



ELBOW

Return to play and performance after surgical repair of distal biceps tendon ruptures in National Football League athletes



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Background: The purpose of this study was to determine whether surgical repair of distal biceps tendon ruptures in professional football players would lead to a decrease in postinjury performance when compared to preinjury performance and control-matched peers. We also sought to define return to sport, postinjury career length, and games played per season in National Football League players following surgical repair of distal biceps tendon ruptures.

Methods: Data for National Football League players who underwent surgical repair of distal biceps tendon ruptures during a 20-year time period were collected. A total of 25 cases in 22 players were included in the analysis. Matched controls based on player position, age, experience, and performance statistics were identified. Performance scores for cases and controls were calculated using a standardized scoring system specific to player position.

Results: Of the 25 cases, 21 (84%) were able to return to sport in the National Football League. The overall 1-year survival rate of return to play in players undergoing surgical repair of distal biceps tendon ruptures was 76% and overall 2-year survival was 56%. Players who underwent surgical repair of distal biceps tendon ruptures had significantly shorter postinjury career lengths and played fewer games per season postinjury than matched controls. There was no significant difference by position in postinjury performance scores when compared to matched controls.

Conclusion: National Football League players undergoing surgical repair of distal biceps tendon ruptures have a high rate of return to sport, though many retire within the next few seasons following surgery. Players who do return to competition can be expected to perform at a level comparable to their peers.

Level of Evidence: Level IV; Case Series; Treatment Study

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Distal biceps tendon ruptures account for 3%-10% of all biceps injuries with an incidence of 1.2 per 100,000 persons per year.^{14,17} The vast majority of these injuries occur in the

dominant extremity of men, with more than half occurring in patients in their 30s. In active patients, surgical repair is recommended to restore elbow flexion strength (30% improvement), supination strength (40% improvement), and upper extremity endurance.³

National Football League (NFL) players are routinely exposed to high physical demands, predisposing these athletes to higher injury rates than any other sport.⁴ Surgical treatment of various upper extremity injuries, such as

Given the public nature of the data, this study was exempt from institutional review board approval and did not require informed consent.

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forearm and clavicle fracture repair, can negatively impact return to sport, postinjury performance, and overall career length in NFL players.^{11,15} However, there is a paucity of literature regarding return to play and performance after distal biceps repair, and to date, there are no known studies examining these outcomes in NFL athletes.

The purpose of this study was to evaluate player performance before and after injury in NFL players who underwent distal biceps tendon repair while controlling for the performance of these athletes with uninjured, matched controls. We also aimed to define return to sport, postinjury career length, and games played per season in NFL players following surgical repair of distal biceps tendon ruptures. We hypothesized that NFL players who underwent surgical repair of the distal biceps would have a significantly shorter postinjury career length and fewer games played per season compared with matched controls. Furthermore, we hypothesized that surgical repair of the distal biceps would lead to a decrease in performance when compared to the player's preinjury performance and control-matched peers, in those athletes that were able to return to play.

Materials and methods

This case series contained NFL players who underwent surgical repair of distal biceps tendon ruptures during a 20-year time period between the 1998 and 2017 seasons. Subjects were identified using a comprehensive online injury database (www.prosportstransactions.com) cross-referenced with team press releases, online injury reports, and player profiles (www.nfl.com and www.pro-football-reference.com). This methodology has been validated in multiple studies across multiple sports.^{1,2,4,5,6,9-11,13,15,16}

Twenty-eight cases of distal biceps tendon ruptures in 26 players were initially identified. All cases were treated with surgery. Players were included for analysis if they had played in at least 1 NFL season before the index injury season. Of the 28 cases, 3 were in players in their first year in the league and were excluded because of lack of performance data prior to the injury. The remaining 25 players had complete statistical performance data and were included in the study cohort.

A one-to-one matched control group was selected based on similarity scores provided by a comprehensive online database (www.pro-football-reference.com). These scores identify players whose careers are most similar according to performance data and seasons of play. Players in the control cohort were additionally matched according to position, and all efforts were made to select controls without a significant injury history. A cohort group was used for comparison to minimize potential confounding variables inherent in the career path of NFL players as their performance may be affected by increasing age and experience. Controls were matched both to the age of the study subject (± 1 year) and career experience (± 1 year) at the time of surgery. For subjects, the index injury season was defined as the season in which the player underwent surgery. Matched controls were assigned an index date or time, which matched the injured subject's surgery date relative to their career experience. For example, if a 28-year-old player underwent surgery 3 years into his career, a

matched control was chosen who was also 28 years old at an index date 3 years into his career.

Return to sport data were collected for all players included in the analysis. Return to sport was defined as play in any single NFL game following surgery. A player did not return to sport if he did not play in any NFL game after surgery. A Kaplan-Meier survivorship curve with final game played as the endpoint was created postinjury for cases and postindex for controls.

