Does the Chronicity of Anterior Cruciate Ligament Ruptures Influence Patient-Reported Outcomes Before Surgery?

Joseph T. Nguyen,[*†] MPH, David Wasserstein,[‡] MD, FRCSC, MSc, MPH(c), Emily K. Reinke,[§] PhD, Kurt P. Spindler,[||] MD, Nabil Mehta,[¶] BSE, John B. Doyle,[¶] BA, MOON Group,[#] and Robert G. Marx,[**] MD, MSc, FRCSC

Investigation performed at the Hospital for Special Surgery, New York, New York, USA

Background: The time between an anterior cruciate ligament (ACL) injury and ACL reconstruction (ACLR) may influence baseline knee-related and general health-related patient-reported outcome measures (PROMs). Despite the common use of PROMs as main outcomes in clinical studies, this variable has never been evaluated.

Purpose: To compare baseline health-related quality of life measures and the prevalence/pattern of meniscal and articular cartilage lesions between patients who underwent acute and chronic ACLR so as to provide clinicians with benchmark PROMs in 2 different patient populations with ACL injuries.

Study Design: Cross-sectional study; Level of evidence, 3.

Methods: A total of 1192 patients from the MOON (Multicenter Orthopaedic Outcomes Network) cohort who underwent primary ACLR were eligible. ''Acute'' ACLR was defined as <3 months (n = 853; 71.6%) and ''chronic'' ACLR as >6 months (n = 339; 28.4%) from injury. Patient demographics, surgical characteristics (articular cartilage injury, medial meniscal [MM] and lateral meniscal [LM] tears), and baseline PROM scores (Marx activity rating scale, International Knee Documentation Committee [IKDC] subjective form, Knee injury and Osteoarthritis Outcome Score [KOOS], and Short Form–36 Health Survey [SF-36]) were collected to determine whether the time from injury to ACLR influences (1) baseline PROMs and (2) the pattern and prevalence of concurrent articular cartilage and meniscal injuries. Analysis of covariance models were used to adjust for confounders on baseline outcome scores (age, sex, body mass index [BMI], smoking status, competition level, education).

Results: The median patient age was 23 years (interquartile range [IQR], 17-35 years), 530 (44.5%) were female, and the median BMI was 25.0 kg/m^2 (IQR, 22.3-27.9 kg/m^2); however, the chronic group was older, had a higher BMI, and consisted of fewer collegiate athletes. A significantly greater number of partial LM tears were seen in the acute group versus the chronic group (14.2% vs 6.5%, respectively; $P < .001$), but there were more meniscal tears overall (73.5% vs 63.2%, respectively; $P = .001$), complete MM tears (49.0% vs 22.5%, respectively; $P < .001$), and articular cartilage injuries (54.0% vs 32.8%, respectively; $P < .001$) in the chronic group versus the acute group. After controlling for confounders, patients in the chronic ACLR group reported a significantly lower baseline Marx score (7.75 vs 12.10, respectively; $P < .001$) but higher baseline IKDC, SF-36 physical functioning, and all KOOS subscale scores except the KOOS–quality of life subscale score compared to those in the acute ACLR group; however, only the KOOS–sports and recreation subscale exceeded the minimum clinically importance difference of 8 points (62.30 vs 48.26, respectively; $P < .001$).

Conclusion: After controlling for age, sex, competition level, smoking, and BMI, patients in the chronic ACLR group participated in less pivoting and cutting sports but reported better pain/function. Whether decreased activity is deliberate after an ACL injury or patients who undergo chronic ACLR are simply less active and may be treated successfully without surgery warrants further investigation. Nonrandomized studies that utilize PROMs should consider time from injury in study design and data interpretation.

Keywords: anterior cruciate ligament; patient-reported outcomes; KOOS; Marx activity rating scale; delayed ACL reconstruction

The anterior cruciate ligament (ACL) is one of the most commonly injured knee ligaments, and as many as 200,000 ACL reconstructions (ACLRs) are performed annually in the United States.[16,22,35] Despite ACLR being a common procedure, patients may present for surgical care at different times from an injury and with different constellations of associated meniscal and articular cartilage lesions. Fortunately, the advent of health-related quality of life (HRQoL) measures has provided a valuable tool to quantifiably measure patient activity, symptoms, and function at presentation.[23,38]

To our knowledge, no prospective cohort studies and only 1 registry[17] have considered the potential differences of HRQoL at baseline between patients who are enrolled and undergo surgery soon after their injury and those who

