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Performance and Return to Sport After Achilles Tendon Repair in National Football League Players

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Abstract

Background: Achilles tendon injuries are common in sports, including football. The purpose of this study was to determine (1) return-to-sport rate in National Football League (NFL) players following Achilles tendon repair, (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.

Methods: Publicly available records were used to identify NFL players who underwent Achilles tendon repair and matched controls were identified. Ninety-five players (98 surgeries) were analyzed (mean age 28.2 ± 2.8 years; mean 5.5 ± 2 .8 years in NFL at time of surgery). Demographic and performance data were collected. Comparisons between case and control groups and preoperative and postoperative time points were made using paired-samples Student *t* tests.

Results: Seventy-one (72.4%) players were able to return to sport in the NFL at a mean of 339.8 ± 84.8 days following surgery. Thirty-one (32%) Achilles tendon repairs were performed during training camp or preseason. Controls (3.6 ± 2.1 years) had a significantly longer NFL career ($P < .05$) than players who underwent Achilles tendon repair (2.7 ± 2.1 years). There was no significant difference in games per season in subsequent seasons following surgery compared with controls. Postoperative performance scores were significantly worse ($P < .05$) for running backs (RBs) (n = 4) and linebackers (LBs) (n = 12) compared to preoperative scores. LBs had significantly worse postoperative performance scores when compared to matched controls ($P < .05$).

Conclusion: Following Achilles tendon repair, less than 75% of players returned to the NFL. Postoperative career length was 1 season shorter than matched controls. No difference was observed in the number of games per season played compared to matched controls. Postoperative performance scores were significantly worse for RBs and LBs compared to preoperative and LBs had significantly worse postoperative performance when compared to matched controls.

Level of Evidence: Level III, retrospective comparative series.

Keywords: Achilles tendon, NFL, football, surgery, return to sport

Introduction

Achilles tendon tears are one of the most common foot and ankle injuries in both contact and noncontact sports.[10] These injuries are a source of significant morbidity with an incidence as high as 18 per 100 000 people.[15-17,20] Recent evidence suggests that the incidence is increasing secondary to an increase in athletic participation that accounts for 68% of all Achilles tendon tears.[21,22]

The pathophysiology of Achilles tendon tears involves the interplay of intrinsic (degenerative changes, hypovascularity, repetitive microtrauma) and extrinsic (rapid acceleration/deceleration) factors.[22] Elite level athletes required to perform explosive changes in direction and extreme loading of the Achilles tendon are at increased risk for Achilles tendon tears.[17] This explosive acceleration and rapid deceleration associated with Achilles tendon tears is displayed and often required by National Football League (NFL) players.

Many elite athletes elect for operative repair of their torn Achilles tendon secondary to lower rerupture rates, improved strength, and high return to sport.[7] However, recent studies demonstrated that injuries that are severe

