Impact of Anterior Cruciate Ligament Reconstruction on NCAA FBS Football Players

Return to Play and Performance Vary by Position

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Background: Anterior cruciate ligament (ACL) injuries are devastating for college football players. Although the change in functional performance of National Collegiate Athletic Association (NCAA) football players after reconstruction has been shown to be negligible, studies have failed to analyze the statistical performance of these players upon their return.

Purpose/Hypothesis: The purpose of this study was to quantify the impact of ACL reconstruction on the statistical performance of collegiate football players. We hypothesized that statistical performance would vary by position and that running backs, wide receivers, and defensive backs, compared with preinjury and controls, would experience the largest decline in performance after returning from ACL reconstruction.

Study Design: Descriptive epidemiology study.

Methods: NCAA Football Bowl Subdivision (FBS) football players who experienced ACL tears between the years 2010 and 2015 were identified. The rates of return to play after surgery were determined for each position. Preinjury and postoperative performance statistics of each running back, receiver, defensive lineman, linebacker, and defensive back who met inclusion criteria were compared. A t-test analysis was used to compare the performance changes experienced by these players versus the performance changes of matched controls.

Results: A total of 349 players were identified. Only 63.64% of eligible offensive linemen returned to play. Upon return, running backs experienced significant performance decreases compared with controls in carries (mean ± SD, –2.4 ± 2.7 vs 2.8 ± 1.6; $P = .003$), yards (–12.3 ± 15.5 vs 13.8 ± 7.8; $P = .006$), and receptions (–0.22 ± 0.32 vs 0.32 ± 0.23; $P = .011$) per game. Receivers displayed significant performance decreases compared with controls in number of touchdowns (–0.019 ± 0.110 vs 0.18 ± 0.06; $P = .004$), receptions (–0.11 ± 0.79 vs 1.2 ± 0.4; $P = .004$), and yards (–3.2 ± 10.6 vs 18.6 ± 5.4; $P = .0009$) per game. Linebackers demonstrated less improvement than controls in tackles for loss (0.007 ± 0.115 vs 0.31 ± 0.11; $P = .0003$) and sacks (0.001 ± 0.061 vs 0.10 ± 0.06; $P = .026$).

Conclusion: Although offensive linemen were the least likely to return to play, running backs and receivers returned to play at a lower level of performance. The performance of defensive players was less affected by ACL reconstruction.

Keywords: ACL; ACL reconstruction; sports injury; athletic performance; football statistics; college football

Disruptions of the anterior cruciate ligament (ACL) are devastating injuries that require a prolonged recovery period that can significantly affect a collegiate athlete's career. Unfortunately, ACL tears are common in collegiate football players. Football has the highest incidence of ACL injuries among National Collegiate Athletic Association (NCAA) male sports.[1] Furthermore, at the National Football League (NFL) Scouting Combine, 5.9% of all procedures performed on former NCAA football players were ACL reconstructions (ACLRs).[1,2] Data suggest that the problem is growing: The incidence of ACL tears among college football players has increased in recent years.[1]

The impact of ACL injuries for these athletes is significant but has been incompletely quantified. Studies have demonstrated that up to 82% of college football players return to play with no significant difference in functional performance between these elite athletes and controls.[5,7] However, these studies failed to analyze the effect of ACLR

on the statistical performance of these players upon their return to NCAA football. Although studies assessing statistical performance of NFL players have been published,[4,6,8] notable differences, such as age, financial gain, skill level, and alterations in physical maturity, exist between NCAA and NFL athletes.

The purpose of this study was to quantify the impact of ACLR on the statistical performance of NCAA football players based on position. We hypothesized that the statistical performance of running backs, wide receivers, and defensive backs in the year of return to play (RTP) after ACLR would decline compared with preinjury and matched controls. The findings from this study will be useful in guiding performance expectations for NCAA football players after ACLR.

METHODS

We identified NCAA Football Bowl Subdivision (FBS) players who experienced ACL tears that required surgical intervention from the years 2010 to 2015. Team press releases and online media outlets such as www.ESPN.com were used to compile this list. For each of these identified players, position played at time of injury, seasonality of injury, and class standing were determined. For underclassmen, the ability to record a statistic following RTP after ACLR was ascertained. For positions such as offensive lineman, for which no statistic is commonly publicly reported, ability to return to game was counted. Owing to the source of information, graft type used for reconstruction was not identified, and neither prior injuries, prior procedures, nor concomitant injuries were used as exclusion criteria.