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undergo surgery at a later time. The classification of time from injury to ACLR, usually termed "acute" and "chronic," lacks a consensus definition in the orthopaedic community, although there is some agreement that chronic ACLR is based on a minimum 6 months after injury.[12] Both surgeon and patient preference may influence surgical timing. For example, proponents of early surgical intervention after an acute ACL injury suggest that early intervention may minimize the risk of further meniscal or cartilage injuries, which are often associated with degenerative joint conditions.[29] Conversely, performing surgery too soon after an injury when knee motion has not been properly restored increases the risk of complications such as arthrofibrosis[34] and wound complications.[28,33] Additional high-quality evidence suggests that in some patients, functional rehabilitation after injuries only and no surgery can also produce successful outcomes.[13,18]

While patients with ACL deficiency are known to score worse on patient-reported outcome measures (PROMs) than the general population,[12] this can be improved with ACLR.[1,7,8] However, to our knowledge, no study has investigated how the time from injury affects baseline PROMs within an ACL-deficient population. The objective of this study was to compare baseline HRQoL measures and the prevalence/pattern of meniscal and articular cartilage lesions between patients who underwent acute and chronic ACLR so as to provide clinicians with benchmark PROMs in 2 different ACL-injured patient populations before surgery. We hypothesized that these 2 populations would demonstrate differences in their responses to various knee-specific outcome measures.

METHODS

Data from the 2002-2004 years of the prospective multicenter cohort MOON (Multicenter Orthopaedic Outcomes Network) study were used. The current study was reviewed and approved by each participating site's respective institutional review board, and all subjects provided written informed consent before data collection. Data utilized for this analysis focused on patient knee-related and general HRQoL measures before undergoing primary unilateral ACLR.

Eighteen surgeons at 7 sites enrolled patients and performed the surgical procedures. Patients were classified into acute or chronic groups based on the recorded date of the injury to ACLR. Acute was defined as <91 days (or ~3 months) and chronic as >180 days (or ~6 months).[12] The chosen definition for "acute" included a range of time reflecting what some might label as "subacute" (ie, 6-12 weeks); however, we felt that this was still a reasonable time frame to include intentional early reconstruction based on the time to diagnosis, referral, and preoperative rehabilitation. A total of 1396 primary ACL reconstructions performed between 2002 and 2004 were eligible. The time of diagnosis or decision to treat the ACL tear surgically was not recorded. Preoperative bracing, activity modification, and rehabilitation were left at the discretion of the treating surgeon.

Patients were asked to complete a baseline questionnaire, self-reporting personal demographic information, injury characteristics, sports participation history, previous knee surgery (either knee), and general health status. PROMs included the Marx activity rating scale,[25] Knee injury and Osteoarthritis Outcome Score (KOOS),[31] International Knee Documentation Committee (IKDC) subjective form,[19] and Short Form–36 Health Survey (SF-36).[27] Surgeons were asked to complete a questionnaire that documented additional intra-articular injuries to the meniscus and articular cartilage at the time of ACL surgery. Meniscal injuries were classified by side (medial, lateral) and as partial or complete tears. Chondral injuries were graded according to the modified Outerbridge classification[4] and located in the medial or lateral tibial plateau, undersurface patella, medial or lateral femoral condyle, or trochlear groove. A high degree of interrater reliability for the grading of meniscal and articular cartilage tears in this cohort had been previously established.[10,24] For the purposes of this study, articular cartilage injury was reclassified as a dichotomous variable (normal/grade 1 vs grade 2/3/4).

The Marx activity rating scale is a 4-question survey that evaluates patients' frequency and intensity of participation in a sporting activity from the past year at their

*Address correspondence to Joseph T. Nguyen, MPH, Healthcare Research Institute, Hospital for Special Surgery, 535 East 70th Street, New York, NY 10021, USA (email: nguyenj@hss.edu).

†Healthcare Research Institute, Hospital for Special Surgery, New York, New York, USA.

‡Division of Orthopaedic Surgery, Sunnybrook Health Sciences Centre, University of Toronto, Toronto, Ontario, Canada.

§Vanderbilt University, Nashville, Tennessee, USA.

||Department of Orthopaedics, Cleveland Clinic, Cleveland, Ohio, USA.

¶Hospital for Special Surgery, New York, New York, USA.

#Participating members of the MOON Group are listed in the Contributing Authors section at the end of this article.