Demographic data, including player age, position, career experience, and date of surgery, were recorded. Performance data, from regular season games only, were recorded for players before and after surgery using www.pro-football-reference.com. Performance statistics were also recorded for controls pre- and post-index. Each statistical category was divided by games played to account for discrepancies in number of games played per season. A player's performance score was then calculated using a previously published and standardized scoring system specific to player position.^{6,10,11,15,16} (Fig. 1). Statistics per game were used to calculate each performance score per game. Positions without previously defined performance scores (offensive lineman) were excluded from performance score analysis. This methodology has been previously published in multiple studies.^{6,10-12,15,16} Post-injury performance scores, games per season, and career lengths for subjects were compared to postindex performance scores, games per season, and career lengths for controls relative to their index date.

Comparisons were made using paired samples Student *t* tests with significance set at $P < .05$.

Results

Twenty-five surgeries in 22 players were analyzed. Average age at time of injury was 28 ± 3.0 years and mean NFL career experience at time of surgery was 6.0 ± 2.8 years. Three players tore their contralateral distal biceps tendon following return to sport and required surgery. They were counted as 2 cases each. Defensive linemen accounted for the most cases (11, 44%), followed by offensive linemen (6, 24%). Together, offensive and defensive linemen accounted for 68% of cases. Defensive players accounted for 76% of cases, with the only offensive players sustaining injury being offensive lineman. There were no cases involving offensive skill position players.

Twenty-one cases (84%) were able to return to sport in the NFL (Table I). Overall, 83.3% of offensive players and 84.2% of defensive players were able to return to sport. Linebackers had the lowest rate of return to sport (66.7%), although only 3 players played this position, whereas all defensive backs were able to return to sport (100%). Mean number of days to return to sport was 321 ± 45 . No players were able to return to play during the same season as injury. One player was injured in the offseason and was able to return to play for the start of the following season (236 days postinjury). The overall 1-year survival rate of return to play in players undergoing surgical repair of distal biceps

$$(\text{Tackles}) + (\text{Assists} / 2) + (\text{Sacks} \times 4) + (\text{Passes Defended}) + (\text{Interceptions} \times 5) + (\text{Touchdowns} \times 6) + (\text{Forced Fumbles} \times 3) + (\text{Fumbles Recovered} \times 2) + (\text{Safeties} \times 2)$$

Figure 1 Player performance score formula for defensive players. Statistics per game were used to calculate each performance score per game using a previously published and standardized scoring system specific to player position.

Position	Surgeries (n)	RTS (n)	RTS (%)	Days to RTS (mean \pm SD)
DL	11	9	81.8	324 \pm 48.1
LB	3	2	66.7	340 \pm 27.6
DB	5	5	100	325 \pm 62.2
OL	6	5	83.3	318 \pm 25.1
Total	25	21	84	321 \pm 45.2

DL, defensive linemen; LB, linebacker; DB, defensive back; OL, offensive lineman; RTS, return to sport; SD, standard deviation.

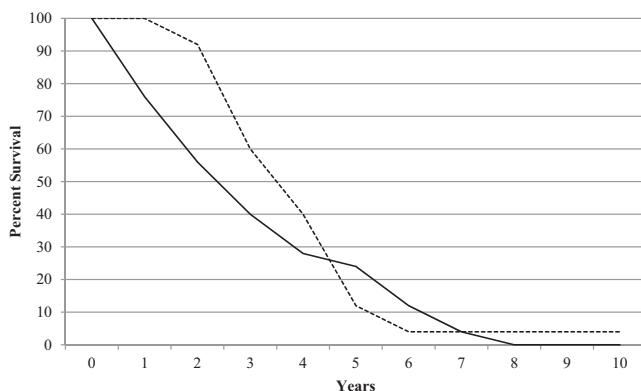


Figure 2 Kaplan-Meier survival curve for cases (solid) and controls (dashed). Zero represents year of surgery for cases and index year for controls.

tendon rupture was 76% and the overall 2-year survival was 56% (Fig. 2).

Comparison of the case cohort with the control cohort revealed that the controls were well matched preindex as there was no significant difference in age, career experience, games per season, or performance scores (Tables II and III). Players in the control group (3.4 ± 2.0 years) had a significantly longer career length postindex than players who underwent surgical treatment of distal biceps tendon ruptures (2.8 ± 2.0 years) postinjury ($P = .049$) (Table IV). Defensive backs who underwent surgical repair of the distal biceps had a significantly shorter career length postinjury compared with controls postindex ($P = .02$) (Table IV). Players in the control group (13 ± 2.3) played significantly more games per season postindex than players who underwent surgical treatment of distal biceps ruptures (11 ± 4.0) postinjury, over the duration of their careers ($P = .02$) (Table IV). There was no difference in games per season postinjury or postindex by position (Table IV). There was no significant

difference by position in postinjury performance scores when compared to postindex matched controls (Table V).