From the compiled list of players who returned to play, a smaller cohort was used for comparison of performance before injury and after ACLR. To be included in the performance comparison, an athlete had to play at least 4 games prior to the injury and at least 4 games for the same team after ACLR. The criterion of 4 games was selected because it represented roughly one-third of a team's games for a season. This requirement was made to allow for adequate statistical comparison. The statistics for this cohort were obtained from the career statistics database on www.NCAA.com. Offensive linemen and quarterbacks were excluded from analysis because the performance of offensive linemen lacked a published, measurable statistic and too few quarterbacks met inclusion criteria for adequate group performance comparison. A sufficient number of running backs, receivers, defensive linemen, linebackers, and defensive backs met inclusion criteria for performance comparison. Wide receivers and tight ends were grouped together as receivers.

The performance statistics for each of these players from the season before injury and the season after surgery were recorded and compared. Average game performance statistics included for running backs were carries, rushing yards, yards per carry, rushing touchdowns, receptions, receiving yards, and receiving touchdowns. For wide receivers, the number of receptions, receiving yards, and receiving touchdowns per game were included. Average game performance statistics included for all 3 defensive positions were total tackles, total tackles for loss, total sacks, pass breakups, interceptions, forced fumbles, and fumble recoveries.

A matched control group of players was created from members of the same conference (eg, Southeastern Conference, Big Ten Conference) who played during the same seasons and had similar preinjury performance. These athletes, just as the ACLR group, had to play at least 4 games for the same team during the seasons being compared. In addition, these players must have had no history of ACL injury during their NCAA playing career. The performance changes experienced by matched controls between seasons were compared with the performance changes of each ACLR group with t-test analysis. For these comparisons, P values less than .05 were considered significant.

RESULTS

A total of 349 players sustaining ACL tears between the years 2010 and 2015 were identified. As demonstrated in Table 1, the majority of ACL tears (67.33%) happened in the months of August, September, and October. Overall, 64 ACL tears occurred in seniors who did not return to play NCAA football, whereas the remaining 285 were sustained by underclassmen who had eligibility remaining after the injury. The percentage of these eligible players who returned to record a statistic during a game varied by position and ranged between 63.64% and 91.43%, as shown in Table 2.

Comparison of the performance of running backs before injury and after ACLR, as shown in Table 3, showed that these players had significant decreases in carries per game ($P = .003$), yards per game ($P = .006$), and receptions per game ($P = .011$) compared with controls. As demonstrated in Table 4, receivers displayed a significantly decreased number of touchdowns per game ($P = .004$) while also showing a significant decrease in receptions ($P = .004$) and receiving yards (.0009) per game compared with the improvement seen by controls.

Defensive linemen (Table 5) did not show any significantly different changes within any statistical categories when compared with controls. Linebackers (Table 6) did not

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TABLE 1
Seasonality of Anterior Cruciate Ligament Tears by Position[a]

	Offensive Lineman	Quarterback	Running Back	Wide Receiver/ Tight End	Defensive Lineman	Linebacker	Defensive Back	Total Tears, n (%)
August	10	5	11	14	13	12	16	81 (23.21)
September	10	6	13	13	9	13	10	74 (21.20)
October	10	5	14	13	12	11	15	80 (22.92)
November	2	5	9	7	7	7	8	45 (12.89)
December	1	0	2	1	0	0	0	4 (1.15)
January	0	0	0	0	0	0	1	1 (0.29)
Spring	6	3	4	12	4	4	5	38 (10.89)
Summer	0	0	4	6	1	2	1	14 (4.01)
Unknown	5	0	1	2	1	2	1	12 (3.44)
Total	44	24	58	68	47	51	57	349

[a]Data are reported as No. unless stated otherwise.

