# Performance and Return to Sport After Nonoperative Treatment of Clavicle Fractures in National Football League Players

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## abstract

Clavicle fractures are often seen in contact sports. The purpose of this study was to determine (1) return-to-sport (RTS) rate of National Football League (NFL) players following nonoperative treatment of clavicle fractures, (2) posttreatment career length and games per season, (3) pre- and posttreatment performance, and (4) posttreatment performance compared with control players matched by position, age, years of experience, and performance. Public records were used to identify NFL players who underwent nonoperative treatment of clavicle fractures. Demographic and performance data were collected for each player. Matched controls (position, age, experience, and performance) were identified. Control and case performance scores were calculated using a standardized scoring system. Return to sport was defined as playing a minimum of 1 game after treatment. Comparisons between the 2 groups and pre- and posttreatment time points were made using paired-samples Student's *t* tests. Thirty players (32 fractures) were analyzed. Two players fractured their contralateral clavicle. Of the players analyzed, 96.9% were able to RTS at a mean of 244.6±119.6 days. Eight players (27.6%) returned within the same season as their injury. Overall 1-year survival rate posttreatment was 93.5%. Players with nonoperative treatment had career lengths similar to those of controls ($P>.05$). No significant ($P>.05$) differences existed in demographic, performance, or games per season data between position groups for cases and matched controls pretreatment and preindex and in posttreatment compared with pretreatment performance scores. Wide receivers played fewer games per season ($P=.043$) following treatment. No position group had significantly worse posttreatment performance scores when compared with postindex matched controls. [*Orthopedics*. 2017; 40(5):e836-e843.]

Clavicle fractures are common injuries in contact sports, accounting for 10% of all sports-related fractures.[1,2] The incidence is likely to rise secondary to an increase in athletic participation. The clavicle is prone to fracture because it is the primary stabilizer of the shoulder girdle.[3,4] The clavicle connects the axial skeleton to the upper extremity, contributes to the motion and stability of the upper extremity, and provides protection to the underlying neurovascular structures. This relationship is important for both skill (throwing and catching) and non-skill (blocking and tackling) positions in football.

Most clavicle fractures are located in the midshaft (81%), with lateral (17%) and medial (2%) fractures seen less frequently.[4-7] Closed clavicle fractures have historically been treated nonsurgically in

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the general population and in elite athletes, including National Football League (NFL) players, with minimal complications.[6-8] Previous literature suggests that nonoperative treatment is associated with low rates of nonunion and symptomatic malunion.[8,9] More recent studies in the general population have suggested that primary surgical treatment results in improvements in return to activity and time to union.[10-12]

However, various orthopedic surgical procedures, such as ankle fracture open reduction and internal fixation, have been shown to have a negative effect on postoperative performance, return to sport (RTS), and length of career in the NFL.[13,14] Given these negative outcomes and the increasing revenue and popularity of the NFL, it is important to understand nonsurgical outcomes in this patient population.

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

## Materials and Methods

Players in the NFL who sustained a clavicle fracture and were treated nonoperatively were evaluated (**Figure 1**). These players were identified through NFL team websites, publicly available Internet-based injury reports, player profiles and biographies, and press releases.

