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Predictors of Patient Reported Outcomes at Two Years Following Revision ACL Reconstruction

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Abstract

Background: Patient reported outcomes (PROs) are a valid measure of results following revision anterior cruciate ligament (ACL) reconstruction. Revision ACL reconstruction has been documented to have worse outcomes compared with primary ACL reconstructions. Understanding positive and negative predictors of PROs will allow surgeons to modify and potentially improve outcome for these patients.

Hypothesis/Purpose: The purpose of this study was to describe PROs following revision ACL reconstruction and test the hypothesis that patient and technique specific variables are associated with these outcomes.

Study Design: Cohort study

Methods: Revision ACL reconstruction patients were identified and prospectively enrolled by 83 surgeons over 52 sites. Data collected included baseline demographics, surgical technique and pathology, and a series of validated PRO instruments (IKDC, KOOS, WOMAC and Marx activity rating score). Patients were followed up at 2 years, and asked to complete the identical set of outcome instruments. Multivariate regression models were used to control for a variety of demographic and surgical factors, in order to determine both the positive and negative predictors of PRO scores at 2 years following revision surgery.

Results: 1205 patients met the inclusion criteria and were successfully enrolled. 697 (58%) were males, with a median cohort age of 26 years. The median time since their last ACL reconstruction was 3.4 years. Two-year questionnaire follow-up was obtained on 989 subjects (82%).

The most significant positive predictors of 2-year IKDC scores were a high baseline IKDC score, high baseline Marx activity level, male gender, and having a longer time between a patient's last ACL reconstruction, while negative predictors included having a previous lateral meniscectomy prior to the revision ACL reconstruction or having Grades 3/4 chondrosis in either the trochlear groove or medial tibial plateau at the time of the revision surgery. For KOOS, having a high baseline score and having a longer time between their last ACL reconstruction and revision surgery were significant positive predictors for having better (i.e. higher) 2-year KOOS scores, while having a previous lateral meniscectomy prior to the revision ACL reconstruction was a consistent predictor for having significantly worse (i.e. lower) 2-year KOOS scores. Statistically

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significant positive predictors for 2-year Marx activity levels included higher baseline Marx activity levels, younger age, male gender, and being a non-smoker. Negative 2-year activity level predictors included having an allograft or a biologic enhancement at the time of revision surgery.

Conclusions: PROs following revision ACL reconstruction are associated with a variety of patient and surgeon related variables. Understanding positive and negative predictors of PROs will allow surgeons to guide patient expectation as well as potentially improve outcome for these patients.

Keywords

ACL reconstruction; revision; outcomes; IKDC; KOOS; Marx

INTRODUCTION

Revision anterior cruciate ligament (ACL) reconstruction has been noted to have worse outcomes than primary ACL reconstructions by a variety of measures, including graft failure rates and patient reported outcomes.[7,9,26,28,27] The reasons for these worse outcomes have not been readily apparent and unfortunately the medical literature is replete with lower level retrospective series and few Level 1 or 2 studies. Based on this lack of understanding of this significant clinical problem, the Multicenter ACL Revision Study (MARS) consortium was developed to attempt to better understand the contributors and predictors for these worse outcomes.[16]

Previous analyses of this cohort by the MARS Group have been performed to assess the impact of graft choice, meniscal and chondral factors, rehabilitation variables, surgeon technical issues and cross-cultural comparisons that impact outcome, but no previous analysis has combined all available, practical variables into a common analysis to stratify the predictors.[1–4,8,10–16] Patient reported outcomes (PROs) have become accepted and popular in medicine and subsequently in orthopaedics.[17,18,23–25] Identifying predictors of these measures following revision ACL reconstruction will identify opportunities for counseling and care for patients undergoing this surgery. The purpose of this study was to describe PROs following revision ACL reconstruction and test the hypothesis that patient and technique specific variables are associated with these outcomes.

