PROMs; however, male sex was associated with significantly better IKDC scores ($\beta = 4.1$ [95% CI, 0.62 to 7.7]; $P = .022$), Lysholm scores ($\beta = 4.2$ [95% CI, 1.3 to 7.2]; $P = .005$), and KOOS ADL values ($\beta = 1.6$ [95% CI, 0.17 to 3.0]; $P = .029$). Additionally, higher BMI was found to be associated with significantly better KOOS QOL values in the isolated ACL tear cohort ($\beta = 0.67$ [95% CI, 0.03 to 1.3]; $P = .039$).

On comparison of autografts with allografts in the combined ACL-MCL injury cohort, autografts were found to be associated with significantly worse IKDC scores ($\beta = -11$ [95% CI, −18 to −4.2]; $P = .002$), Lysholm scores ($\beta = -9.2$ [95% CI, −15 to −3.1]; $P = .004$), KOOS QOL values ($\beta = -11$ [95% CI, −20 to −1.6]; $P = .023$), KOOS Pain values ($\beta = -5.1$ [95% CI, −10 to −0.03]; $P = .049$), KOOS Symptoms values ($\beta = -7.6$ [95% CI, −10 to −0.03]; $P = .02$), and KOOS Sport values ($\beta = -21$ [95% CI, −32 to −10]; $P < .001$). Conversely, in the isolated ACL tear cohort, autografts were only found to result in significantly worse KOOS Sport values ($\beta = -10$ [95% CI, −19 to −1.3]; $P = .024$). Time of follow-up showed a significant positive correlation with all PROMs for both cohorts; in addition, preoperative PROM scores showed a significant positive correlation with all PROMs for both cohorts, except the Lysholm score, KOOS Symptoms, and KOOS Sport in the combined ACL-MCL injury cohort.

Table 2. PROM Scores at Varying Intervals Stratified by Presence of Concomitant MCL Injury

	ACL With Grade 2-3 MCL Tear		ACL Without Grade 2-3 MCL Tear	
Parameter	n	Estimated Marginal Mean (95% CI)	n	Estimated Marginal Mean (95% CI)
IKDC score				
Preoperative	82	49.6 (46.9-52.3)	150	54.3 (52.3-56.3)
3 mo	76	53.7 (50.9-56.5)	142	55.3 (53.2-57.3)
6 mo	71	66.6 (63.8-69.5)	128	68.4 (66.3-70.6)
1 yr	71	80.3 (77.5-83.2)	137	81.5 (79.4-83.5)
2 yr	82	85.5 (82.8-88.2)	150	86.5 (84.5-88.5)
Lysholm score				
Preoperative	82	65.9 (63.2-68.6)	150	68.8 (66.8-70.8)
3 mo	76	74.9 (72.1-77.6)	142	77.1 (75.1-79.2)
6 mo	71	83.3 (80.4-86.1)	128	85 (82.9-87.2)
1 yr	71	89.6 (86.7-92.4)	137	91 (88.9-93.1)
2 yr	82	91.8 (89.1-94.5)	150	91.9 (89.9-93.9)
KOOS				
Pain				
Preoperative	90	75.3 (73.1-77.5)	163	77.1 (75.4-78.7)
3 mo	84	81.9 (79.7-84.2)	155	84.5 (82.9-86.2)
6 mo	79	87.6 (85.3-89.9)	139	88 (86.3-89.7)
1 yr	77	91.5 (89.1-93.8)	150	92.6 (91-94.3)
2 yr	90	93.4 (91.2-95.6)	163	94.5 (92.9-96.2)
Symptoms				
Preoperative	90	68.2 (65.6-70.8)	163	71.3 (69.4-73.2)
3 mo	84	73.2 (70.5-75.8)	155	77.5 (75.6-79.5)
6 mo	79	80 (77.3-82.7)	139	83.1 (81.1-85.1)
1 yr	77	85.2 (82.4-87.9)	150	87.2 (85.3-89.2)
2 yr	90	86.5 (83.9-89.1)	163	88.4 (86.5-90.3)
ADL				
Preoperative	90	83.4 (81.7-85.2)	163	85.4 (84.1-86.7)
3 mo	84	89.2 (87.4-91)	155	91.2 (89.9-92.5)
6 mo	79	94.5 (92.7-96.3)	139	94.8 (93.4-96.1)
1 yr	77	97.4 (95.5-99.2)	150	97.6 (96.3-99)
2 yr	90	97.9 (96.2-99.7)	163	98.2 (96.9-99.4)
QOL				
Preoperative	90	30.4 (26.6-34.2)	163	35.3 (32.5-38.2)
3 mo	84	44.7 (40.8-48.6)	155	49.1 (46.2-52)
6 mo	79	52.9 (48.9-56.9)	139	57.3 (54.3-60.3)
1 yr	77	64.4 (60.3-68.4)	150	69.1 (66.1-72)
2 yr	90	75.6 (71.8-79.4)	163	78.2 (75.4-81.1)
Sport				
Preoperative	86	32.5 (27.8-37.2)	154	40.7 (37.2-44.2)
3 mo	57	40.2 (34.6-45.8)	128	46.7 (42.9-50.5)
6 mo	72	62.5 (57.5-67.6)	128	62.7 (58.9-66.5)
1 yr	75	79.4 (74.4-84.3)	140	81.8 (78.1-85.4)
2 yr	82	84.2 (79.4-89)	151	84.9 (81.3-88.4)