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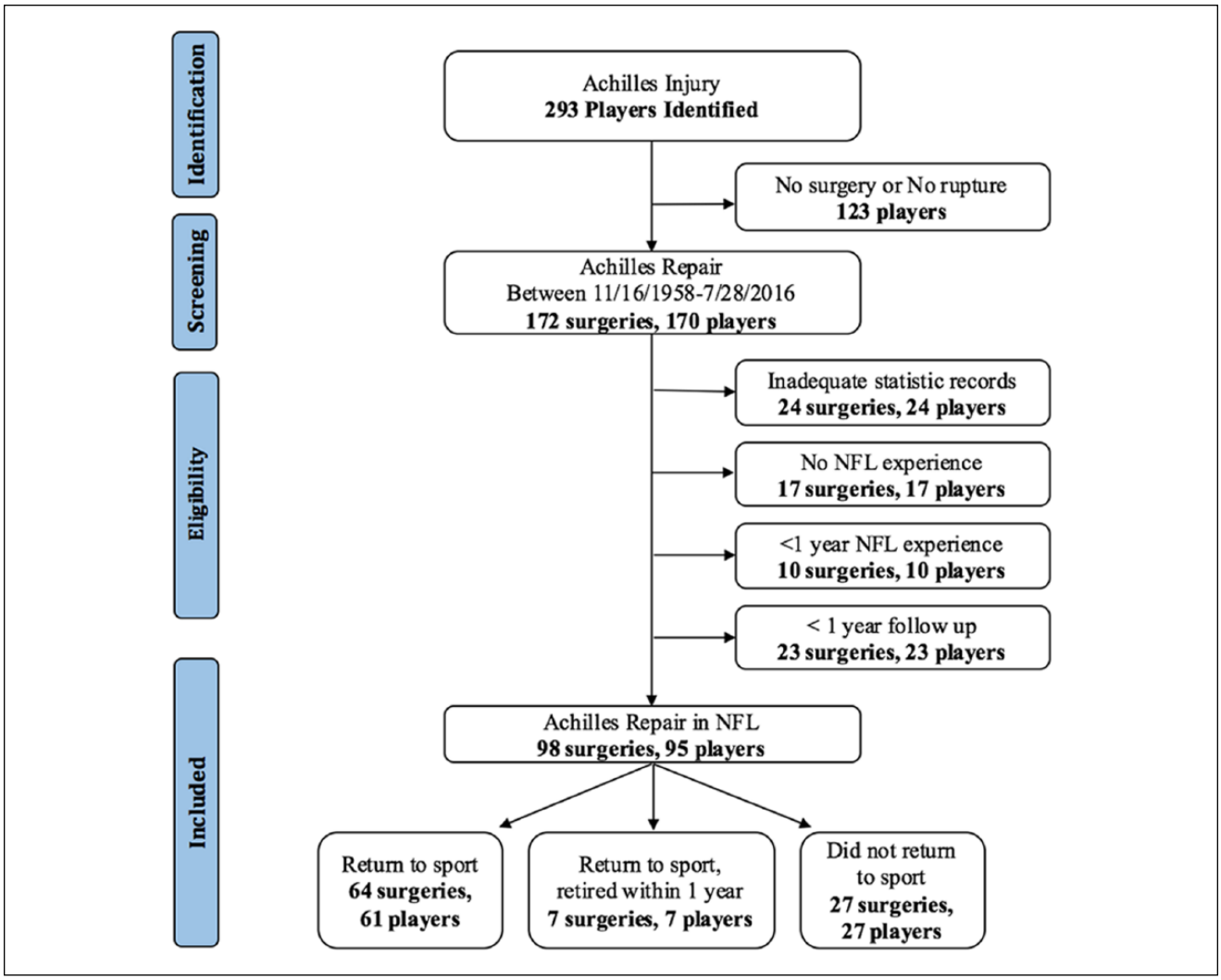

Figure 1. Flowchart illustrating application of exclusion criteria.

enough to warrant operative intervention in NFL players can have a negative effect on postoperative performance, return to sport (RTS), and length of career.[4,18] Given the increasing revenue and popularity of the NFL, it is important to understand operative 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 Achilles tendon repair in NFL athletes.

The purpose of this study was to determine (1) RTS rate in NFL players following Achilles tendon repair, (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 Achilles tendon repair would have (1) a 75% RTS rate, (2) a postoperative career length and games per season significantly less than that of matched controls, (3) significantly worse postoperative performance compared to preoperative, and (4) significantly worse performance postoperatively when compared with matched controls.

Methods

Players in the NFL who sustained an Achilles tendon tear and underwent repair 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. 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.

All players identified who met inclusion criteria were evaluated in this study as it related to RTS rate. A player was deemed to have RTS if he played in any NFL game

Table 1. Number of Surgeries With Return to Sport (RTS) Data by Position.

