

Recurrent Anterior Cruciate Ligament Tears in the National Football League

A Case-Control Study

Casey R. Stuhlman,* MD, Christopher J. Owens,* MD, Eric M. Samuelson,* MD, Ryan P. Vermillion,[†] PT, ATC, Mark D. Shermansky,[†] ATC, Kevin B. King,[†] ATC, and Patrick M. Connor,^{*†‡§} MD

Investigation performed at OrthoCarolina, Charlotte, North Carolina, USA

Background: Anterior cruciate ligament (ACL) injuries are common in American football players. The risk of subsequent ACL reinjury to either the ipsilateral or the contralateral knee in National Football League (NFL) draftees with a history of successful ACL reconstruction before entering the NFL remains unknown.

Hypothesis: NFL athletes with a history of successful ACL reconstruction before being drafted will likely demonstrate increased risk of subsequent ACL injury when compared with a control cohort consisting of players of similar positions and draft class.

Study Design: Cohort study; Level of evidence, 3.

Methods: Detailed orthopaedic evaluations of NFL Combine participants from 2006 to 2012 were obtained to identify players entering the NFL draft with a history of successful ACL reconstruction. A control cohort was created in a 2:1 ratio, consisting of players matched by position and draft class.

Results: Of the 2016 players invited to the NFL Combine during the study period, 100 met the inclusion criteria. A total of 26 subsequent ACL reinjuries (12 ipsilateral, 14 contralateral) occurred in 25 players (25%) while playing in the NFL, with injuries occurring at a mean of 22.1 months after the NFL draft. In comparison, 18 of the 200 (9%) carefully matched cohort players without history of prior ACL injury sustained a new ACL injury during this time period ($P < .001$).

Conclusion: NFL athletes with a history of successful ACL reconstruction before being drafted into the NFL have a significantly higher rate of subsequent ACL reinjury while playing in the NFL when compared with a carefully matched cohort of players without a history of prior ACL injury.

Keywords: anterior cruciate ligament (ACL); National Football League (NFL); college football; injury epidemiology

Anterior cruciate ligament (ACL) injuries are quite common, with more than 200,000 injuries reported annually in the United States.³ Certain activities, such as American football, that require participants to frequently perform high-risk maneuvers such as aggressive deceleration, cutting, and pivoting, as well as to engage in collisions with other athletes, are known to be at particularly high risk for ACL injury.^{3,8}

Each year, the National Football League (NFL) Selection Committee holds an invitational event, the NFL Combine, where the most elite collegiate players from across the country are invited to undergo a thorough medical history and physical examination in preparation for the upcoming NFL draft.^{4,7} Team physicians and medical staff from each

NFL team evaluate the potential draftees, with particular attention paid to any previous injuries or surgeries as well as resultant time missed from practice or games because of these injuries. In a comprehensive review of NFL Combine data from 1987 to 2000, Bradley et al³ reported that 8% of all participants reported a history of ACL injury, 75% of whom had elected to undergo an ACL reconstructive procedure before their participation in the event. Between 1987 and 2000, ACL reconstruction was found to be the third most common surgical procedure reported at the NFL Combine.⁴ Later, Bradley et al² reported a similar study looking at data from the 2005 NFL Combine, where they found a 12% incidence of prior ACL injury reported by all participants and that 88% had elected to undergo a reconstructive procedure before the event. In their study, ACL reconstruction was found to be the second most commonly reported knee surgery, second only to arthroscopic partial meniscectomy.²

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While some studies have previously suggested that potential NFL draftees with a history of ACL reconstruction are less likely to eventually play in the NFL, others have suggested that there are no significant differences in career length or games played in those NFL players with or without a history of ACL reconstruction.^{5-7,11} Bradley et al³ reported the overall incidence of ACL injuries in the NFL between 1994 and 1998, reporting 209 new ACL injuries over this time period (~42 new ACL injuries per year). More recently, Dodson et al⁹ reported an incidence of 219 ACL injuries between 2010 and 2013 (~55 new ACL injuries per year). It is estimated that only 62% to 79% of NFL athletes who sustain an ACL injury are able to return to play for at least 1 game in the NFL.^{8,16,20} Further, Carey et al⁸ reported up to a one-third decrease in performance in NFL running backs and wide receivers who were able to successfully return to the NFL after ACL reconstruction. What is not currently known, however, is the risk of reinjury to a previously reconstructed ACL, or injury to the contralateral ACL, in NFL players who underwent a successful ACL reconstruction before entering the NFL.