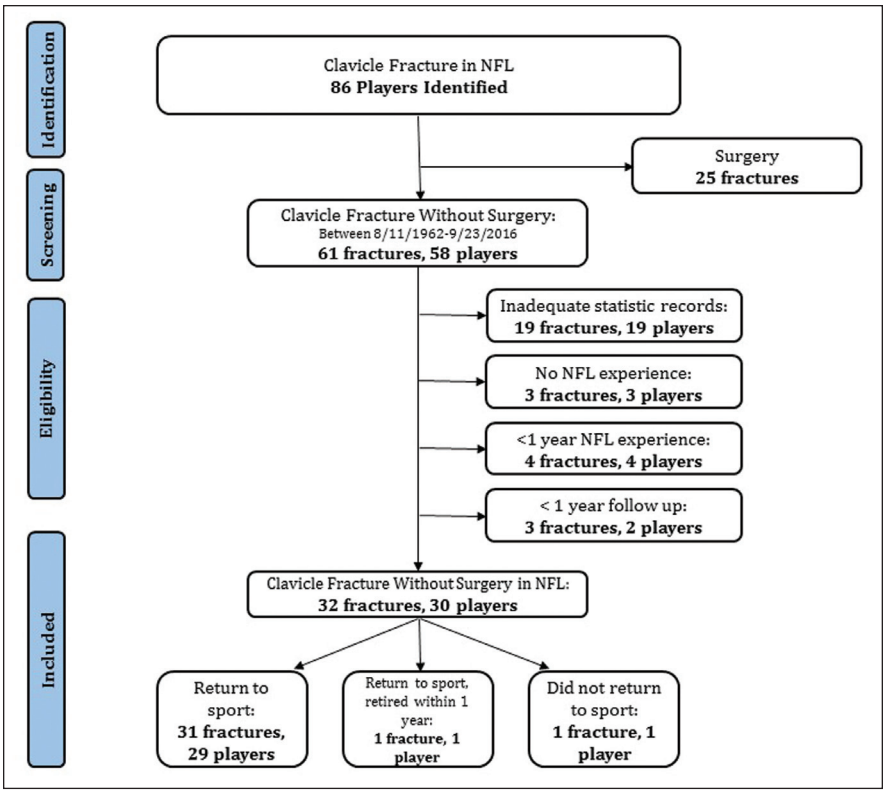


**Figure 1:** Flowchart illustrating application of exclusion criteria. Abbreviation: NFL, National Football League.

The search was manually conducted by 2 orthopedic surgery residents (R.A.J., K.R.S.). Searches were performed for all NFL teams and players. Players who underwent nonoperative treatment of clavicle fractures from August 1962 to September 2016 were identified.

All players identified were included in this study because it related to RTS rate. A player was deemed to have RTS if he played in any single NFL game after nonoperative treatment. A player did not have RTS if he did not play in any NFL game after nonoperative treatment. Inclusion criteria were any NFL athlete on an active roster or listed on injured reserve in the NFL prior to clavicle fracture. Players were included if they were found to have a clavicle fracture and to have been treated nonoperatively as reported by at least 2 separate sources. Athletes who were injured before completing their first NFL regular season were excluded. Players who sustained a clavicle fracture in the 2015–2016 season were excluded from analysis because they had less than a 1-year opportunity to RTS. In addition, online reports that were conflicting, were incomplete, or did not have a date of injury were also excluded from the study (n=0).

Demographic variables including a player's age, position, prior professional experience, and date of injury were recorded. Players were categorized by their positions, including quarterback, running back, tight end, wide receiver, offensive lineman, defensive lineman, linebacker, defensive back, kicker, or punter. Performance statistics before and after nonoperative treatment of clavicle fracture were collected from www.pro-football-reference.com for each player identified. Statistics were collected for regular season NFL games only, with preseason and playoff games excluded.

A control group was selected. Controls were matched to study cases based on position, age (±1 year), years of experience (±1 year), and performance data prior to

Table 1

**Performance Score Variables by Position**

| Position | Variables Collected |
|---|---|
| Quarterback | Demographics: age, experience |
| | Pretreatment and posttreatment (and index) variables: number of seasons, games |
| | Total, per game, and per season variables collected pretreatment and posttreatment (and index): completions, attempts, completion percentage, passing yards, passing touchdowns, interceptions, sacks, fumbles, rushing yards, rushing touchdowns |
| Running back | Demographics: age, experience |
| | Pretreatment and posttreatment (and index) variables: number of seasons, games |
| | Total, per game, and per season variables collected pretreatment and posttreatment (and index): rushing attempts, rushing yards, rushing yards per attempt, rushing touchdowns, receptions, receiving yards, receiving touchdowns, fumbles |
| Tight end/wide receiver | Demographics: age, experience |
| | Pretreatment and posttreatment (and index) variables: number of seasons, games |
| | Total, per game, and per season variables collected pretreatment and posttreatment (and index): receptions, receiving yards, receiving yards per reception, receiving touchdowns, fumbles |
| Offensive lineman/ punter/kicker | Demographics: age, experience |
| | Pretreatment and posttreatment (and index) variables: number of seasons, games |
| Defensive back/ linebacker/defensive lineman | Demographics: age, experience |
| | Pretreatment and posttreatment (and index) variables: number of seasons, games |
| | Total, per game, and per season variables collected pretreatment and posttreatment (and index): tackles, assisted tackles, total tackles, sacks, safeties, interceptions, forced fumbles, touchdowns, passes deflected |

