Performance and Return to Sport After Forearm Fracture Open Reduction and Internal Fixation in National Football League Players

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Abstract

Background: Forearm fractures are one of the most common upper extremity injuries requiring surgery in professional football. Surgical fixation of forearm fractures may speed recovery and decrease games missed in football. **Methods:** National Football League (NFL) players who underwent forearm fracture open reduction and internal fixation (ORIF) were identified. Matched controls (position, age, experience, performance) were identified. Control and case performance scores were calculated using a standardized scoring system. Return to sport (RTS) in the NFL was defined as playing in a single NFL game after surgery. Comparisons between case and control groups and preoperative and postoperative time points were made using paired-samples Student *t* tests. **Results:** Thirty-six surgeries were analyzed following ORIF. Thirty-three were able to RTS in the NFL at an average of 152.1 ± 129.8 days. Controls had a significantly longer NFL career ($P < .001$) and played in significantly more games per season ($P = .026$) than players who underwent surgery. There was a significant ($P = .013$) decrease in games/season for DBs following surgery. No significant difference was seen in postoperative performance scores compared with preoperative scores among any positions, nor in postoperative and postindex performance scores compared with matched controls. **Conclusion:** There is a high rate of RTS in the NFL following forearm fracture ORIF. Following surgery, players' careers were 1 year shorter and played nearly 2 fewer games per season than matched controls. Games per season following surgery was significantly lower among DBs when compared with presurgery. Postoperative performance scores were not significantly different compared with preoperative and when compared with matched controls.

Keywords: forearm fracture, open reduction internal fixation, ORIF, NFL upper extremity injury, sports injuries

Introduction

Forearm fractures are one of the most common upper extremity injuries in both contact and noncontact sports.^{12,13} These injuries are a source of significant morbidity with an estimated incidence of 643 087 annual cases per year in the United States.⁸ This incidence is likely to rise secondary to an increase in athletic participation nationwide.

Forearm fractures result from either direct trauma or a fall on an outstretched arm. Compared with beginners, elite-level athletes are more likely to sustain complex and intra-articular fracture patterns requiring operative intervention.¹⁶ This trend continues in the National Football League (NFL) where the physical demands expose athletes to a higher rate of injuries than any other sport.²

The forearm is the link between the elbow and wrist that provides a stable position of the hand and wrist in activities

of power and rotational movements. This relationship is important for both skill (throwing, catching) and nonskill positions (blocking, tackling) in football.⁵ Fractures of the forearm affect the radius and ulna and can often involve their proximal and distal articulations. Nonoperative cast stabilization is used in nondisplaced fracture patterns with operative fixation such as plate, intramedullary, or external fixation reserved for displaced fractures depending on the fracture pattern.¹³

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Figure 1. Flowchart illustrating application of exclusion criteria.

Note. ORIF = open reduction and internal fixation; NFL = National Football League.

Many elite athletes elect for surgical fixation of their forearm fracture to speed recovery and decrease games missed.⁵ However, recent studies demonstrated that various orthopedic procedures, such as ankle fracture open reduction and internal fixation (ORIF), Achilles tendon repair, and patella tendon repair, can have a negative effect on postoperative performance, return to sport (RTS), and length of career.^{3,15} Given the increasing revenue and popularity of the NFL, it is important to understand surgical outcomes in this patient population. To our knowledge, there have been no published studies to date that have compared postoperative performance statistics with matched controls following forearm fracture ORIF in NFL athletes.

The purpose of this study was to determine: (1) RTS rate in NFL players following forearm fracture ORIF; (2) postoperative career length and games per season; (3) pre- and postoperative performance; and (4) postoperative performance compared with control players matched by position, age, years of experience, and performance. The authors hypothesized that NFL players who underwent forearm fracture ORIF would have: (1) a greater than 90% RTS rate; (2) no significant difference in postoperative career length and games per season compared with matched controls; (3)

no significant difference in postoperative performance compared with preoperative; and (4) no significant performance difference postoperatively when compared with matched controls.

