

# THE EFFECT OF TURF TOE INJURIES ON PLAYER PERFORMANCE IN THE NATIONAL FOOTBALL LEAGUE

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## ABSTRACT

**Background:** “Turf toe” results from hyperdorsiflexion of the first metatarsophalangeal joint, injuring the plantar capsuloligamentous complex. We hypothesized that National Football League (NFL) player performance following turf toe injury would decrease in comparison to controls at the same position.

**Methods:** Demographics, return to play, and season performance data on players sustaining turf toe injuries in the NFL from 2010-2015 were collected. An Offensive Power Rating (OPR=[total yards/10]+[total touchdowns x6]) or Defensive Power Rating (DPR=total tackles+[total sacks x2]+[total interceptions x2]) was calculated for each player. Control data were collected for NFL players in 2013 with no history of turf toe injury. Statistical analysis was performed using Wilcoxon Rank Sum tests.

**Results:** Twenty-four injured players and 436 controls were included. Nineteen players returned to play within the regular season of injury (mean 36.7 ± 28.9 days). Seventeen players were removed from team injury reports for turf toe within the regular season (mean 42.6 ± 26.2 days). Three players required season-ending surgery. Comparison of 1-year post- versus pre-injury revealed an insignificant median OPR difference (-18.9 IQR -43.4 to 10.3 vs. control -12.2 IQR -46.2 to 47.7, p = 0.328) and median DPR difference (-1.0 IQR -26.0 to 17.0 vs. control 2.0 IQR -15.0 to 18.0, p = NA). Comparison of 2-year data revealed no significant median OPR difference (-32.6 IQR -122.2 to 1.0 vs. control -20.7 IQR -72.6 to 44.7, p = 0.327) and median DPR difference (-5.0 IQR -19.0 to 6.0 vs. control -4.5 IQR -22.0 to 12.5, p= NA).

**Conclusions:** Turf toe results in significant loss of playing time. Despite the long recovery period, NFL players have similar performance following injury compared to controls. The effect of turf toe injuries on performance is variable.

**Level of evidence:** IV

**Keywords:** football, turf toe, performance, sports

## INTRODUCTION

“Turf toe” is a common injury affecting high level athletes, occurring in 10.9% of elite college football players.<sup>1</sup> Initially coined in 1976 by Bowers in response to an increasing injury pattern related to new turf, “turf toe” represents a hyperextension injury to the hallux metatarsophalangeal (MTP) joint resulting in a plantar capsuloligamentous sprain or tear, which can ultimately lead to progressive deformity.<sup>2</sup> As a result, previous literature has focused on identifying and modifying risk factors for injury prevention.<sup>3</sup> Turf toe represents a spectrum of injury, ranging from mild attenuation to complete disruption of plantar tissue.<sup>4</sup> Treatment can range from symptomatic management to surgical repair or reconstruction. While many of these cases can be managed non-operatively, up to 50% of patients may experience persistent pain and stiffness, with decreased mobility compared to other uninjured toes.<sup>5,6</sup> In the setting of persistent dysfunction or instability, surgical intervention may be indicated in the high-level athlete to prevent late deformity.<sup>7</sup>

Recently, a greater analytical emphasis has been placed on the management of orthopedic injuries in the high-level athlete, focusing on statistical performance after return to play.<sup>8,9</sup> Offensive and defensive power ratings have previously been described to rate overall performance in NFL athletes to adjust for production and statistics affected by position played and provide a comprehensive metric to compare across position groups.<sup>9</sup> To date, no data is available that quantitatively compares the change in performance in athletes suffering turf toe injury. Professional American football athletes, particularly players at “skill” positions, place unique demands on the MTP joint, with injury potentially detracting from performance even after return to play. Given the persistent symptoms experienced by NFL players with turf toe, we hypothesized that post-injury performance

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and statistical output in NFL players would decrease in comparison to healthy controls at the same position. Our ultimate goal is to better understand and predict the short and long-term consequences of turf toe injury

