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Effect of Anterior Cruciate Ligament Reconstruction and Meniscectomy on Length of Career in National Football League Athletes

A Case Control Study

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Background: Meniscal and anterior cruciate ligament (ACL) injuries are common in college football athletes. The effect of meniscectomy and/or ACL surgery on the length of an athlete's career in the National Football League (NFL) has not been well examined.

Hypothesis: Athletes with a history of meniscectomy or ACL surgery before the NFL combine have a shorter career than matched controls.

Study Design: Case-control study; Level of evidence, 3.

Methods: A database containing the injury history and career NFL statistics of athletes from 1987-2000 was used to match athletes with a history of meniscectomy and/or ACL surgery, and no other surgery or major injury, to controls without previous surgeries. Athletes were matched by position, year drafted, round drafted, and additional injury history.

Results: Fifty-four athletes with a history of meniscectomy, 29 with a history of ACL reconstruction, and 11 with a history of both were identified and matched with controls. Isolated meniscectomy reduced the length of career in years (5.6 vs 7.0; $P = .03$) and games played (62 vs 85; $P = .02$). Isolated ACL surgery did not significantly reduce the length of career in years or games played. Comparing the athletes with meniscectomy or ACL reconstruction to athletes with combined ACL reconstruction and meniscectomy, a history of both surgeries, resulted in a shorter career in games started (7.9 vs 35.1; $P < .01$), games played (41 vs 63; $P = .07$), and years (4.0 vs 5.8; $P = .08$) than a history of either surgery alone.

Conclusion: A history of meniscectomy, but not ACL reconstruction, shortens the expected career of a professional football player. A combination of ACL reconstruction and meniscectomy may be more detrimental to an athlete's durability than either surgery alone. Further research is warranted to better understand how these injuries and surgeries affect an athlete's career and what can be done to improve the long-term outcome after treatment.

Keywords: knee; meniscus; anterior cruciate ligament; American football

Injuries to the meniscus and ACL are very common in college football players. Over 12% of all participants at

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the National Football League (NFL) combine have a history of meniscal injury, and approximately 8% have a history of ACL injury.⁷ The most common previously performed procedure among participants at the NFL combine is meniscectomy, found in approximately 10% of athletes, while ACL reconstruction is the third most common previously performed procedure (almost 6% of athletes).⁷ Meniscal and ACL injuries, as well as the surgical treatment for these injuries, have been shown to be associated with a decreased probability of playing professional football.^{8,9}

However, the effect of meniscectomy and/or ACL surgery on the length of an athlete's career in the NFL has

not been well studied. Both of these procedures could have obvious implications for the durability of an athlete when faced with the high demands of participating in professional football. In a previous uncontrolled cohort study looking at the effects of injury history at the combine on athletes by position, we found that a history of ACL reconstruction was associated with a shorter career for offensive linemen while meniscal injury was associated with a shorter career for athletes in the defensive secondary.⁹ Carey et al¹⁰ studied the effect of ACL injury on running backs and wide receivers already playing in the NFL and found that less than 80% of these athletes returned to play, and the performance of those who did return to play was reduced by one third. The purpose of this case-control study was to investigate whether a history of meniscectomy and/or ACL surgery before the NFL combine is associated with the length of an athlete's career in the NFL. We hypothesized that athletes with a history of meniscectomy or ACL surgery were likely to have a shorter career than carefully matched controls.

MATERIALS AND METHODS

A database containing the injury and surgery history for all 5047 athletes reviewed at the annual NFL combine by the medical staff of one NFL team from 1987-2000 was created and subsequently linked to a dataset of NFL career statistics from the Elias Sports Bureau (New York, New York) containing the round drafted, number of seasons, and number of (regular season and/or playoff) games played in the NFL for the 2845 of these athletes who went on to play at least one game in the NFL. All athletes with a history of meniscectomy and/or ACL reconstruction before the combine who played at least one game in the NFL were identified. Athletes with a history of meniscal repair were not included in this study. Individuals with a history of any other surgery or more than 2 nonmeniscal, non-ACL diagnoses were excluded from the analysis. Athletes with 1 or 2 additional diagnoses were then screened to exclude those who had a major injury (essentially anything more than a muscle strain, minor fracture, or burner), which might confound the analysis.