Materials and Methods

Players in the NFL who sustained a forearm fracture and underwent ORIF were evaluated (Figure 1). Forearm fractures were defined as any fracture to the radius and/or ulna. These players were identified through NFL team Web sites, publicly available Internet-based injury reports, player profiles and biographies, and press releases. The search was manually conducted by 2 orthopedic surgery residents with validation of the findings by the senior author. Searches were performed for all NFL teams and players. Players who underwent forearm fracture ORIF from August 1987 to January 2016 were identified.

All players identified were included in this study as it related to RTS rate. A player was deemed to have RTS if he played in a single NFL game after surgery. A player did not RTS if he did not play in any NFL game after surgery. Inclusion criteria were any NFL athletes on an active roster in the

NFL prior to forearm fracture. Players were included if they were found to have forearm fracture ORIF as reported by at least 2 separate sources. Athletes who were injured and underwent procedures before completing their first NFL regular season were excluded. Players who sustained a forearm fracture and underwent ORIF in the 2015-2016 season were excluded from analysis because they had less than a 1-year opportunity to RTS.

Demographic variables including a player's age, position, prior professional experience, and date of surgery were recorded. Players were categorized by their positions, including quarterback "QB," running back "RB," tight end "TE," wide receiver "WR," offensive lineman "OL," defensive lineman "DL," linebacker "LB," defensive back "DB," kicker "K," or punter "P," except fullback "FBs," which were considered RBs. Performance statistics were collected from profootballreference.com for each player identified before and after forearm fracture ORIF (Supplemental Table 1). Statistics were collected for regular season NFL games only with preseason and playoff games excluded.

A control group was selected to compare data. Controls were matched to study cases based on position, age (± 1 years), years of experience in NFL (± 1 years), and performance data prior to the surgery date. Although FBs were considered RBs in the reporting of position, they were still controlled to other FBs. Each control was given an index date which matched the case player's surgery date to compare postoperative or postindex performance. For example, if a player underwent forearm ORIF 3 years into his career, the control's index date was 3 years into his career.

Player statistics for cases preoperative and postoperative and controls preindex and postindex were collected and aggregated. Each statistical category was divided by games played to account for discrepancies in number of games played per season. A player's performance score (Supplemental Table 2) was then calculated by using a previously published and standardized scoring system based on metrics important to the player's specific position.^{14,15,19} Statistics per game were used to calculate each performance score per game.

All players were included in RTS, games per season, and career length analysis. A Kaplan-Meier survivorship curve with "retirement" as the end point was constructed postoperatively for cases and postindex for controls. Positions without previously defined performance scores (punters, kickers, and offensive lineman) were excluded from performance score analysis. Comparisons between case and control groups and preoperative and postoperative time points were made using paired-samples Student *t* tests (<http://in-silico.net/tools/statistics/ttest>) using *P* value less than .05.

Results

Thirty-six surgeries in 34 players were analyzed (Table 1). Mean age at surgery was 27.6 ± 3.0 years and mean experience

Table 1. Number of Surgeries With RTS Data by Position.

	n	RTS, n	RTS, %	Days to RTS
QB	1	1	100.0	27.0
RB	2	2	100.0	42.0 ± 2.8
TE	3	3	100.0	156.3 ± 119.2
WR	3	2	66.7	146.0 ± 158.4
DB	21	19	90.5	176.4 ± 145.2
LB	4	4	100.0	122.5 ± 127.5
DL	1	1	100.0	252.0
OL	1	1	100.0	53.0
Total	36	33	91.7	152.1 ± 129.8

Note. RTS = return to sport; QB = quarterback; RB = running back; TE = tight end; WR = wide receiver; DB = defensive back; LB = linebacker; DL = defensive lineman; OL = offensive lineman.

in the NFL at surgery was 4.9 ± 2.8 years. One player refractured his ipsilateral forearm within 6 months of initial surgery and RTS. He was counted as a single player (2 surgeries). Two players refractured their ipsilateral forearms after RTS and were counted as 2 players (4 surgeries). Thirty-three cases (91.7%) and 31 (91.1%) players were able to RTS in the NFL. The overall 1-year survival rate of players undergoing forearm fracture ORIF was 83.3%. Players in the control group (4.3 ± 2.0 years) were in the NFL significantly longer ($P < .001$) than players who underwent forearm fracture ORIF (3.2 ± 2.0 years; Table 2). Players in the control group (12.9 ± 2.5 games per season) played in significantly more games per season postindex ($P = .026$) than players who underwent forearm fracture ORIF (11.2 ± 3.9) postsurgery (Table 2).