METHODS

The MARS Group was assembled with the aim of determining what impacts outcome in an ACL revision setting, and to identify potentially modifiable factors that could improve these outcomes. This collaboration consists of a group of 83 sports medicine fellowship trained surgeons across 52 sites. Surgeons are a near equal mix of academic and private practitioners. After obtaining approval from respective institutional review boards (IRBs), this multicenter consortium began patient enrollment in 2006 and ended in 2011, during which time 1205 revision ACL reconstruction patients were enrolled in this prospective longitudinal cohort. The study enrolled patients undergoing revision of a previously failed ACL reconstruction who agreed to participate, signed an informed consent, and completed a series of patient-reported outcome instruments. Indications for the revision ACL reconstruction included functional instability, abnormal laxity testing or an MRI indicating graft tear. Multi-ligament reconstructions were excluded. Surgeon inclusion criteria included maintenance of an active IRB approval, completion of a training session that integrated articular cartilage and meniscus agreement studies, review of the study design and patient inclusion criteria, and a review of the surgeon questionnaire. Surgical technique was at the discretion of the treating surgeon. All allografts were obtained from a single allograft supplier (Musculoskeletal Transplant Foundation; Edison, NJ).

Data Sources and Measurement

After obtaining informed consent, the patient filled out a 13-page questionnaire that included questions regarding demographics, sports participation, injury mechanism, comorbidities and knee injury history, as previously described.[16] Within this questionnaire, each participant also completed a series of validated general and knee-specific outcome instruments, including the Knee Injury and Osteoarthritis Outcome Score (KOOS), the International Knee Documentation Committee Subjective form (IKDC) and the Marx activity rating scale. Contained within the KOOS was the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Surgeons filled out a 42-page questionnaire that included the impression of the etiology **(traumatic, technical and/or biologic)** of the previous failure, physical exam findings, surgical technique utilized, the intra-articular findings and surgical management of meniscal and chondral damage.

Completed data forms were mailed from each participating site to the data coordinating center. Data from both the patient and surgeon questionnaires were scanned with Teleform™ software (OpenText; Waterloo, Ontario, Canada) utilizing optical character recognition, and the scanned data was verified and exported to a master database. A series of logical error and quality control checks were subsequently performed prior to data analysis.

Patient Follow-up

Two-year patient follow-up was completed by mail with re-administration of the same questionnaire as the one they completed at baseline. Patients were also contacted by phone to determine whether any subsequent surgery had occurred to either knee since their initial revision ACL reconstruction. If so, operative reports were obtained, whenever possible, in order to document pathology and treatment.

Statistical Analysis

To describe our patient sample, we summarized continuous variables as percentiles (i.e., 25th, 50th, and 75th), and categorical variables with frequencies and percentages. Multivariable regression analyses were constructed to examine which baseline risk factors were independently associated with each outcome variable. The primary outcome variables of interest were the 2-year outcome scores of the IKDC, KOOS, WOMAC and Marx activity level. These primary outcome variables were all treated as continuous. Regression analysis was used to control for age, gender, body mass index (BMI), activity level, smoking status, number of years of education, baseline outcome scores, surgeon, revision number, time from previous ACL reconstruction, and a variety of previous and current surgical variables, in order to assess the demographic and surgical risk factors for clinical outcomes 2 years after revision surgery. To stay within the allowable degrees of freedom, each continuous variable was tested for a non-linear relationship with a p-value < 0.05 significance level. Statistical analysis was performed using open source R statistical software (www.r-project.org; Version 3.0.3).

RESULTS

Study Population and Follow-up

A total of 1205 patients (697 [58%] males) met the inclusion criteria and were successfully enrolled. The median age was 26 years, and median time since the patients' last ACL reconstruction was 3.4 years. At 2 years, questionnaire follow-up was obtained on 82% (989/1205).

All outcome scores showed significant improvement from baseline to 2 years, with the exception of the WOMAC stiffness subscale ($p<0.001$; Table 1). The IKDC, KOOS, and WOMAC pain and ADL subscales all significantly improved at 2 years, while activity level significantly dropped at 2 years as compared to their baseline measure.