Position	n	RTS, n	RTS, %	Days to RTS
QB	5	5	100.0	326.4 ± 17.5
RB	11	5	45.5	363.6 ± 119.3
TE	5	3	60.0	326.3 ± 74.1
WR	10	8	80.0	317.5 ± 160.4
DB	12	9	75.0	336.2 ± 38.5
LB	19	14	73.7	351.1 ± 42.7
DL	21	17	80.1	328.2 ± 83.4
OL	13	8	61.5	341.9 ± 98.1
K	1	1	100.0	501
P	1	1	100.0	403
Total	98	71	72.4	339.8 ± 84.8

Abbreviations: DB, defensive back; DL, defensive lineman; K, kicker; LB, linebacker; OL, offensive lineman; P, punter; QB, quarterback; RB, running back; RTS, return to sport; TE, tight end; WR, wide receiver.

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 or listed on injured reserve in the NFL prior to Achilles tendon tear. Players were included if they were found to have Achilles tendon repair surgery 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 an Achilles tendon tear and underwent Achilles tendon repair in the 2015-2016 season were excluded from analysis because they had less than a 1-year opportunity to return to sport. In addition, online reports that were conflicting, incomplete, or did not have a date of surgery were also excluded from the study. Ninety-eight surgeries in 95 players were analyzed (Table 1).

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." Performance statistics were collected from profootballreference.com for each player identified before and after Achilles tendon repair (Appendix A). 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, years of experience, and performance data prior to the surgery date (Table 2). Each control was given an index date that matched the case player's surgery date to compare postoperative or postindex performance. For example, if a player had Achilles repair surgery 3 years into his career, the control's index date was 3 years into his career.

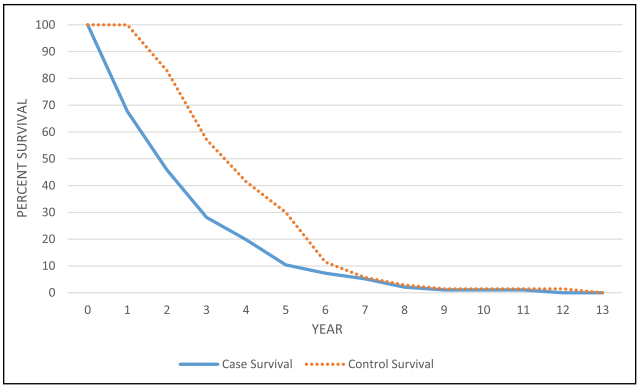

Figure 2. Kaplan-Meier survival analysis for cases and controls. Zero (0) signifies year of surgery for cases and index year for controls.

Player statistics for cases pre- and postoperative and controls pre- 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 (Appendix B) was then calculated by using a previously published and standardized scoring system based on metrics important to the player's specific position.[5,18,25] 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 endpoint 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* less than .05.

Results

One player retore his ipsilateral Achilles tendon within 1 month of surgery and returned to sport. He was counted as a single event. One player retore his ipsilateral Achilles and did not return to sport. He was counted as a single event. One player tore both Achilles 2 years apart and was counted as 2 separate events. Seventy-one (72.4%) players were able to return to sport in the NFL. The overall 1-year survival rate of players undergoing Achilles tendon repair surgery was 67.7% (Figure 2). Players in the control group (3.6 ± 2.1 years) were in the NFL significantly longer ($P < .001$) than players who underwent Achilles tendon repair surgery (2.7 ± 2.1 years) (Table 3). Players in the control group (12.9 ± 2.8 games per season) played in a similar number of games per season postindex than players who underwent

Table 2. Age and Experience for Each Position at Time of Surgery (for Cases) and Index Time (for Controls).