ACL, anterior cruciate ligament; ADL, Activities of Daily Living; CI, confidence interval; IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score; MCL, medial collateral ligament; PROM, patient-reported outcome measure; QOL, quality of life.

Stratified mixed-effects regression analysis also showed that the timing of surgery relative to injury played a significant role in postoperative outcomes. In the combined ACL-MCL injury cohort, surgery between 1.5 and 2 months and surgery between 2 and 3 months after initial injury were associated with significantly lower IKDC scores ($\beta = -6.1$ [95% CI, −12 to −0.21; $P = .043$] and $\beta = -8.3$ [95% CI, −14 to −2.9; $P = .003$], respectively), KOOS QOL values ($\beta = -9.3$ [95% CI, −18 to −0.63; $P = .036$] and $\beta = -11$ [95% CI, −19 to −3.7; $P = .004$], respectively), and KOOS Sport values ($\beta = -12$ [95% CI, −23 to −1.9; $P = .021$] and $\beta = -13$ [95% CI, −22 to −3.4; $P = .008$], respectively) compared with surgery within the first 6 weeks. Surgery greater than 6 months after initial injury was also associated with significantly lower KOOS QOL values ($\beta = -12$ [95% CI, −24 to −0.36]; $P = .044$) (Figs 2-4). For the isolated ACL tear cohort, surgery between 3 and 6 months after initial injury was associated with significantly lower KOOS ADL values ($\beta = -2.4$ [95% CI, −4.7 to −0.05]; $P = .045$).

Table 3. Mixed-Effects Regression Analysis for 2-Year IKDC and Lysholm Scores

	IKDC Score				Lysholm Score			
	ACL Without Grade 2-3 MCL Tear		ACL With Grade 2-3 MCL Tear		ACL Without Grade 2-3 MCL Tear		ACL With Grade 2-3 MCL Tear	
Characteristic	β (95% CI)	*P* Value	β (95% CI)	*P* Value	β (95% CI)	*P* Value	β (95% CI)	*P* Value
Age at treatment	−0.18 (−0.39 to 0.03)	.09	−0.33 (−0.58 to −0.08)	.011	−0.12 (−0.29 to 0.06)	.2	−0.22 (−0.45 to 0.00)	.054
Sex								
Female	—		—		—		—	
Male	4.1 (0.62 to 7.7)	.022	1.7 (−2.3 to 5.7)	.4	4.2 (1.3 to 7.2)	.005	2.3 (−1.2 to 5.9)	.2
BMI	−0.17 (−0.62 to 0.28)	.5	−0.32 (−0.81 to 0.16)	.2	−0.03 (−0.41 to 0.35)	.99	−0.29 (−0.73 to 0.15)	.2
Graft								
Allograft	—		—		—		—	
Autograft	−4.4 (−10 to 1.5)	.14	−11 (−18 to −4.2)	.002	−3.8 (−8.7 to 1.1)	.13	−9.2 (−15 to −3.1)	.004
Time between injury and surgery								
<6 wk	—		—		—		—	
1.5-2 mo	−3.3 (−9.2 to 2.6)	.3	−6.1 (−12 to −0.21)	.043	−1.4 (−6.3 to 3.6)	.6	−5.1 (−10 to 0.31)	.065
2-3 mo	1.3 (−4.0 to 6.6)	.6	−8.3 (−14 to −2.9)	.003	1.2 (−3.2 to 5.6)	.6	−4.7 (−9.6 to 0.12)	.056
3-6 mo	−5.2 (−11 to 0.63)	.08	−3.3 (−9.4 to 2.7)	.3	−1.7 (−6.5 to 3.1)	.5	−1.5 (−7.0 to 4.0)	.6
>6 mo	−2.5 (−8.3 to 3.2)	.4	−5.5 (−14 to 2.7)	.2	0.55 (−4.2 to 5.3)	.8	−4.8 (−12 to 2.7)	.2
Time of follow-up	1.3 (1.2 to 1.5)	<.001	1.4 (1.2 to 1.5)	<.001	0.6 (0.51 to 0.69)	<.001	0.71 (0.57 to 0.84)	<.001
Preoperative score	0.25 (0.13 to 0.37)	<.001	0.23 (0.08 to 0.38)	.002	0.19 (0.10 to 0.27)	<.001	0.1 (0.00 to 0.21)	.054

