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Time from ACL injury to reconstruction and the prevalence of additional intra-articular pathology: Is patient age an important factor?

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Abstract

Purpose—Meniscus and cartilage lesions have been reported to be prevalent during delayed reconstruction of ACL injuries. Relatively little work has been done exploring the influence of patient age on this relationship. The purpose of this study is to determine whether the effect of time from ACL injury to reconstruction on the prevalence of associated meniscal and chondral injury is influenced by patient age. It was hypothesized that patients in whom the time from ACL injury to reconstruction exceeds 12 weeks will exhibit an increased prevalence of medial compartment pathology relative to those reconstructed within 12 weeks of injury in patients of all ages.

Methods—Data detailing time from ACL injury to reconstruction and the prevalence of intra-articular findings were obtained in 311 of 489 consecutive patients undergoing primary isolated ACL reconstruction. Patients were divided into two groups based on whether the time from ACL injury to reconstruction was less than 12 weeks or at least 12 weeks. The prevalence of associated intra-articular injury was then compared between the two groups. Patients were then stratified based on age (22 years and under versus over age 22) and the analysis was repeated on both groups.

Results—Analysis of all patients together revealed a significantly higher prevalence of medial meniscus injury ($p = 0.013$) and medial compartment chondral injury ($p < 0.0005$) in patients in whom the time from ACL injury to reconstruction exceeded 12 weeks. The prevalence of lateral meniscal injury did not increase with increasing time ACL injury to surgery. Among patients age 22 and under, there was no increase in the prevalence of intra-articular pathology in any compartment in the late reconstruction group. In contrast, among patients over age 22, there was a significant increase in the prevalence of medial chondral injury ($p = 0.042$) in the late reconstruction group.

Conclusion—The prevalence of injuries to the meniscus and articular cartilage in the medial compartment of the knee is increased with increasing time from ACL injury to reconstruction. This relationship may vary depending on patient age. Patients over age 22 exhibit a higher prevalence of intra-articular injury with delayed reconstruction, while no such differences are noted among younger patients.

Keywords

ACL reconstruction; chronicity; meniscus injury; chondral injury

Introduction

The anterior cruciate ligament (ACL) is frequently injured and its reconstruction is among the most commonly performed orthopaedic procedures.[6] Modern ACL reconstruction techniques allow clinically stable ligament reconstruction in the majority of cases; however, outcomes of ACL surgery are not uniformly excellent. Numerous factors have been noted to portend worse outcome following ACL surgery. Among the most consistently reported predictors of poorer outcomes following ACL reconstruction is a chronic ACL tear versus acute or subacute tears.[7, 10, 15, 17, 19] Although the definition of a chronic tear is not rigidly defined, many described chronic tears as those reconstructed at least 12 weeks following injury.[3, 9, 16]

Although multiple factors contribute to poorer outcomes in patients with chronic ACL injuries, increased intra-articular pathology is likely a major contributor. Numerous authors have noted that both meniscal and articular cartilage lesions are more commonly seen during reconstruction of more chronic ACL injuries.[2, 5, 7-11, 13-15, 17-20] Other studies have further demonstrated that the increased prevalence of meniscal pathology is isolated to the medial meniscus.[2, 5, 7, 11, 13, 14, 20]

Interestingly, relatively little work has been done exploring the influence of patient age on the relationship between time to reconstruction and the prevalence of meniscal and chondral lesions. Several studies focusing only on skeletal immature patients have noted associations between delayed reconstruction and the prevalence of meniscal and chondral injuries.[11, 13] Other work has demonstrated that both meniscal and chondral lesions are more prevalent in older patients undergoing ACL reconstruction, regardless of time from injury to reconstruction.[5, 8, 14, 20] Only one study in the literature explores the relationship between time to surgery and the prevalence of intra-articular pathology following stratification of patients by age.[8] This study does not differentiate the compartments (medial versus lateral) in which the intra-articular pathology was noted, potentially limiting its interpretation.