		Age, y (Mean ± SD)			Experience (Mean ± SD)		
Position	n	Cases	Controls	*P* Value	Cases	Controls	*P* Value
QB	5	30.8 ± 3.7	31.1 ± 4.2	.531	8.1 ± 3.8	7.7 ± 5.0	.587
RB	5	27.9 ± 3.5	27.4 ± 2.9	.352	4.4 ± 2.7	4.4 ± 3.1	1.000
TE	3	28.5 ± 3.4	28.4 ± 3.9	.792	6.1 ± 3.6	6.1 ± 3.6	1.000
WR	8	25.9 ± 2.5	25.8 ± 2.5	.876	3.1 ± 2.4	3.0 ± 2.4	.351
DB	9	27.3 ± 2.1	27.5 ± 2.3	.399	4.9 ± 2.5	4.8 ± 2.2	.347
LB	14	28.1 ± 2.1	27.9 ± 2.4	.607	5.8 ± 2.1	5.8 ± 2.1	1.000
DL	17	28.5 ± 3.2	28.2 ± 3.4	.317	5.6 ± 3.2	5.6 ± 3.1	.332
OL	7	29.4 ± 1.7	29.4 ± 2.3	.957	6.3 ± 2.0	6.3 ± 2.0	1.000
K	1	27.3	27.2		5.2	5.2	
P	1	29.5	29.1		6.3	6.3	
Overall	70	28.2 ± 2.8	28.0 ± 3.0	.309	5.5 ± 2.8	5.4 ± 2.9	.199

Abbreviations: DB, defensive back; DL, defensive lineman; K, kicker; LB, linebacker; OL, offensive lineman; P, punter; QB, quarterback; RB, running back; SD, standard deviation; TE, tight end; WR, wide receiver.

Table 3. Games per Season and Career Length Postsurgery and Postindex for Cases and Controls.

		Games per Season, n (Mean ± SD)			Career Length, y (Mean ± SD)		
Position	n	Cases	Controls	*P* Value	Cases	Controls	*P* Value
QB	5	10.0 ± 3.2	9.6 ± 4.4	.886	6.2 ± 3.5	5.6 ± 4.1	.671
RB	5	13.0 ± 2.7	12.6 ± 1.6	.808	1.3 ± 0.8	3.2 ± 1.8	.084
TE	3	13.1 ± 3.0	8.4 ± 1.3	.198	2.3 ± 1.5	2.2 ± 1.7	.844
WR	8	10.9 ± 5.4	14.8 ± 1.1	.101	2.7 ± 2.4	4.1 ± 2.0	.195
DB	9	12.7 ± 2.2	13.3 ± 2.3	.361	2.4 ± 1.2	3.9 ± 1.5	.022*
LB	14	14.2 ± 2.4	13.7 ± 2.4	.606	2.5 ± 2.2	3.7 ± 2.2	.001*
DL	17	12.2 ± 4.0	13.4 ± 2.5	.343	2.4 ± 1.6	3.3 ± 2.0	.002*
OL	7	12.8 ± 2.5	12.3 ± 2.5	.775	3.4 ± 1.0	3.1 ± 1.1	.209
K	1	13.0	8.0		1.3	2.0	
P	1	16.0	16.0		1.0	4.0	
Overall	70	12.6 ± 3.4	12.9 ± 2.8	.513	2.7 ± 2.1	3.6 ± 2.1	<.001*

Abbreviations: DB, defensive back; DL, defensive lineman; K, kicker; LB, linebacker; OL, offensive lineman; P, punter; QB, quarterback; RB, running back; SD, standard deviation; TE, tight end; WR, wide receiver.
*Statistically significant.

Achilles tendon repair surgery (12.6 ± 3.4) postsurgery (Table 3).

Thirty-two (100%) of the NFL's teams had at least 1 Achilles tendon repair surgery performed. The team with the greatest number of players undergoing Achilles tendon repair was the New York Jets, with 9 (9%) players. The most common position to undergo Achilles tendon repair surgery was DL, with 21 (21%) players (Table 1). Sixty-three (64%) Achilles tendon repairs occurred in the off-season.

There were no significant ($P > .05$) differences in demographic, performance, and games per season data between cases and matched controls presurgery and preindex (Tables 2-4). Postoperative performance scores were significantly worse for RBs ($P = .04$) and LBs ($P = .03$) compared to preoperative scores (Figure 3). There was a statistically significant ($P = .04$) decrease in games per season for DL cases following surgery (Table 4). LBs had significantly worse postoperative performance scores when compared to postindex matched controls ($P < .05$) (Figure 3). There was a clinically significant decline in performance statistics following Achilles tendon repair compared to controls for QBs (5 touchdowns and 60 passing yards per year), RBs (5 touchdowns per year), TEs (6 touchdowns per year), DBs (2 interceptions and 1 pass defended per year), and LBs (7 sacks or 28 tackles per year).