### METHODS

Game summaries, weekly team injury reports, team press releases, and media reports (ESPN.com, NFL.com, Rotoworld.com) were used to identify players sustaining “turf toe” injuries from 2010-2015 NFL seasons. Players who sustained a turf toe injury and played at positions where an Offensive Power Rating (OPR) or Defensive Power Rating (DPR) could be calculated were included: running back (RB), tight end (TE), wide receiver (WR), defensive lineman (DL), linebacker (LB), and defensive back (DB). Players who did not have a minimum of one regular season of play before and after the year of injury were excluded from the study. A control group was generated from all active roster RBs, TEs, WRs, DLs, LBs, and DBs in the NFL in 2013 who did not sustain a turf toe injury during the study period, which encapsulates performance metrics from 2010-2015. Players who did not participate in the 2012 and 2014 regular seasons were excluded as controls.

Demographics and return to play statistics were collected on injured players during the index season. The following variables were recorded: date of injury, player age, number of prior years of NFL experience, last year of NFL play if during the study period, whether the player retired due to turf toe, operative vs. non-operative treatment of turf toe injury, time to return to play, and time off injury report. Time to return to play was defined as the number of days after turf toe injury at which the player participated in at least one in-game play. Days until off injury report was defined as the number of days after turf toe injury until the player was no longer listed on the team injury report for a toe injury.

Performance data was collected for a minimum of one year before and up to two years after the season of injury. Offensive performance data was collected using the following variables: games played, yards rushing and receiving, and touchdowns. Defensive performance variables included games played, interceptions and fumbles recovered, tackles, and quarterback sacks. Using a previously validated performance evaluation score,<sup>8,9</sup> an Offensive Power Rating (OPR = [total rushing and receiving yards/10] + [total TDs x 6]) and Defensive Power Rating (DPR = total tackles + [total sacks x 2] + [total interceptions and fumbles recovered x 2]) was generated for each year of data for injured and control subjects. OPR and DPR as metrics for player performance have been shown to have high intra-class correlation coefficients and criterion-oriented validity using Pro Bowl selection

**Table 1. Demographics of Players Sustaining Turf Toe Injury and Controls**

	Players sustaining turf toe injury	Controls	P value
<b>Offense</b>			
Number of players	11	72	--
Age (years)	25.45	26.29	0.25
Number of games played in 2 seasons prior to index season	23.00	23.72	0.92
Position			0.29
Receiver	5	20	
Rusher	6	52	
<b>Defense</b>			
Number of players	13	364	
Age (years)	26.38	26.92	0.24
Number of games played in 2 seasons prior to index season	27.00	25.48	NA*
Position			0.83
Defensive Line	3	106	
Linebacker	5	111	
Defensive Back	5	147	

\*indicates inability to estimate probability using Wilcoxon rank sum test.

as a benchmark.<sup>8</sup> In accordance with this previously described approach for performance analysis, control players with low statistical production from 2010-2015 (sum of OPR < 150 or sum of DPR < 35) were excluded from analysis.<sup>6</sup>

Group differences (between injured and non-injured groups) in continuous variables were evaluated using Wilcoxon Rank Sum tests. Associations between injury group (injured and non-injured groups) and categorical variables were evaluated using Fisher’s Exact tests. Statistical significance was assessed at the 0.05 level, and all analyses were conducted using SAS 9.4 (SAS Institute, Cary NC).

### RESULTS

From 2010-2015, 50 players sustained a “turf toe” injury and 24 players (11 offense and 13 defense) met criteria for inclusion in this study [Table-1]. Twenty-six players were excluded for one or more of the following criteria: six were offensive linemen, three were quarterbacks, nine did not play at least one full regular season before the season of injury (index), and 10 did not play at least one full regular season after index. Of the 13 offensive players who met criteria for inclusion, six were running backs (RBs), two were tight ends (TEs), and three were wide receivers (WRs). Of the 13 defensive players meeting inclusion criteria, five were defensive