Positive and Negative Predictors of 2-Year Outcome Scores

IKDC—The most significant drivers of 2-year IKDC scores were a patient's, 1) baseline IKDC score ($p<0.001$); 2) baseline Marx activity level ($p<0.001$); 3) gender ($p<0.001$); and, 4) time since their last ACL reconstruction ($p=0.003$). Specifically, having a high baseline IKDC score, high baseline Marx activity level, male gender, and having a longer time between their last ACL reconstruction were significant positive predictors for having better (i.e. higher) 2-year IKDC scores. A summary of all individual significant positive and negative predictors of 2-year IKDC scores are listed in Table 2.

KOOS—The variables that consistently influenced all 2-year KOOS scores were, 1) a patient's baseline score; 2) the time since their last ACL reconstruction; and, 3) having a previous lateral meniscectomy prior to their revision ACL reconstruction. Specifically, having a high baseline score and having a longer time between a patient's last ACL reconstruction were significant positive predictors for having better (i.e. higher) 2-year KOOS scores, while having a previous lateral meniscectomy prior to the revision ACL reconstruction was a consistent predictor for having significantly worse (i.e. lower) 2-year KOOS scores across all subscales. Having a high baseline activity level significantly predicted higher 2-year KOOS activities of daily living (ADL), sports and recreation, and quality of life (QOL) scores. Patients who had an interference screw for their tibial fixation also had significantly higher 2-year KOOS scores in four of the five subscales (symptoms, pain, ADL, and sports/recreation). Choosing an autograft for the revision ACL reconstruction predicted significantly higher KOOS sports/recreation and QOL scores at 2 years. Conversely, having Grade 3–4 trochlear groove chondrosis predicted significantly lower 2-year KOOS scores in four of the five subscales (symptoms, pain, ADL, and sports/recreation). A summary of these significant positive and negative predictors of 2-year KOOS scores are listed in Table 3.

WOMAC—The variables that consistently influenced all 2-year WOMAC scores were, 1) a patient's baseline WOMAC score; 2) the time since their last ACL reconstruction; 3) having an interference screw for their tibial fixation, and 4) having a previous lateral meniscectomy prior to their revision ACL reconstruction. Specifically, having a high baseline score, a longer time between their last ACL reconstruction, and having an interference screw for tibial fixation were the most consistent significant positive predictors for having better (i.e. higher) 2-year WOMAC scores, while having a previous lateral meniscectomy prior to the revision ACL reconstruction was the most consistent predictor for having significantly worse (i.e. lower) 2-year WOMAC scores.

A summary of individual significant positive and negative predictors of 2-year WOMAC scores are listed in Table 4.

Marx Activity Level—The significant drivers of 2-year Marx activity levels were a patient's, 1) baseline Marx activity level; 2) age; and 3) gender (all $p<0.001$; Table 5). Specifically, having a high baseline Marx activity level, younger age, and male gender were the most significant positive predictors for having a higher 2-year Marx activity level. Other positive predictive variables for 2-year activity levels were being a non-smoker, while negative predictors included having an allograft and a biologic enhancement (typically platelet rich plasma).

A summary of individual significant positive and negative predictors of 2-year Marx activity level are listed in Table 5 and Figure 1.

DISCUSSION

Revision ACL reconstruction unfortunately does not always result in outcomes equivalent to a patient's results from the primary reconstruction. The current study reports two-year PROs for a large, prospective cohort of revision ACL reconstructions and identifies predictors for these outcomes. In general PROs at two years were improved over baseline both statistically and clinically. Marx activity score was the real exception to improvement with decreased activity at two years (Table 1). Higher baseline scores were associated with higher two year outcomes scores for all of the PROs included in this study. Longer time from previous ACL reconstruction predicted higher IKDC, KOOS and WOMAC scores while males were predicted to have higher IKDC and Marx scores. Previous partial lateral meniscectomy predicted lower WOMAC and KOOS scores at two-year follow-up.

The predictors for better or worse results become invaluable for surgeons managing these patients for two reasons; 1) counseling patients on expected outcome; and, 2) modifying the treatment plan when appropriate. These results allow improved care for both of these reasons. Obvious preoperative factors that portend a good or poor result can be communicated to the patient and technical factors identified can be incorporated into the surgical management to improve outcome.

