

Analysis of nfl injuries



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INTRODUCTION

Achilles tendon (AT) ruptures are increasing in incidence across all populations[1-9]. Recent large-scale analyses put the incidence as high as 7-40 ruptures per 100,000 person-years[3-5, 10]. A 33-year study from Finland discovered from 1979 to 2011 the injury rate increased from 2.1 to 21.5 ruptures per 100 person-years in all age groups and activities[6]. Even in the athlete population, the number of athletes suffering AT ruptures is increasing which poses a potentially career-altering and even ending injury[1, 6, 11-13]. Nearly a third (27.5-32%) of all National Football League (NFL) players who suffer an AT rupture are unable to return to competition[13, 14]. In the NFL from 1980-2001, around 4 AT ruptures that required surgical intervention occurred each year[11]. From 2009 to 2014 in the NFL, there was an average of 14.67 (Standard deviation: 4.13) AT ruptures each season[15].

These ruptures are seen most frequently in running, jumping and cutting movements[6, 12, 16]. Achilles tendon ruptures typically occur from a non-contact mechanism during explosive acceleration or a sudden change of direction with an eccentrically loaded foot[14]. The AT has elastic properties that are required for locomotion and is the strongest tendon in the human body[12, 17, 18]. This elastic nature and strength allows it to transmit high forces, up to 12 times one's body weight[17, 19, 20]. Durability requirements of the AT create a unique set of challenges in proper treatment decisions. Current reconstruction concepts differ behind the ideal treatment strategy[9, 21]. The recovery process from all surgical techniques is an arduous challenge involving significant physical therapy and medical treatment.

Unfortunately a majority of patients, especially those in the general population are able to return to a pre-injury level, with the current exception being elite athletes[22].

Although several studies evaluate AT ruptures in multiple populations, including professional athletics, studies that assess trends in professional football are scarce. NFL athletes provide an interesting patient population due to the intricate details and variables reported for every game where data is archived and widely available. A recent NFL Injury Surveillance System (ISS) analysis by Mai HT et al., discovered only a 72.5% return to play rate for athletes who suffered an AT rupture. If the athlete was able to return, the average return was 375.1 days, similar to the recovery period for ACL reconstruction (378.1 days)[13]. Athletes fortunate enough to return to competitive action frequently experience a significant decline in performance, and their competitive athletic longevity may be shortened[13, 14, 23]. The potential devastating effect on high-level athletes has required the development of ideas to optimize treatment management and improve return to play rates[23].

Previously, anterior cruciate ligament (ACL) injuries have been scrutinized due to their high incidence, long rehabilitative process and potential career-threatening nature of the injury[24]. A recent review by Balazs et al. identified four studies that found an increased risk of ACL injury on artificial playing surfaces in football cohorts, although these findings are not consistent across all studies[24]. Current research evaluates multiple variables in efforts to find potential contributing risk factors, including playing surface, that may increase the risk and rate of these devastating

injuries[24, 25]. Identifying and understanding risk factors from prior research has been used to develop and improve protocols and outcomes after ACL injuries[24]. With the growing incidence of AT injuries, research is necessary to improve management and prevention of AT ruptures, especially in football players where the current literature is limited.

This study performed an extensive review of reported NFL injuries from public injury records and injury reports during the 2009-10 to 2016-17 seasons. This data was compiled to monitor the incidence and injury rates of AT injuries that occurred during the regular season to evaluate the influence of playing surface on rupture rate. Additionally, further analysis to identify potential effects of position and frequency of injury at different periods of the season on AT ruptures was performed to guide future studies. Our hypothesis is that playing surface has no impact on the incidence and injury rate of AT ruptures in professional football players despite a recent overall increase in AT ruptures.

METHODS

A thorough online review was conducted by three co-authors to document AT ruptures sustained in the NFL between the 2009-10 and 2016-17 seasons. Online search criteria consisted of information acquired from Rotoworld.com, NFL.com, ESPN.com, SBNation.com, SI.com and from each team's local sports reports and blogs covering the team. Open searches through Google.com utilized combinations of the words "Achilles" and "tendon" along with the player, team and year of injury. Published weekly injury reports and team injury reserve lists were utilized to identify players who

suffered injuries to their lower extremity or leg. Their names were added to the open internet search key words in attempts to improve accuracy of documenting all AT ruptures of NFL athletes. Only injuries with corresponding reports that confirmed the injury were included.

Additional information gathered through the online search and acquired reports included player-specific details including team, position, approximate date of injury, activity at time of injury and other injury specific details including mechanism and playing surface when available. Injury incidence was recorded for each season. A season was defined as the day after the prior Super Bowl until the day of the Super Bowl in each given season.

