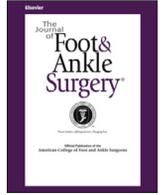




Contents lists available at ScienceDirect

## The Journal of Foot &amp; Ankle Surgery

journal homepage: [www.jfas.org](http://www.jfas.org)

## Outcome of Turf Toe Injuries in NFL Players

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## ARTICLE INFO

Level of Clinical Evidence: 4

## Keywords:

Forefoot injuries

NFL injuries

Turf toe

## ABSTRACT

The increase in artificial turf in the 1970s was thought to have contributed to increased incidence of turf toe injury in National Football League (NFL) players. To our knowledge, there are no publications that have analyzed the impact of this injury on performance. This is a retrospective case series. Online resources were used to identify NFL players who sustained a turf toe injury between the 2011 and 2014 seasons. The performance of each offensive skill player was analyzed separately by calculating their power rating (PR) over 6 seasons. Injured offensive skill players were then compared to a control group consisting of all RBs and WRs without a turf toe injury who competed in the 2012 season. Seventy-one turf toe injuries were identified. Twenty-nine occurred on grass, 29 on turf and the playing surface of 13 injuries could not be identified. The average PR prior to injury was 105.7/season (7.3/game), 87.3 (6.9/game) for the season of injury and 115.5 (8.1/ game) for postinjury seasons. The PR was not significantly different after a turf toe injury compared to before injury or to uninjured control player. There was no significant difference in NFL players' performances after turf toe injury based on power ratings.

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Turf toe is an injury to the first metatarsophalangeal (MTP) capsular-ligamentous complex. It was first described in 1976 by Bowers and Martin in football players at the University of West Virginia (1). Their report coincided with a time when many National Football League (NFL) and college stadiums were “upgrading” their playing surfaces from natural grass to artificial turf. This was considered a cost-saving advancement. It remains controversial whether the artificial turf surface would increase the risk of injuries as compared to natural grass. Meyers and Bunhill found, in a prospective study, many similarities between the 2 surfaces with unique pattern of injuries for each playing surface (2).

During this time many players were also exchanging their traditional hard soled cleats for more lightweight, flexible footwear to emphasize speed and traction. Bowers and Martin's hypothesized this injury could be related to the recent switch to the harder playing surface (Astroturf) and to the more flexible soccer style cleats (1).

The classically described mechanism occurs when one player falls on the posterior leg or heel of another player whose forefoot is fixed to

the ground, delivering an axial load across the foot and hyperextension of the first MTP joint (Fig. 1). The first metatarsophalangeal capsular-ligamentous complex is a condyloid articulation formed by the elliptical cavity of the proximal phalanx receiving the ovoid surface of the metatarsal head; the horizontal plane of movement is limited by ligaments. This transforms it to a hinge joint stabilized dorsally by the extensor tendon and plantarly by the heavy plantar ligament. This leaves it designed to function on a single vertical axis allowing dorsiflexion and plantarflexion (up 50 degrees and down 30 degrees) of the great toe. In the acute setting, the patient typically presents with a swollen, possibly ecchymotic great toe with pain upon weightbearing, especially during the flat foot to toe-off phase of the gait cycle. Acute deformities could be seen including first MTP joint dislocation, hallux varus or valgus deformity. Palpation commonly reveals tenderness over the plantar side of the first MTP. The patient will complain of pain upon active flexion and passive extension of the first MTP joint. The medial, lateral, and vertical stability of the first MTP joint to be examined. Vertical Lachman test is used to assess the degree of vertical translation of the proximal phalanx as compared to the first metatarsal bone. A positive test is defined as an increased laxity as compared to the contralateral first MTP joint. Under the first MTP joint 2 small bones, the sesamoids, are embedded in the hallucis brevis tendon attaching to the great toe. The sesamoids function as pulleys, assisting in propulsion. The sesamoid bones slide forward and back as the great toe dorsiflexes and plantarflexes. In addition, the sesamoids protect the flexor hallucis longus

Online public information was used with no risk to human or animal subjects. Consent was not needed. The study was exempted from institutional research board review.