The use of PROs for assessing patient outcome has become accepted in sports medicine as well as in the broader orthopaedic surgery community. This has not always been true. As recently as 2005, the use of PROs was editorialized as an invalidated assessment that was inferior to structural factors in determining outcome.[21,29]. This despite surgeon's intuitive knowledge that asking a patient how they were functioning was as informative as measuring structural outcomes. As the use of PROs has become more mainstream, we have developed an increased understanding of their role and statistical integrity.[17,18,23–25]

The use of PROs has facilitated the development of large patient cohorts that creates the opportunity to assess a large number of variables that are involved in patient treatment. In revision ACL reconstruction this has included as many as 80 variables in an analysis of > 1000 patients. While it lacks ability to provide some of the data available from physical exams and imaging, it serves a valuable role in assessing innumerable factors and with modern sophisticated statistical methods, independent predictors can be determined for a variety of outcomes.

This study is unique in the field of revision ACL reconstruction. No previous studies have had the ability to assess outcome predictors due to lack of adequate numbers of subjects for analysis. Previous primary ACL reconstruction studies have looked at these predictors, but as health care professionals know the revision setting is a different and more complex reconstruction scenario. Thus, comparing and contrasting our findings with other studies is difficult. To put our PRO results in perspective, an analysis of median PRO scores in Table 1 finds that the median KOOS subscale scores are at the definition of a "symptomatic knee" as described by Wasserstein et al.[22] and defined by Englund et al. as a KOOS QOL score ≤ 87.5, and two or more of the following: 1.) KOOS Pain ≤ 86.1, 2.) KOOS Symptoms ≤ 85.7, 3.) KOOS ADL ≤ 86.8, 4.) KOOS Sports/Recreation ≤ 85.0.[6] Our median scores would meet these criteria for the KOOS QOL (56), KOOS Symptoms (79), and KOOS Sports/ Recreation (75) subscale scores. Thus at least 50% of our patients may meet the criteria for a symptomatic knee at 2-year follow up.

Dunn et al. in analyzing the predictors of activity level at 2 years in the MOON cohort found that higher baseline activity (Marx score), and lower baseline BMI predicted higher (more active) scores.[5] Predictors for lower activity level scores included female gender, smoking and interestingly, revision ACL reconstruction. Similar to the findings in the current study were that meniscus and cartilage status did not predict 2-year activity level scores. In the current revision cohort, male gender and being a nonsmoker predicted increased activity level scores at 2 years. A variety of factors specific to the revision setting were impactful, but would not be involved with a primary reconstruction.

Spindler et al. in a MOON study analyzing predictors of activity and sports function at six years following ACL reconstruction found the use of an allograft predicted poorer IKDC, KOOS Sports/Recreation and KOOS QOL scores.[20] Higher baseline BMI predicted poorer IKDC and KOOS Sports/Recreation scores at 6 years, and baseline smoking predicted poorer IKDC scores at 6 years. Lateral meniscus status predicted the KOOS Sports/ Recreation and KOOS QOL scores. If the patient had undergone a revision ACL reconstruction, poorer IKDC, MARX and all KOOS subscales were predicted. Early acknowledgement of the impact of revision ACL reconstruction in the MOON cohort was the impetus for the development of MARS.

Interestingly, when examining PROs in that predominantly primary cohort at 6 years the scores are no worse and typically improved compared to the current MARS study findings at 2 years.[19] The median IKDC score was identical at 77. The KOOS Sports/Recreation subscale score was 90 for MOON vs. 75 at 2 years for MARS. The KOOS QOL subscale score was 81 for MOON and 56 for MARS. Thus, at 2 years revision patients are doing significantly worse than primary ACL patients at 6 years with some but not all measures. The caveat is that the comparison is not adjusted for confounding factors such as patient age, gender, etc.

Consistent with all cohort studies there are limitations imposed by the study design. We do not have quantitative measures of laxity or arthritis at 2-year follow-up (e.g., KT-1000, radiographs). This will be addressed by onsite follow-up at 10 years. The strengths are that this is the largest prospectively enrolled revision ACL reconstruction cohort reported to date, validated PROs collected at baseline and two years and the generalizability of our cohort by including private and academic fellowship trained sports medicine physicians from a variety of geographic and practice settings.