A control was identified for each injured athlete in the cohort matched by position. Controls could not have any history of surgery and had the same number, or one fewer, of minor non-ACL, nonmeniscus diagnoses as the injured athlete (athletes with a history of any other significant injury such as other knee injuries, shoulder instability, etc, were excluded). When possible, the other diagnoses were matched exactly (ie, both had a history of hamstring strain). Matching criteria were then based on entering the league within ± 2 years and being drafted within ± 2 rounds. When multiple matches were possible, those closest in year and round were chosen. The athletes were not matched on age, but the ages of the injured athletes were compared with the ages of the controls to ensure there was no potential bias due to this variable.

Years in the league and games played in the league were used as markers for length of career. Games started

TABLE 1
Career Length of Athletes With Isolated
Meniscectomy Versus Controls

Sample Size = 54		Mean	Median	SD	P Value
Years	Meniscectomy	5.6	6.0	2.8	.026
	Control	7.0	7.5	3.5	
Games played	Meniscectomy	62	59	41	.018
	Control	85	88	58	
Games started	Meniscectomy	34	18	39	.076
	Control	50	41	52	
Pro Bowl	Meniscectomy	0.17	0	0.58	.14
	Control	0.52	0	1.6	

was used as a marker of both length of career and performance. Other measures of performance were the number of games started to games played ratio (GS/GP = ratio) and number of Pro Bowl appearances.

Summary statistics for these measures of length of career and performance in the NFL were calculated separately for the athletes with a history of meniscectomy, ACL reconstruction, and both surgeries as well as their respective control groups. Independent samples *t* tests were calculated to compare the cases with the controls for each of these outcome measures. One-way ANOVA and post hoc least squares difference tests were used to compare the mean length of career between athletes with a history of meniscectomy or ACL reconstruction to athletes with a history of meniscectomy and ACL reconstruction. Finally, survival analysis using Cox regression was also performed to assess the effect of ACL reconstruction, meniscectomy, or both on length of career in the NFL.

RESULTS

Fifty-four individuals with an isolated history of meniscectomy, 29 with an isolated history of ACL reconstruction, and 11 with a history of both ACL reconstruction and meniscectomy were identified. Controls for each athlete were selected using the approach outlined above. The dataset was reviewed to ensure that each control was only used once, within the meniscectomy, ACL reconstruction, and combined cohorts. Overall, 32 athletes were matched to controls with the same year and round drafted, while 57 had controls within ± 1 year and/or round. Only 5 athletes (3 in the meniscectomy cohort and 2 in the combined cohort) required a match within ± 2 years and/or rounds.

There did not appear to be an age bias in any of the cohorts. In the meniscectomy cohort, the mean difference in age between the injured athletes and controls was -0.1 ± 1.4 years (negative value indicated the injured athlete was younger than the control athlete). In the ACL reconstruction cohort, the mean difference in age between the injured athletes and controls was -0.4 ± 1.2 years; for the combined cohort, the mean difference was -0.7 ± 1.3 years (again, negative value indicated the injured athlete was younger than the control athlete).

TABLE 2
Career Length of Athletes With Isolated Anterior Cruciate Ligament (ACL) Surgery Versus Controls

Sample Size = 29		Mean	Median	SD	<i>P</i> Value
Years	ACL	6.1	7.0	3.1	.77
	Control	6.4	5.0	3.9	
Games played	ACL	64	68	50	.35
	Control	78	64	62	
Games started	ACL	36	30	60	.46
	Control	46	16	40	
Pro Bowl	ACL	0.28	0	60	.76
	Control	0.38	0	40	

TABLE 3
Career Length of Athletes With Combined Anterior Cruciate Ligament Reconstruction and Meniscectomy Versus Controls

Sample Size = 11		Mean	Median	SD	<i>P</i> Value
Years	Combined	4.0	4.0	2.9	.21
	Control	6.1	4.0	4.5	
Games played	Combined	41	24	20	.20
	Control	73	40	43	
Games started	Combined	8	1	13	.10
	Control	39	5	55	
Pro Bowl	Combined	0.09	0	0.30	.54
	Control	0.27	0	0.91	

The results are summarized in Tables 1 to 3. A history of isolated meniscectomy was associated with a significantly shorter average length of career in terms of years and games played in the NFL. Isolated ACL reconstruction did not reduce the mean length of career in this cohort. The median length of career in years and games played was higher in athletes with a history of ACL reconstruction than their controls. Athletes with a history of combined ACL and meniscal surgery did have a shorter career in terms of years and games played in the league compared with their controls, but the difference was not significant in this small cohort of 11 athletes. Athletes with a history of ACL and meniscal surgery started significantly fewer games (7.9 ± 12.5) than athletes with isolated ACL reconstruction or meniscal resection (35.1 ± 39.0) ($P < .01$). There was a trend toward shorter careers in terms of years (4.0 ± 2.9 vs 5.8 ± 2.9 ; $P = .08$) and games played (41 ± 33 vs 63 ± 44 ; $P = .07$) in athletes with ACL reconstruction and meniscal resection compared with those with ACL reconstruction or meniscectomy.