**Financial Disclosure:** None reported.

**Conflict of Interest:** None reported.

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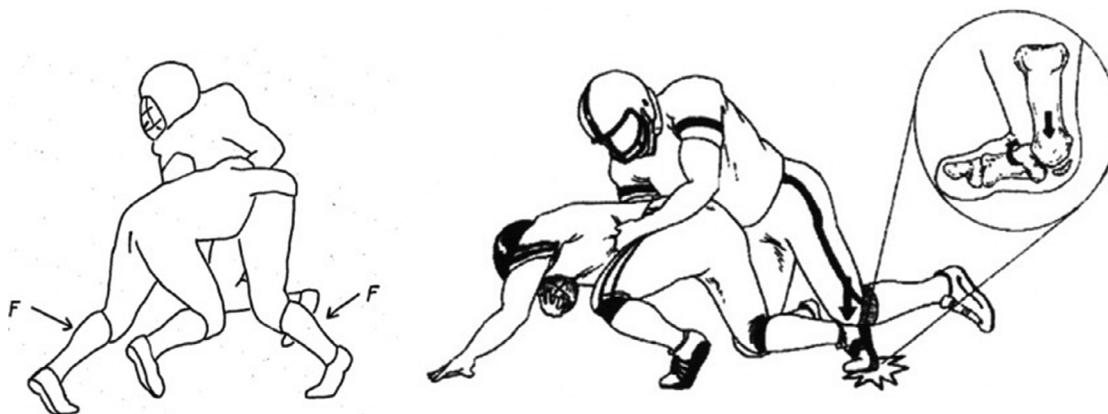


Fig. 1. Force (F) drives MTP joint into hyperextension, as the forefoot is fixed and heel is elevated. (Mechanism of injury reprinted from Bowers et al. *Med Sci Sports*. 1976;8(2):81-83).

tendon by cushioning the first MTP joint and dispersing the impact on the metatarsal head (Fig. 2). The sesamoid bone should be palpated during the exam to assess for tenderness and possible migration. A retracted sesamoid bone, an unstable joint, or a traumatic deformity suggests a severe turf toe injury.

This makes for a challenging condition to treat for orthopedic surgeons since recovery time can be highly variable and severity exists on a large spectrum that can range from a mild sprain to a complex tear. Kaplan et al reported an 11% incidence of turf toe injury in the National Football League Combine (3).

Anderson classified turf toe into 3 grades: Grade I injury represents a stretching of the plantar complex; it is typically treated conservatively and athletes do not miss significant time; grade II injury is a partial tear of the plantar plate and athletes miss at least 2 weeks of sports; and grade III injury is a complete rupture of the plantar plate with delayed return to sports to be expected (4). The more complex or unstable tears though typically require operative repair and in extreme instances have ended Hall of Fame careers (5).

Many publications have highlighted the functional disability that can occur in these elite athletes after a turf toe injury (6-10). Loss of push-off power and the pain that occurs can have serious consequences in a player's performance, especially in a sport played at such high speeds that involves frequent cutting, jumping, pivoting, and potential violent collisions.

To our knowledge there has been little information published on the actual effect of these injuries in regard to a player's performance after recovery. The purpose of this study was to quantify the impact a turf toe injury has on NFL players, specifically in time to return to competition and their performance postinjury compared to preinjury. Offensive skill players (Wide Receivers [WR's], Running Back [RB's], Tight End [TE's]) were selected as the focus of player performance comparison, as these skill positions could be objectively measured using power rankings and they've been shown to be disproportionately affected by this injury (11).

#### Patients and Methods

This was a retrospective review to identify all NFL players who sustained a turf toe injury during the seasons 2011-2014. Players with first MTP capsular ligamentous complex injury were identified through a review of online resources including NFL injury reports, player registries, game summary sites, NFL news and the Fantasy Doctors database. Additional recorded event variables included player position, player age, time of season in which the injury occurred, type of playing surface on which the injury occurred, and number of games missed.

Performance analysis was done only on the offensive skills player's (WR's, RB's) who were found to have a turf toe injury during the study period. For every player, the following data was collected for each season of interest: games played, total yards (rushing and receiving), and total touchdowns. These skill players were analyzed using the power rating formula (total yards divided by 10 plus touchdowns multiplied by 6). Power ratings

as an outcomes instrument has been previously shown to be a reliable and valid scoring system for quantification of a player's performance (12). The season in which the injury occurred was designated as the index season. To quantify the impact of their injury, each player had a power rating calculated for the 3 seasons prior to injury, the index season and the 2 seasons immediately following injury. If a player did not compete in one of the three seasons preceding the index season or 2 seasons after, then the power rating was recorded as null (no observation) rather than zero. Players were excluded from performance analysis if their total power rating (sum of all 6 seasons) was less than 200 points to minimize dilution from players with low production during the study period. A control group consisted of all running backs and wide receivers who did not have a turf toe injury who competed in the 2012 season. The 2012 season was designated as the index season and they too had a power ranking calculated for the index season, the 3 seasons prior and the 2 seasons after.