Eighteen (56%) of the NFL's 32 teams had at least 1 forearm fracture ORIF performed. The team with the greatest number of players undergoing forearm fracture ORIF was the Tennessee Titans with 7 (19%) cases. The defensive back position represented the largest proportion of players that underwent forearm fracture ORIF with 21 (58.3%) cases (Table 1). Two (6%) forearm fracture ORIF happened in the offseason.

There were no significant ($P > .05$) differences in demographic, performance, and games per season data between cases and matched controls presurgery and preindex (Tables 3 and 4) and in postoperative performance scores compared with preoperative scores (Figure 2). There was a statistically significant ($P = .013$) decrease in games per season (14.4 ± 1.6 to 11.7 ± 3.6) for DBs following surgery (Table 5). No positions had a significant difference ($P > .05$) in postoperative performance scores when compared with postindex matched controls (Figure 2).

Discussion

The purpose of this study was to determine: (1) RTS rate in NFL players following forearm fracture ORIF; (2) postoperative career length and games per season; (3) pre- and

Table 2. Games per Season and Career Length Postsurgery and Postindex for Cases and Controls.

Position	n	Games/season (mean $\pm$ SD)			Career length (years $\pm$ SD)		
		Cases	Controls	P value	Cases	Controls	P value
QB	1	4.2	8.5		5.4	2.0	
RB	2	12.3 $\pm$ 3.9	14.3 $\pm$ 1.5	0.695	2.8 $\pm$ 2.2	2.6 $\pm$ 1.4	.818
TE	3	10.4 $\pm$ 3.3	13.2 $\pm$ 1.8	0.087	2.4 $\pm$ 1.1	3.8 $\pm$ 1.0	.378
WR	2	14.8 $\pm$ 1.1	12.7 $\pm$ 1.8	0.500	6.6 $\pm$ 0.9	5.8 $\pm$ 1.1	.100
DB	19	11.1 $\pm$ 3.8	13.0 $\pm$ 2.7	0.052	3.0 $\pm$ 1.8	5.2 $\pm$ 2.0	<.001*
LB	4	11.2 $\pm$ 5.3	12.8 $\pm$ 1.9	0.584	3.0 $\pm$ 2.9	3.8 $\pm$ 2.2	.500
DL	1	15.0	8.5		3.0	2.0	
OL	1	7.7	14.5		1.4	4.0	
Overall	33	11.2 $\pm$ 3.9	12.9 $\pm$ 2.5	0.026*	3.2 $\pm$ 2.0	4.3 $\pm$ 2.0	.001*

Note. SD = standard deviation; QB = quarterback; RB = running back; TE = tight end; WR = wide receiver; DB = defensive back; LB = linebacker; DL = defensive lineman; OL = offensive lineman.

*Statistically significant.

Table 3. Preoperative and Preindex Performance Scores for Cases and Matched Controls.

Position	n	Performance score $\pm$ SD		P value
		Cases	Controls	
QB	1	14.6	11.0	
RB	2	2.8 $\pm$ 2.7	2.4 $\pm$ 1.8	.622
TE	3	7.9 $\pm$ 6.2	6.3 $\pm$ 4.6	.222
WR	2	7.2 $\pm$ 3.1	6.2 $\pm$ 2.5	.250
DB	17	4.2 $\pm$ 2.0	4.2 $\pm$ 1.8	.988
LB	3	5.5 $\pm$ 2.2	5.4 $\pm$ 1.5	.908
DL	1	2.6	2.6	

Note. SD = standard deviation; QB = quarterback; RB = running back; TE = tight end; WR = wide receiver; DB = defensive back; LB = linebacker; DL = defensive lineman.