Survival analysis demonstrated no effect of ACL reconstruction on length of career. Meniscectomy did shorten the length of career, as athletes with a history of meniscectomy were 1.6 times (95% confidence interval [CI], 1.1-2.4) more likely to have a shorter career than those with no previous meniscectomy ($P = .015$) (Figure 1). There was a trend toward athletes with combined ACL reconstruction

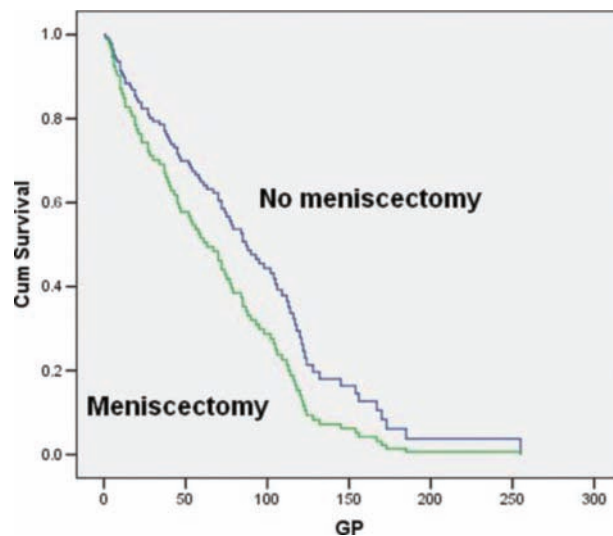


Figure 1. Effect of meniscectomy on National Football League (NFL) career length.

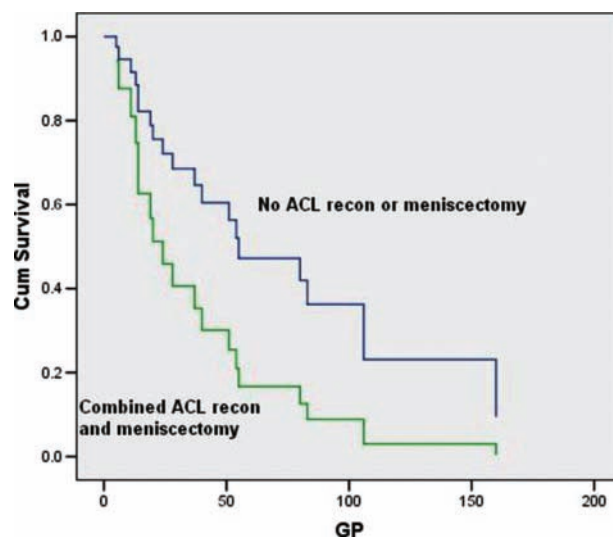


Figure 2. Effect of anterior cruciate ligament (ACL) reconstruction and meniscectomy on National Football League (NFL) career length.

and meniscectomy being 2.4 times (95% CI, 0.8-7.1) more likely to have a shorter career than controls ($P = .12$) (Figure 2).

DISCUSSION

Elite athletes in American football often suffer ACL and meniscal injuries, which have been hypothesized to result in significant morbidity to these athletes. The current

study attempted to quantify the effect of ACL reconstruction and/or meniscectomy before entering the league on the length of career for athletes in the NFL. In this cohort, athletes with prior meniscectomy had significantly shorter careers than controls, while no significant difference was found between players with ACL surgery compared with controls. Athletes with both ACL surgery and meniscectomy had shorter careers than their controls, but the difference was not significant in this small sample.