Discussion

Distal biceps tendon ruptures occur secondary to an excessive eccentric tension as the arm is forced from a flexed to extended position.¹⁴ Patients typically describe a painful “pop” at the time of injury with proximal retraction of the biceps muscle belly and weakness with forearm supination.¹⁷ The unique physical demands placed on NFL athletes during game play and practice make these athletes prone to this injury. Surgical repair is recommended to allow for the best chance at a full return to play and performance.

There is a paucity of data regarding return to play and performance in athletes in any sport. One prior study investigated athletes undergoing repair of distal biceps tendon ruptures.⁷ This case series analyzed just 10 athletes across a range of sports (8 of which were categorized as weight lifters or body builders) and their level of competition was poorly defined. The authors of this study reported that “all patients returned to unlimited activities and experienced no pain.” However, postinjury performance was not analyzed. No other studies have published on return to competitive athletic performance following surgical repair of distal biceps tears. Furthermore, there are no published data assessing the effect of surgical repair of distal biceps tears on future athletic performance.

We found that 84% of NFL players undergoing surgical repair of distal biceps tendon ruptures were able to return to sport (defined as play in a single NFL game). This return to sport rate is lower than that reported following other upper extremity surgeries in NFL players, including forearm fracture repair (91.7%), clavicle fracture repair (94.1%), and thumb UCL repair (95.7%).^{11,15,16} No players were able to return during the same season of injury.

Table II Age and career experience by position at time of surgery (cases) and index time (controls)

Position	n	Age, yr (mean \pm SD)			Career experience, yr (mean \pm SD)		
		Cases	Controls	<i>P</i> value	Cases	Controls	<i>P</i> value
DL	9	27 \pm 3.1	27 \pm 3.1	.35	5 \pm 3.0	5 \pm 3.0	.35
LB	2	28 \pm 2.1	27 \pm 1.4	.5	6 \pm 2.8	6 \pm 2.8	>.99
DB	5	26 \pm 2.2	26 \pm 2.9	.62	5 \pm 1.9	4 \pm 2.1	.37
OL	5	31 \pm 2.3	30 \pm 2.2	.18	8 \pm 2.4	8 \pm 2.4	>.99
Total	21	28 \pm 3.0	28 \pm 3.0	>.99	6 \pm 2.8	6 \pm 2.9	.16

DL, defensive linemen; LB, linebacker; DB, defensive back; OL, offensive lineman; SD, standard deviation.

Table III Games per season and performance score per game by position at time of surgery (cases) and index time (controls)

Position	n	Games per season (mean \pm SD)			Performance score per game (mean \pm SD)		
		Cases	Controls	<i>P</i> value	Cases	Controls	<i>P</i> value
DL	9	12 \pm 2.1	13 \pm 2.1	.40	3.2 \pm 0.9	3.2 \pm 1.3	.99
LB	2	13 \pm 1.7	16 \pm 0.4	.31	6.2 \pm 0.9	5.5 \pm 1.9	.78
DB	5	11 \pm 4.0	12 \pm 2.1	.81	5.8 \pm 1.2	5.9 \pm 1.7	.81
OL	5	13 \pm 1.2	14 \pm 1.4	.24	—	—	—
Total	21	12 \pm 2.4	13 \pm 2.1	.14	—	—	—

DL, defensive linemen; LB, linebacker; DB, defensive back; OL, offensive lineman; SD, standard deviation.

Furthermore, in our study, a large number of players retired within the next few seasons following surgery. One-year survival in players undergoing surgical repair of distal biceps tears was 76%. At 2 years postinjury, just 56% of players undergoing surgical repair of distal biceps tears remain in the NFL.

Our study shows that return to play at any performance level is not guaranteed, as only 84% of the players returned for at least 1 game. We also confirmed our second hypothesis, as players who underwent surgical repair of distal biceps tendon ruptures had significantly shorter postinjury career lengths compared with matched controls. Furthermore, players who underwent surgical repair of distal biceps tendon ruptures played significantly fewer games per season postinjury than matched controls. There was no significant difference in postinjury performance compared with preinjury, and no significant difference in postinjury performance compared with matched controls.

We found that cases had a statistically significantly shorter career length following surgery (2.8 years) when compared with controls (3.4 years), but it is unlikely that this difference is clinically significant. The average career length for all NFL players overall is 3.3 years.⁸ Mean experience for players undergoing surgical repair of distal biceps tendon ruptures in our study was 6 years, well exceeding the overall career length average. Given that the mean career experience at time of injury for players in our study well exceeded the average career length of NFL players overall, it is likely that these players were already toward the end of their playing careers at the time of injury.