Table 2

**Number of Fractures With Return to Sport (RTS) Data by Position**

| Position | No. of Fractures | No. RTS | RTS Rate | Mean±SD RTS, d |
|---|---|---|---|---|
| Quarterback | 9 | 9 | 100% | 230.0±134.8 |
| Running back | 5 | 5 | 100% | 267.4±137.8 |
| Tight end | 1 | 1 | 100% | 329.0[a] |
| Wide receiver | 10 | 10 | 100% | 235.2±118.0 |
| Defensive back | 5 | 4 | 80.0% | 231.0±146.2 |
| Linebacker | 2 | 2 | 100% | 287.0±39.6 |
| Overall | 32 | 31 | 96.9% | 244.6±119.6 |

[a]*Mean (only 1 player).*

the injury date. Each control was given an index date (relative to career length) that matched the case player's injury date to compare posttreatment or postindex performance. For example, if a player sustained a clavicle fracture and underwent nonoperative treatment 3 years into his career, the control's index date was 3 years into his career.

Player statistics for cases pretreatment and posttreatment and for 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 (**Table 1**) was then calculated by using a previously published and standardized scoring system based on metrics important to the player's specific position.[14-16] Statistics per game were used to calculate each performance score per game.

All players were included in the RTS, games per season, and career length analysis. A Kaplan–Meier survivorship curve with "retirement" as the endpoint was constructed posttreatment for cases and postindex for controls. Positions without previously defined performance scores (punter, kicker, and offensive lineman) were excluded from performance score analysis. Comparisons between case and control groups and pretreatment and posttreatment time points were made using paired-samples Student's *t* tests via In-silico Online. $P<.05$ was considered significant.

## Results

Thirty-two fractures in 30 players were analyzed (**Table 2**). The mean age of the players was 28.1±3.8 years and their mean experience in the NFL was 5.5±3.5 years at the time of fracture. Two players fractured their contralateral clavicle after RTS. They were counted as 2 players (4 fractures). The wide receiver position represented the largest proportion of players, with 9 players (10 fractures, 30.0%) who were treated nonoperatively for clavicle fracture (**Figure 2**). Twenty-nine players (96.9%) with 31 fractures were able to RTS in the NFL at a mean of 244.6±119.6 days. Eight players (27.6%) returned within the same season as their injury.

Two players (6.9%) RTS in less than 6 weeks, and 25 players (86.2%) RTS at greater than 12 weeks. Of the 25 players who RTS after 12 weeks, 40% were out of season when they were expected to return.

The overall 1-year survival rate of players undergoing nonoperative treatment of clavicle fracture was 93.5% (**Figure 3**). Players in the control group were not in the NFL significantly longer than players who underwent nonoperative treatment of clavicle fracture (3.6±2.7 years vs 3.5±1.9 years, *P*=.892) (**Table 3**). Players in the control group played in a similar number of games per season postindex as players who underwent nonoperative treatment of clavicle fracture (11.7±4.0 games per season vs 11.6±4.1 games per season, *P*=.853).

There was a significant difference (*P*=.048) in the ages of running back cases and controls (25.4±2.3 years vs 24.6±2.3 years) and in overall experience (**Table 4**). Otherwise, there were no significant (*P*>.05) differences in demographic, performance, or games per season data between position groups for cases and matched controls pretreatment and preindex (**Tables 4-6**) and in posttreatment compared with pretreatment performance scores (**Table 7**, **Figure 4**). There was a statistically significant (*P*=.043) decrease in games per season (14.0±2.2 games to 9.9±4.3 games) for wide receivers following nonoperative treatment (**Table 8**). No position had a significant difference (*P*>.05) in posttreatment performance when compared with pretreatment performance, and there was no significant performance difference posttreatment when compared with matched controls (**Table 9**, **Figure 3**).