TABLE 2
Anterior Cruciate Ligament Tears and Return to Play by Position[a]

	Offensive Lineman	Quarterback	Running Back	Wide Receiver/ Tight End	Defensive Lineman	Linebacker	Defensive Back	Total Tears
Total	44	24	58	68	47	51	57	349
Seniors	11	3	13	8	12	8	9	64
Underclassmen	33	21	45	60	35	43	48	285
Players who recorded statistic after injury	21	19	37	53	32	39	41	242
Return to play, %	63.64	90.48	82.22	88.33	91.43	90.70	85.42	84.91
Players who met performance comparison criteria	NA	10	20	28	20	19	19	116

[a]Data are reported as No. unless stated otherwise. NA, not applicable.

TABLE 3
Performance of Running Backs Before Injury and After Surgery[a]

	ACLR Group (n = 20)		Control Group (n = 54)		
	Before Injury	After Surgery	Before Injury	After Surgery	P
Carries per game	11.51 ± 2.96	9.10 ± 2.71	7.06 ± 1.22	9.91 ± 1.54	**.003**
Yards per game	58.14 ± 15.23	45.88 ± 15.45	33.94 ± 6.11	47.74 ± 7.96	**.006**
Yards per carry	5.06 ± 0.36	4.58 ± 0.55	4.75 ± 0.28	4.76 ± 0.32	.13
Rushing touchdowns per game	0.58 ± 0.23	0.46 ± 0.17	0.37 ± 0.08	0.45 ± 0.09	.13
Receptions per game	1.27 ± 0.47	1.05 ± 0.40	0.80 ± 0.18	1.12 ± 0.22	**.011**
Receiving yards per game	11.2 ± 4.3	8.58 ± 3.28	6.41 ± 1.59	8.69 ± 1.84	.053
Receiving touchdowns per game	0.04 ± 0.05	0.03 ± 0.02	0.03 ± 0.017	0.05 ± 0.02	.50

[a]Data are reported as mean ± SD. Bolded P values indicate statistically significant between-group differences ($P < .05$). ACLR, anterior cruciate ligament reconstruction.

decline in any statistical category, but they did demonstrate less improvement after ACLR in total tackles for loss ($P = .0003$) and total sacks ($P = .026$) compared with the improvement seen by controls on a per-game basis. Defensive backs demonstrated a significant decrease in total tackles for loss ($P = .002$) and total sacks ($P = .043$) compared with controls on a per-game basis (Table 7).

DISCUSSION

The majority of NCAA football players returned to competition after undergoing ACLR. However, position played had a significant impact on performance in the year of RTP. Receivers, followed by running backs, demonstrated the greatest decreases in performance compared with preinjury

TABLE 4
Performance of Wide Receivers and Tight Ends Before Injury and After Surgery[a]

	ACLR Group (n = 28)		Control Group (n = 78)		
	Before Injury	After Surgery	Before Injury	After Surgery	P
Receptions per game	2.36 ± 0.59	2.29 ± 0.69	2.01 ± 0.34	3.25 ± 0.45	**.004**
Receiving yards per game	31.30 ± 8.98	28.63 ± 9.38	25.58 ± 4.40	44.23 ± 6.30	**.0009**
Receiving touchdowns per game	0.26 ± 0.09	0.25 ± 0.11	0.17 ± 0.04	0.35 ± 0.07	**.004**

[a]Data are reported as mean ± SD. Bolded *P* values indicate statistically significant between-group differences (*P* < .05). ACLR, anterior cruciate ligament reconstruction.

TABLE 5
Performance of Defensive Linemen Before Injury and After Surgery[a]

	ACLR Group (n = 20)		Control Group (n = 54)		
	Before Injury	After Surgery	Before Injury	After Surgery	P
Interceptions per game	0.00 ± 0.01	0.00 ± 0.00	0.00 ± 0.01	0.01 ± 0.01	.85
Fumble recoveries per game	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	.32
Forced fumbles per game	0.06 ± 0.03	0.06 ± 0.04	0.03 ± 0.02	0.00 ± 0.00	.22
Total tackles per game	2.39 ± 0.49	2.63 ± 0.45	2.11 ± 0.27	2.86 ± 0.33	.11
Total tackles for loss per game	0.41 ± 0.11	0.50 ± 0.16	0.38 ± 0.09	0.52 ± 0.11	.64
Total sacks per game	0.20 ± 0.08	0.22 ± 0.09	0.21 ± 0.06	0.26 ± 0.07	.50
Pass breakups per game	0.07 ± 0.05	0.07 ± 0.04	0.08 ± 0.03	0.09 ± 0.03	.88

[a]Data are reported as mean ± SD. ACLR, anterior cruciate ligament reconstruction.

