



ELSEVIER

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jseinternational.org

Return to play after rotator cuff tear in National Football League athletes

Hans E. Lapica, MD^a, Robert J. Burgmeier, MD^b, Jonas W. Ravich, MS^b,
Matthias R. Schurhoff, MD^b, Luis A. Vargas, MD, PhD^{b,*}

^aHCA Florida JFK Hospital - University of Miami Department of Orthopaedic Surgery, Palm Beach Shoulder Service at Atlantis Orthopaedics, Lake Worth, FL, USA

^bBaptist Health Orthopedic Care, Baptist Health South Florida, Coral Gables, FL, USA

ARTICLE INFO

Keywords:

Rotator cuff tear
National Football League
Return to play
Athletes
Collision
Career length

Level of evidence: Level IV; Case Series;
Prognosis Study

Background: Rotator cuff tears are rare injuries in National Football League (NFL) athletes and there are limited data to help guide players and team physicians. The purpose of this study was to assess return to play (RTP) rates, performance levels, and career length following a rotator cuff tear during their playing career.

Methods: Using publicly available data, we identified players who sustained a rotator cuff tear between 2000 and 2019. Demographic information, treatment (operative vs. nonoperative), RTP rate, preinjury and postinjury performance score, position, and career length were entered into the analysis.

Results: Twenty-nine athletes with a mean age of 27.4 years (± 3.1) at the time of injury were included in this study. Forty-eight percent were offensive and 52% defensive players. 79.3% (23/29) were able to RTP at the same professional level for an average of 2.8 ± 3.4 years. The average time to RTP after injury was 198.4 ± 125.3 days. The average age of players who RTP was 26.7 ± 2.5 years compared to those who did not (30.3 ± 3.7 , $P = .02$). Similarly, the preinjury NFL career length was 4.0 ± 2.2 in players who RTP compared to those who did not (7.5 ± 2.7 , $P = .01$). Most injuries (82.2%) were treated surgically; however, there was no significant difference ($P > .05$) in RTP rates, performance score, or career longevity between operative and nonoperative cohorts.

Conclusion: Overall RTP rates for NFL athletes following a rotator cuff injury are promising with approximately 80% returning at the same performance level regardless of treatment type. Older, veteran players particularly those over the age of 30 were significantly less likely to RTP and should be counseled accordingly.

© 2023 The Authors. Published by Elsevier Inc. on behalf of American Shoulder and Elbow Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

The demands of professional football often result in a high rate of player injury when compared with other professional sports.^{1,5} The shoulder has been found to be the fourth most common site of injury representing 10%-20% of the total number of injuries.⁸ These shoulder injuries can arise from various causes including a direct blow, poor throwing mechanics, chronic overuse, repetitive microtrauma, collisions, and falls.¹² Despite the frequency of shoulder injuries, rotator cuff tears both partial and full thickness are relatively rare. In a study evaluating elite college football players attending the National Football League (NFL) Combine,

167 (49.7%) had reported suffering a shoulder injury at some point in their career. However, only 4 of the 167 (1.8%) of these shoulder injuries were rotator cuff tears.⁸ Consequently, there is a paucity of data regarding the clinical outcomes and return to play (RTP) rates after suffering a rotator cuff tear in elite professional football players.

Two previous studies on rotator cuff tears in elite football athletes have demonstrated overall favorable RTP rates ranging from 90 to 93%.^{2,4} However, another study found that college football players with a rotator cuff tear were 29.1% less likely to be drafted and if drafted these players started fewer games and had shorter playing careers than matched controls without rotator cuff tears.⁵ The purpose of this study was to identify rotator cuff tears in NFL athletes and report on RTP rates, performance levels, and career longevity after suffering this injury. We also aimed to identify factors including treatment (surgical vs. nonsurgical), age, or position that may influence RTP.

Institutional review board approval was not required for this case series.

*Corresponding author: Luis A. Vargas, MD, PhD, Baptist Health Orthopedic Care, Baptist Health South Florida, 1150 Campo Sano Avenue, Coral Gables, FL 33146, USA.

E-mail address: luisva@baptisthealth.net (L.A. Vargas).

