

Characterization and Predictors of Concomitant Meniscus Injuries in 3,538 Patients Prior to Undergoing Anterior Cruciate Ligament Reconstruction at a Single, High-Volume Institution

Tomas F. Vega, James B Segars, Campbell Bowman Aiken, Sharan Sankar, Matthew P Ithurnburn, Alex Yates, Marcus Anthony Rothermich, Benton A Emblom, Jeffrey R Dugas, E Lyle Cain

INTRODUCTION:

The anterior cruciate ligament (ACL) provides dynamic anteroposterior and rotational stability of the knee and functions synergistically with the menisci to provide further joint stability. In the context of ACL tears, a range of variables have been associated with concomitant meniscus injury. However, existing studies exploring the relationship between ACL tears and meniscal injuries are either relatively small, multicenter, or are derived from large population databases, which may fail to rigorously capture relevant demographic and injury-related variables. To further understand relationships between ACL tears and concomitant meniscus injuries, we sought to characterize the location, size, and morphology of meniscus tears present in a large sample of patients prior to undergoing ACL reconstruction at a single center. We additionally assessed the association between meniscus tears and potential demographic, athletic, and clinical predictors.

METHODS:

We used a prospectively-collected database to retrospectively-identify potential study participants based on CPT codes with procedures performed through January 2023 at our high-volume sports medicine center. We then reviewed clinical and operative notes within the electronic health record. We included patients that underwent ACL reconstruction and were at least 2 years post-operative and excluded those with prior ipsilateral knee surgeries or missing pre-operative data. We classified meniscus injuries based on clinically-available information extracted from surgical images, operative reports, and/or visit notes based on medial or lateral meniscus involvement, tear location (medial, lateral, anterior, posterior, midbody, root, or ramp), tear size, and tear morphology (parrot beak, bucket handle, radial, longitudinal, vertical, horizontal, complex). Demographic data collected included age, sex, body mass index (BMI), time from initial ACL injury (acute, ≤ 6 weeks; chronic >6 weeks), competitive athletic status at time of injury and level of competition, and mechanism of injury for athletes and non-athletes. We summarized the proportions of concomitant meniscus injuries and their characteristics and compared relevant demographic, sport, and clinical measures between those with and without concomitant meniscus injuries using independent t-tests and Chi-square tests. Additionally, we examined demographic and sport-related predictors (and odds ratios, when relevant) of meniscus injury using logistic regression modeling.

RESULTS: A total of 3,538 patients prior to ACL reconstruction were included (60% males; average age=25.0 years; 61% competitive athletes; 90% presenting with acute injuries). Of these, 2,171 (61%) had some form of concomitant meniscus injury/tear, whereas 1,367 (39%) did not. Overall, lateral meniscus injuries were more common than medial meniscus injuries (Table 1). Tears of the posterior horn of the lateral meniscus accounted for 54% of all tears, of which radial tears made up the majority. There were a total of 331 ramp lesions, involving 9% of patients. Additional data related to the distribution of meniscus injuries based on specific locations and tear types are shown in Table 1. Demographic and sport-related data for those with and without meniscus injury are shown in Table 2. There were higher proportions of male patients and competitive athletes in those with meniscus injuries (63% and 63%, respectively) than in those without meniscus injuries (56% and 57%, respectively; Table 2). There was trend toward younger age in those with meniscus injuries as compared to those without, but this was not statistically-significant ($p=0.07$; Table 2). Male sex was associated with 1.4 times higher odds ($OR=1.37$; $p<0.01$) of having a concomitant meniscus injury prior to ACL reconstruction and being a competitive athlete was associated with 1.3 times higher odds ($OR=1.26$; $p<0.01$) of having a concomitant meniscus injury prior to ACL reconstruction. Age, BMI, and injury acuity were not associated with concomitant meniscus injury prior to ACL reconstruction ($p>0.05$).

DISCUSSION AND CONCLUSION:

We found that 61% of patients that underwent ACL reconstruction demonstrated concomitant meniscus tears, which falls at the upper threshold of rates reported in the literature. Our finding that lateral meniscus tears were the most common injury location was expected, as over 90% of our cohort had acute injuries. Specifically, 33% of lateral meniscus injuries were to the posterior horn, which is a rate comparable to previously-reported values. Male sex and competitive athlete status were both significantly associated with concomitant meniscal injury. The trend toward increased meniscus injuries in younger age patient may be explained by the fact that younger people are more likely to be engaged in competitive sports. Further study should examine predictors of specific meniscus injury subtypes as well as stratifying meniscus injury types within athletes and non-athletes, between sexes, and between those with acute and chronic ACL injury.

Table 1. Meniscus Injury Location and Tear Type

Tear Type	Medial Meniscus (n=1,489)					Lateral Meniscus (n=2,088)				
	Anterior	Posterior	Mid-body	Root	Unspecified	Anterior	Posterior	Mid-body	Root	Unspecified
Radial	3	26	10	5	6	27	211	196	36	72
Bucket-Handle	5	86	38	0	80	1	80	17	5	49
Parrot Beak	0	14	5	0	4	5	60	13	4	7
Longitudinal	1	130	22	1	19	3	175	21	2	23
Horizontal	1	86	17	1	10	1	107	20	1	18
Complex	3	93	17	4	22	10	158	41	12	27
Vertical	0	54	14	0	10	1	98	16	2	15
Unspecified	6	201	32	21	111	12	287	49	45	161
Ramp	-	331	-	-	-	-	-	-	-	-
Total	19	1021	155	32	262	60	1176	373	107	372

Table 2. Demographic and Sport-Related Data and Comparisons Between Groups

Variable	Meniscus Injury (n=2,171)	No Meniscus Injury (n=1,367)	p-value
Age at surgery*, years	24.6 ± 11.6	25.4 ± 11.9	0.07*
Sex distribution, n (%)			
Female	799 (37%)	607 (44%)	<0.01*
Male	1,372 (63%)	760 (56%)	
Body mass index*, kg/m ²	26.3 ± 5.1	26.0 ± 5.5	0.25*
Time from injury, n (%)			
Acute	2,010 (93%)	1,290 (94%)	0.10*
Chronic	119 (5%)	63 (5%)	
Unable to determine	42 (2%)	14 (1%)	
Athlete status, n (%)			
Competitive athlete	1,365 (63%)	776 (57%)	<0.01*
Non-athlete	806 (37%)	591 (43%)	
Level of competition (competitive athletes only=2,148), n	Professional: 57 Collegiate: 272 High school: 841 Middle school: 98 Club/travel: 14 Youth Recreational: 7 Adult recreational: 76	Professional: 23 Collegiate: 137 High school: 485 Middle school: 57 Club/travel: 9 Youth Recreational: 7 Adult recreational: 58	--

*Data are presented as mean ± standard deviation; *Comparison with independent t-test; *Comparison with Chi-square test