The purpose of this study was to examine and quantify the risk of recurrent ipsilateral or new contralateral ACL injury in collegiate athletes who have a history of a successful ACL reconstruction before entering the NFL draft. In this study, a “successful” ACL reconstruction is defined by the ability of a player to return to full, unrestricted play after surgical reconstruction and rehabilitation to the point where the player was invited to the NFL Combine and ultimately drafted into the NFL. We hypothesized that NFL athletes who underwent a successful ACL reconstruction before being drafted into the league would demonstrate a higher incidence of subsequent ACL injury, involving either the ipsilateral or the contralateral knee, when compared with a carefully matched cohort without prior ACL injury.

METHODS

After approval from the NFL research committee, the NFL Health and Safety Panel, and our local institutional review board, the detailed orthopaedic evaluations of all collegiate athletes participating in the NFL Combine from 2006 to 2012 were obtained and reviewed. To be included in the study cohort, a player must have had a history of a successful ACL reconstruction before participating in the NFL Combine and then must have been drafted onto an NFL team in the subsequent NFL draft. Players who met the

inclusion criteria were then matched with a control cohort, at a 2:1 ratio, with matching based on the position played, the draft round selected, and the year drafted. In our control cohort, 2 control players were selected who played the same position as the study patient, with 1 control player being drafted immediately before and the other control player being drafted immediately after the player in the study cohort. For example, an offensive lineman with a history of an ACL reconstruction who participated in the NFL Combine and was subsequently selected in the NFL draft was matched with 2 other offensive linemen control draftees, both of whom had no history of ACL injury and were selected in the same NFL draft year. One of the control offensive linemen control players would have been drafted immediately before and the other offensive linemen control player drafted immediately after the study player, with all 3 players drafted in the same year.

Similar to a method validated in prior NFL studies,⁹ a comprehensive internet-based follow-up was carried out to identify all players included in the study (both study and control cohort players) who sustained a subsequent ACL injury. The sources for this internet-based search included comprehensive and publicly available NFL player registries, NFL news websites, NFL injury lists, and NFL player statistic websites.

The primary outcome measure of this study was subsequent ACL injury to either the ipsilateral or contralateral knee while playing in the NFL. The time from the NFL draft until the date of the subsequent ACL injury was also recorded.

The Fisher exact test was used to assess the incidence of subsequent ACL injuries between the index and control cohorts.

RESULTS

Between 2006 and 2012, there were 2016 players invited to the NFL Combine, of whom 184 players (9.1%) had previously undergone at least 1 successful ACL reconstruction. Of those players, 100 (54.3%) were drafted into the NFL. Within the study cohort, there were 26 subsequent ACL injuries in 25 NFL players (25%), as 1 player sustained injuries to both ACLs. Twelve players (12%) sustained a rerupture of their previous ACL reconstruction, and 14 players (14%) sustained a new injury to their contralateral knee (Figure 1). In the study cohort, the mean time from the NFL draft to the injury of either ACL was 22.1 ± 16.3 months. Specifically, the mean time to reinjury of a

[§]Address correspondence to Patrick M. Connor, MD, OrthoCarolina Sports Medicine Center, 1915 Randolph Road, Charlotte, NC 28207, USA (email: patrick.connor@orthocarolina.com).

*OrthoCarolina, Charlotte, North Carolina, USA.

†Carolina Panthers, Charlotte, North Carolina, USA.

‡Carolinas Medical Center, Department of Orthopaedic Surgery, Charlotte, North Carolina, USA.

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Ethical approval for this study was obtained from Carolinas HealthCare System Institutional Review Board (study No. 06-14-19E).

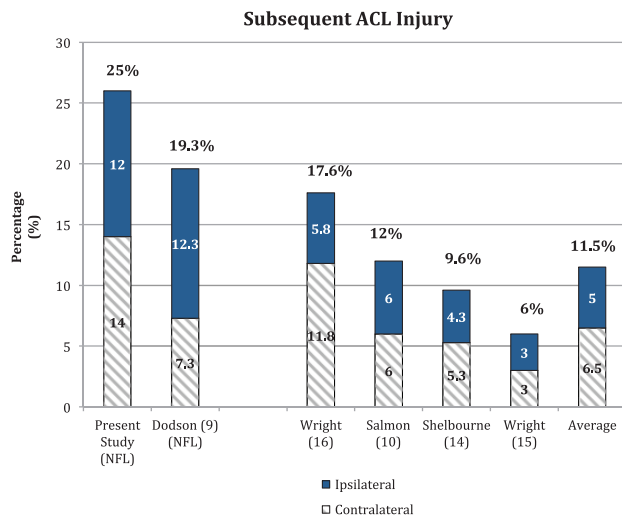


Figure 1. Rate of subsequent ACL injury to either knee after previous ACL reconstruction. ACL, anterior cruciate ligament; NFL, National Football League.