CONCLUSIONS

This is the largest cohort to date reporting two-year PROs for patients undergoing revision ACL reconstruction. Factors associated with two-year PROs were identified, including baseline PRO scores, patient age and sex, time from previous ACL reconstruction and history of a previous partial lateral meniscectomy. Understanding predictors of these scores helps surgeons guide patient expectations and optimize surgical technique.

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What is known about the subject:

Revision ACL reconstruction has worse results than primary reconstructions. Patient reported outcomes demonstrate these worse outcomes, but predictors of these worse outcomes have not been known.

What this study adds to existing knowledge: Negative and positive predictors for patient reported outcomes are demonstrated for a variety of PROs including KOOS, IKDC and Marx.

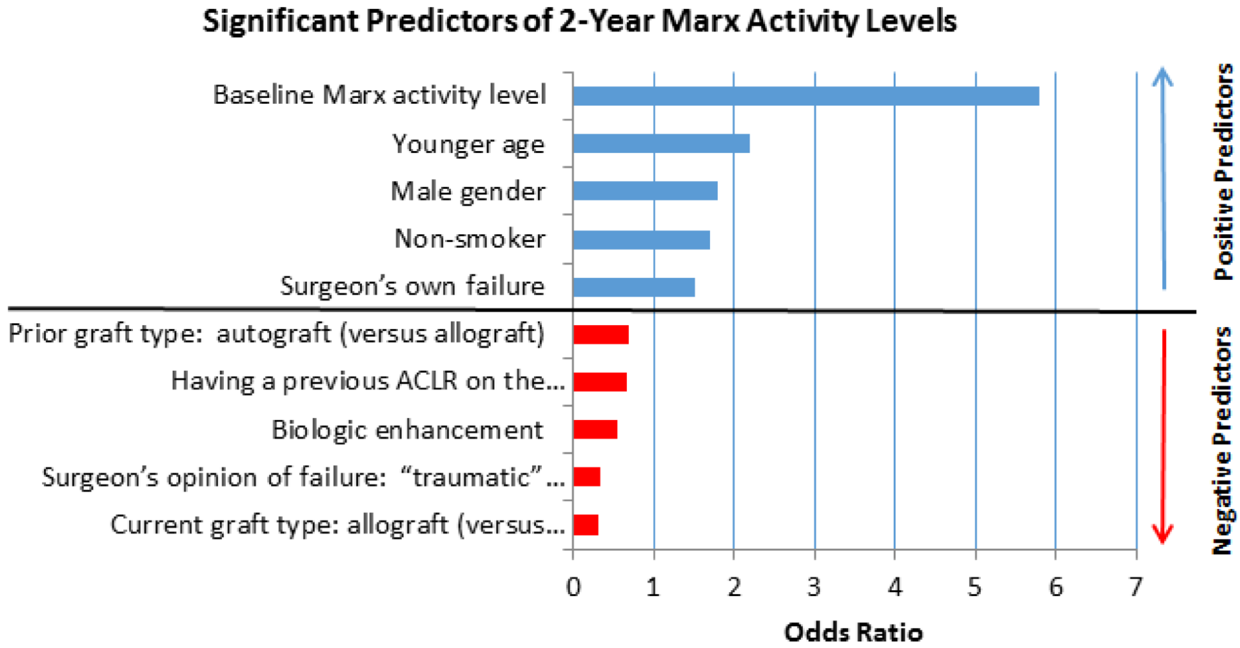

Figure 1.

Significant predictors of 2-year Marx activity levels. ACLR, anterior cruciateligament reconstruction.

Table 1.

Median (25%, 75% quartile) Outcome Scores over Time

	Scale	Baseline (T0)[a]	2-Year Follow-up[b]
IKDC[c]	0–100	52 (38,63)	77 (61,86)
KOOS[d]	0–100		
• Symptoms		68 (54,82)	79 (64,89)
• Pain		75 (58,86)	89 (75,94)
• ADL[e]		87 (69,96)	97 (88,100)
• Sports/recreation		45 (25,65)	75 (55,90)
• Quality of life		31 (19,44)	56 (38,75)
WOMAC[f]	0–100		
• Stiffness		75 (50,88)	75 (62,100)
• Pain		85 (70,95)	95 (80,100)
• ADL[e]		87 (69,96)	97 (88,100)
Marx activity level	0–16	11 (4,16)	7 (2,12)

[a]T0 = time at revision ACL reconstruction surgery

[b]scores all significantly changed as compared to baseline (p<0.001), with the exception of the WOMAC stiffness scale.