Data was analyzed using SPSS version 22.2 (SPSS, Inc) to determine if significant differences existed in the study group between times points before and after injury, or between the performance of the study group and control group. Univariate analysis of continuous variables was performed using 2-sided *t* tests.  $P < 0.05$  was accepted as statistically significant.

#### Results

Sixty-seven players with a total of 71 turf toe injuries were identified during the study period (2011-2014). Player demographics were the following: 26 offensive skilled players (QB, TE, WR, RB), 15 defensive skilled players (Cornerback [CB], Strong Safety [SS], Free Safety [FS]), 13 defensive linemen/linebackers, and 13 offensive linemen.

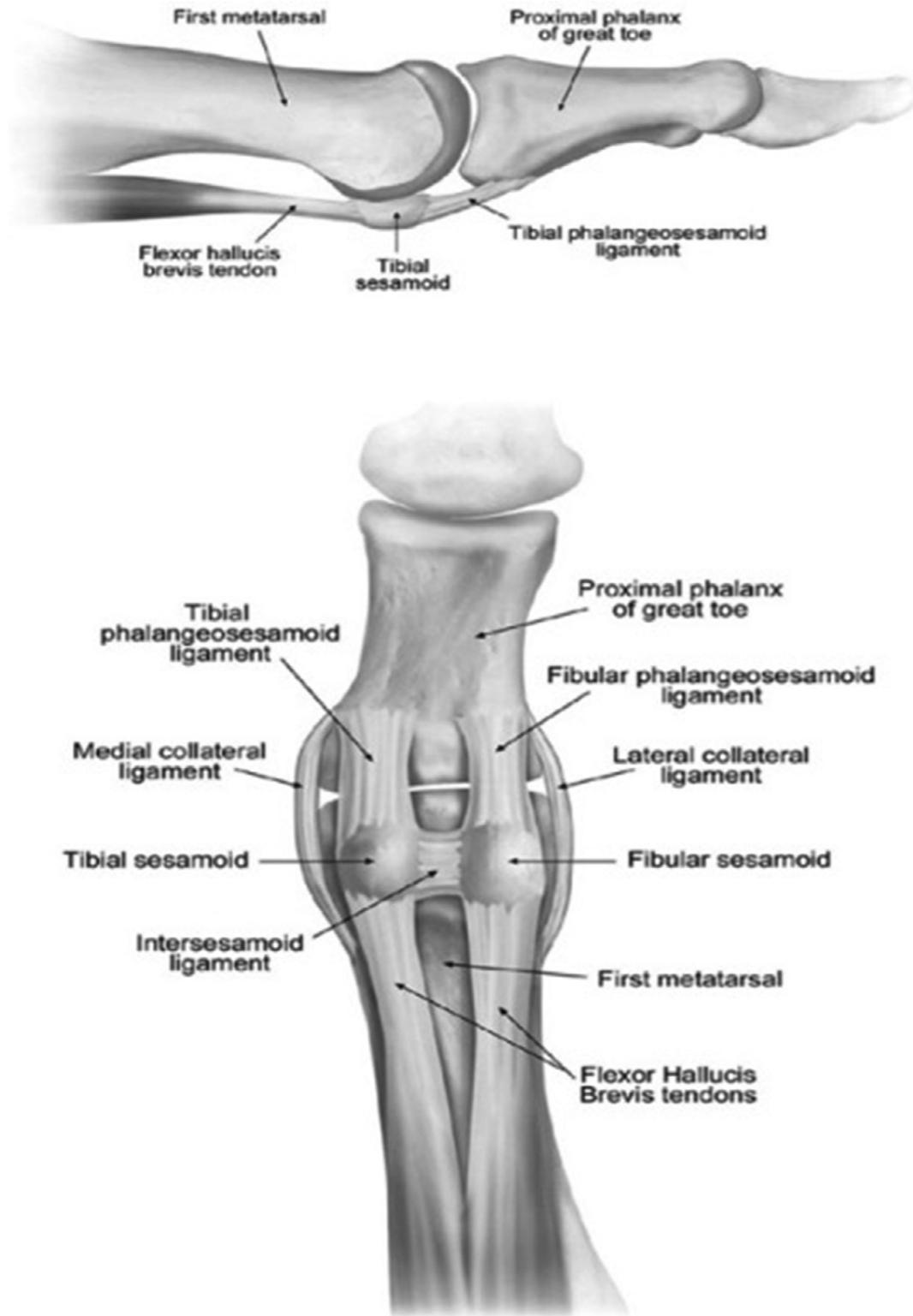
The average age of the players was 26.4 years old. Twenty-nine injuries occurred on a grass playing surface, 29 injuries on an artificial turf surface and the playing surface for 13 of the injuries could not be identified. The average playing time missed was 3.2 games (Table 1).