ACL, anterior cruciate ligament; BMI, body mass index; CI, confidence interval; IKDC, International Knee Documentation Committee; MCL, medial collateral ligament.

To better delineate concomitant factors that could influence patient outcomes, we broke down the intra-operative findings by patients who underwent a partial meniscectomy, as well as the presence of grade 2 to 4 Outerbridge classification findings in respective anatomic regions within the knee (Table 4). Although there is a considerable difference between grade 2 and grade 4 chondral injuries, the decision was made to group them together for analysis to maintain statistical power owing to the relatively small sample size for each grade. The only significant difference between the combined ACL-MCL injury group and the isolated ACL tear group was a higher percentage of partial medial meniscectomies (29%) in the isolated ACL tear group compared with the combined ACL-MCL injury group (14%, $P = .008$).

Discussion

In this study, we found that early ACLR, specifically within 6 weeks of injury, resulted in improved patient-reported outcomes for patients with concomitant MCL injuries compared with delayed reconstruction. This study investigated the critical clinical question of the optimal timing of ACLR in cases accompanied by concomitant MCL injuries.

Our results showed that patients with combined ACL-MCL injuries who underwent surgery within 6 weeks of injury reported significantly higher IKDC scores, KOOS QOL values, and KOOS Sport values compared with those who underwent surgery after 6 weeks. Our data also indicated that the choice of graft type influenced outcomes, with patients who received allografts reporting better PROMs in the short term. Specifically, patients with allografts had higher IKDC scores compared with patients with autografts. Similar trends were observed in Lysholm scores and KOOS QOL, Pain, Symptoms, and Sport values.

Historically, the management of combined ACL and MCL injuries has followed a delayed approach for several reasons. One fundamental concern has been the belief that the MCL possesses a relatively robust natural healing capacity.[28,29] Consequently, clinicians have often opted to provide a period of conservative management, typically involving bracing and immobilization, to allow the MCL to undergo the natural healing process.[25,26,30] This approach was also rooted in the intention to prevent stiffness of the knee joint, which can result from immediate surgical intervention and prolonged immobilization associated with postoperative bracing.[31-34] Additionally, the choice of delayed management was influenced by concerns that early ACLR might lead to an increased risk of complications and graft failure, especially owing to potential residual valgus laxity caused by incomplete MCL healing.[35,36] However, as research in the field has evolved, recent studies have prompted a re-evaluation of these