[c]IKDC = International Knee Documentation Committee “subjective” form

[d]KOOS = Knee injury and Osteoarthritis Outcome Score

[e]ADL = activities of daily living

[f]WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index

Table 2.

Significant Predictors for 2-Year IKDC Scores

	Variable	Odds Ratio	95% CI	p value
Positive Predictors (improved scores)	• Baseline IKDC score	3.1	(2.5, 3.7)	<0.001
	• Baseline Marx activity level	2.2	(1.6, 3.2)	<0.001
	• Time since last ACL Reconstruction (years)	1.9	(1.3, 2.8)	0.003
	• Femoral fixation (interference screw)	1.8	(1.0, 3.1)	0.047
	• Male gender	1.6	(1.3, 2.1)	<0.001
	• Tibial fixation (interference screw)	1.6	(1.1, 2.2)	0.007
	• LFC chondrosis (grade 2)	1.5	(1.1, 2.2)	0.023
	• Current graft source: soft tissue	1.5	(1.1, 2.2)	0.025
Negative Predictors (worse scores)	• MTP chondrosis (grades 3/4)	0.45	(0.21, 0.97)	0.042
	• Trochlear chondrosis (grades 3/4)	0.53	(0.35, 0.80)	0.003
	• Previous lateral meniscectomy	0.59	(0.41, 0.86)	0.005
	• Current graft type: allograft	0.76	(0.59, 0.99)	0.045

Key: LFC = lateral femoral condyle; MTP = medial tibial plateau

Table 3.

Significant Predictors for 2-Year KOOS Scores

Variable	Symptoms	Pain	ADL	Sports/Rec	QOL
Positive Predictors					
• Baseline score	3.9 (3.1, 4.8); p<0.001	3.8 (3.1, 4.8); p<0.001	5.1 (3.8, 6.8); p<0.001	3.0 (2.4, 3.6); p<0.001	2.1 (1.8, 2.6); p<0.001
• Time since last ACL reconstruction (years)	1.7 (1.1, 2.5); p=0.001	1.9 (1.3, 2.8); p=0.001	1.9 (1.3, 2.8); p<0.001	2.0 (1.4, 3.0); p=0.008	1.8 (1.3, 2.7); p=0.003
• Baseline Marx activity level			1.6 (1.1, 2.4); p=0.007	1.8 (1.3, 2.6); p=0.001	2.0 (1.4, 2.9); p<0.001
• Lateral Meniscus treatment: no treatment for tear			2.5 (1.3, 4.7); p=0.008		
• Femoral fixation (interference screw)					2.2 (1.3, 4.0); p=0.006
• Tibial fixation (interference screw)	1.5 (1.1, 2.1); p=0.013	1.6 (1.1, 2.2); p=0.007	2.0 (1.1, 3.7); p=0.024	1.5 (1.0, 2.1) p=0.033	
• Current graft: autograft				1.3 (1.0, 1.7) p=0.037	1.3 (1.0, 1.7); p=0.031
• Current graft type: soft tissue		1.5 (1.1, 2.3); p=0.029			
Negative Predictors					
• Current smoker					0.6 (0.4, 0.9); p=0.012
• Previous ACL Reconstruction on the contralateral knee					0.7 (0.5, 0.98); p=0.037
• 2nd Revision ACL Reconstruction					0.6 (0.4, 0.9); p=0.019
• Previous medial meniscectomy	0.7 (0.5, 0.95); p=0.022	0.7 (0.5, 0.9); p=0.006			
• Previous lateral meniscectomy	0.6 (0.4, 0.8); p=0.002	0.7 (0.5, 0.9); p=0.019	0.6 (0.4, 0.9); p=0.024	0.7 (0.5, 0.96); p=0.029	0.5 (0.3, 0.7); p<0.001
• Trochlear groove chondrosis (grades 3/4)	0.6 (0.4, 0.9); p=0.019	0.6 (0.4, 0.9); p=0.014	0.4 (0.2, 0.6); p<0.001	0.5 (0.3, 0.8); p=0.003	
• MTP chondrosis (grades 3/4)				0.3 (0.2, 0.7); p=0.002	
• LTP chondrosis (grade 2)				0.7 (0.5, 1.0) p=0.046	