Descriptive statistics characterizing the injuries by playing surface, time in the season (broken up in to four game segments specific to each team considering their bye week) and players participating on offense, defense or being a specialist (i. e. kicker, punter, long-snapper) were determined for analysis. As previously described by Lawrence et al., injury rates were calculated per 100 team-games (TG)[26]. A TG is defined as one team exposure to a game[26]. One regular season or post-season game is equal to two TG as there are two individual teams participating in each game[26]. Mid-P exact tests were calculated to evaluate differences in IRs with statistical significance established at $p < .05$.

Team and schedule information was gathered through Pro Football Reference and official team websites. The yearly team schedules and location of games played was recorded to help determine the home team and playing surface for all injuries suffered in games. Adjustments were made when games did not take place at the stadium of the home team and

corrected accordingly. An analysis of the number of AT injuries per game for each variable was calculated. An NFL game in this study included the participation of two teams. Injury rate ratios were used to compare the incidence of AT injuries on different playing surfaces (i. e. natural grass and artificial turf).

RESULTS

Between the 2009-10 and 2016-17 seasons, there were a total of 45 Achilles tendon ruptures reported in the NFL during games (Figure 1). There was a subtle increase in the number of ruptures suffered each year. The most Achilles tendon ruptures occurred during the 2013-14 and 2016-17 season (N = 9) and the incidence of ruptures on grass was 24 (IR: 1. 00 per 100 TG) compared to 21 (IR: 1. 13 per 100 TG) on artificial turf playing surfaces (Figure 2). The difference in rate was not statistically significant ($p = . 67$).

Of the 45 Achilles tendon ruptured over the eight years, 32 (71. 1%) were suffered by defensive players. Offensive players only sustained 13 ruptures and specialists reported no ruptures over that time (Figure 3). Defensive players suffered the greatest number of Achilles tendon ruptures every season monitored except for 2015-16. Defensive players had a significantly increased IR ($p = . 005$) compared to offensive players (Table 1). When factoring in the playing surface, offensive players suffered a higher percentage of their ruptures on turf (N = 8, 61. 5%) compared to defensive players that sustained a great number of their ruptures on natural grass (N = 19, 59. 4%).

Achilles tendon ruptures were most likely to occur early in the season. The greatest incidence was reported in the 1st or 2nd 4 game segments of the regular season schedule (N = 17 and N = 14 respectively). These 31 ruptures in the first 8 games of the regular season made up 68.9% of all Achilles ruptures in games over eight seasons (Table 2). There was a significant rate difference between the first four games of the regular season with the last four games of the regular season (IRR: 3.40, $p = .01$). The second four games of the regular season also demonstrated a significant rate difference with the final four games of the regular season (IRR: 2.80, $p = .04$).

DISCUSSION

Previous studies have documented the increased incidence of acute Achilles tendon ruptures in the general population. After the NFL lockout, the increasing incidence of Achilles tendon ruptures in the NFL was noted and gained national attention[11]. The purpose of this study was to document the incidence and injury rates of Achilles tendon ruptures in games over eight NFL seasons. Using this data, we were able to evaluate the potential influence of playing surface on the rate of Achilles tendon ruptures between grass and artificial turf to improve our understanding of the growing injury. Game information provides playing surface details for each game for analysis. Since this injury compilation is from public records, the ability to accurately identify the playing surface for training and practice injuries is limited.

Analysis of 4, 272 regular season and playoff team-games reported 45 Achilles tendon ruptures. The overall game injury rate was 1.05 AT ruptures per 100 TG. As the current literature on AT rupture epidemiology in professional football is limited, this is one of the few studies in the past decade reporting IRs. The IR for artificial turf was 1.13 per 100 TG and 1.00 per 100 TG on natural grass. There was no demonstrated difference between rates on artificial turf and natural grass ($p = .67$). These early findings support that playing surface does not affect the rate of AT ruptures.

Other studies evaluating injury patterns have confirmed that certain injuries are more likely during certain activities or periods of the season, like hamstring strains in the NFL preseason[27]. To further understand our findings, overall AT ruptures were broken down into four game segments of the regular season and the post-season. The greatest IR was observed in the first and second four-game portions of the regular season (IR: 1.66 and 1.37 per 100 TG respectively). The only significant rate difference occurred between those two four-game segments with the final four games of the regular season ($p = .01$ and $.04$ respectively). These findings support the significantly increased rate of injury early in the season. A further analysis of all AT ruptures in practice and games is important to help understand the significance of these early findings. Previously between the 1997 and 2002 seasons, a total AT analysis reported that Achilles tendon ruptures sustained were evenly distributed[14]. Our game findings do not support this earlier analysis; however, the overall incidence has increased substantially since the previous study[14]. Further evaluation may confirm these findings and help identify risk factors that lead to an increased risk of AT rupture early in the

season. Additionally, further evaluation should identify if this increase is only during the beginning of the regular season or is also distributed throughout pre-season training camps.