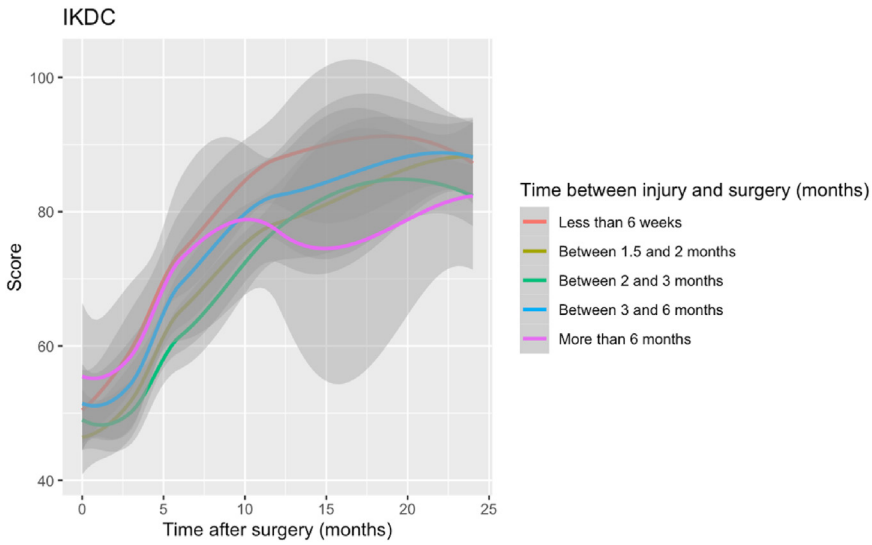

Fig 2. Change in International Knee Documentation Committee (IKDC) score over time after surgery among patients with anterior cruciate ligament and grade 2 to 3 medial collateral ligament tear, stratified by time between injury and surgery.

historical practices, shedding new light on the potential advantages of early ACLR in combination with nonoperative MCL management.

An essential aspect of conservatively managing combined ACL-MCL injuries revolves around the anatomic healing of the MCL. Although previous research has demonstrated the MCL's relatively robust natural healing capacity,[28,29] it is important for clinicians to also understand that this healing capacity can lead to fibrotic tissue and inflammation that can lead to discomfort and stiffness. Immobilization, a historical element of delayed treatment plans, can exert detrimental effects on MCL development and healing. Biomechanical studies have underscored the pivotal role of knee mobility in the normal maturation of the MCL's mechanical properties by showing that immobilization may lead to muscle atrophy, collagen mass reduction, and increased collagen degradation within the MCL.[37-40] Additionally, the presence of an intact ACL, serving as a secondary stabilizer against valgus stress, may play a pivotal role in MCL healing. Animal studies have indicated that ACL insufficiency adversely affects MCL healing whereas restoring ACL stability can create a more favorable environment for MCL recovery.[41] Therefore, one argument for early ACLR lies in its potential to restore stability to the medial side of the knee, thereby limiting tissue disorganization and facilitating anatomic MCL healing. By promptly stabilizing the ACL and allowing for the immediate mobilization of an anatomically correct knee joint, a more conducive environment for the natural recovery process of the MCL may be created.

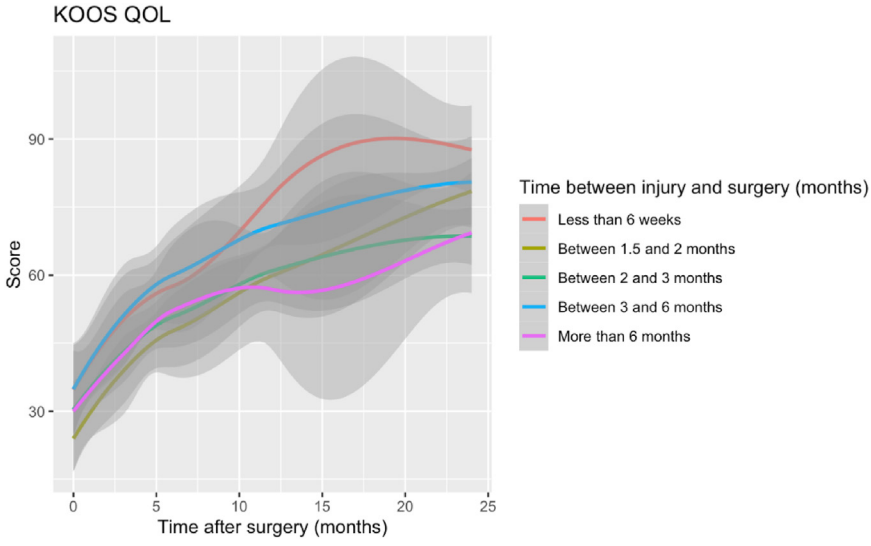

Fig 3. Change in Knee Injury and Osteoarthritis Outcome Score Quality of Life (KOOS QOL) over time after surgery among patients with anterior cruciate ligament and grade 2 to 3 medial collateral ligament tear, stratified by time between injury and surgery.