<https://doi.org/10.1016/j.jseint.2023.03.024>

2666-6383/© 2023 The Authors. Published by Elsevier Inc. on behalf of American Shoulder and Elbow Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Table 1
Performance score ratio calculation by position.

Position	Performance score calculation
Quarterback	$[(\text{passing yards}/25) + (\text{rushing yards}/10) + (4 \times \text{touchdowns}) - (2 \times \text{interceptions})]/\text{games played}$
Running back	$[(\text{total yards gained}/10) + (6 \times \text{touchdowns})]/\text{games played}$
Wide receiver	$[(\text{total yards gained}/10) + (6 \times \text{touchdowns})]/\text{games played}$
Defensive	$[(\text{sacks}) + (\text{interceptions} \times 2) + (6 \times \text{touchdowns})]/\text{games played}$

Materials and methods

NFL players diagnosed with a rotator cuff tear between 2000 and 2019 were identified for this study using publicly available data as has been previously described.^{1,3,6,7,11} NFL athletes with rotator cuff tears using multiple sources of publicly available information, including NFL game summaries, play-by-play documents, weekly injury reports, press releases, newspaper archives, and player profiles. All identified players underwent further screening to determine eligibility for the study. Inclusion criteria consisted of any NFL player who sustained a rotator cuff tear during their NFL career over the last 2 decades. NFL players that suffered a rotator cuff tear in the season prior to their rookie season were also included in the analysis. Athletes were excluded if their shoulder injury could not be verified as a rotator cuff tear or if they were unable to RTP for reasons unrelated to their rotator cuff injury such as suspension, unrelated injury, or personal matters. NFL player statistics and data as well as RTP dates were recorded from Pro-Football-Reference.com, a website providing a variety of statistics for American football. These were then cross verified with NFL.com game logs and their recorded player statistics. All searches were conducted by a research team in the sports medicine division, consisting of MD candidates, orthopedic fellows, and faculty.

Demographic data for each player were recorded and included age, body mass index (BMI), position, and years of playing career length prior to injury. RTP data consisted of date of injury, treatment (operative vs. nonoperative), overall RTP rate, and time to RTP. Regular season game statistics for NFL athletes who met the inclusion criteria were compiled both before and after the diagnosis of rotator cuff tear. Games played, games started, seasons played, sacks, interceptions, yards gained, and touchdowns were recorded on a preinjury and postinjury basis. Successful RTP was defined as being on the active roster for at least one NFL regular season game after treatment.⁶

Player performance was measured using a standardized, previously published scoring system based on pertinent achievements important to an individual player’s position which included yards, touchdowns, sacks, and interceptions (Table 1).⁶ In dividing a player’s accumulated score by the number of games played, the performance score (PS) for each player was normalized. Using this scoring system, we tracked the performance both before and after the diagnosis of a rotator cuff tear, except for offensive lineman, whose performance is not commonly assessed with publicly available in-game statistics. The PS ratio was calculated by dividing the postinjury by preinjury score, which allowed for player performance comparison using their preinjury play data as an internal control with each player serving as his own control. A player with a PS ratio greater than 1.0 had an increase PS score after injury, whereas a player with a PS ratio less than 1.0 had a worse PS score after injury.⁶

To assess career longevity, injury-specific data points were recorded including RTP duration and the presence of recurrent injury after the treatment. Additionally, players were categorized into an operative or nonoperative cohort based on the final treatment status at the end of the injured season. Statistical analysis

compared career statistics, such as PS, before and after the index season between the operative and nonoperative cohorts.

Statistical analysis

All continuous data were reported as mean +/- standard deviation. One-sample test for binomial proportion without continuity correction and 95% confidence limits (95% CI) for proportions were reported. The continuous variables for each cohort were compared using the independent sample Mann–Whitney U test. Statistical significance was set at alpha 0.05. All statistics were calculated using IBM SPSS software version 27 (IBM Corp., Armonk, NY, USA) and R software version 4.0.3 (R Studio, Boston, MA, USA).