Discussion

The authors hypothesized that NFL players who underwent Achilles tendon repair would have (1) a 75% RTS rate, (2) a postoperative career length and games per season significantly less than that of matched controls, (3) significantly worse postoperative performance compared to preoperative,

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

	Presurgery and Preindex (Mean ± SD)			Postsurgery (Mean ± SD)	
Position	Cases	Controls	*P* Value[a]	Cases	*P* Value[b]
QB	10.9 ± 4.4	10.4 ± 3.3	.494	10.0 ± 3.2	.715
RB	12.9 ± 4.7	12.9 ± 2.8	.999	13.0 ± 2.7	.982
TE	13.9 ± 1.4	14.4 ± 1.8	.725	13.1 ± 3.0	.667
WR	12.4 ± 2.7	13.1 ± 1.6	.264	10.9 ± 5.4	.514
DB	14.1 ± 1.6	14.1 ± 3.0	.993	12.7 ± 2.2	.219
LB	14.4 ± 1.7	14.5 ± 1.2	.899	14.2 ± 2.4	.797
DL	14.4 ± 2.0	14.1 ± 1.7	.619	12.2 ± 4.0	.040*
OL	13.3 ± 1.6	14.2 ± 1.5	.243	12.8 ± 2.5	.646
K	13.2	10.8		13.0	
P	12.0	16.0		16.0	

Abbreviations: DB, defensive back; DL, defensive lineman; K, kicker; LB, linebacker; OL, offensive lineman; P, punter; QB, quarterback; RB, running back; SD, standard deviation; TE, tight end; WR, wide receiver.
[a]Student *t* test comparing case presurgery and control preindex games/season.
[b]Student *t* test comparing case presurgery and case postsurgery games/season.

and (4) significantly worse performance postoperatively when compared with matched controls. The first study hypothesis was confirmed because there was a 72.4% 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 not significantly different, RBs and LBs had significantly worse postoperative performance, and LBs had significantly worse postoperative performance when compared to matched controls.

One previous study investigated RTS and postoperative performance for players who underwent Achilles tendon repair in the NFL.[18] The prior study demonstrated an RTS of 72.5% in 80 NFL athletes.[18] The RTS from this prior study is nearly identical to the results of the present study with an RTS of 72.4% in 95 NFL athletes. However, this study did not evaluate performance scores for specific position groups and did not compare the outcomes of Achilles tendon repair against matched controls. 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 point in 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. Furthermore, there may be the same pathology present on the contralateral side similar to that of the operative side, with recent studies demonstrating a contralateral Achilles tendon rupture rate as high as 6.4%.[11,21,26]

Despite an RTS of 72.4%, there was a large number of players who retire within the next few seasons after surgery and index year. By year 3 postsurgery, only 28.1% of players who underwent Achilles tendon repair surgery remained 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.[24] The average experience for players in this investigation was 5.5 years, already surpassing the overall career length average. The average career length after Achilles tendon repair surgery has previously been described as 1.6 years.[18] The current investigation found an average career length of 2.7 years after Achilles tendon repair surgery. 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 difference in career length after surgery when comparing cases (2.7 years) to controls (3.6 years), which has not previously been described.