The purpose of this study is to determine whether the effect of time from ACL injury to reconstruction on the prevalence of associated meniscal and chondral injury is influenced by patient age. It was hypothesized that patients in whom the time from ACL injury to reconstruction exceeds 12 weeks will exhibit an increased prevalence of medial compartment pathology relative to those reconstructed within 12 weeks of injury. It was further hypothesized that this relationship will be noted in both younger (age 22 and under) and older patient groups.

Material and Methods

Following IRB approval, all ACL reconstructions in skeletally mature patients performed by two high-volume ACL surgeons between January 1, 2005 and December 31, 2008 were prospectively entered into an ACL database. For the purpose of this study, retrospective analysis of the database identified 672 potential patients. Of these patients, 489 met inclusion and exclusion criteria (Table 1). Complete injury and surgical data were available on 311 patients (63.5%) who comprise the study group. The vast majority of excluded patients lacked a documented injury date in their chart.

Data Collection

By accessing the prospectively collected ACL database, the time interval from ACL injury to reconstruction was collected for each of the 311 patients. Intra-operative findings from each reconstruction were then recorded. These data included the presence of complete medial or lateral meniscal tears, as well as significant chondral damage in the medial, lateral, or patellofemoral compartments. Significant chondral damage was defined using the Outerbridge classification system as a grade 2 lesion involving greater than 50% of the width of any compartment or the presence of any grade 3 or 4 lesions.[12]

Statistical Analysis

Summary statistics were calculated, including mean and standard deviation for normally distributed variables and median for variables that were not normally distributed.

Patients were divided into two groups based on whether the time from ACL injury to reconstruction was less than 12 weeks or at least 12 weeks. This break point was selected for consistency with previously published work that utilized the same time point.[3, 9, 16] Demographic data for the two groups were compared using a t-test for normally distributed continuous data, a Wilcoxon rank-sum test for non-normally distributed continuous data, and a Fisher exact test for categorical data.

The prevalence of associated intra-articular injury (meniscal and chondral injuries as defined above) was then compared between the two groups using Fisher exact tests. A power analysis determined that given the available sample size, a 15% increase in the prevalence of intra-articular pathology would be detectable with $\alpha = 0.05$ and a power of 0.80. The continuous variable age was then dichotomized to compare effect of time from injury to reconstruction on the prevalence of intra-articular pathology in younger versus older patients. Patients age 22 and under were classified as being in the younger group. This age was chosen because age 22 often represents the end of formal education and the beginning of full time work, significantly changing activity level and sports participation in many cases. The prevalence of intra-articular pathology based on time from ACL injury to reconstruction was then analyzed separately in each group using the Fisher exact test. Statistical calculations were performed using Stata version 12.1 (StataCorp, College Station, TX, USA).

Results

The patients undergoing ACL reconstruction ranged in age from 13 to 59 years (mean: 26.8, SD: 10.4) and included 158 males (51%) and 153 females (49%). The median time from ACL injury to ACL reconstruction was 6 weeks (Inter-quartile range: 4 to 14 weeks). Overall, medial meniscus tears were noted in 90 patients (29%) and lateral meniscus tears were noted in 117 patients (38%). Articular cartilage damage was present in the medial compartment in 70 patients (23%), in the lateral compartment in 73 patients (24%), and in the patellofemoral compartment in 58 patients (19%). Patients reconstructed within 12 weeks of ACL injury were noted to be younger and included a higher proportion of females than those reconstructed beyond 12 weeks following injury (Table 2).

Analysis of patients of all ages revealed a significantly higher prevalence of medial meniscus injury ($p = 0.013$) and significant medial compartment chondral injury ($p < 0.0005$) in patients in whom the time from ACL injury to reconstruction exceeded 12 weeks. This group also demonstrated an increased prevalence of significant chondral injury in the patellofemoral compartment compared to the early reconstruction group ($p = p = 0.016$). There was no significant difference in the prevalence of lateral compartment cartilage or meniscus damage between the two groups (Table 3).