**Department of Orthopaedics, Hospital for Special Surgery, New York, New York, USA.

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healthiest state.[25] Running, cutting, decelerating, and pivoting each account for a score of between 0 and 4 points (maximum total, 16 points). The IKDC subjective form is an 18-question survey that assesses knee-specific conditions from the past 1 month, including ligament, meniscus, articular cartilage, osteoarthritis, and patellofemoral pain on a scale from 0 (worst) to 100 (best) points.[19] The KOOS is a 42-item survey that measures 5 domains: frequency and severity of pain during functional activities (KOOS-pain subscale); symptoms including stiffness, swelling, grinding/clicking, catching, and restricted motion (KOOS-symptoms subscale); difficulty experienced during activities of daily living (KOOS-ADL subscale); difficulty experienced during sports and recreational activities (KOOS-sports/rec); and knee-related quality of life (KOOS-QoL).[31] Each dimension is transformed to a 0-to-100 scale, with 100 representing an asymptomatic state. The response is supposed to reflect the past 1 week. The SF-36 is a general survey of 36 questions that measures perceived health in 8 domains with summarized physical component summary (PCS) and mental component summary (MCS) scores.[27]

Statistical Analysis

Descriptive analysis of the study population was performed for continuous (median and interquartile range [IQR]) and discrete (frequency and percentage) variables. To evaluate the association of patient and clinical characteristics between the acute and chronic groups, independent-samples t tests (continuous variables) and chi-square tests (discrete variables) were used. Normality of continuous data was evaluated and confirmed using the Shapiro-Wilk test.

Analysis of covariance (ANCOVA) models were generated to adjust for any potential confounding patient factors (eg, age, sex, education level) on the relationship between chronicity and baseline PROMs. All independent variables were considered as eligible candidates to be evaluated in the ANCOVA models, including all patient demographic and intraoperative meniscal and articular cartilage data. All analyses were performed using SPSS version 20.0 (IBM Corp) with statistical significance set at $P \leq .05$.

Post Hoc Analysis

After noting a difference in the prevalence of chondral and meniscal injuries with the duration of time from injury to surgery, we analyzed the cohort to determine all independently associated factors that changed the odds of a meniscal tear or chondrosis at surgery. This was performed utilizing a multivariate logistic regression model. All baseline characteristics, including the time from injury, were considered covariates. As above, analysis was performed using SPSS with statistical significance set at $P \leq .05$. Odds ratios (ORs) and 95% CIs are presented.

RESULTS

From 2002 to 2004, a total of 1396 MOON cohort patients were eligible. Among them, 853 (61.1%) underwent ACLR at <3 months and 339 (24.3%) at >6 months after their initial injury. The remaining 204 (14.6%) patients underwent surgery between 3 and 6 months or were not classified because of a lack of information on the date of injury and were excluded, yielding a final study sample of 1192 patients. The median age was 23 years (IQR, 17-35 years), and 530 (44.5%) were female. The median body mass index (BMI) of the cohort was 25.0 kg/m^2 (IQR, 22.3-27 kg/m^2), with nearly half (49.5%) classified as overweight or obese (BMI $\geq$25 kg/m^2). Table 1 reports complete demographic data.

While there was no difference between the proportions of patients with complete lateral meniscal (LM) tears, there was a significantly higher rate of patients with partial tears in the acute group compared with those in the chronic group (14.2% vs 6.5%, respectively; P = .001). Conversely, for medial meniscal (MM) tears, there was no difference in the percentage of partial tears but a significantly higher rate of complete meniscal tears in the chronic group versus the acute group (49.0% vs 22.5%, respectively; P < .001). The chronic group also had a significantly higher prevalence of articular cartilage injuries versus the acute group (54.0% vs 32.8%, respectively; P < .001).

Differences in PROMs were also observed between the acute and chronic ACLR groups (Table 2). The chronic group had a significantly lower Marx score compared with the acute group (7.44 vs 12.74, respectively; P < .001) but a higher IKDC subjective score at baseline compared with the acute group (56.19 vs 50.50, respectively; P < .001). Statistical significance for higher reported KOOS scores among patients in the chronic ACLR group compared to those in the acute ACLR group was achieved in all subscales except the KOOS-QoL (36.70 vs 38.05, respectively; P = .312) and KOOS-ADL (83.31 vs 82.07, respectively; P = .255) (Table 2). While there was no statistical difference found in the SF-36 MCS score between patients in the chronic and acute ACLR groups (51.77 vs 51.62, respectively; P = .847), those in the chronic group did have a significantly higher SF-36 PCS score compared with those in the acute group (44.04 vs 40.07, respectively; P < .001).