Results

We identified 29 NFL players who suffered a rotator cuff tear between 2000 and 2019. Offensive and defensive positions were equally distributed among the athletes with 48% being offensive players and 52% being defensive player. Of the 14 defensive players, there were 5 defensive linemen, 4 linebackers, and 5 defensive backs. Of the 15 offensive players, there were 5 offensive linemen, 4 quarterbacks, 3 wide receivers, and 3 running backs. The average player age at the time of injury was 27.4 ± 3.1. Complete demographic data including age, BMI, and position are displayed in Table II.

Twenty-three players (23/29) were able to RTP after sustaining a rotator cuff tear (79%; 95% CI: 59.2%, 89.4%). The average time to RTP after injury was 198.4 ± 125.3 days. The average career length after injury was 36.6 ± 49.8 games over 2.8 ± 3.4 years. The average PS ratio for players that successfully RTP was 1.0 ± 0.7. There was a significant difference in the age of the players who returned to play vs. those who did not RTP. The average age of players who RTP was 26.7 ± 2.5 while the average age of players who did not RTP was 30.3 ± 3.7 (P = .02). Four of the 6 players who did not RTP were over the age of 30. This significant difference was also reflected in playing career length prior to injury, with older, veteran players less likely to RTP. The average years in the league prior to injury of players who RTP was 4.0 ± 2.2 while the average years in the league prior to injury of players who did not RTP was 7.5 ± 2.7 (P = .01) (Table III).

Twenty-four of the 29 athletes (82.2%) underwent operative treatment for their rotator cuff injury. Nineteen of those 24 (79%, 95% CI: 56.6%, 89.9%) successfully returned to play (Table II). The average age of players who underwent operative treatment was 27.3 ± 3.4. The average time to RTP after surgery was 259.5 ± 61.4 days. The average career length after surgery was 31.9 ± 48.9 games over 2.5 ± 3.3 years. The average PS ratio for players that successfully RTP after surgery was 1.0 ± 0.6. Seven of the 24 (29.2%) athletes underwent a trial of nonoperative management and were able to RTP immediately after their injury. All seven of these players were able to RTP after undergoing surgical intervention in the offseason.

Five of the 29 (17.2%) athletes were treated definitively with nonoperative management and 80% (4/5) returned to play immediately after injury (95% CI: 37.6%, 96.4%). The average age of players who underwent nonoperative management was 27.8 ± 0.8. The average career length for these athletes was 58.2 ± 53.9 games over 4.2 ± 3.8 years. The average PS ratio for these athletes was 1.0 ± 0.8. Positions represented in the nonoperative cohort were quarterback, running back, defensive line, linebacker, and defensive back. There was no significant difference in RTP rates (P = .95), number of games played after injury (P = .32), number of years played after injury (P = .35), or in PS ratios (P = .97) between operative and nonoperative cohorts.

Table II
Characteristics of NFL players with a rotator cuff tear (operative vs. nonoperative).

Variable	Operative (n = 24)	Nonoperative (n = 5)	P value	Combined (n = 29)
Age, y	27.3 ± 3.4	27.8 ± 0.8	.5	27.4 ± 3.1
BMI	32.0 ± 4.8	30.8 ± 2.4	.97	31.8 ± 4.4
Position				
QB	3 (12.5)	1 (20)		4 (13.8)
WR	3 (12.5)	0 (0)		3 (10.3)
RB	2 (8.3)	1 (20)		3 (10.3)
OL	5 (20.8)	0 (0)		5 (17.2)
DL	4 (16.7)	1 (20)		5 (17.2)
LB	3 (12.5)	1 (20)		4 (13.8)
DB	4 (16.7)	1 (20)		5 (17.2)
RTP	19 (79)	4 (80)	.97	23 (79)
RTP time, d	259.5 ± 61.4	0 ± 0	.001	198.4 ± 125.3
Career length, games	31.9 ± 48.9	58.2 ± 53.9	.32	36.6 ± 49.8
Career length, y	2.5 ± 3.3	4.2 ± 3.8	.35	2.8 ± 3.4
Performance score ratio*	1.0 ± 0.6	1.0 ± 0.8	.97	1.0 ± 0.7

Continuous variables are presented as mean ± SD. Categorical variables are presented as frequency (percentage). BMI, body mass index; DB, defensive back; DL, defensive linemen; LB, linebacker; NFL, National Football League; OL, offensive linemen; QB, quarterback; RB, running back; RTP, return to play; SD, standard deviation; WR, wide receiver.
*Calculated average PS, ratio do not include offensive line.