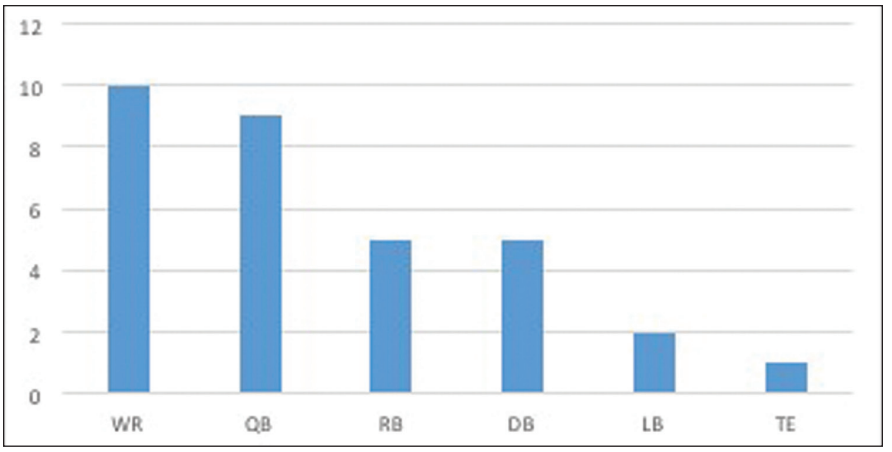


**Figure 2:** Number of clavicle fractures by position. Abbreviations: DB, defensive back; LB, linebacker; QB, quarterback; RB, running back; TE, tight end; WR, wide receiver.

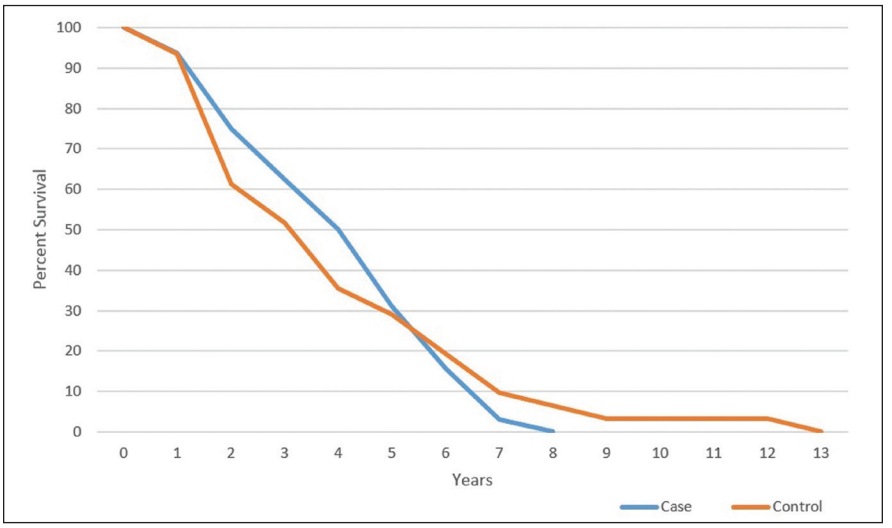


**Figure 3:** Kaplan–Meier survival analysis for cases and controls. Zero (0) signifies year of treatment for cases and index year for controls.

## Discussion

The purpose of this study was to determine (1) RTS rate of NFL players following nonoperative treatment of clavicle fractures, (2) posttreatment career length and games per season, (3) pre- and posttreatment performance, and (4) posttreatment performance compared with control players matched by position, age, years of experience, and performance. The first study hypothesis was confirmed with a 96.9% RTS rate. The remaining hypotheses were partially confirmed in that the posttreatment career length was not statistically significant but the posttreatment games per season was significantly decreased for wide receivers. No position had a significant difference (*P*>.05) in posttreatment performance when compared with pretreatment performance, and there was no significant performance difference posttreatment when compared with matched controls.

Previous studies showed RTS rates ranging from 67% to 100% for athletes who underwent nonoperative treatment of clavicle fractures.[8,10,17-19] The RTS rates from these prior studies are similar to that of the current study (96.9% for 30 NFL athletes). Robertson et al[17] reported an average RTS of 87.5 days for soccer players, which is significantly shorter than the mean of approximately 245 days reported in the current study. Compared with the current study, their faster RTS is likely due to the lower-contact nature of soccer; the longer soccer season, with more opportunity to return during the same season; and