Among patients age 22 and under, there was no increase in the prevalence of intra-articular pathology in any compartment in the late reconstruction group when compared to the early reconstruction group (Table 4). In contrast, among patients over age 22, there was a significant increase in the prevalence of medial chondral injury ($p = 0.042$) in the late reconstruction group. No increased prevalence of pathology in other compartments was noted (Table 5).

Discussion

The most important finding of this study is that the relationship between increased time from ACL injury to reconstruction and increased prevalence of medial compartment injury (that has been noted in numerous previous studies) may not be consistent across all ages of patients. The vast majority of prior studies evaluating this relationship did not stratify patients based on age.[2, 5, 7, 9, 10, 14, 15, 17-20]

This study is not the first to suggest the variability in this relationship for patients of different ages. In a large study based on data from the Norwegian Knee Ligament Registry, Granan et al performed a similar analysis of the effect of time from ACL injury to reconstruction on the prevalence of intra-articular injury in patients in three different age groups: under age 17, age 17 to 40, and over age 40.[8] They noted a significant increase in chondral injury with increased time from injury to reconstruction in the middle and older age groups but not in the younger patients. Similarly, they noted a significant increase in meniscal injury with increased time to reconstruction in the middle group but not in the younger or older groups. Although these data are relatively consistent with the findings of the current study, the previous study does not differentiate between medial and lateral meniscal or chondral injury, potentially influencing their findings.

In contrast to the findings of the current study, Lawrence et al and Millett et al noted significantly increased prevalence of meniscal and chondral injury with increased time to reconstruction in young patients.[11, 13] These studies were both restricted to patients age 14 and under, with a number of skeletally immature patients included. The current study excludes all skeletally immature patients, likely leading to significant differences in the population included in these prior works and the current study. These younger patients generally have surgery delayed while awaiting skeletal maturity rather than the other reasons (which are not known) for increased time from injury to reconstruction in our patient population. Further, these patients may have different activity levels and respond to activity restrictions in different ways, potentially influencing rates of subsequent intra-articular injury.

Based on the results of this and previous studies, it is clear that blanket statements cannot be made regarding the effect of increased time from ACL injury to reconstruction that apply to all patients. The “risks of delay” in ACL reconstruction that have been referenced in several recent studies are certainly real and important in the populations that were studied,[2, 11, 13] but may not be broadly generalizable to all patients with an ACL injury.

Similarly, it is critically important to note that the goal of this study is not to determine whether delay in the time from ACL injury to reconstruction increases the risk of intra-articular injury in any given patient. Such a study would require assessment of intra-articular injury immediately following injury and comparison of these findings to the presence of intra-articular injury at the time of surgery. These data are not available in the current study. In the current study, the occurrence of new intra-articular pathology between ACL injury and reconstruction is just one factor that may contribute to the increased prevalence of intra-articular pathology in patients with a greater delay to surgery. Other factors may include the

influence activity level on time to reconstruction and the initial prevalence of intra-articular injury, as well as the influence of intra-articular injuries themselves on the timing of surgery. The goal of this study is to assess the prevalence of intra-articular pathology at reconstruction for “acute” versus “chronic” injuries, not to comment on the etiology of this pathology or comment on the best time interval in which reconstruction should be performed.

This study has several important limitations, the first of which is a lack of data regarding the activity level of patients between ACL injury and reconstruction. We also lack data regarding the number of episodes of instability experienced between ACL injury and surgery in the majority of patients, preventing meaningful analysis of these data. Further, intra-articular injury was defined by the surgeon's intra-operative assessment and not confirmed by another method. While numerous studies have assessed the consistency of classification systems of articular cartilage[12] and meniscal lesions,[1, 4, 12] we are aware of no studies validating surgeons' abilities to assess for the presence or absence of such lesions. However, we do not believe the assumption of relatively consistent identification of such pathology introduces significant error. Also, due primarily to incomplete data regarding injury date, we were forced to exclude a significant percentage of patients from our analysis. The resulting inclusion rate may result in selection bias, the significance of which is unknown. Though the analysis was done retrospectively, the intra-articular data were prospectively collected, decreasing detection bias. A final limitation is the relatively low number of younger patients undergoing delayed reconstruction, potentially limiting our power to detect increases intra-articular pathology in this group.