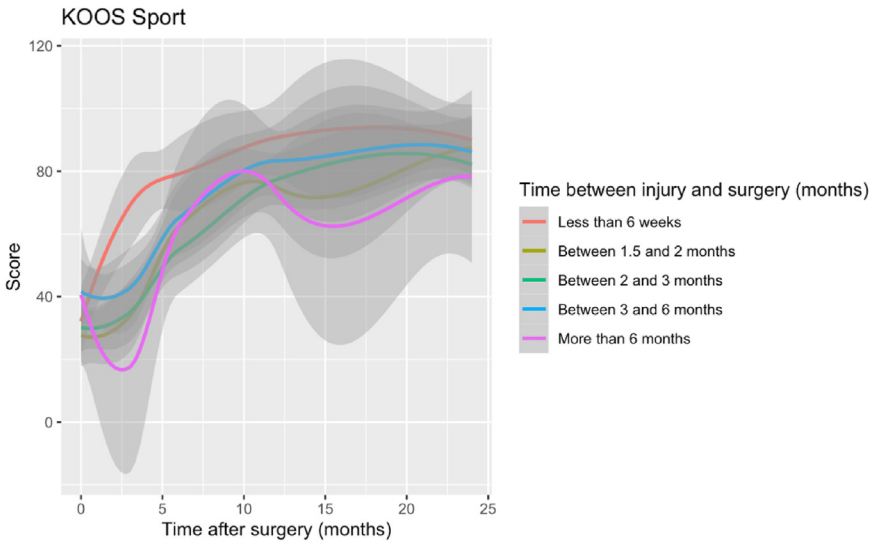

Fig 4. Change in Knee Injury and Osteoarthritis Outcome Score Sport (KOOS Sport) over time after surgery among patients with anterior cruciate ligament and grade 2 to 3 medial collateral ligament tear, stratified by time between injury and surgery.

An additional concern historically associated with early surgical intervention in combined ACL-MCL injuries was the potential for postoperative bracing to induce stiffness. Initially, patients were often placed in full leg casts postoperatively, leading to severe stiffness and associated functional complications.[31,42-44] However, contemporary approaches to postoperative bracing have evolved significantly. Modern techniques prioritize the use of hinged knee braces and progressive rehabilitation protocols, aimed at maintaining or even improving joint mobility while providing adequate support for healing tissues. These advancements have substantially mitigated the risk of stiffness associated with early surgical intervention.[35-48] Moreover, our study's findings, which demonstrate favorable clinical and functional outcomes with early ACLR combined with nonoperative MCL management, suggest that the concern of stiffness should not deter clinicians from considering this approach.

This study also found that patients in our cohort with concomitant MCL injuries underwent surgery significantly earlier than patients with isolated ACL tears. We hypothesize that some patients with isolated ACL tears might have presented to the office long after the initial injury, by which time any additional MCL injury might have already healed. This was not because of recommendations from the surgical office to delay treatment. In contrast, patients with concomitant MCL injuries who were seen acutely—and therefore had acute MCL injuries—were recommended to undergo surgery on a more acute basis. Furthermore, our data indicated that the choice of graft type (allograft vs autograft) influenced the outcomes, with patients who received allografts reporting better PROMs in the short term. The worse clinical outcome scores associated with autografts in our cohort may be attributed to several factors. Autografts, particularly in older patients or patients with a

Table 4. Intraoperative Findings Between Isolated ACL Tear Group and Combined ACL-MCL Injury Group

Characteristic	Patients, n	ACL Without Grade 2-3 MCL Tear (n = 163)	ACL With Grade 2-3 MCL Tear (n = 90)	*P* Value*
Medial meniscectomy	253	48 (29)	13 (14)	.008
Lateral meniscectomy	253	61 (37)	33 (37)	>.99
Percentage with Outerbridge score between grades 2 and 4 by anatomic region				
Medial femoral condyle	253	17 (10)	11 (12)	.7
Lateral femoral condyle	253	11 (6.7)	4 (4.4)	.5
Patella	253	27 (17)	16 (18)	.8
Trochlea	253	14 (8.6)	4 (4.4)	.2
Lateral tibial plateau	253	10 (6.1)	9 (10)	.3
Medial tibial plateau	253	1 (0.6)	2 (2.2)	.3

NOTE. Data are presented as number (percent).
ACL, anterior cruciate ligament; MCL, medial collateral ligament.
*Pearson χ^2test or Fisher exact test.

lower activity/risk profile, might lead to increased postoperative pain and longer recovery times compared with allografts. Additionally, the harvesting procedure for autografts could contribute to increased morbidity and slower rehabilitation, affecting overall clinical outcomes.