Confounding variables on baseline PROMs were assessed using ANCOVA models (see the Appendix, available online at http://ajsm.sagepub.com/supplemental). Increased age, BMI, female sex, and having been or currently being a smoker consistently predicted worse knee-specific PROM scores. In contrast, LM or MM injuries did not demonstrate an interaction effect. Only concomitant chondral injuries were associated with lower baseline Marx scores.

The models testing the relationship between chronicity and baseline PROMs were adjusted for confounding baseline factors (Table 3) (full listing in the Appendix, available online). The IKDC, KOOS, Marx, and SF-36 differences are depicted graphically in Figure 1. Most differences in baseline PROMs increased after adjustment.

Post hoc analysis revealed relatively consistent predictors of meniscal tears or articular cartilage wear at surgery. A delay of >6 months increased the odds of a meniscal tear by 69% (OR, 1.69 [95% CI, 1.26-2.28]; P = .001) and chondral damage by 40% (OR, 1.40 [95% CI, 1.02-1.92]; P = .040). Both were also more common in more competitive

TABLE 1
Baseline Patient and Surgical Characteristics of Acute and Chronic ACLR Groups[a]

	n	Overall	Acute ACLR Group	Chronic ACLR Group	*P* Value
Patient age, y	1192	23.0 (17.0-35.0)	20.0 (17.0-31.0)	30.0 (23.0-40.0)	<.001
Female sex	1192	530 (44.5)	407 (47.7)	123 (36.3)	<.001
Body mass index, kg/m^2	1169	25.0 (22.3-27.9)	24.2 (22.0-27.0)	26.5 (23.4-29.5)	<.001
Normal		590 (50.5)	474 (56.5)	116 (35.2)	
Overweight		409 (35.0)	263 (31.3)	146 (44.2)	
Obese		170 (14.5)	102 (12.2)	68 (20.6)	
School year completed	1164	14.0 (11.0-16.0)	13.0 (11.0-16.0)	15.0 (12.0-17.0)	<.001
Smoking status	1182				<.001
Never		951 (80.5)	717 (84.9)	234 (69.4)	
Quit/current		231 (19.5)	128 (15.1)	103 (30.6)	
Competition level	1186				<.001
None/recreational		548 (46.2)	315 (37.0)	233 (69.8)	
High school		339 (28.6)	296 (34.7)	43 (12.9)	
College		117 (9.9)	103 (12.1)	14 (4.2)	
Amateur		159 (13.4)	121 (14.2)	38 (11.4)	
Professional		23 (1.9)	17 (2.0)	6 (1.8)	
Previous contralateral surgery	1192	107 (9.0)	77 (9.0)	30 (8.8)	.923
Lateral meniscal tear	1192				.001
No tear		651 (54.6)	447 (52.4)	204 (60.2)	
Partial		143 (12.0)	121 (14.2)	22 (6.5)	
Complete		398 (33.4)	285 (33.4)	113 (33.3)	
Medial meniscal tear	1192				<.001
No tear		733 (61.5)	587 (68.8)	146 (43.1)	
Partial		101 (8.5)	74 (8.7)	27 (8.0)	
Complete		358 (30.0)	192 (22.5)	166 (49.0)	
Any meniscal lesion	1192	788 (66.1)	539 (63.2)	249 (73.5)	.001
Any chondral lesion	1192	463 (38.8)	280 (32.8)	183 (54.0)	<.001

[a]Values are reported as median (interquartile range) or n (%). ACLR, anterior cruciate ligament reconstruction.

TABLE 2
Unadjusted Differences in PROMs Between Acute and Chronic ACLR Groups[a]

	Acute ACLR Group		Chronic ACLR Group		
	n	Mean ± SE	n	Mean ± SE	*P* Value
Marx activity rating scale	851	12.74 ± 0.16	331	7.44 ± 0.26	<.001
IKDC subjective form	842	50.50 ± 0.57	331	56.19 ± 0.90	<.001
KOOS					
Quality of life	852	38.05 ± 0.71	338	36.70 ± 1.13	.312
Pain	851	73.11 ± 0.59	333	75.68 ± 0.94	.020
Sports and recreation	843	50.23 ± 1.01	335	57.53 ± 1.61	<.001
Activities of daily living	851	82.07 ± 0.58	338	83.31 ± 0.92	.255
Symptoms	852	67.39 ± 0.62	338	71.03 ± 0.99	.002
SF-36					
Physical functioning	852	58.91 ± 0.84	337	66.15 ± 1.34	<.001
Physical role functioning	849	32.45 ± 1.39	337	55.69 ± 2.21	<.001
Bodily pain	853	57.03 ± 0.74	338	62.94 ± 1.18	<.001
General health perceptions	853	86.49 ± 0.48	338	80.85 ± 0.76	<.001
Vitality	852	63.22 ± 0.67	337	62.09 ± 1.06	.368
Social role functioning	853	72.92 ± 0.82	338	79.11 ± 1.30	<.001
Emotional role functioning	849	73.36 ± 1.31	337	79.13 ± 2.08	.019
Mental health	852	74.97 ± 0.57	337	76.60 ± 0.90	.128
SF-36 PCS	847	40.07 ± 0.34	334	44.04 ± 0.54	<.001
SF-36 MCS	847	51.62 ± 0.41	334	51.77 ± 0.66	.847