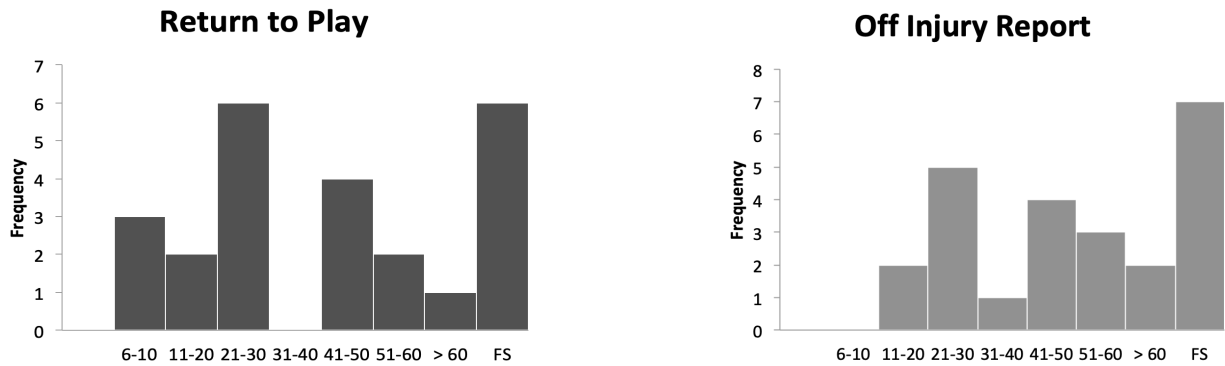


Figure 1. Number of days (a) to return to play and (b) until removed from the injury report for all turf toe injured players. FS denotes players who not return until the following season.

backs (DBs), three were defensive linemen (DLs), and five were linebackers (LBs). Of the 731 RBs, TEs, WRs, DBs, DLs, and LBs who participated in the 2013 NFL season (in this case, index) and did not sustain a turf toe injury from 2010-2015, 72 offensive players and 364 defensive players met criteria for inclusion in this study. The remaining players were excluded for one or more of the following criteria: 273 did not play at least one full regular season before and after index and 292 had low performance statistics (5-year cumulative OPR < 150 or DPR < 35). No differences were found in demographics when comparing players sustaining turf toe injury to their respective control groups [Table -1].

Eighteen players (75%) returned to play within the regular season of injury at a median of 28 (IQR 20.25 to 42) days [Figure-1a]. The remaining six players returned to play during the following regular season. Three players required season-ending surgery for turf toe, and one player who did not meet criteria for inclusion this study retired at the end of the injury season due to persistent pain from turf toe. Fifteen players (62.5%) were eventually removed from team injury reports for toe injury at a median of 42 (IQR 27 to 51) days [Figure-1b].

There were no significant differences in offensive player performance between players with turf toe injury and their respective controls. Injured players had a median OPR of 84.0 (IQR 4.7 to 109.3) the season before index, 67.3 (IQR 10.8 to 114.3) the season after index, and 45.3 (4 to 114.3) two seasons after index. In comparison, control players had a median OPR of 89.2 (IQR 53.4 to 154) the season before index, 91.45 (IQR 42.8 to 149.08) the season after index, and 87.35 (IQR 46.1 to 141.02) 2 seasons after index [Figure-2]. From the season before to one season after index, injured players had a median change in OPR of -18.9 (IQR -43.4 to 10.3) vs. -12.2 (IQR -46.2 to 47.7) for controls ( $p = 0.328$ ). Data using two seasons after index demonstrated a median change in OPR of -32.6 (IQR -122.2 to 1.0) vs. -20.7 (-22.0

to 12.5) for controls ( $p = 0.327$ ).

There were also no significant differences in defensive player performance between injured players and controls. Injured players had a median DPR of 45 (IQR 34 to 79) the season before index, 51 (IQR 36 to 64) the season after index, and 52.5 (IQR 42.25 to 55.5) two seasons after index. Control players had a median DPR of 37 (IQR 20 to 60) the season before index, 40 (IQR 22 to 58.25) the season after index, and 37 (IQR 19 to 25) two seasons after index [Figure-3]. From the season prior to index to one season after, injured players had a median change in DPR of -1.0 (IQR -26.0 to 17.0) vs. 2.0 (IQR -15.0 to 18.0) for controls. Data examining two seasons post-index demonstrated a median change in DPR of -5.0 (IQR -19.0 to 6.0) vs. -4.5 (IQR -22.0 to 12.5) for controls. Exact probabilities for DPR analysis were unable to be estimated using Wilcoxon rank sum test.