Variable	Symptoms	Pain	ADL	Sports/Rec	QOL
• MFC chondrosis (grade 4)					0.5 (0.3, 0.9); p=0.011
• Surgeon's opinion on cause of failure: tibial tunnel malposition			0.4 (0.2, 0.9); p=0.037	0.3 (0.1, 0.9); p=0.026	

Key: numbers listed in each cell are ones which were statistically significant. Listed in the order of Odds Ratio; (95% Confidence Intervals); p-value. MTP = medial tibial plateau; LTP = lateral tibial plateau; MFC = medial femoral condyle; ADL = activities of daily living; Sports/Rec = sports and recreation; QOL = quality of life.

Table 4.

Significant Predictors for 2-Year WOMAC Scores

	Variable	Stiffness	Pain	ADL
Positive Predictors (improved scores)	• Baseline score	4.3 (3.4, 5.6); p<0.001	4.0 (3.0, 5.3); p<0.001	5.1 (3.8, 6.8); p<0.001
	• Time since last ACL Reconstruction (years)	1.8 (1.2, 2.6); p=0.003	1.7 (1.1, 2.6); p=0.001	1.9 (1.3, 2.8); p=0.050
	• Baseline Marx activity level			1.6 (1.1, 2.4); p=0.007
	• Lateral meniscus treatment: no treatment for tear			2.5 (1.3, 4.7); p=0.008
	• Femoral fixation (interference screw)	1.8 (1.1, 3.1); p=0.032		
	• Tibial fixation (interference screw)	1.7 (1.2, 2.3); p=0.029	1.4 (1.0, 2.0); p=0.040	2.0 (1.1, 3.7); p=0.024
	• Surgeon's years of experience		1.3 (1.0, 1.6); p=0.022	
Negative Predictors (worse scores)	• Previous medial meniscectomy	0.7 (0.5, 0.9); p=0.010		
	• Previous lateral meniscectomy	0.7 (0.4, 0.9); p=0.021	0.6 (0.4, 0.9); p=0.022	0.6 (0.4, 0.9); p=0.024
	• Trochlear groove chondrosis (grades 3/4)	0.6 (0.4, 0.96); p=0.030		0.4 (0.2, 0.6); p<0.001
	• Patellar chondrosis (grades 3/4)		0.6 (0.4, 0.9); p=0.017	
	• Surgeon's opinion on cause of failure: traumatic	0.4 (0.1, 0.96); p=0.042		
	• Surgeon's opinion on cause of failure: tibial tunnel malposition			0.4 (0.2, 0.9); p=0.037

Key: ADL = activities of daily living

Table 5.

Significant Predictors for 2-Year Marx Activity Level

	Variable	Odds Ratio	95% CI	p value
Positive Predictors (improved scores)	• Baseline Marx activity level	5.8	(4.0, 8.4)	<0.001
	• Younger age	2.2	(1.4, 3.2)	<0.001
	• Male gender	1.8	(1.4, 2.3)	<0.001
	• Non-smoker	1.7	(1.1, 2.7)	0.018
	• Surgeon's own failure	1.5	(1.1, 2.2)	0.017
Negative Predictors (worse scores)	• Current graft type: allograft	0.30	(0.13, 0.70)	0.005
	• Surgeon's opinion of failure: "traumatic"	0.33	(0.12, 0.92)	0.033
	• Biologic enhancement	0.55	(0.33, 0.90)	0.019
	• Having a previous ACL Reconstruction on the contralateral knee	0.67	(0.45, 0.99)	0.047
	• Prior graft type: autograft	0.69	(0.50, 0.96)	0.027