[a]ACLR, anterior cruciate ligament reconstruction; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; MCS, mental component summary; PCS, physical component summary; PROMs, patient-reported outcome measures; SE, standard error; SF-36, Short Form–36 Health Survey.

TABLE 3
Adjusted Differences in PROMs Between Acute and Chronic ACLR Groups[a]

	Acute ACLR Group		Chronic ACLR Group		
	n	Mean ± SE	n	Mean ± SE	*P* Value
Marx activity rating scale	818	12.10 ± 0.32	315	7.75 ± 0.44	<.001
IKDC subjective form	810	48.19 ± 1.22	315	57.82 ± 1.72	<.001
KOOS					
Quality of life	818	35.06 ± 1.54	320	36.68 ± 2.16	.528
Pain	818	70.51 ± 1.27	317	75.31 ± 1.81	.025
Sports and recreation	809	48.26 ± 2.23	317	62.30 ± 3.11	<.001
Activities of daily living	817	81.33 ± 1.26	320	84.34 ± 1.76	.152
Symptoms	818	64.42 ± 1.35	320	70.46 ± 1.89	.008
SF-36					
Physical functioning	818	56.72 ± 1.81	318	67.32 ± 2.54	<.001
Physical role functioning	815	28.83 ± 3.06	318	52.80 ± 4.28	<.001
Bodily pain	819	55.58 ± 1.63	319	63.08 ± 2.28	.006
General health perceptions	819	82.53 ± 1.04	319	80.80 ± 1.45	.315
Vitality	819	58.17 ± 1.45	319	61.49 ± 2.03	.171
Social role functioning	819	72.49 ± 1.81	319	78.02 ± 2.53	.067
Emotional role functioning	816	65.80 ± 2.88	318	75.59 ± 4.03	.041
Mental health	819	72.51 ± 1.26	319	75.19 ± 1.76	.202
SF-36 PCS	815	39.46 ± 0.74	316	44.26 ± 1.04	<.001
SF-36 MCS	815	49.28 ± 0.92	316	50.52 ± 1.28	.416

[a]ACLR, anterior cruciate ligament reconstruction; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; MCS, mental component summary; PCS, physical component summary; PROMs, patient-reported outcome measures; SE, standard error; SF-36, Short Form–36 Health Survey.

athletes (professional/college/high school vs recreational/nonathletic). The odds of a meniscal tear was greater in male patients, and the odds of chondral wear was greater in older patients and those with a higher BMI (Table 4). When broken down by LM and MM tears, patients who delayed surgery >6 months had over a 2-fold risk of having an MM tear (OR, 2.64; $P < .001$), particularly a complete tear (OR, 2.85; $P < .001$) when controlling for all other factors in the model (Table 5).

DISCUSSION

This is only the second study designed to identify factors that contribute to differences in PROMs at baseline for primary ACLR[9] and the only study to specifically examine the influence of chronicity from injury. We noted IKDC, SF-36 physical functioning, KOOS-pain, KOOS-sports/rec, KOOS-ADL, KOOS-symptoms scores that were statistically significantly higher in patients who underwent ACLR at >6 months from their injury. However, of these, only the Marx scores were significantly lower, and only the KOOS-sports/rec subscale difference was greater than the minimal detectable change of 5.8 points.[6,30,32] Our findings suggest that future nonrandomized studies examining the outcomes of ACLR require the inclusion of time from injury as a covariate or the statistical adjustment of baseline PROMs based on the time from injury.