Table III
Characteristics of NFL players with a rotator cuff tear (RTP vs. no RTP).

Variable	RTP (n = 23)	No RTP (n = 6)	P value
Age, y	26.7 ± 2.5	30.3 ± 3.7	.02
Years in league prior to injury	4.0 ± 2.2	7.50 ± 2.74	.01
BMI	31.6 ± 4.4	32.5 ± 5.1	.85
Operative	19 (79)	5 (80)	.97
Nonoperative	4 (21)	1 (20)	

Continuous variables are presented as mean ± SD. Categorical variables are presented as frequency (percentage). BMI, body mass index; NFL, National Football League; RTP, return to play; SD, standard deviation.

Analysis by position demonstrated that linemen made up the largest subgroup representing 34.4% (10/29) of the entire cohort. When linemen were compared to all other position groups, there were no differences in RTP rates, number of games played after injury, number of seasons played after injury, or PS ratios. The only significant difference between linemen and other position groups was average BMI (Table IV).

Discussion

Rotator cuff tears are rare injuries in NFL athletes and there are limited data to help guide players and team physicians regarding RTP after suffering this type of injury. Despite the frequency of shoulder injuries in professional football, we identified only 29 athletes with a rotator cuff tear over a 20-year period. Our study found that 79% of the players who suffered a rotator cuff tear were able to RTP at the same professional level. Age and playing career length prior to injury appeared to be the only factors identified that impacted RTP rates, with older, veteran players less likely to RTP than younger players. Most players (83%) underwent surgical treatment for their injury and 80% of these players were able to RTP at the same performance level when compared to their preinjury performance level. Only five players were treated nonsurgically and 80% of these players were also able to RTP at the same professional level. There was no difference in RTP rates, career longevity, or performance between the operative and nonoperative cohorts.

Two prior studies have examined rotator cuff injuries and RTP in elite-level football players. In 1996, Blevins et al reported on a series of ten contact athletes (9 professional American football players and 1 recreational American football player) with rotator cuff tears

that underwent operative management. A 90% RTP rate was noted in this series, 70% at the same level.² In 2002, Foulk et al published the results of a survey of NFL team physicians that examined the incidence and clinical outcomes of rotator cuff tears in NFL players over a 10-year period from 1983 to 1993. The authors identified 51 full-thickness tears in 49 players and 90% of these tears underwent surgical repair with either an open or mini-open technique. Ninety-three percent of players returned to play at a mean of 5 months, while 3 players elected for retirement.⁴ Our cohort of NFL athletes demonstrated similar outcomes with 80% of the players returning to play at the same level after suffering a rotator cuff tear. Method of treatment (surgical vs. nonsurgical), position, and BMI did not appear to influence overall RTP rates. The only significant differences between the players that returned to play vs. those that did not RTP were age and playing career length at the time of injury with older, veteran players being less likely to RTP. The average age of the players that did not RTP was 30.3 years, with 4 of these 6 players older than 30 at the time of initial injury. In addition to being older, these players also averaged 3 more seasons of playing career length when compared to the players that were able to RTP. Based on these data, veteran NFL players over 30 years of age who suffer a rotator cuff tear should be counseled appropriately regarding these lower RTP rates regardless of treatment or position.

Another study evaluated the effect of rotator cuff tears on performance level in elite-level football players. In this study, the authors evaluated the impact of a preexisting rotator cuff tear on draft status, career performance and career longevity for players that attended the NFL Combine from 2003 to 2011. The conclusions from this study were that a preexisting rotator cuff tear negatively impacted the players' ability to be drafted and if drafted the history of a rotator cuff tear negatively impacted career longevity and performance.⁵ Evaluation of our cohort of NFL athletes revealed that not only did most players RTP after their injury but they returned at the same performance level when compared to their preinjury performance. Career longevity also did not appear to be negatively impacted as players in our series returned to play for an average of 2.8 years after their injury. Given that the average NFL playing career has been reported to be approximately 2.7 years, a postinjury average playing career of 2.8 years appears promising.⁹

Acute surgical repair is generally recommended for young patients who are diagnosed with symptomatic rotator cuff tears.^{2,4,10} In our series, 24 of the 29 players (82.7%) underwent surgical treatment, while 5 of the 29 (17.2%) were definitively managed

Table IV
Linemen vs. all other positions.