Early ACLR in conjunction with nonoperative management of the MCL seeks to strike a balance between promoting MCL healing and restoring knee stability; however, further investigation is still warranted. The heterogeneity of outcome measures and the scarcity of randomized controlled trials make it challenging to unequivocally endorse a singular treatment option, and currently, there is no one-size-fits-all approach. Thus, the optimal timing of ACLR must be carefully considered on an individual basis.

Limitations

Our study must be considered in the context of its limitations. First, the nonrandomized treatment allocation, based on individual patient factors and surgeon preferences, may introduce confounding variables that could influence the observed outcomes. Second, the study primarily assesses short- to medium-term outcomes up to 2 years postoperatively, leaving questions about the long-term consequences, such as the development of osteoarthritis, unanswered. Furthermore, the assessment of patient-reported outcomes, while using well-established PROMs, remains subject to inherent variability and subjectivity. Finally, although our findings show statistical significance, it is important to assess their clinical relevance. The statistically significant differences in PROMs, although indicative of measurable improvements, should be evaluated in the context of their impact on patients' functional abilities and overall quality of life.

Conclusions

Patients undergoing ACLR with grade 2 or 3 MCL injuries have improved patient-reported outcomes if surgery is performed within 6 weeks from the time of injury. In this cohort, allografts resulted in better outcome scores compared with autografts.

Disclosures

All authors (B.M.B., S.H., M.L., S.C., V.N., P.A.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Diermeier TA, Rothrauff BB, Engebretsen L, et al. Treatment after ACL injury: Panther Symposium ACL Treatment Consensus Group. *Br J Sports Med* 2021;55:14-22.
2. Shen X, Qin Y, Zuo J, Liu T, Xiao J. A systematic review of risk factors for anterior cruciate ligament reconstruction failure. *Int J Sports Med* 2021;42:682-693.
3. Ardern CL, Taylor NF, Feller JA, Whitehead TS, Webster KE. Sports participation 2 years after anterior cruciate ligament reconstruction in athletes who had not returned to sport at 1 year: A prospective follow-up of physical function and psychological factors in 122 athletes. *Am J Sports Med* 2015;43:848-856.
4. Chalmers PN, Mall NA, Moric M, et al. Does ACL reconstruction alter natural history?: A systematic literature review of long-term outcomes. *J Bone Joint Surg Am* 2014;96:292-300.
5. Cinque ME, Dornan GJ, Chahla J, Moatshe G, LaPrade RF. High rates of osteoarthritis develop after anterior cruciate ligament surgery: An analysis of 4108 patients. *Am J Sports Med* 2018;46:2011-2019.
6. Dunn WR, Spindler KP, Annunziato A, et al. Predictors of activity level 2 years after anterior cruciate ligament reconstruction (ACLR): A Multicenter Orthopaedic Outcomes Network (MOON) ACLR cohort study. *Am J Sports Med* 2010;38:2040-2050.
7. Edwards PK, Ebert JR, Joss B, et al. Patient characteristics and predictors of return to sport at 12 months after anterior cruciate ligament reconstruction: The importance of patient age and postoperative rehabilitation. *Orthop J Sports Med* 2018;6:2325967118797575.
8. Nwachukwu BU, Chang B, Voleti PB, et al. Preoperative short form health survey score is predictive of return to play and minimal clinically important difference at a minimum 2-year follow-up after anterior cruciate ligament reconstruction. *Am J Sports Med* 2017;45:2784-2790.
9. Andernord D, Karlsson J, Musahl V, Bhandari M, Fu FH, Samuelsson K. Timing of surgery of the anterior cruciate ligament. *Arthroscopy* 2013;29:1863-1871.
10. Forsythe B, Lu Y, Agarwalla A, et al. Delaying ACL reconstruction beyond 6 months from injury impacts likelihood for clinically significant outcome improvement. *Knee* 2021;33:290-297.
11. James EW, Dawkins BJ, Schachne JM, et al. Early operative versus delayed operative versus nonoperative treatment of pediatric and adolescent anterior cruciate ligament injuries: A systematic review and meta-analysis. *Am J Sports Med* 2021;49:4008-4017.
12. Niederer D, Behringer M, Stein T. Functional outcomes after anterior cruciate ligament reconstruction: Unravelling the role of time between injury and surgery, time since reconstruction, age, gender, pain, graft type, and concomitant injuries. *BMC Sports Sci Med Rehabil* 2023;15:49.
13. Reijman M, Eggerding V, van Es E, et al. Early surgical reconstruction versus rehabilitation with elective delayed reconstruction for patients with anterior cruciate ligament rupture: COMPARE randomised controlled trial. *BMJ* 2021;372:n375.
14. Shen X, Liu T, Xu S, et al. Optimal timing of anterior cruciate ligament reconstruction in patients with anterior cruciate ligament tear: A systematic review and meta-analysis. *JAMA Netw Open* 2022;5:e2242742.
15. von Essen C, Eriksson K, Barenius B. Acute ACL reconstruction shows superior clinical results and can be performed safely without an increased risk of developing