The menisci of the knee play an important role in a variety of processes important for knee health, including shock absorption, load bearing, knee stability, as well as lubrication and nutrition of articular cartilage.²⁵ Athletic activity has been shown to be associated with degeneration of the anterior horn of both the medial and lateral meniscus as well as the posterior horn of the lateral meniscus.¹⁹ Meniscal degenerative changes have been shown to progress over a single season in collegiate football players.³⁴ Meniscal injuries are the most common knee injuries seen by orthopaedic surgeons, and meniscectomy is the most common surgical procedure performed on elite football athletes.^{2,7}

Meniscectomy may affect the length of an NFL career through a variety of mechanisms. Removing portions of unstable menisci during surgery significantly alters the load-bearing and shock absorption capabilities of the knee. For example, Baratz et al³ showed that partial meniscectomy resulted in a 65% increase in peak local contact stress and that complete removal of the medial meniscus resulted in an increase in peak intra-articular contact pressures of 235%. More recently, Lee et al²¹ reported a 24% increase in mean medial contact stress with 50% meniscectomy and 134% increase with total meniscectomy in human knees. Overall, approximately 50% of people with previous meniscal tears have radiographic evidence of osteoarthritis 10 to 20 years after injury.²² Degenerative changes have been reported in 38% of patients after arthroscopic partial medial meniscectomy and 24% of patients after arthroscopic partial lateral meniscectomy at an average follow-up of 4.5 years.³³ Scheller et al³⁵ found degenerative changes in approximately 80% of knees at a mean follow-up of 12.3 years after partial lateral meniscectomy. Altered biomechanics in the setting of high functional demands of professional football could hasten degenerative change in the previously injured knee and lead to a shorter, and perhaps lower performance, playing career.

Another important factor related to the detrimental effects of meniscectomy on NFL athletes is the large percentage of NFL athletes with a high body mass index (BMI). A recent study of one NFL team reported that the mean BMI by position was at least overweight (BMI, 25-30) for all positions, and linemen, running backs, linebackers, and tight ends were obese (BMI >30) or severely obese (BMI >35).²⁰ The same study showed that BMI has increased among offensive and defensive linemen since the 1970s. Harp and Hecht¹⁵ demonstrated that the percentage of NFL athletes classified as obese (BMI >30) was more than double the percentage found in age-matched controls (56% vs 23%). At least one study has shown that higher BMI correlates to worse outcomes in terms of Lysholm score after meniscectomy.³⁵ Meniscectomy, even arthroscopic,

should not be underestimated as a potential cause of significant long-term morbidity, despite the fact that arthroscopic partial meniscectomy is associated with relatively low postoperative morbidity and a quick return to competitive athletics after surgery. We believe that the morbidity of meniscectomy in this particular population is due to a combination of the often increased body weight in these athletes combined with the high loads on the knee in professional football, which may hasten the development of degenerative changes.

Clinically, Hede et al¹⁷ demonstrated a negative correlation between knee function and the amount of meniscus resected in a long-term study of patients undergoing partial or total meniscectomy. A couple of studies have looked specifically at the effects of meniscectomy on competitive athletes. Although one study with a mean follow-up of 3 years reported good to excellent results in 85% of 41 athletes who underwent arthroscopic partial lateral meniscectomy,³¹ Bonneux and Vandekerckhove⁶ reported only 64.5% good/excellent Lysholm scores and 48.4% good/excellent International Knee Documentation Committee (IKDC) scores at an average follow-up of 8 years after arthroscopic partial lateral meniscectomy in a cohort of 31 knees in competitive athletes.

While the length of career and number of games played were significantly shorter in athletes with prior meniscal surgery compared with controls, no significant difference was seen between athletes with prior ACL reconstruction versus controls. An ACL rupture was often considered to be a career-ending injury before the advent of reliable techniques for ACL reconstruction. Numerous authors have reported the rate of return to strenuous competitive sports after nonoperatively treated ACL injury to be less than 25%.^{16,29,36} This fact is not surprising because knee instability in the setting of ACL insufficiency predisposes an individual to develop meniscal tears and potentially articular cartilage injury and osteoarthritis,^{18,23,28} all of which could significantly limit the ability to compete in athletic activities.^{24,36} Reconstruction of the ACL not only restores knee stability; it can decrease the risk of developing future knee injury. Andersson et al¹ reported that ACL reconstruction lowered the rate of meniscal tear and surgery at 2 years after ligament reconstruction from 27% to 3%.

Advances in surgical techniques and rehabilitation protocols in recent decades have greatly improved the prognosis after ACL injury, with reported rates of return to prior level of sporting activity ranging from 41% to 92%.¹⁴ In the current study, athletes with ACL reconstructions before playing in the NFL were able to play an average of over 6 years at the highest level of competition, which was not significantly different from the length of time played by controls.