Variable	Linemen (n = 10)	All other positions (n = 19)	P value
Age, y	27.3 ± 3.0	27.5 ± 3.2	.98
BMI	37.0 ± 2.8	29.1 ± 2.0	.0001
RTP rate	8 (80)	15 (79)	.95
RTP time, d	231.7 ± 123.2	180.3 ± 128.5	.35
Career length, games	34.8 ± 41.0	37.4 ± 54.5	.89
Career length, y	2.6 ± 2.7	23.0 ± 3.8	.96
Performance score ratio	1.2 ± 0.8*	1.0 ± 0.6	.51

Continuous variables are presented as mean ± SD. Categorical variables are presented as frequency (percentage).

BMI, body mass index; RTP, return to play; SD, standard deviation.

*Calculated average PS, ratio do not include offensive line.

nonoperatively. While there was no significant difference in RTP rates between the operative and nonoperative cohort, players treated nonoperatively were able to RTP sooner. This difference in RTP time is not surprising given the time needed for adequate recovery and rehabilitation after surgical intervention. However, given the size of our cohort and limited data regarding tear size and pattern, we are unable to draw conclusions regarding the superiority of treatment type. It is likely that the players treated nonoperatively had less severe injuries like partial tears and were therefore able to recover and play through their injury. Another interesting finding is that 7 of the 24 (29.1%) players in the operative cohort were able to RTP after their initial injury and then underwent delayed surgical intervention at the end of the season. This delay in surgery did not appear to negatively impact these players, as all 7 were able to RTP the following season. This is consistent with a similar finding reported by Foulk et al, who noted that 42 of 49 NFL players with rotator cuff tears in their series underwent delayed surgical repair at the end of the season and 41 of the 42 (97.6%) were able to RTP at the same level for at least 1 season.⁴ While delayed surgical intervention does not appear to impact overall RTP rates, it does come with significant risks including additional concomitant shoulder injuries, rotator cuff tear progression, and progressive muscle atrophy. Further studies with serial imaging could help clarify the true risk of delayed surgical intervention for rotator cuff tears in elite contact athletes.

Historically, rotator cuff tears have been found to occur more frequently in lineman when compared to other positions.^{4,5} Analysis of our cohort is consistent with prior studies and found that lineman made up the largest position group with 30% of the tears occurring in lineman. This increased incidence of rotator cuff tears in lineman is not fully understood but may be due to the physicality of the position and large repetitive loads placed across their shoulders. While these previous studies have also demonstrated less favorable RTP rates for lineman, our data demonstrated comparable RTP rates and career longevity for lineman when compared to other position groups.^{4,5} The exact reason for this difference is unclear but may be related to the evolution of surgical techniques, improved rehabilitation, or the limitations in full contact practices that have been instituted over the years as part of the collective bargaining agreement.

There are several limitations that should be noted with regard to this study. As in other similar published studies, the data used for analysis were collected using publicly available independent third-party sources and not official medical records. This methodology can lead to possible inaccuracies in terms of diagnosis, treatment type, concomitant injuries, and RTP statistics. Minor injuries or conservatively treated injuries may not be reported correctly in

sports media and injuries reported as “shoulder injury,” “subluxation” or “shoulder dislocation,” may also include rotator cuff problems. Also, detailed information like type (partial vs. full thickness), size, and location of the tear were not available yet could be important factors that influence treatment, RTP, and performance. In our study, there was no difference in rotator cuff tear rates between positions, but we were unable to assess whether certain positions were associated with certain tear patterns that may affect treatment modality. Additionally, the study could not collect detailed surgical information like surgical approach (open vs. arthroscopic), surgical procedure (débridement vs. repair), method of fixation, or concomitant procedures. Additionally, the small sample size may be underpowered to detect many differences that may be real but not observed in this cohort.