TABLE 6
Performance of Linebackers Before Injury and After Surgery[a]

	ACLR Group (n = 19)		Control Group (n = 54)		
	Before Injury	After Surgery	Before Injury	After Surgery	P
Interceptions per game	0.00 ± 0.01	0.03 ± 0.03	0.02 ± 0.01	0.04 ± 0.02	.19
Fumble recoveries per game	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	.96
Forced fumbles per game	0.05 ± 0.04	0.08 ± 0.05	0.05 ± 0.02	0.08 ± 0.02	.99
Total tackles per game	3.36 ± 0.91	4.71 ± 1.46	3.80 ± 0.65	5.71 ± 0.55	.18
Total tackles for loss per game	0.35 ± 0.15	0.40 ± 0.16	0.38 ± 0.09	0.68 ± 0.10	**.0003**
Total sacks per game	0.10 ± 0.07	0.10 ± 0.05	0.16 ± 0.05	0.26 ± 0.06	**.026**
Pass breakups per game	0.06 ± 0.04	0.11 ± 0.08	0.10 ± 0.03	0.16 ± 0.03	.24

[a]Data are reported as mean ± SD. Bolded *P* values indicate statistically significant between-group differences (*P* < .05). ACLR, anterior cruciate ligament reconstruction.

status and with controls. Defensive players were able to return to performance standards closer to preinjury and controls.

Overall, 84.91% of NCAA football players returned to play. All positions with the exception of offensive linemen had excellent RTP percentages, which ranged from 82.22% to 91.43%. These are similar to RTP percentages determined in previous studies of NCAA football players.[5] Offensive linemen, however, returned to play in a game only 63.64% of the time; this finding is drastically lower than any other position. However, these data coincide with data from similar studies in NFL players, which demonstrated an overall RTP rate of 63%[9] and a higher RTP rate for receivers and running backs (79%)[4] and defensive players

(74%).[8] The relatively low rate of RTP among offensive linemen was surprising, considering that defensive linemen had the highest RTP percentage in our study—91.43%. We are uncertain of the factors contributing to the lower rate of RTP among offensive linemen, but we speculate that these linemen may have sustained a higher rate of contact injuries that resulted in more complex injuries. Unfortunately, we did not have access to operative reports to confirm or refute this hypothesis. In addition, we speculate that the high body mass index of offensive linemen, which is typically the highest of all positions, may have contributed to the low RTP as well. Further research is necessary to explore this potential secondary finding and any potential causes.

TABLE 7
Performance of Defensive Backs Before Injury and After Surgery[a]

	ACLR Group (n = 19)		Control Group (n = 54)		
	Before Injury	After Surgery	Before Injury	After Surgery	P
Interceptions per game	0.11 ± 0.06	0.12 ± 0.07	0.09 ± 0.03	0.18 ± 0.05	.14
Fumble recoveries per game	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	.55
Forced fumbles per game	0.03 ± 0.03	0.02 ± 0.02	0.03 ± 0.02	0.05 ± 0.02	.29
Total tackles per game	2.92 ± 0.83	2.96 ± 0.67	2.80 ± 0.49	3.92 ± 0.38	.070
Total tackles for loss per game	0.14 ± 0.08	0.07 ± 0.04	0.12 ± 0.03	0.22 ± 0.04	**.002**
Total sacks per game	0.03 ± 0.03	0.01 ± 0.01	0.02 ± 0.01	0.44 ± 0.07	**.043**
Pass breakups per game	0.21 ± 0.11	0.28 ± 0.11	0.25 ± 0.07	0.44 ± 0.07	.17

[a]Data are reported as mean ± SD. Bolded P values indicate statistically significant between-group differences (P < .05). ACLR, anterior cruciate ligament reconstruction.