It is important to point out that this cohort represents a subset of ACL reconstructions for 2 reasons. First, because these athletes were able to play at least one game in the NFL, they represent the subset of successful ACL reconstructions, as those who underwent less successful surgery either do not make it to the combine or do not make the transition to play professional football. Previous studies have shown that athletes at the NFL combine with a history

of ACL reconstruction are less likely to play in the league than athletes without a history of ACL reconstruction.^{8,9} Therefore, it is important to emphasize that while athletes who have undergone successful ACL reconstruction appear to have good durability in professional football, not all ACL reconstructions will be successful in this cohort. Second, these were athletes who had an isolated ACL reconstruction without any meniscal injury that required surgical treatment. Meniscal injuries have long been known to be associated with ACL injuries.³⁰ Overall the prevalence of meniscal injuries in the setting of concomitant acute ACL injury has been reported to be between 40% and 80%.⁵ As we see in the final cohort, a combination of ACL reconstruction and meniscectomy may be particularly detrimental to a career in professional football.

The final group of athletes in this study includes those who had both an ACL reconstruction and a meniscectomy before playing in the NFL. Numerous authors have shown that acute ACL injury is more commonly associated with lateral meniscal tears than medial meniscal tears.^{4,32,37} In the absence of a normally functioning ACL, the medial meniscus is a secondary restraint to anterior tibial translation.³⁸ Metak and Scherer²⁶ showed that combined ACL and meniscal injury led to more severe damage to the knee joint than the sum of the single lesions in a sheep model. Meniscal injury and meniscectomy, particularly on the medial side, are associated with worse instability and more osteoarthritis after ACL injury and reconstruction.^{11-13,27} In athletes with combined ACL and meniscal injuries, the increased severity of the injury may lead to increased pain, disability, and more rapid progression of degenerative arthritis than in either injury alone, even after surgical treatment. Our analysis of athletes with combined ACL reconstruction and meniscectomy was very underpowered as we could only identify 11 athletes without other significant injuries and/or surgeries. Although there was no significant difference in length of career between these athletes and their controls, the survival analysis strongly suggests this is due to the small sample size. Furthermore, the athletes with a history of ACL reconstruction and meniscectomy face a shorter average career in terms of games started than athletes with isolated ACL or meniscal surgery and a strong trend toward fewer games played and years in the league.

The limitations of the current study include the fact that it is a retrospective review of data from a database rather than a prospective cohort or randomized trial. As such, the study can only suggest association and certainly does not demonstrate causation. Data on each surgery, for example, the type of graft used for ACL reconstruction, medial versus lateral meniscus, or amount of meniscus resected, as well as athlete BMI, are not available. Although every effort was made to match athletes with ACL reconstruction and/or meniscectomy to controls, it is possible that confounding variables exist between the 2 groups. Another limitation of the study is the sample size, in the isolated ACL cohort, and particularly the combined ACL and meniscectomy cohort. For the latter, it is likely that the trend seen in the decreased number of years in the league and number of games played would be

statistically significant between the experimental and control groups if the number of matched pairs were higher. Another significant limitation is that we have no data on the status of the chondral surfaces at the time of index surgery. There may be more initial chondral injuries in athletes with combined ACL and meniscal surgery, which may predispose them to shorter careers. There are no medical data from the athletes' NFL career and no data on the actual cause for the end of each athlete's career, medical or otherwise. Finally, the study did not look at meniscal repairs because there were not sufficient numbers available in the database of athletes who were evaluated at the NFL combine in the late 1980s and 1990s.

Despite the limitations, this is a well-matched case control study looking at the effect of previous knee surgery on the length of career in professional football athletes, and a number of important conclusions can be drawn from the current study. Anterior cruciate ligament reconstruction is a reliable surgical technique that enables professional football players to have similar length careers as their counterparts without ACL injury. Although meniscectomy does have a shorter recovery time than ACL reconstruction, these surgeries actually lead to a significantly shorter career with fewer games played in the long term. Consequently, repairing an injured meniscus or debriding the least amount of meniscus possible may be very important in terms of protecting an elite athlete's potential for a long and durable career. Finally, the combination of ACL reconstruction and meniscectomy is likely to shorten the career of a professional athlete more than either surgery in isolation. Further research is warranted to better understand how these injuries and surgeries affect an athlete's career and what can be done to improve the long-term outcome after treatment.

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