TABLE 1
NFL Draftees From 2006 to 2012 Who Have Undergone Previous ACL Reconstruction Compared With Case-Controlled NFL Draftees Who Have Not^a

Subsequent ACL Injuries		
Prior ACL Reconstruction (n = 100)	Controls (n = 200)	P
25%	9%	<.001

^aACL, anterior cruciate ligament; NFL, National Football League.

previous ACL reconstruction and the mean time to injury of a contralateral ACL were 23.1 ± 16.9 months and 17.6 ± 16.3 months from the NFL draft, respectively.

Within our matched control cohort, 18 (9%) of the 200 control players sustained an ACL injury during the same study period (Table 1).

DISCUSSION

As described in Figure 1, in the general (nonelite) athletic population, the risk of subsequent ACL injury has been previously described.^{13,17,18} Wright et al,¹⁸ in a cohort of patients with a mean age of 24 years (range, 11-54 years) and a minimum follow-up of 2 years, reported a 6% incidence of new ACL injuries, a 3% rerupture rate of the previously reconstructed ACL graft, and a 3% injury rate of the contralateral ACL. Similarly, Shelbourne et al¹⁷ prospectively evaluated more than 1400 ACL reconstructions in a cohort of patients with a mean age of 21.6 years (range, 14-58 years) and a minimum follow-up of 5 years. They reported a 9.6% rate of subsequent ACL injuries, with 4.3% involving the previously reconstructed ACL graft and 5.3% involving the contralateral knee.¹⁷ Moreover, Salmon

et al,¹³ in a retrospective case series with a mean age of 28 years (range, 14-62 years) and a mean follow-up of 5 years, reported a 12% incidence of subsequent ACL injuries, with 6% in the previously reconstructed knee and 6% in the contralateral knee. Wright et al¹⁹ published a systematic literature review consisting of 6 prospective studies with a minimum 5-year follow-up. The review yielded an ipsilateral ACL graft rupture rate ranging from 1.8% to 10.4%, with a pooled percentage of 5.8%, and a contralateral ACL injury rate ranging from 8.2% to 16.0%, with a pooled percentage of 11.8%.

The purpose of this study was to examine and quantify the risk of subsequent ACL reinjury (involving either the ipsilateral reconstructed knee or the contralateral native knee) in NFL players with a history of a successful ACL reconstruction before being drafted into the league. In a recent epidemiologic study, Dodson et al⁹ reported the incidence of ACL reinjury in NFL athletes, but because of the cross-sectional design and lack of a control cohort, they were unable to assess the risk of subsequent injury in this elite athlete population. To our knowledge, the current study is the first to specifically quantify the risk of subsequent ACL reinjury in NFL athletes with prior successful ACL reconstruction and compare that risk with that of a carefully matched control cohort.

The current study demonstrated the overall rate of subsequent ACL reinjury in NFL players involving either knee to be significantly higher than that of the carefully matched cohort of similar position players (25% vs 9%; *P* < .001). Further, the injuries were found to occur at a mean of 22.1 months after the NFL draft in which the players were selected.

The findings of this study have important implications, as previous studies have reported the negative impact these injuries can have on a player's ability to return to play in the NFL, as well as the subsequent level of performance for those who are able to successfully return.^{8,16} In a study evaluating ability to return to play in NFL athletes after ACL injury, Shah et al¹⁶ found that only 63% were able to return for at least 1 NFL game. Further, they reported that players required a mean of 10.8 months to return and missed on average the equivalent of 78% of an NFL season.¹⁶ Similarly, Carey et al⁸ found that only 79% of NFL running backs and wide receivers were able to return to play for at least 1 NFL game after an ACL injury. This resulted in a substantial amount of time away from competition, with players requiring a mean of 55.8 weeks to return from their injury and missing an average of 14.8 games.⁸ More recently, Yang et al²⁰ reported an observed 61.7% return-to-play rate in NFL athletes between 2010 and 2013 after ACL injury. The significant impact that an ACL injury has on an NFL athlete is further highlighted by the fact that the average NFL career length is estimated at only 3.5 years.¹⁶ These studies demonstrate the importance and potential impact of the present study to allow physicians to convey evidence-based data regarding the risk of subsequent ACL reinjury in collegiate players who have either a current ACL injury or a history of ACL injury and aspire to play in the NFL.