Table 3

**Games per Season and Career Length by Position for Cases and Controls Posttreatment and Postindex, Respectively**

| | | Mean±SD Games per Season, No. | | | Mean±SD Career Length, y | | |
|---|---|---|---|---|---|---|---|
| **Position** | **No.** | **Cases** | **Controls** | ***P*** | **Cases** | **Controls** | ***P*** |
| Quarterback | 9 | 10.0±4.3 | 10.8±4.8 | .705 | 3.5±1.7 | 5.0±3.7 | .140 |
| Running back | 5 | 13.4±2.8 | 12.0±3.4 | .616 | 2.9±1.7 | 2.8±2.5 | .896 |
| Tight end | 1 | 15.0[a] | 16.0[a] | NA | 4.0[a] | 1.7[a] | NA |
| Wide receiver | 10 | 9.9±4.3 | 11.6±4.2 | .247 | 4.2±2.3 | 4.0±2.0 | .676 |
| Defensive back | 4 | 14.0±2.0 | 11.1±3.3 | .092 | 3.8±1.0 | 1.6±1.0 | .053 |
| Linebacker | 2 | 16.0[a] | 15.2±1.2 | .500 | 0.6±0.6 | 1.9±1.6 | .555 |
| Overall | 31 | 11.6±4.1 | 11.7±4.0 | .853 | 3.5±1.9 | 3.6±2.7 | .892 |

*Abbreviation: NA, not applicable (only 1 player).*
[a]*Mean (only 1 player).*

Table 4

**Age and Experience by Position for Cases and Controls at Time of Treatment and Index Time, Respectively**

| | | Mean±SD Age, y | | | Mean±SD Experience, y | | |
|---|---|---|---|---|---|---|---|
| **Position** | **No.** | **Cases** | **Controls** | ***P*** | **Cases** | **Controls** | ***P*** |
| Quarterback | 9 | 29.6±4.5 | 29.2±3.3 | .490 | 6.4±3.4 | 6.2±3.4 | .169 |
| Running back | 5 | 25.4±2.3 | 24.6±2.3 | .048[a] | 2.9±2.0 | 2.7±1.7 | .374 |
| Tight end | 1 | 31.3[b] | 30.2[b] | NA | 9.4[b] | 8.4[b] | NA |
| Wide receiver | 10 | 26.1±2.1 | 26.3±2.4 | .418 | 3.8±1.7 | 3.8±1.7 | 1.000 |
| Defensive back | 4 | 31.4±4.6 | 31.1±4.0 | .406 | 9.3±5.1 | 8.8±4.5 | .182 |
| Linebacker | 2 | 30.0±0.4 | 30.2±0.9 | .685 | 7.6±1.3 | 7.6±1.3 | 1.000 |
| Overall | 31 | 28.1±3.8 | 27.8±3.5 | .193 | 5.5±3.5 | 5.3±3.3 | .012[a] |

*Abbreviation: NA, not applicable (only 1 player).*
[a]*Statistically significant.*
[b]*Mean (only 1 player).*

the possibility (alpha error) of the small sample sizes favoring injuries at the start of the season.

Morgan et al[8] examined the evolving management of clavicle fractures in NFL athletes. Of the 13 players treated nonoperatively for clavicle fracture, 15.4% were able to return to play within the same season. This is lower than the current study, in which 27.6% (8 of 29) of players returned within the same season as their injury and nonoperative treatment. One possible explanation for the difference is sustaining the fracture later in the season. However, the study by Morgan et al[8] did not address this issue.

Of the 25 players who RTS after 12 weeks, 40% were out of season when they were expected to return. Therefore, the RTS time is likely higher than it would have been if the players were not in the off-season. This is also exaggerated by the short NFL season compared with other sports.

Wide receivers played significantly fewer games (compared with preinjury) following nonoperative treatment of clavicle fractures. This may be due to the overhead nature of their position group, the diving or catching nature of their position, or carrying the ball after the catch is made and having defenders attempt to hit or strip the ball from the arm. However, this is in contrast to a study by Robinson et al[20] in which players who participated in overhead sports had subjective and objective outcomes equivalent to those of other athletes following clavicle fracture.

The difference between prior studies and the current study is that the former did not examine performance scores for specific position groups and did not compare

the outcomes of nonoperative treatment of clavicle fractures against matched controls. Because controls were matched for age, NFL experience, and performance, 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.