The demographics of those patients reconstructed at >6 months from injury differed from those patients reconstructed early in almost every category. Most notably, these patients were older, had a higher BMI, played at a lower competitive level of sports (some of which was confounded by age: eg, collegiate or high school), and were more often male. These findings have not been previously reported in the ACL literature. In practice, patients reconstructed late likely represent 2 subpopulations: older, less active persons who may have attempted a longer duration of nonoperative treatment of their ACL injury and a mixed group of persons with high and lower activity levels who lacked access to care or purposefully delayed surgery for other reasons. Level 1 evidence supports delayed reconstruction as a plausible treatment pathway,[13] although which patients benefit most from early surgery versus optional delayed reconstruction remains to be determined.[13,18]

Preoperative PROMs were also distributed differently according to various demographic factors, including lower scores among patients who were older, were female, had a higher BMI, or were current smokers. This was the rationale for performing an adjusted analysis, which demonstrated persistence and even strengthened most baseline differences between patients with acute and chronic reconstructions. Thus, although patients in the chronic ACLR group were less active by the Marx score, they scored significantly better for sports/function (ie, higher KOOS score) in the sports in which they still participated, irrespective of age or sex. The Marx score is weighted higher toward ACL-dependent sports (ie, involving cutting or pivoting), suggesting that this group has either adapted activity to the ACL-deficient state or was less involved with cutting and pivoting sports before the injury.