## DISCUSSION

Turf toe represents a spectrum of injury and ranges from partial to complete disruption of the plantar tissues on the first MTP joint. First described in athletes in 1976, turf toe has become more extensively scrutinized for long-term sequelae with the goal of determining optimal management. In athletes, injury typically occurs when an axial load is applied to the heel of a plantarflexed foot with the great toe in extension, typically as part of a tackle.<sup>10</sup> The risk of this injury increases with age, artificial playing surfaces, and more flexible shoe wear<sup>3</sup> and will affect nearly 10% of high-level football athletes,<sup>10</sup> and has been reported to occur in up to 45% of NFL players.<sup>11</sup> This study found significantly fewer cases of turf toe injury, likely secondary to methodology requiring injury to be severe enough that it was recorded on the team weekly injury report.

This study demonstrates that players who sustained a turf toe injury missed a substantial portion of the season, with a median return to play of 28 days. The wide range

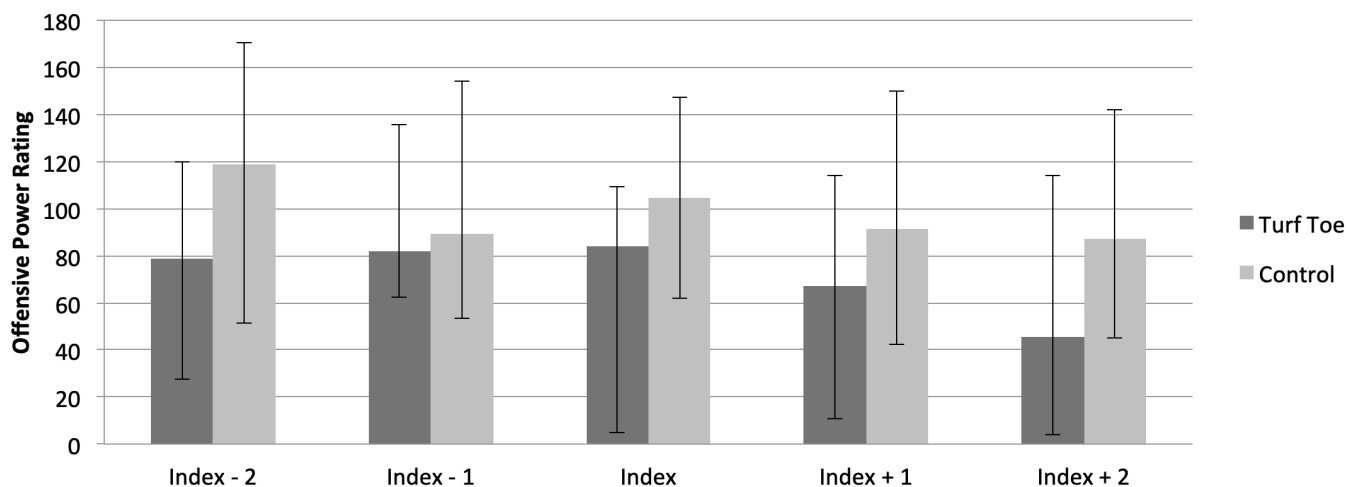


Figure 2. Median offensive power rating and interquartile range of injured players vs controls per season.