Conclusions

The prevalence of injuries to the meniscus and articular cartilage in the medial compartment of the knee is increased with increasing time from ACL injury to reconstruction. This relationship may vary with patient age. Patients over age 22 exhibit a higher prevalence of intra-articular injury with delayed reconstruction, while no such differences were noted among younger patients in the current study.

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Table 1

Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Primary ACL reconstruction	Revision ACL reconstruction
Skeletally mature	Skeletally immature
	History of prior knee surgery
	Multi-ligament knee injury (PCL, LCL, or MCL injury of grade 2)
	Staged procedures (bucket handle meniscus injuries)
	Congenital absence of the ACL

Table 2

Demographics of Acute and Chronic ACL reconstruction groups

	Time from injury to reconstruction		Significance
	Less than 12 weeks	12 weeks or more	
Median time from ACL injury to reconstruction	4.7 weeks	23.9 weeks	p < 0.0005
Sex	111/218 male (50.9%)	58/91 male (63.7%)	p = 0.026
Mean Age at ACL reconstruction	25.3 ± 10.4 years	30.6 ± 9.3 years	p < 0.0005

Table 3

Incidence of associated intra-articular injury at ACL reconstruction

	Time from injury to reconstruction		Significance
	Less than 12 weeks	12 weeks or more	
Median time from ACL injury to reconstruction	5.3 weeks	27.6 weeks	p < 0.0005
Medial Meniscus Tear Present	54/218 (24.8%)	36/91 (39.6%)	p = 0.013
Lateral Meniscus Tear Present	86/218 (39.4%)	32/91 (35.2%)	p = n.s.
Medial Compartment Cartilage Damage Present	36/216 (16.7%)	34/91 (37.4%)	p < 0.0005
Lateral Compartment Cartilage Damage Present	48/215 (22.3%)	25/91 (24.2%)	p = n.s.
Patellofemoral Compartment Cartilage Damage Present	33/216 (15.3%)	25/91 (24.2%)	p = 0.016

n.s. = not significant

Table 4

Incidence of associated intra-articular injury at ACL reconstruction in patients age 22 and under

	Time from injury to reconstruction		Significance
	Less than 12 weeks	12 weeks or more	
Median time from ACL injury to reconstruction	4.5 weeks	20.3 weeks	p < 0.0005
Medial Meniscus Tear Present	22/126 (17.5%)	4/24 (16.7%)	p = n.s.
Lateral Meniscus Tear Present	59/126 (44.4%)	10/24 (41.3%)	p = n.s.
Medial Compartment Cartilage Damage Present	7/124 (16.7%)	3/24 (12.5%)	p = n.s.
Lateral Compartment Cartilage Damage Present	19/124 (15.3%)	4/24 (16.7%)	p = n.s.
Patellofemoral Compartment Cartilage Damage Present	5/124 (4.0%)	3/24 (12.5%)	p = n.s.

n.s. = not significant

Table 5

Incidence of associated intra-articular injury at ACL reconstruction in patients over age 22

	Time from injury to reconstruction		Significance
	Less than 12 weeks	12 weeks or more	
Median time from ACL injury to reconstruction	5.3 weeks	27.6 weeks	p < 0.0005
Medial Meniscus Tear Present	32/92 (34.8%)	32/67 (47.8%)	p = n.s.
Lateral Meniscus Tear Present	27/92 (29.3%)	22/67 (32.8%)	p = n.s.
Medial Compartment Cartilage Damage Present	29/92 (31.5%)	31/67 (46.3%)	p = 0.042
Lateral Compartment Cartilage Damage Present	29/91 (31.9%)	21/67 (31.3%)	p = n.s.
Patellofemoral Compartment Cartilage Damage Present	28/92 (30.4%)	22/67 (32.8%)	p = n.s.

n.s. = not significant