The highest number of Achilles tendon repair surgeries occurred in DL (21), LB (19), and OL (13). This is a similar distribution to a previous study looking at the effect of injury on a career in the NFL in which DL and OL had the highest and third highest incidence of injury, respectively.[4] Interestingly, offensive (37.1 ± 1.9) and defensive (34.6 ± 1.4) linemen have the highest body mass index (BMI) in NFL players.[14] With recent studies demonstrating a significantly increased incidence of Achilles tendon pathology in patients with elevated BMI, the increased number of Achilles tendon injuries in these players could be secondary to the elevated BMI.[12,13,23]

Prior studies have also failed to comment on performance and RTS differences between position groups following Achilles tendon repair. The RBs' and LBs' performance significantly regressed postoperatively, and the LBs had significantly worse performance postoperatively compared to matched controls. There was an average performance score difference per game of 1.9 for RBs and 1.8 for LBs. Extrapolated over a 16-game season, this results in a performance score difference of 30.4 and 28.8 for RBs and LBs, respectively. Using the performance score, RBs had 5 fewer touchdowns and LBs had 7 fewer sacks and 28 fewer tackles compared to matched controls, indicating both clinically and statistically significant results.

Furthermore, the TE and DB positions regressed postoperatively while their controls remained similar or improved. There is an average performance score difference per game of 2.3 and 0.7 for TEs and DBs, respectively. Extrapolated over a 16-game season, the result is a performance score difference of 36.8 for TEs and 11.2 for DBs, which equates to 6 touchdowns per season for TEs and 2 interceptions and 1 pass defended per season for DBs. The QBs' performance scores decreased postoperatively and postindex in the controls resulting in a performance score difference per game of 1.4 between the cases and controls. Using the same logic, this results in 5 touchdowns and 60 passing yards per

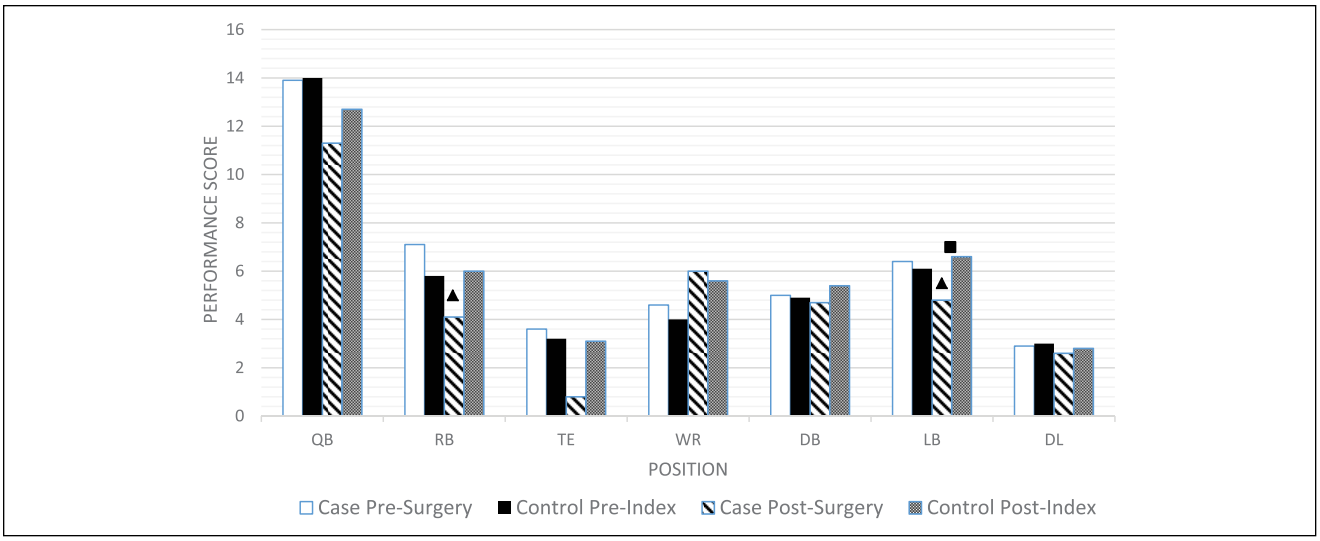

Figure 3. Performance scores by position before and after surgery compared to controls pre- and postindex. ▲, significant difference between pre- and postsurgery performance scores for cases; ■, significant difference between postsurgery and postindex performance scores.

season fewer than controls. Although these differences in performance are not statistically significant, they are clearly clinically significant.