Nine players (13%) were placed on injured reserve, meaning the injury was severe enough that they were designated to an "inactive role" where they could not return to practice or games for the rest of the season. Eight players (12%) had injuries severe enough to warrant operative repair.

Sixteen offensive skill players met the minimum requirement of at least 200 total points during the 6 seasons span in question. Of these players, the average time missed was 2.8 games. Only one player within this smaller cohort required operative repair while a second player had an injury severe enough to be placed on injured reserve but ultimately did not require surgery.

Per season, the power rating showed that the average PR preinjury was 105.7, PR index season was 87.3 and average PR postinjury was 115.5. Per game, the power rating showed that the average PR preinjury was 7.3, PR index season was 6.9 and average PR postinjury was 8.1.

For comparison, 336 running backs and wide receivers without an identified turf injury competed in the 2012 NFL season. After exclusion of players with a total power rating less than 200 points, 149 control players remained for game performance analysis. As done with the



**Fig. 2.** Anatomy of the plantar plate. (A) Sagittal medial view and (B) coronal plantar view of the hallux metatarsophalangeal joint. (Reprinted from Waldrop et al. Foot Ankle Int. 2013; 34: 403–408).

study group, we compared each player's 3 seasons prior to the control year, the control season (2012) and the 2 seasons immediately following (Table 2).

Per season, the power rating showed that the average PR preinjury was 108, PR Index season was 102, and average PR postinjury was 98.5.

Per game, the power rating showed that the average PR preinjury was 7.8, PR index season was 7.3 and average PR postinjury was 7.2.

There was no significant reduction in the performance of the study group when comparing their preinjury power ranking to their postinjury power ranking. In fact, their average power ranking improved,

**Table 1**  
Demographics of players with turf toe injuries

Characteristics	Number
Number of players	67
Number to turf toe injuries	71
Offensive skilled	26
Offensive linemen	13
Defensive skilled	15
Defensive linemen	13
Average age (y)	26.4
Grass playing surface injuries	29
Artificial turf surface injuries	29
Playing time missed (games)	3.2
Inactive role (players)	9
Operative repair (players)	8

without reaching a statistical significance, from 105.7 per season prior to injury to 115.5 after the injury ( $p = .53$ ). Their average power ranking also improved from 7.3 per game prior to injury to 8.1 per game after injury ( $p = .4$ ). When compared to the control group, there was also no statistical difference in performance. The average power ranking per season for the study group postinjury was 115.5 compared to 99.2 for the control group ( $p = .24$ ). The per game average postinjury was 8.1 for the study group versus 7.2 for the control ( $p = .27$ ).

## Discussion

Turf toe is an injury that has a strong association with the National Football League. Past studies have reported an incidence of 30% to 45% of professional football players who've sustained this injury at some point in their career (10,13). It was the third most common injury found in college football players behind the knee and ankle (8). The first MTP joint complex typically must withstand 40% to 60% body weight during the normal gait and the forces can increase 2 to 3 times body weight during athletic activity (14,15). The injury typically results in loss of dorsiflexion and push-off power which can significantly limit players in a sport where speed, explosion from the line of scrimmage and quick cutting is a necessity. Coker et al (9) showed while these may be less common injuries than ankle sprains, they can be more disabling and result in a disproportionate amount of missed practices and games comparatively. The period of recovery often lasts a minimum of 4 weeks, regardless of the level of the sprain and 50% of athletes reviewed have noted persistent symptoms with greater than 5-year follow-up (8). Hallux valgus and early hallux rigidus can be a sequela of this injury, resulting in long-term morbidity past the acute recovery period (8).