Table 4. Mean Games per Season for Cases and Controls Presurgery and Preindex.

Position	Games/season (mean $\pm$ SD)		P value
	Case presurgery	Control preindex	
QB	5.7	5.3	
RB	13.1 $\pm$ 2.1	13.7 $\pm$ 2.8	.416
TE	12.8 $\pm$ 4.2	15.0 $\pm$ 0.8	.374
WR	13.1 $\pm$ 0.5	12.1 $\pm$ 2.9	.656
DB	14.4 $\pm$ 1.6	13.9 $\pm$ 2.9	.051
LB	13.5 $\pm$ 2.6	14.2 $\pm$ 0.9	.595
DL	15.2	13.2	
OL	13.2	13.7	

Note. SD = standard deviation; QB = quarterback; RB = running back; TE = tight end; WR = wide receiver; DB = defensive back; LB = linebacker; DL = defensive lineman; OL = offensive lineman.

postoperative performance; and (4) postoperative performance compared with control players matched by position, age, years of experience, and performance. The authors hypothesized that NFL players who underwent forearm fracture ORIF would have (1) a greater than 90% RTS rate; (2) no significant difference in postoperative career length and games per season compared with matched controls; (3) no significant difference in postoperative performance compared with preoperative; and (4) no significant performance difference postoperatively when compared with matched controls. The first study hypothesis was confirmed because there was a 91.7% RTS rate. The remaining hypotheses were partially confirmed in that the postoperative career length was significantly less than matched controls, postoperative games per season was significantly different in DBs, there were no significant difference in postoperative performance compared with preoperative, and no significant performance differences postoperatively when compared with matched controls.

One previous study investigated RTS and postoperative performance for players who underwent forearm fracture ORIF in the NFL.¹⁵ The prior study demonstrated a RTS of 96.3% in 27 NFL athletes.¹⁵ The RTS from this prior study is higher than the results of the present study with a RTS of 91.7% in 34 NFL athletes. The improved RTS in the study by Mai et al.¹⁵ is likely secondary to limiting their selection of players to injuries that occurred after 2003 while the current article includes players who underwent forearm fracture ORIF from 1987 to the present. During that time period, there was a shift from closed to open treatment with 42% of radius fractures treated with ORIF in 1999 to 81% treated with ORIF in 2007.¹⁴ Several recent studies have demonstrated improved early functional outcomes and range of motion using ORIF compared with various closed treatment options offering a possible explanation for the improved RTS in the study by Mai et al.^{7,10,11,20}

Figure 2. Performance scores by position before and after surgery compared with controls pre and postindex.

Note. QB = quarterback; RB = running back; TE = tight end; WR = wide receiver; DB = defensive back; LB = linebacker; DL = defensive lineman.

Table 5. Mean Games per Season Pre- and Postsurgery for Cases.

Position	Games/season (mean $\pm$ SD)		P value
	Presurgery	Postsurgery	
QB	5.7	4.2	
RB	13.1 $\pm$ 2.1	12.3 $\pm$ 3.9	0.661
TE	12.8 $\pm$ 4.2	10.4 $\pm$ 3.3	0.070
WR	13.1 $\pm$ 0.5	14.8 $\pm$ 1.1	0.380
DB	14.4 $\pm$ 1.6	11.7 $\pm$ 3.6	0.013*
LB	13.5 $\pm$ 2.6	13.8 $\pm$ 0.3	0.767
DL	15.2	15.0	
OL	13.2	7.7	

Note. QB = quarterback; RB = running back; TE = tight end; WR = wide receiver; DB = defensive back; LB = linebacker; DL = defensive lineman; OL = offensive lineman

*Statistically significant.