While the ability to RTP is an important metric, particularly for a professional athlete, it may not always correlate to a good to excellent clinical outcome and we were unable to comment on the presence of persistent pain or functional deficits after the rotator cuff injury. Conversely, the exact reasons for a player not returning to play could not be elucidated and may be due to factors unrelated to their rotator cuff tear. Finally, as with any study analyzing RTP in professional contact athletes, the incentives and motivations are unique to each player’s contract and situation and may not be generalizable to other athletic populations.

Conclusion

Overall RTP rates for NFL athletes that suffer a rotator cuff tear are promising with approximately 80% of the players able to return at the same performance level regardless of treatment (operative vs. nonoperative). Older, veteran players, particularly those over the age of 30 were significantly less likely to RTP after suffering a rotator cuff tear and should be counseled regarding this risk.

Disclaimers:

Funding: No funding was disclosed by the authors.

Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

- Bakshi NK, Khan M, Lee S, Finney FT, Stotts J, Sikka RS, et al. Return to play after multiligament knee injuries in National Football League athletes. *Sports Health* 2018;10:495-9. <https://doi.org/10.1177/1941738118768812>.
- Blevins FT, Hayes WM, Warren RF. Rotator cuff injury in contact athletes. *Am J Sports Med* 1996;24:263-7.
- Cotton MO, Slipek JM 3rd, Klavas DM, McCulloch PC, Harris JD, Jack RA 2nd. Performance and return to sport after open fracture in National Football League players. *Orthop J Sports Med* 2021;9:23259671211027862. <https://doi.org/10.1177/23259671211027862>.
- Foulk DA, Darmelio MP, Rettig AC, Misamore G. Full-thickness rotator-cuff tears in professional football players. *Am J Orthop* 2002;31:622-4.
- Gibbs DB, Lynch TS, Gombera MM, Saltzman MD, Nuber GW, Schroeder GD, et al. Preexisting rotator cuff tears as a predictor of outcomes in National Football League athletes. *Sports Health* 2016;8:250-4. <https://doi.org/10.1177/1941738116636602>.
- Hsu WK. Performance-based outcomes following lumbar discectomy in professional athletes in the National Football League. *Spine* 2010;35:1247-51. <https://doi.org/10.1097/BRS.0b013e3181bf8bb5>.
- Jildeh TR, Buckley P, Abbas MJ, Page B, Young J, Mehran N, et al. Impact of patellar tendinopathy on player performance in the National Basketball Association. *Orthop J Sports Med* 2021;9:23259671211025305. <https://doi.org/10.1177/23259671211025305>.
- Kaplan LD, Flanigan DC, Norwig J, Jost P, Bradley J. Prevalence and variance of shoulder injuries in elite collegiate football players. *Am J Sports Med* 2005;33:1142-6. <https://doi.org/10.1177/0363546505274718>.

9. Khalil LS, Jildeh TR, Abbas MJ, McIntosh MJ, Sokoli A, Cominos ND, et al. Career longevity and performance after shoulder instability in National Football League athletes. *Arthroscopy* 2021;37:1437-45. <https://doi.org/10.1016/j.arthro.2020.12.225>.
10. Khalil LS, Jildeh TR, Taylor KA, Gullledge CM, Smith DG, Sandberg ML, et al. The relationship between shoulder range of motion and elbow stress in college pitchers. *J Shoulder Elbow Surg* 2021;30:504-11. <https://doi.org/10.1016/j.jse.2020.06.016>.
11. Okoroa KR, Kadri O, Keller RA, Marshall N, Cizmic Z, Moutzouros V. Return to play after revision anterior cruciate ligament reconstruction in National Football League players. *Orthop J Sports Med* 2017;5:2325967117698788. Published 2017 Apr 4. <https://doi.org/10.1177/2325967117698788>.
12. Weiss LJ, Wang D, Hendel M, Buzzerio P, Rodeo SA. Management of rotator cuff injuries in the elite athlete. *Curr Rev Musculoskelet Med* 2018;11:102-12. <https://doi.org/10.1007/s12178-018-9464-5>.