Interestingly, the RBs, OLs, and LBs also had the worst RTS, with only 45.5% of RBs, 61.5% of OL, and 73.7% of LBs returning to sport postoperatively. On the other hand, QBs and special team players had an RTS of 100%. This trend is similar to that found in a previous study looking at the effect of injury on a career in the NFL in which LBs, RBs, and OL were the most negatively affected by injury and QBs and specialists were the least negatively affected by injury.[4]

The majority (64%) of NFL players in the present study sustained Achilles tendon rupture and underwent Achilles tendon repair surgery during the offseason training camps. No study has directly compared Achilles tendon ruptures between the offseason training camps and regular season. However, a prior study by Feeley et al demonstrated significantly more injuries occurred during the first 2 weeks of training camp compared to the final 3 weeks, with the severity of injuries decreasing as the training camp progressed.[9] Additionally, a study of professional rugby players found there to be significantly increased injuries in the preseason compared to the regular season.[3] Askling et al found that a preseason program improved function and decreased injury rate in professional soccer players, indicating that the addition of preseason strength and conditioning training may be beneficial to elite professional athletes.[2] These findings may have significant implications in the occasional recreational athlete who may have limited conditioning.

There are several limitations of this study. The use of publicly available data to identify Achilles tendon tears and repairs is prone to selection, reporting, and observer bias. However, this method of data acquisition has been used in multiple previous studies.[1,6,8,18,19] Additionally, the use of public data limits the ability to obtain the severity of the injury and the exact operative procedure (open or percutaneous) being performed for Achilles tendon repair. 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. 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 specialist with performance scoring.

Conclusion

Following Achilles tendon repair, less than 75% of players returned to the NFL. Postoperative career length was 1 season shorter than matched controls. No difference was observed in the number of games per season played compared to matched controls. Postoperative performance scores were significantly worse for RBs and LBs compared to preoperative, and LBs had significantly worse postoperative performance when compared to matched controls.

Appendix A

Position	Variables Collected
Quarterback	Demographic: Age, experience Presurgery and postsurgery (and index) variables: Number of seasons, games Total, per game, and per season variables collected pre- and postsurgery (and index): Completions, attempts, completion percentage, passing yards, passing touchdowns, interceptions, sacks, fumbles, rushing yards, rushing touchdowns
Running back	Demographic: Age, experience Presurgery and postsurgery (and index) variables: Number of seasons, games Total, per game, and per season variables collected pre- and postsurgery (and index): Rushing attempts, rushing yards, rushing yards per attempt, rushing touchdowns, receptions, receiving yards, receiving touchdowns, fumbles
Tight end / wide receiver	Demographic: Age, experience Presurgery and postsurgery(and index) variables: Number of seasons, games Total, per game, and per season variables collected pre- and postsurgery (and index): Receptions, receiving yards, receiving yards per reception, receiving touchdowns, fumbles
Offensive lineman / punter / kicker	Demographic: Age, experience Presurgery and postsurgery (and index) variables: Number of seasons, games
Defensive back / linebacker / defensive lineman	Demographic: Age, experience Presurgery and postsurgery (and index) variables: Number of seasons, games Total, per game, and per season variables collected pre- and postsurgery (and index): Tackles, assisted tackles, total tackles, sacks, safeties, interceptions, forced fumbles, touchdowns, passes deflected

Appendix B

Position	Performance Score Formula
Quarterback	(Passing yards ÷ 25) +(Passing touchdowns × 4) + (Rushing yards ÷ 10) + (Rushing touchdowns × 6)
Running back / wide receiver / tight end	(Receiving yards ÷ 10) + (Receiving touchdowns × 6) + (Rushing yards ÷ 10) + (Rushing touchdowns × 6)
Defensive players	(Tackles) + (Assists ÷ 2) + (Sacks × 4) + (Passes defended) + (Interceptions × 5) + (Interceptions / Fumbles returned for touchdowns × 6) + (Forced fumbles × 3) + (Fumbles recovered × 2) + (Safeties × 2)

Declaration of Conflicting Interests

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