However, the study by Mai et al. did not look at performance scores for specific position groups and did not compare the outcomes of forearm fracture ORIF against matched controls.¹⁵ By using controls that were age-, NFL experience-, and performance-matched, the current study was able to improve performance data comparisons for case players against controls at the same junction of their career. By simply comparing a player to himself, rapid improvements (or regressions) in performance that are prevalent among similar players in the league may otherwise not be accounted for.

Despite an RTS of 91.7%, there are a large number of players who retire within the next few seasons after surgery and

index year. By year 3 postsurgery, only 50% of players who underwent forearm fracture ORIF remain in the NFL. The average career length in the NFL is reported as 6 years for players making an opening day roster in their rookie season and 3.3 years for all NFL players overall.¹⁸ The average experience for players in this investigation was 4.9 years, already surpassing the overall career length average. The average career length after forearm fracture ORIF has previously been described as 2.5 years.¹⁵ The current investigation found an average career length of 3.2 years after forearm fracture ORIF. The increase in career length in this investigation is likely due to more recent seasons included in the current study (an additional 2 NFL seasons). The current investigation also found a significant ($P < .05$) difference in career length after surgery when comparing cases (3.2 years) with controls (4.3 years) which has not previously been described.

The defensive back position represented the largest proportion of players who underwent forearm fracture ORIF with 21. This is a similar distribution to a previous study evaluating upper extremity injuries in the NFL in which DBs were twice as likely to sustain forearm injuries compared with other players with a majority classified as fractures.⁵ The authors hypothesize that the increased incidence of forearm fractures within this position group is due to the nature of their tackling at a high rate of speed. The need for high speed and high impact use of the arms at DB may have contributed to the significantly fewer games per season played postsurgery compared with controls. These gameplay factors may also necessitate a longer recovery period as the 176.4 days to RTS was the second longest among positions in the study.

Prior studies have also failed to comment on performance and RTS differences between position groups following forearm fracture ORIF. There was no significant difference in performance between cases and matched controls presurgery and preindex. TEs, WRs, and LBs all improved their performance scores postoperatively as did their corresponding controls postindex. DBs and their matched controls had no difference in their performance scores postoperatively or postindex. Furthermore, the cases and controls for DLs regressed at a similar rate postoperatively and postindex. These results indicate that forearm fracture ORIF did not have significant influence on the development and performance of these players.

On the contrary, the RBs' performance improved postoperatively while the controls' performance declined postindex for a performance score difference of 1.7 per game. Extrapolated over a 16-game season would lead to a score difference of 27.2 or 4 touchdowns per season. Although not statistically significant as there were only 2 RBs who underwent surgery, this value may be clinically significant. It is unclear as to the cause of this difference, but the authors hypothesize that time missed secondary to forearm fracture ORIF may have protected the RBs from further injury.

There are limitations of this study. The use of publicly available data to identify forearm fracture ORIF is prone to selection, reporting, and observer bias. However, this method of data acquisition has been used in multiple previous studies.^{1,4,6,9,17,19} In addition, the use of public data limits the ability to obtain the severity of the injury and the exact surgical procedure being performed. In this study, career length was not adjusted for "time missed" for players who underwent surgery. Their time in the league was in fact longer than reported; however, their seasons spent playing (ie, career length) after surgery is accurate. Inherent to this type of study, there are multiple unknown confounding variables such as presurgical course and no direct physical contact or medical records access to corroborate diagnosis. In addition, the specific forearm bone(s), fracture pattern, surgical approach, technique, and implant, among other surgical variables, were unable to be determined. Other limitations include the absence of patient-reported outcomes, incomplete follow-up, and career length for players still in the NFL, and inability to compare offensive lineman or specialists with performance scoring.

In conclusion, there is a high rate of RTS in the NFL following forearm fracture ORIF. Following surgery, players' careers were 1 year shorter and played nearly 2 fewer games per season than matched controls. Games per season following surgery was significantly lower among DBs when compared with presurgery. Postoperative performance scores were not significantly different compared with preoperative and when compared with matched controls.

Ethical Approval

This study was approved by our institutional review board.

Statement of Informed Consent

Informed consent was not obtained.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Declaration of Conflicting Interests

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