Players undergoing surgical repair of distal biceps tendon ruptures did play significantly fewer games per season postsurgery (11 games per season) compared to matched controls (13 games per season). In our study, there was no significant difference in postinjury performance for cases compared with matched controls. Our data provide valuable information regarding expectations for postinjury return to sport. Players undergoing distal biceps tendon repair who are able to return to sport can expect to perform at a level comparable to their preinjury performance. Based on our data, a player who has this injury and undergoes surgery may play in fewer games per season but is unlikely to have a shorter postinjury career than their peers.

In our study, defensive linemen accounted for the largest proportion of players undergoing surgical repair of distal biceps tears (11/25). Defensive players overall represented 76% of all cases. We propose that the higher rate of injury among defensive players, and defensive linemen in particular, is due to the fact that their arm is placed in a position at risk for an eccentric contraction of the biceps as the extremity is forced from a flexed to extended position, particularly when fighting through a block or making a tackle. We believe offensive linemen to be at increased risk for similar reasons. Of note, offensive linemen were the only players on the offensive side of the ball to sustain this injury.

There are several significant limitations to our study that deserve attention. First, using publicly available data to identify distal biceps tendon surgical repair is prone to selection, reporting, and observer bias. The use of publicly available data limits the capability to define injury severity

Table IV Games per season and career length by position postinjury (cases) and postindex (controls).

Position	n	Games per season (mean \pm SD)			Career length, yr (mean \pm SD)		
		Cases	Controls	<i>P</i> value	Cases	Controls	<i>P</i> value
DL	9	14 \pm 1.6	15 \pm 1.2	.25	2.9 \pm 2.6	3.9 \pm 3.0	.09
LB	2	10 \pm 2.0	13 \pm 3.8	.56	4.5 \pm 2.1	3.5 \pm 0.7	.5
DB	5	8 \pm 5.8	11 \pm 2.1	.17	2.0 \pm 1.2	2.8 \pm 0.8	.02*
OL	5	11 \pm 3.0	13 \pm 2.6	.32	2.6 \pm 1.7	3.2 \pm 0.8	.5
Total	21	11 \pm 4.0	13 \pm 2.3	.02*	2.8 \pm 2.0	3.4 \pm 2.0	.049*

DL, defensive lineman; LB, linebacker; DB, defensive back; OL, offensive lineman; SD, standard deviation.

* statistical significance.

Table V Performance scores per game and pre- and postinjury for cases and postindex for matched controls

Position	n	Performance score per game (mean \pm SD)				
		Cases			Controls	
		Preinjury	Postinjury	<i>P</i> value	Postindex	<i>P</i> value
DL	9	3.2 \pm 0.9	2.4 \pm 0.9	.06	2.8 \pm 0.9	.34
LB	2	6.2 \pm 0.85	5.2 \pm 2.2	.48	5.3 \pm 1.4	.90
DB	5	5.8 \pm 1.2	4.7 \pm 3.3	.45	5.7 \pm 0.6	.48

DL, defensive lineman; LB, linebacker; DB, defensive back; SD, standard deviation.

and the specific surgical procedure and technique performed. Details such as past medical and surgical history, surgical technique, and rehabilitation protocols were not available for collection. Additionally, the sample analyzed in this study may underrepresent the true number of cases that occurred over this 20-year period because of the nature of data collection using publicly available information. The time to return to sport reported in this study is largely dependent on the point in the season at which the injury occurred, making it difficult to draw conclusions from this information. We could not control for potential cofounders including concomitant injuries, trades, personal obligations, coaching changes, or changes in offensive and defensive systems that may have impacted both the case and control cohorts. We must stress that these factors likely confound the findings of decreased postinjury career length and games per season reported in our study, and these results should be interpreted with caution. Furthermore, we could not control for compliance with treatment and rehabilitation protocols. Additional limitations include incomplete follow-up and career length analysis for players still in the NFL. Lastly, we are unable to evaluate offensive linemen with performance scoring.

Conclusions

In this study, we aimed to determine whether surgical repair of distal biceps tendon ruptures in NFL

players would lead to a decrease in postinjury performance and to define return to sport, postinjury career length, and games played per season following injury. In our analysis, 84% of NFL players were able to return to sport following distal biceps tendon surgical repair. Surgical repair of the distal biceps did not lead to a decrease in performance when compared to the player's preinjury performance and control-matched peers, in those athletes that were able to return to play. NFL players who underwent surgical repair of the distal biceps tendon played fewer games per season compared with matched controls, although this finding is likely influenced by a number of factors we could not control for. Players sustaining this injury are unlikely to have a clinically significant decrease in their postinjury career length relative to their peers.

Disclaimer

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