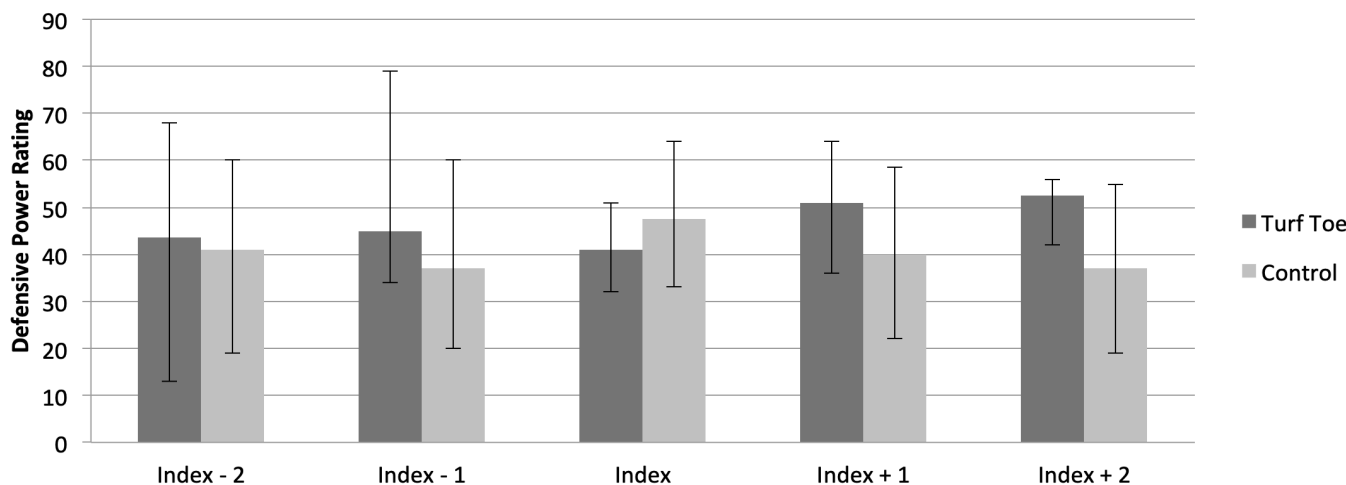


Figure 3. Median defensive power rating and interquartile range of injured players vs controls per season.

in return to play metrics reflects a wide spectrum of injury severity for “turf toe,” and underlines the difficulty in studying this injury at a population level. One player was not included in this study because he retired due to injury and did not return to play the following season. Of the players who did return and met inclusion criteria, 25% of them did not return to play until the following season, with three (12.5%) requiring season ending surgery. A study using surveillance data of National Collegiate Athletic Association football players found that turf toe had an incidence of 0.062 per 1000 athlete exposures and comprised 0.83% of all football injuries.<sup>3</sup> 1.74% of players required operative intervention and the average time lost from injury was 10.1 days. While not directly comparable, the large discrepancy in metrics from those of this study may stem from the inherent differences in surveillance data and media reported data, the latter

skewing towards more severe grades of injury.

Though it did not reach statistical significance, offensive players affected by turf toe did show a trend toward lower performance after injury compared with controls. This is in line with previous thought that the effect of turf toe is dependent on the demands placed on the foot. It has also been previously postulated that position played may impact time missed due to injury, with linemen reported to better tolerate the injury than sprinters.<sup>2</sup> Not only does turf toe injury occur more frequently in running backs and wide receivers due to the mechanism, it may have a significant impact on performance, particularly considering the long-standing symptoms that can persist after injury.<sup>1,5,10</sup>

There are several limitations to this study. This study was retrospective which limits its full clinical applicability. This was accounted for by comparing injured patients to

similar healthy controls to determine if the difference in performance between seasons was different by players with turf toe injuries. Additionally, this study did not stratify patients by grade or injury severity, as this data was not publicly available. Furthermore, the limited number of patients who met criteria for study would not have allowed for subgroup analysis based on grade of injury. This is partially because turf toe is a relatively infrequent injury, occurring in approximately 0.06 per 1000 athlete exposures.<sup>3</sup> This may partially explain the high variance in the data. The variability in individual player performance and playing time in a team sport with frequent substitutions may also contribute to this high variance in both the study and control groups. An a priori power analysis was not performed, and a post-hoc power analysis was determined to be non-contributory.<sup>13</sup> Regardless, given the different positions affected and the limited overall sample size, these power ratings provide an acceptable proxy by which to compare performance.

Turf toe represents a spectrum of injury that can lead to a significant loss of playing time in NFL athletes depending on the degree of soft tissue rupture. Despite this loss of time, professional football players appear to return to a similar level of play following a turf toe injury compared to healthy controls when measured by composite offensive and defensive metrics. Further examination with a larger series of patients would be useful to understand the degree to which injury severity may affect performance.

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