The offensive skill positions represented the largest proportion of players who underwent nonoperative treatment of clavicle fractures—25 (82.8%). The authors hypothesize that the increased incidence of clavicle fractures within these position groups is likely due to a tackle driving the player into the ground onto the shoulder or diving for the ball and landing on the shoulder. Conversely, defensive players are typically performing the action of tackling and are better able to control their bodies, avoiding direct impact on the shoulder when they reach the ground.

Prior studies have also failed to comment on performance and RTS differences between position groups following nonoperative treatment of clavicle fractures. There was no significant difference in performance between cases pretreatment and matched controls preindex. The running back and wide receiver groups had improved performance scores posttreatment, as did their corresponding controls postindex. This indicates that nonoperative treatment of clavicle fractures may not have a significant influence on the development and performance of these players after they RTS.

On the other hand, the performance of quarterbacks and linebackers decreased posttreatment, while the performance of controls improved postindex. The performance score difference was 2.2 per game for quarterbacks and 4.0 per game for linebackers. Extrapolated over a 16-game season, this would lead to a performance score difference of 35.2 and 64.0 for quar-

Table 5

**Performance Scores by Position Pretreatment and Posttreatment for Cases and Controls, Respectively**

| | Mean±SD Performance Score | | |
|---|---|---|---|
| **Position** | **Cases** | **Controls** | ***P*** |
| Quarterback | 14.6±4.5 | 13.0±2.6 | .234 |
| Running back | 5.3±4.4 | 5.7±5.4 | .653 |
| Tight end | 6.7[a] | 6.3[a] | NA |
| Wide receiver | 4.5±3.4 | 4.5±3.5 | .974 |
| Defensive back | 5.6±3.1 | 5.7±1.3 | .903 |
| Linebacker | 2.5[a] | 2.9[a] | NA |

*Abbreviation: NA, not applicable (only 1 player).*
[a]*Mean (only 1 player).*

Table 6

**Games per Season by Position Pretreatment and Preindex for Cases and Controls, Respectively**

| | Mean±SD Games per Season, No. | | |
|---|---|---|---|
| **Position** | **Cases** | **Controls** | ***P*** |
| Quarterback | 12.5±2.7 | 11.1±3.2 | .133 |
| Running back | 14.1±2.7 | 11.3±3.2 | .063 |
| Tight end | 15.5[a] | 15.8[a] | NA |
| Wide receiver | 14.0±2.2 | 12.9±3.0 | .317 |
| Defensive back | 14.4±0.4 | 13.5±0.6 | .170 |
| Linebacker | 14.7±0.3 | 14.3±1.1 | .580 |

*Abbreviation: NA, not applicable (only 1 player).*
[a]*Mean (only 1 player).*

Table 7

**Performance Scores by Position Pretreatment and Posttreatment for Cases**

| | Mean±SD Performance Score | | |
|---|---|---|---|
| **Position** | **Pretreatment** | **Posttreatment** | ***P*** |
| Quarterback | 14.6±4.5 | 12.0±6.2 | .178 |
| Running back | 5.3±4.4 | 5.9±5.3 | .702 |
| Tight end | 6.7[a] | 6.9[a] | NA |
| Wide receiver | 4.5±3.4 | 5.1±4.5 | .466 |
| Defensive back | 5.6±3.1 | 5.1±3.0 | .326 |
| Linebacker | 2.5[a] | 1.8[a] | NA |