arthrofibrosis. *Knee Surg Sports Traumatol Arthrosc* 2020;28:2036-2043.
16. Culvenor AG, Eckstein F, Wirth W, Lohmander LS, Frobell R. Loss of patellofemoral cartilage thickness over 5 years following ACL injury depends on the initial treatment strategy: Results from the KANON trial. *Br J Sports Med* 2019;53:1168-1173.
17. Freshman RD, Truong NM, Cevallos N, et al. Delayed ACL reconstruction increases rates of concomitant procedures and risk of subsequent surgery. *Knee Surg Sports Traumatol Arthrosc* 2023;31:2897-2905.
18. Miyamoto RG, Bosco JA, Sherman OH. Treatment of medial collateral ligament injuries. *J Am Acad Orthop Surg* 2009;17:152-161.
19. Sandberg R, Balkfors B, Nilsson B, Westlin N. Operative versus non-operative treatment of recent injuries to the ligaments of the knee. A prospective randomized study. *J Bone Joint Surg Am* 1987;69:1120-1126.
20. Cox CL, Spindler KP. Multiligamentous knee injuries—Surgical treatment algorithm. *N Am J Sports Phys Ther* 2008;3:198-203.
21. Domnick C, Raschke MJ, Herbort M. Biomechanics of the anterior cruciate ligament: Physiology, rupture and reconstruction techniques. *World J Orthop* 2016;7:82-93.
22. Naqvi U, Sherman AL. Medial collateral ligament knee injuries In: *StatPearls*. Treasure Island, FL: StatPearls, 2022. www.ncbi.nlm.nih.gov/sites/books/NBK431095. Accessed October 15, 2024.
23. Inoue M, McGurk-Burleson E, Hollis JM, Woo SL. Treatment of the medial collateral ligament injury. I: The importance of anterior cruciate ligament on the varus-valgus knee laxity. *Am J Sports Med* 1987;15:15-21.
24. Willinger L, Balendra G, Pai V, et al. High incidence of superficial and deep medial collateral ligament injuries in 'isolated' anterior cruciate ligament ruptures: A long overlooked injury. *Knee Surg Sports Traumatol Arthrosc* 2022;30:167-175.
25. Elkin JL, Zamora E, Gallo RA. Combined anterior cruciate ligament and medial collateral ligament knee injuries: Anatomy, diagnosis, management recommendations, and return to sport. *Curr Rev Musculoskelet Med* 2019;12:239-244.
26. Guenther D, Pfeiffer T, Petersen W, et al. Treatment of combined injuries to the ACL and the MCL complex: A consensus statement of the Ligament Injury Committee of the German Knee Society (DKG). *Orthop J Sports Med* 2021;9:23259671211050929.
27. Wright ML, Coladonato C, Ciccotti MG, Tjoumakaris FP, Freedman KB. Combined anterior cruciate ligament and medial collateral ligament reconstruction shows high rates of return to activity and low rates of recurrent valgus instability: An updated systematic review. *Arthrosc Sports Med Rehabil* 2023;5:e867-e879.
28. Braaten JA, Banovetz MT, Rodriguez AN, Thomas P, LaPrade RF. From anatomy to complex reconstruction: A modern review on the medial collateral ligament of the knee. *Arch Bone Jt Surg* 2022;10:818-826.
29. Vosoughi F, Rezaei Dogahe R, Nuri A, Ayati Firoozabadi M, Mortazavi J. Medial collateral ligament injury of the knee: A review on current concept and management. *Arch Bone Jt Surg* 2021;9:255-262.
30. Dale KM, Bailey JR, Moorman CT. Surgical management and treatment of the anterior cruciate ligament/medial collateral ligament injured knee. *Clin Sports Med* 2017;36:87-103.
31. Harner CD, Irrgang JJ, Paul J, Dearwater S, Fu FH. Loss of motion after anterior cruciate ligament reconstruction. *Am J Sports Med* 1992;20:499-506.