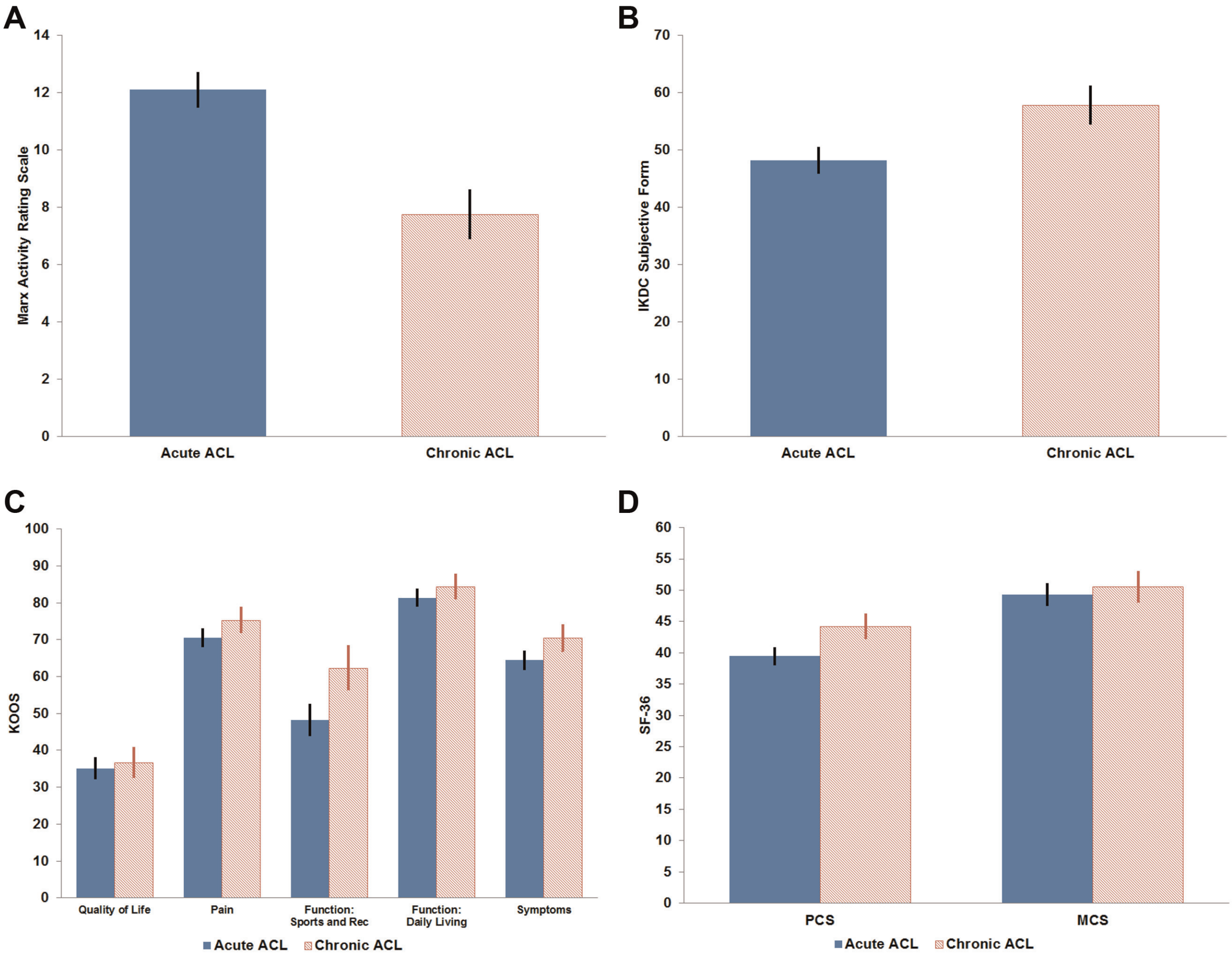

Figure 1. Adjusted differences between the acute and chronic anterior cruciate ligament reconstruction groups in the (A) Marx activity rating scale, (B) International Knee Documentation Committee (IKDC) subjective form, (C) Knee injury and Osteoarthritis Outcome Score (KOOS), and (D) Short Form–36 Health Survey (SF-36) physical and mental component summaries. Error bars indicate 95% CIs.

Patient or surgeon preference may also trigger delayed surgical treatment. Patients with lower activity and competition levels may be less keen to pursue operative management or may be more likely to be offered nonoperative management for the initial injury. The surgeon's recommendation, for example, for/against ACLR for patients at different levels of competition, for patients who play certain sports, and by patient age or sex, may also influence treatment.

Overall, patients who underwent ACLR at a time further away from their injury in this cohort were significantly more likely to have meniscal (73.5% vs 63.2%, respectively) and chondral lesions (54.0% vs 32.8%, respectively) at surgery than those in the acute group, although both groups had a clinically significant prevalence of concurrent injuries. While other studies have shown that LM tears are more common in the acute scenario, we demonstrated the pattern of this injury: namely, that partial LM tears predominate closer to injury (14.2%) but are less common over time (6.5%).[5] It is plausible that a significant number of these partial LM tears heal, even in the ACL-deficient knee. Previous MOON findings have supported that at 2 and 6 years after ACLR, untreated partial LM tears confer no effect on PROMs.[7] The reliability of these findings is supported by the high intersurgeon reliability for the classification of meniscal and articular cartilage injuries among MOON consortium surgeons.[10,24]

The differences that we noted in complete MM tears (49.0% chronic vs 22.5% acute) drove much of the difference overall: a 69% increased odds of a meniscal tear based on chronicity of >6 months. A higher prevalence of MM tears with a greater time from the ACL injury has been demonstrated previously.[5,17,21] Even in the KANON study,[13] among patients who did not undergo ACLR, approximately one-third still underwent meniscectomy. This pattern may relate to the known function of the posterior horn of the medial meniscus as a dynamic secondary stabilizer to anterior knee translation in the ACL-deficient knee.[2,3] Furthermore, our results have demonstrated that

TABLE 4
Significant Predictors of Meniscal or Chondral Damage at Surgery Using Multivariate Logistic Regression[a]

	Meniscal Tear		Chondral Damage	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Age	—	NS	1.07 (1.05-1.09)	<.001
Female sex	0.71 (0.55-0.92)	.009	—	NS
Body mass index (higher)	—	NS	1.06 (1.02-1.09)	.001
Competition level (vs none/recreational)				
Professional	3.59 (1.05-12.26)	.040	—	NS
College	—	NS	2.2 (1.35-3.57)	.001
Chronic ACLR	1.69 (1.26-2.28)	.001	1.40 (1.02-1.92)	.040
Marx score at baseline (higher)	—	NS	0.96 (0.93-0.98)	.004

[a]ACLR, anterior cruciate ligament reconstruction; NS, not statistically significant; OR, odds ratio.

TABLE 5
Adjusted ORs of Delayed Surgery for Lateral and Medial Meniscal Tears[a]

	Lateral Meniscal Tear			Medial Meniscal Tear		
	Overall	Partial	Complete	Overall	Partial	Complete
Chronic ACLR	NS	0.39 (0.23-0.66)[b]	NS	2.64 (1.93-3.61)[b]	NS	2.85 (2.07-3.92)[b]

[a]Values are reported as OR (95% CI). All models were adjusted for age, sex, body mass index, smoking status, competition level, and patient-reported outcome scores. ACLR, anterior cruciate ligament reconstruction; NS, not statistically significant; OR, odds ratio.
[b]Statistically significant ($P < .001$).

the meniscal tears seen in the chronic group were more likely to be complete; these types of tears may be associated with poorer outcomes or more expensive treatment such as meniscal repair.[7] Better protection of critical knee structures during rehabilitation or in those awaiting surgery seems warranted.

A higher prevalence of chondral injuries with chronicity has also been reported in prior single-surgeon series, although with variable definitions of "chronic" from >6 weeks[14] to >2 years,[37] and in 1 ACLR registry.[17] We also found that patients who were older, played at a collegiate level, or had a lower Marx score at baseline had increased odds of chondral damage.