When the resultant risk of ACL reinjury as seen in the present study is compared with that of the general (non-elite) athletic patient population, the increased risk of reinjury in the elite NFL athlete becomes evident.¹² Compared with the study by Shelbourne et al,¹⁷ the present study demonstrates a more than 2 times increased risk of subsequent ACL injury in NFL players after prior successful ACL reconstruction and return to play (Figure 1). Further, compared with the pooled data from Wright et al,¹⁹ NFL athletes were 2.4 times more likely to retear a previously reconstructed ACL and 1.4 times more likely to injure the contralateral ACL compared with the general patient population.

This study did not purport to record the mechanism of ACL injury. However, it is well-reported in the literature that ACL injuries are largely noncontact injuries. The increased physicality of the NFL, compared with sporting activities within the general patient population, alone may not be enough to fully explain the drastically increased risk of subsequent ACL injuries seen within the NFL. One potential variable proposed within the current literature is the type of playing surface, with previous authors citing a potentially increased prevalence of ACL injury found on artificial turf playing surfaces. Hershman et al¹⁰ specifically examined the rate of ACL injury in NFL games played on artificial turf compared with natural grass playing surfaces. The authors reported a 66% higher rate of ACL injury in NFL games played on artificial turf ($P < .001$). More recently, Balazs et al¹ performed a systematic review of the current available literature looking at the relative risk of ACL injury on artificial turf versus natural grass. The review involved 4 studies (accounting for 753 ACL injuries) that specifically evaluated the playing surfaces for American football. Three of these studies reported an increased risk of ACL injury on artificial playing surfaces, while the remaining study found a decreased incidence of ACL injury on synthetic surfaces. While the exact mechanism of injury has not yet been borne out in the literature, extrinsic variables such as playing surfaces and equipment may be contributing to an observed increase in ACL injuries in the NFL athlete. Further research must be conducted to examine the contributing risk factors for ACL injury in the NFL athlete. Although this retrospective study did not have specific data regarding playing surfaces and ACL reinjury, our data may serve as a platform from which to compare both incidence and efficacy of future preventive measures.

One potential limitation of our study is that our cohort consisted of previous collegiate athletes who underwent a thorough medical and physical examination at the NFL Combine and were subsequently drafted into the NFL. Although unlikely, it is possible that some athletes with a history of ACL reconstruction were not invited to the NFL Combine but were subsequently selected in the NFL draft. These players would not have been captured and evaluated within our study protocol. Other potentially confounding variables that could not be accounted for in this study included the type of graft used for the primary ACL reconstruction, the number and severity of concurrent knee injuries, the team depth chart at a particular position, and the overall team success, which could influence decision making

during the season. Furthermore, the incidence of subsequent and new ACL injuries in these NFL athletes was determined by examining publicly available internet-based sources rather than a prospective study. This method has been utilized and substantiated in other studies regarding injuries in the NFL, as the NFL Injury Surveillance System requires individual player injuries to be de-identified.^{8,9,14-16} Last, this study involves a sampling of players from 2006 to 2012, which may not account for dynamic changes in ACL reconstruction techniques, rehabilitation protocols, return-to-play guidelines, playing surfaces, or footwear issues that may or may not be applicable to future NFL draftees.

CONCLUSION

Twenty-five percent of NFL draftees from 2006 to 2012 who had a previous successful ACL reconstruction sustained an additional ACL injury while playing in the NFL at a mean of 22.1 months after being drafted. This risk is compared with a 9% risk of ACL injury found in a carefully matched cohort of drafted NFL players of the same position, of the same NFL draft class, and without a history of ACL injury ($P < .001$). Further, the risk of subsequent ACL injury within the NFL population was found to be 4.7 times greater than that of the general population.^{13,17-19} The information from this study will allow team physicians to communicate evidence-based data to collegiate athletes with a history of a successful ACL reconstruction who aspire to play in the NFL regarding the risk of subsequent ACL injury.

Further, the findings of this study may serve to highlight the current need for additional focus on ACL injury prevention and may serve as a benchmark cohort from which to compare all future NFL ACL research endeavors.

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