32. Indelicato PA. Non-operative treatment of complete tears of the medial collateral ligament of the knee. *J Bone Joint Surg Am* 1983;65:323-329.
33. Irrgang JJ, Harner CD. Loss of motion following knee ligament reconstruction. *Sports Med* 1995;19:150-159.
34. Shelbourne KD, Porter DA. Anterior cruciate ligament-medial collateral ligament injury: Nonoperative management of medial collateral ligament tears with anterior cruciate ligament reconstruction. A preliminary report. *Am J Sports Med* 1992;20:283-286.
35. Alm L, Krause M, Frosch KH, Akoto R. Preoperative medial knee instability is an underestimated risk factor for failure of revision ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc* 2020;28:2458-2467.
36. Holuba K, Vermeijden HD, Yang XA, O'Brien R, van der List JP, DiFelice GS. Treating combined anterior cruciate ligament and medial collateral ligament injuries operatively in the acute setting is potentially advantageous. *Arthroscopy* 2023;39:1099-1107.
37. Amiel D, Akeson WH, Harwood FL, Frank CB. Stress deprivation effect on metabolic turnover of the medial collateral ligament collagen: A comparison between nine- and 12-week immobilization. *Clin Orthop Relat Res* 1983;172:265-270.
38. Binkley JM, Peat M. The effects of immobilization on the ultrastructure and mechanical properties of the medial collateral ligament of rats. *Clin Orthop Relat Res* 1986;203:301-308.
39. Padgett LR, Dahners LE. Rigid immobilization alters matrix organization in the injured rat medial collateral ligament. *J Orthop Res* 1992;10:895-900.
40. Thornton GM, Shrive NG, Frank CB. Healing ligaments have decreased cyclic modulus compared to normal ligaments and immobilization further compromises healing ligament response to cyclic loading. *J Orthop Res* 2003;21:716-722.
41. Woo SL, Young EP, Ohland KJ, Marcin JP, Horibe S, Lin HC. The effects of transection of the anterior cruciate ligament on healing of the medial collateral ligament. A biomechanical study of the knee in dogs. *J Bone Joint Surg Am* 1990;72:382-392.
42. Andersson C, Gillquist J. Treatment of acute isolated and combined ruptures of the anterior cruciate ligament. A long-term follow-up study. *Am J Sports Med* 1992;20:7-12.
43. Andersson C, Odensten M, Gillquist J. Knee function after surgical or nonsurgical treatment of acute rupture of the anterior cruciate ligament: A randomized study with a long-term follow-up period. *Clin Orthop Relat Res* 1991;264:255-263.
44. Noyes FR, Mangine RE, Barber SD. The early treatment of motion complications after reconstruction of the anterior cruciate ligament. *Clin Orthop Relat Res* 1992;277:217-228.
45. Chambat P, Guier C, Sonnery-Cottet B, Fayard JM, Thaunat M. The evolution of ACL reconstruction over the last fifty years. *Int Orthop* 2013;37:181-186.

46. Millett PJ, Pennock AT, Sterett WI, Steadman JR. Early ACL reconstruction in combined ACL-MCL injuries. *J Knee Surg* 2004;17:94-98.
47. Myer GD, Paterno MV, Ford KR, Quatman CE, Hewett TE. Rehabilitation after anterior cruciate ligament reconstruction: Criteria-based progression through the return-to-sport phase. *J Orthop Sports Phys Ther* 2006;36:385-402.
48. Wang B, Zhong J-L, Xu X-H, Shang J, Lin N, Lu H-D. Incidence and risk factors of joint stiffness after anterior cruciate ligament reconstruction. *J Orthop Surg Res* 2020;15:175.