As with other studies involving football players,[4,8,9] our study demonstrated that among NCAA FBS players who returned to play after ACLR, performance varied depending upon the position played. Given normal progression of college athletes, most NCAA football players would be expected to improve on their performance from year to year as they continue to develop both physically and mentally. The majority of performance statistical outcomes among the control groups demonstrated this progression. However, after ACLR, running backs and wide receivers experienced performance decreases that were significantly different from controls in key categories. Running backs who returned to play after ACLR gained fewer rushing yards per game and had fewer carries and receptions per game than preinjury statistics, whereas controls without a known ACL tear improved in these categories. The receivers who returned after ACLR had a statistical decrease in all categories studied (receptions, receiving yards, and touchdowns per game) compared with preinjury levels and controls, who improved in all 3 categories during the same time period. Our findings were similar to those of Carey et al,[4] who reported that NFL running backs and receivers experience a statistical performance decline of one-third compared with preinjury levels.

Defensive players had significant, although less marked, differences in their performance categories compared with controls. The most substantial was the significant difference in tackles for loss and sacks experienced by linebackers and defensive backs after ACLR compared with controls. Although making plays behind the line of scrimmage is often essential for linebackers, these statistics are usually not as meaningful for defensive backs, who are typically judged by ability to make open-field tackles, deflect passes, and create turnovers (forced fumbles, fumble recoveries, and interceptions). In these categories (tackles, forced fumbles, fumble recoveries, interceptions, and pass break-ups), defensive backs demonstrated no significant differences compared with controls. Defensive linemen did not differ in any statistical category compared with controls. A previous study of 23 NFL defensive players who returned to play after ACLR showed declines in statistical performance, but the study lacked power to analyze differences as a function of position.[8]

Interestingly, in our study, running backs and, to a lesser degree, receivers who underwent ACLR performed at a higher preinjury level than controls. This relationship was also noted by Carey et al,[4] who postulated that running backs and receivers who experienced ACL tears may be more likely to sustain these injuries because (1) "they compete in more plays per game, carry the ball longer for each play, and attract more defensive attention" and (2) the qualities that contribute to improved performance (instantaneous decelerations and explosive pivoting and cutting) may also be risk factors for ACL disruptions.[4]

The current study does have its limitations. The ACL injuries were identified from publicly available media and team reports rather than official medical records, so concomitant injuries, reconstruction techniques, and the graft used are not known. The impact of concomitant injuries is not quite clear since no studies have had an adequate sample size to quantify this impact at the professional or collegiate level. Concomitant injuries have been shown to affect the career longevity of professional football players and RTP percentages but have been shown to have no impact on RTP for college football players.[3,5,9] Although the exact reconstruction technique and graft used were not known, patellar tendon autografts are used by the vast majority of college orthopaedic surgeons.[5] It is also important to note that although the data set compiled is quite substantial, not all players who underwent ACLR between the years 2010 and 2015 may have been captured by our search because some NCAA institutions do not specify the nature of injuries. We also recognize that there may have been false reports; however, each player injury reported on a national site was verified through use of a local news report or media press release.

With regard to the performance analysis, our performance cohort focused on the more skilled FBS players, whereas those who did not play in 4 games prior to injury, such as redshirts and practice players, were not included. Only the first season after return was analyzed, whereas the career longevity and performance of these players were not. Finally, we acknowledge that there are a variety of reasons why a player might not return to play after ACLR, such as academic ineligibility. Although academic eligibility is not a concern at the NFL level, most studies, including previous studies of NCAA athletes returning to play after

ACLR, have not quantified or excluded players because of other non–knee related issues that prohibited RTP.[5,7-9] Therefore, to provide a meaningful comparison, we did not exclude these outside factors. Despite the limitations, this study has the largest number of NCAA FBS football athletes studied and is the first to analyze the statistical performance in this population. In addition, the case-control design is similar to previous studies conducted on NFL athletes[4,8] and can be used for comparison between NCAA and NFL players.

CONCLUSION

The results of this study indicate that the RTP rate among NCAA football players is higher than that of NFL counterparts but, like NFL, varies by position. Among NCAA FBS players, offensive linemen are the least likely to return to play. Similar to NFL players, NCAA running backs and receivers return to play at a lower level of performance compared with their preinjury status and compared with controls. The performance of defensive players, especially linemen, is less affected by ACLR.

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