*Abbreviation: NA, not applicable (only 1 player).*
[a]*Mean (only 1 player).*

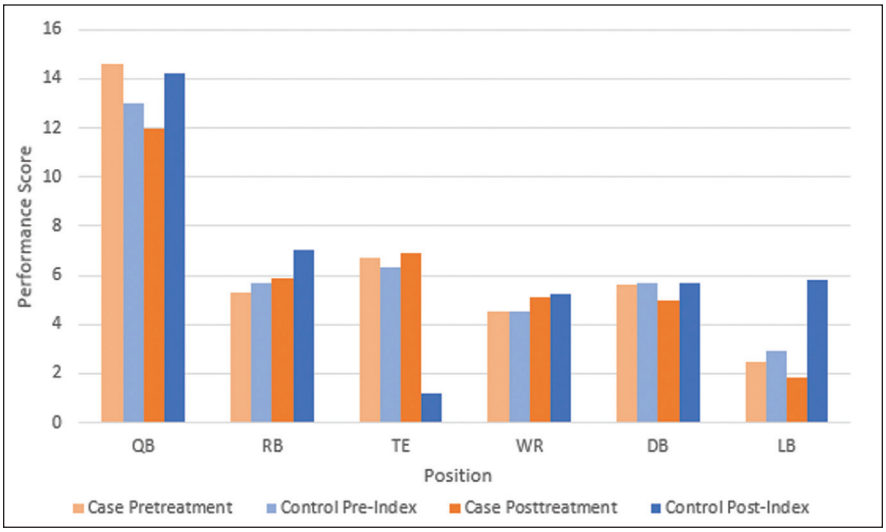


**Figure 4:** Performance scores by position for cases before and after treatment compared with for controls pre- and postindex. Abbreviations: DB, defensive back; LB, linebacker; QB, quarterback; RB, running back; TE, tight end; WR, wide receiver.

Table 8

**Games per Season by Position Pretreatment and Posttreatment for Cases**

| | Mean±SD Games per Season, No. | | |
|---|---|---|---|
| **Position** | **Pretreatment** | **Posttreatment** | ***P*** |
| Quarterback | 12.5±2.7 | 10.0±4.3 | .109 |
| Running back | 14.1±2.7 | 13.4±2.8 | .671 |
| Tight end | 15.5[a] | 15.0[a] | NA |
| Wide receiver | 14.0±2.2 | 9.9±4.3 | .043[b] |
| Defensive back | 14.4±0.4 | 14.0±2.0 | .656 |
| Linebacker | 14.7±0.3 | 16.0±0.0 | .110 |

*Abbreviation: NA, not applicable (only 1 player).*
[a]*Mean (only 1 player).*
[b]*Statistically significant.*

terbacks and running backs, respectively. With use of the performance score, quarterbacks had 400 fewer yards passing and 4 fewer passing touchdowns per season and linebackers had 48 fewer tackles and 4 fewer sacks per season compared with matched controls. These are clearly both clinically significant results.

One possible explanation for the significant difference in performance for quarterbacks is the involvement of their dominant throwing arm (44.4%) leading to increased pain and decreased range of motion negatively affecting their throwing mechanics. Further studies are needed to assess the biomechanical effect of clavicle fracture on throwing motion.

### Limitations

This study had several limitations. The use of publicly available data to identify nonoperative treatment of clavicle fractures is prone to selection, reporting, and observer bias. However, this method of data acquisition has been used in multiple previous studies.[21-25] Additionally, the use of public data limits the ability to obtain the severity of the injury. In this study, career length was not adjusted for "time missed" for players who underwent nonoperative treatment. Their time in the league was, in fact, longer than reported; however, their seasons spent playing (ie, career length) after treatment is accurate. Inherent to this type of study, there are multiple unknown confounding variables, such as no direct physical contact or medical records access to corroborate diagnosis. In addition, the specific fracture pattern could not 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. Also, the authors were unable to compare nonoperative treatment with open reduction and internal fixation of clavicle fractures in NFL athletes.

## Conclusion

There is a high rate of RTS in the NFL following nonoperative treatment of clavicle fractures. Regarding number of games per season and career length in the NFL, players who underwent nonoperative treatment of their clavicle fracture were similar to controls. Wide receivers played in significantly fewer games posttreatment. No position group had significantly worse postoperative performance scores when compared with postindex matched controls.

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Table 9

**Performance Scores by Position Posttreatment and Postindex for Cases and Matched Controls, Respectively**

| | Mean±SD Performance Score | | |
|---|---|---|---|
| **Position** | **Cases** | **Controls** | ***P*** |
| Quarterback | 12.0±6.2 | 14.2±5.2 | .297 |
| Running back | 5.9±5.3 | 7.0±8.2 | .682 |
| Tight end | 6.9[a] | 1.2[a] | NA |
| Wide receiver | 5.1±4.5 | 5.2±4.0 | .882 |
| Defensive back | 5.1±3.0 | 5.7±2.3 | .718 |
| Linebacker | 1.8[a] | 5.8[a] | NA |

*Abbreviation: NA, not applicable (only 1 player).*
*[a]Mean (only 1 player).*


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