The highest comparable published quality of evidence for the interaction between the timing of ACLR and associated injuries comes from the Norwegian registry of 3475 patients.[17] In this cohort, 26% had articular cartilage lesions, 47% had meniscal tears, and 15% had both, which are similar results to our own. They demonstrated that adults <40 years of age had a 3% increased odds of an articular cartilage injury for each month from injury to surgery and a 0.4% increase for meniscal tears. These authors' evaluation of their data by month from injury is a potentially clinically useful tool; however, it assumes that the relationship between time and associated injuries is linear.

Limitations

The primary limitation of this study is a lack of understanding of why some MOON patients delayed surgery. Others have explored this issue previously.[36] Defining those who intentionally and nonintentionally delay reconstruction will help further inform treatment and prognostic recommendations. There are some people for whom delay is potentially safe from the perspective of limiting further meniscal and articular cartilage injuries and others for whom it is likely not. Presumably, those who delay surgery may not further damage their knee if they can control instability through activity modification, bracing, or functional rehabilitation, but this has not been proven.[11,15,20] Because we did not collect information on the activities that these patients pursued from the time of injury to surgery, we could not measure how this affected the prevalence of related meniscal and articular cartilage injuries in our study population. While MOON cohort patients were all directed to undergo the same standardized postoperative rehabilitation, preoperative rehabilitation and treatment (including recommendations and compliance for activity modification and bracing), as well as compliance, were not recorded.

A second limitation is the lack of a standardized chronicity classification for ACLR, limiting some of the interpretation of these results compared with those in the published literature. We chose a classification in line with the majority[12]; however, we modified the "acute" definition from a ceiling of 6 weeks to approximately 12 weeks (or 3 months) for clinical plausibility. This likely captured what some might consider a "subacute" population. By author consensus, however, it was felt that patients undergoing purposeful acute reconstruction (the goal for defining this "acute" cohort) may require up to 3 months from injury through diagnosis, referral, and preoperative rehabilitation to come to surgery. In contrast, we hypothesized that those reconstructed at >6 months were most likely to have purposefully delayed seeking surgical treatment or be initially treated with a purely nonoperative plan.

A final limitation lies in the relationship between the time frames examined and the PROMs utilized in this study, specifically the Marx score. The Marx score asks a patient to reflect on activity in his or her "healthiest state" in the past 1 year. We assumed that most patients who visit a surgeon for ACLR would deem this to mean their preinjury status (ie, "healthiest state"); however, individual interpretation and the time frame from injury (if >1 year) may have influenced this response. Patients who modified activity (eg, via "coping" or based on medical advice) before surgery may account for the lower Marx score by chronicity, but we cannot be certain. In contrast, the KOOS and IKDC refer to 1 week and 1 month prior, respectively, and therefore represent the preoperative state.

CONCLUSION

After controlling for age, sex, competition level, smoking, and BMI, patients undergoing ACLR at >6 months after their injury participated in less pivoting and cutting sports but reported better pain/function scores than those reconstructed within 3 months. Whether decreased activity is deliberate after an ACL injury, or whether these are simply less active patients, many of whom may be treated successfully without surgery, warrants further investigation. These findings have considerable implications for the interpretation of PROMs from previously published and future nonrandomized studies (eg, cohorts, registries, case series) that did not consider time from injury in study design and data interpretation.

Future work should be aimed at separating remotely reconstructed patients based on nonoperative treatment strategies and patient modifications. As outcomes become available in this cohort, a second significant future endeavor will be to compare intermediate- and long-term outcomes (revision, reoperation, and PROMs) based on chronicity. Cost-benefit analysis of early surgery versus late surgery from the perspective of PROMs and the potential risks of increased posttraumatic osteoarthritis are also important areas of future research.[26]

CONTRIBUTING AUTHORS

Annunziato Amendola, MD (Duke University); Jack T. Andrish, MD (Cleveland Clinic); Robert H. Brophy, MD (Washington University in St Louis); Warren R. Dunn, MD (University of Wisconsin–Madison); Laura J. Huston, MD (Vanderbilt University); Christopher C. Kaeding, MD (The Ohio State University); Eric C. McCarty, MD (University of Colorado); Richard D. Parker, MD (Cleveland Clinic); Michelle L. Wolcott, MD (University of Colorado); Brian R. Wolf, MD, MS (University of Iowa); Rick W. Wright, MD (Washington University in St Louis).

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