For these reasons, "turf toe" has anecdotally been assumed to be a "career threatening" injury. It was our initial hypothesis that offensive skilled players would have significant reductions in key quantifiable statistics, such as yards gained and touchdowns scored, after sustaining this injury. To our surprise, in this small cohort of players, they were able to return to their preinjury level of play and actually demonstrate improvements in play compared to their preinjury selves and a control

**Table 2**  
Average power rating pre- and postinjury in cases (turf toe injuries) vs controls per season and per game

	Cases		Controls	
	Season	Game	Season	Game
Power rating				
Preinjury	105.7	7.3	108	7.8
Postinjury	115.5	8.1	98.5	7.2
Index season	87.3	6.9	102	7.3

group. This observation is likely because "turf toe" exists across a wide spectrum of severity. If one player sustains a simple sprain and another sustains a complex tear, they may often be grouped together under a common diagnosis, even though the treatments and prognosis may be entirely different for the two. Our goal as physicians is recognition of the injury and formulating the appropriate treatment individualized toward the patient's specific injury. Often times the goal for the high-level athlete is to return to play as quickly as possible. Returning is dependent on the player's position, level of discomfort, and healing potential. When indicated, conservative treatment will often consist of rest in the acute period then return to play with taping and an orthotic to offload the joint. Anderson felt return to play typically correlated with painless dorsiflexion of 50 to 60 degrees (5). Complete tears of the MTP capsule/plantar plate or persistent symptoms oftentimes necessitate operative repair. A positive Lachman's test on physical exam is typically present in the case of a complete capsular avulsion (16). In our experience, we will use live fluoroscopy in the clinic to make the diagnosis. If the sesamoids do not track with the proximal phalanx on a lateral view of the great toe then a complete avulsion can be assumed.

Few studies have looked at player performance after this injury. Anderson retrospectively reviewed his experience treating 19 collegiate and professional athletes with a disabling turf toe injury over a 10-year period. Nine operative repairs were required. All but 2 patients (2 professional football players) were able to resume full athletic activity (5). Covell et al looked at their experience treating 19 high level athletes (including 12 NFL players) who required operative fixation for traumatic hallux valgus, a turf-toe injury variant that involves rupture of the medial collateral ligament of the great toe. They report good operative results with an end point of 74% return to play (17). This outcome measure showed that these athletes were able to return to play at their preinjury level of competition (i.e., make it back to the NFL) but they were unable to quantify the athletic performance of these athletes once they returned. These studies were not designed to determine if players were able to resume their careers at the same statistical level they were performing prior to injury. It should be noted that Covell's study looked only at injuries severe enough to warrant an operation, while we were examining all turf toe injuries, from the mild sprain to the severe. Of the offensive skilled players analyzed with the power rankings formula, only one of these players went on to have operative repair and a second player was placed on the injured reserve and did not return to the league the next season. In a systematic review, Vopat et al found a limited number of high level evidence studies evaluating turf toe injuries in athletes. Seventeen, out of the 47 athletes who underwent surgical treatment, were professional. The authors reported that time to return to sports differed significantly by grade of injury and competition level (16.5 weeks for both high school and college levels and 14.7 weeks for professional level for grade III injuries). The median time to return to sports was not significantly different based on type of sports (Basketball, Baseball, Football, Soccer, Taekwondo, Track) or skilled football positions (18).

The power ratings was used to quantify the impact of other orthopedic injuries on players. In a retrospective review of Achilles tendon rupture in NFL players, Parekh et al (19) reported that players experienced a greater than 50% reduction in their power ratings following such injury and 32% of players who sustained an Achilles rupture did not return to play in the NFL.

Our study does have several obvious weaknesses. First, we retrospectively analyzed players whose care we did not participate in, so all information is being obtained through secondhand sources that are likely unaware of all the specific injury and treatment details. Second, the cohort of offensive skills players whose performance we analyzed with the power ranking is relatively small. Just a couple of players with very productive seasons after their injury were able to skew the postinjury statistics in a direction that gives the appearance that a turf toe injury can actually "help" your performance. While we do not believe

this is the case, our results do provide evidence that this injury is one that can be treated successfully with expectations of returning to play at the preinjury level. Further studies are needed to quantify the impact of turf toe grade of injury on players performance.

The present study showed that NFL offensive skill players were able to return to their prior level of play after sustaining a turf toe injury. We used a novel technique that emphasizes total yards and touch-downs to critically analyze the performance of running backs and wide receivers. These are arguably the most important statistics when trying to quantify the impact of an offensive skill players and this formula has been used for decades in football calculations to quantify a player's performance. To our knowledge this is the first study to analyze the performance of professional athletes after sustaining a turf toe injury.

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