Immediately following the NFL lockout in the 2011 season, there were 10 reported Achilles tendon ruptures in the first 12 days of training camp[11]. That off-season was unique for at least the last decade due to the elimination of rookie mini-camps and off-season training sessions (OTAs), but potentially highlighted the importance of adequate preparation for current physical demands of professional football players[11]. Ultrasound evaluation found that subjects who are less active have a thinner Achilles tendon compared to athletes[18, 28]. A recent meta-analysis of 27 studies identified that differences in the loading conditions affected the adaptive responses (tendon stiffness, Young's modulus, and tendon cross-sectional area)[29]. Additionally, although shorter high intensity programs may induce adaptive tendon responses, intervention programs of longer duration appears to be more efficient and clearly demonstrated increased adaptive responses (greater than or equal to 12 weeks)[29]. The combination of findings after an NFL Lockout off-season preventing team-affiliated practice and the meta-analysis findings stress the significance of adequate player preparation[29]. An adequate player preparation programs involves sufficient high level intensity training of significant length that prepares the athlete and allows for tendon adaptations to prepare them for training camp exposures. Continued efforts to identify the best training protocols to prepare athletes for the demands of football training camp is crucial for optimal injury prevention.

Additional analyses identify specific positions or position groups most likely to sustain specific injuries[14, 27]. We were interested if the reactive nature of defensive players increased their likelihood for injury. Of the 45 AT ruptures identified, a majority (N = 32, 71. 1%) were sustained by defensive players that demonstrated a significantly increased rate in games compared to offensive players ($p = . 005$).

Eccentric movements increase the tendon length[29, 30]. The Achilles tendon functions as both a spring and a shock absorber[18]. Previously, athletes have been found to have a thicker Achilles tendon than subjects who are less active[18, 28]. Currently, ruptures are believed to be caused due to the overloading of the taut tendon, but other studies have also discovered degenerative changes within the ruptured tendon[8, 29, 30]. Although research demonstrates a genetic influence on the predisposition of a person towards an Achilles tendon injury[31], these findings clearly demonstrate an additional risk experienced by defensive players. We suspect one factor that increased the incidence of AT injuries for defensive players is the reactive nature of the position and movements required of defensive players compared to the movements utilized by offensive and specialist players. A further analysis may be able to confirm this hypothesis and if practice injuries are included may be able to provide an adequate sample size to identify specific positions more susceptible to injuries.

CONCLUSION

Utilizing game data, there is no apparent correlation between playing surface and rate of AT ruptures. Our findings identify significant rate differences in

AT ruptures in the first and second four game segments of the regular season compared to the final four games. Additionally, our findings are some of the most recent published game IRs for AT ruptures. Defensive players suffered a majority of ruptures compared to offensive or specialist players. Further analysis to identify an overall IR including practices and additional analysis of player position and time of the season of injury will improve our understanding of AT ruptures in professional football.

LIMITATIONS

This analysis of the NFL relies on publicly available data. We are aided in our analysis as the NFL requires all teams to report and publish injury reports each week of the season in addition to every game of the season televised. This allows the accuracy of game data to be of increased accuracy compared to practice information that is not as widely publicly available. Even with the precautions, there are possibilities for AT ruptures to not be documented. With the current attention to long-term injuries, there is potential bias from an increased attention and publication of athletes who sustained AT ruptures compared to the beginning of our study.

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FIGURES

Figure 1.

Figure 2.

Figure 3.

Table 1.

Incidence IRR bp-value

Defense 320.752.46 (1.31-4.85).005

Offense 130.30

a Injury rate based on 4,272 TG (4,096 regular season and 176 post-season TG)

b Injury rate ratios with 95% confidence limits

Table 2.

Incidence IRR bp-value

1st 4 games 171.66

1.21 (0.59-2.51)c.60

2.13 (0.93-5.21)d.08

3.4 (1.30-10.31)e.01

2.92 (0.53-61.68)f.29

2nd 4 games 141.37

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1. 75 (0. 74-4. 40)d. 21

2. 80 (1. 04-8. 67)e. 04

2. 41 (0. 43-51. 37)f. 42

3rd 4 games80. 78

1. 6 (0. 52-5. 38)e. 42

1. 38 (0. 22-30. 76)f. 85

4th 4 games50. 49

0. 86 (0. 12-20. 45)f. 83

Post-season10. 57

aInjury rate based on 4, 096 regular season (1, 024 each 4-game period) or 176 post-season TG

bInjury rate ratios with 95% confidence limits

Compared with c2nd 4 games of the regular season, d3rd 4 games of the regular season, e4th 4 games of the regular season, or fpost-season