

Return to Sport After Turf Toe Injuries

A Systematic Review and Meta-analysis

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Background: The prevalence of turf toe injuries has increased in recent years. However, uncertainty remains as to how to optimally treat turf toe injuries and the implications that the severity of the injury has on outcomes, specifically return to sport (RTS).

Purpose: To determine RTS based on treatment modality and to provide clinicians with additional information when comparing operative versus nonoperative treatment of turf toe injuries in athletes.

Study Design: Systematic review; Level of evidence, 4.

Methods: A systematic review and meta-analysis was performed using the PubMed/Ovid MEDLINE/PubMed Central databases (May 1964 to August 2018) per PRISMA-IPD (Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Individual Participant Data) guidelines. RTS, treatment, severity of injury, athletic position, and sport were recorded and analyzed.

Results: Of 858 identified studies, 12 met the criteria for the final meta-analysis. The studies included 112 athletes sustaining a total of 121 turf toe injuries; 63 (52.1%) of these injuries were treated surgically, while 58 (47.9%) were treated nonoperatively, and 53.7% were classified by the grade of injury (grade I, $n = 1$; grade II, $n = 9$; grade III, $n = 55$). Overall, 56 (46.3%) injuries could not be classified based on the data provided and were excluded from the final analysis. The median time to RTS for patients treated nonoperatively was 5.85 weeks (range, 3.00-8.70 weeks) compared with 14.70 weeks (range, 6.00-156.43 weeks) for patients treated surgically ($P < .001$); however, there was variability in the grade of injury between the 2 groups. Similarly, patients who sustained grade II injuries returned to sport more quickly (8.70 weeks) than patients who had a grade I (13.04 weeks) or grade III injury (16.50 weeks) ($P = .016$). The amount of time required to RTS was significantly influenced by the athlete's level of play (16.50 weeks for both high school and college levels; 14.70 weeks for professional level) ($P = .018$).

Conclusion: The time to RTS for an athlete who suffers from a turf toe injury is significantly influenced by the severity of injury and the athlete's level of competition. Professional athletes who suffer from turf toe injuries RTS sooner than both high school and college athletes. However, there are a limited number of high-level studies evaluating turf toe injuries in the athletic population. Further research is necessary to clearly define the appropriate treatment and RTS protocols based on sport, position, and level of play.

Keywords: turf toe; metatarsophalangeal joint sprain; return to sport; systematic review; meta-analysis

Turf toe is a relatively common injury in physical sports, and the prevalence has increased in recent years because of the large number of athletes participating in sports. The incidence rate for turf toe in National Collegiate Athletic Association (NCAA) collegiate football is estimated to be 0.46 to 0.53 injuries per team per season.⁷ A study performed by Kaplan et al⁹ found the incidence of turf toe to be as high as 11% at the National Football League (NFL) Combine.

Turf toe is defined as an injury to the plantar surface of the first metatarsophalangeal (MTP) joint. It commonly occurs when the ankle is plantarflexed with hyper

dorsiflexion of the first MTP joint while an axial force is applied to the foot. In football, this mechanism frequently occurs when a player falls onto the posterior aspect of another player's foot while the foot is plantarflexed.¹⁶

Turf toe is classified according to the severity of plantar capsule disruption. Anderson¹ classified turf toe into 3 grades. Grade I injuries are less severe and involve stretching of the plantar complex with minimal swelling and localized tenderness. Treatment for grade I injuries consists of icing, taping, and utilization of an in-shoe orthotic. Patients may return to sport (RTS) as tolerated and usually do not miss significant time. Grade II injuries are classified as a partial tear of the plantar capsule of the first MTP joint. For these injuries, a period of nonweightbearing is typically utilized. Normally, grade II injuries result in at least 2 weeks away from sport.¹¹ Grade III injuries are complete

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ruptures of the plantar plate. Significant time away from sport is expected, which can exceed 6 months. Some grade III injuries may fail conservative treatment and may require surgery.¹¹ Other indications for surgery include a large capsular avulsion with an unstable joint, diastasis of a bipartite sesamoid, diastasis of a sesamoid fracture, retraction of sesamoid(s), traumatic hallux valgus deformity, vertical instability (positive Lachman test finding), loose body, and chondral injury.¹¹

Despite the well-described grading system, there is a paucity of data in the literature reporting RTS for athletes suffering from turf toe injuries. The purpose of this study was to determine RTS based on treatment modality and to provide clinicians with additional information when comparing operative versus nonoperative treatment of turf toe injuries in athletes. Our hypothesis was that an increasing severity of turf toe would lead to more time away from sport.

METHODS

Search Strategy and Study Selection

This study followed the PRISMA-IPD (Preferred Reporting Items for Systematic Reviews and Meta-Analyses of Individual Participant Data) guidelines.¹⁷ A systematic literature review was conducted on September 5, 2018, using the PubMed/Ovid MEDLINE/PubMed Central databases; dates of publication were May 1964 through August 2018. The following search terms were utilized: turf toe; metatarsophalangeal joint sprain; death toe; metatarsophalangeal joint dislocation. Three authors (M.H., T.P., A.T.) performed a manual study selection from the studies listed in the databases using the main keywords to exclude duplicates and include studies specifically related to the discussed item. A fourth coauthor (M.L.V.) helped resolve any discrepancies with a discussion. All selected articles were then screened for additional studies using the reference list provided in each study.

Eligibility Criteria

Case reports and case series that included all of the following criteria were considered eligible: published in the English language; patients diagnosed and treated for a turf toe, first MTP joint sprain, and/or death toe; and documented RTS. Patients were excluded if they had any other associated injuries during their time of treatment.

Data Extraction and Quality Appraisal

Patient demographics included sex, age, type of sport played, position played, and level of competition. Football position was further subdivided between skilled positions (tailback, fullback, quarterback, and wide receiver) and linemen (offensive and defensive lineman). The level of competition (high school, college, and professional) was assigned to each athlete if specified in the study. Treatment type (nonoperative vs surgical) and severity of injury were also extracted. The primary outcome was time to RTS as measured in weeks beginning on the date of injury.

The severity of injury was classified as either grade I, II, or III using Anderson's¹ classification. If the study reported the grade of injury, that grade was used in the statistical analysis. When the study did not include the grade, information provided in the text, along with images, was reviewed by 3 investigators (M.H., T.P., A.T.), who assigned a grade using the above classification system. The fourth investigator (M.L.V.) evaluated any injuries or classifications that came into question. Where there was insufficient information to provide an accurate classification, no grade was assigned. Thus, a record-level data set (ie, individual patient data review) was constructed from the case reports and case series for the analysis. An assessment of methodological quality with the Cochrane Collaboration tool⁸ was performed by the reviewers. A tiebreaker was designated in the case of any disagreement.

Statistical Analysis

Descriptive statistics were used to summarize all data from the case reports and case series. Categorical data were reported as frequencies and percentages. Given the overall data limitations and nonadherence to normality assumptions, continuous data were summarized as medians and ranges. The primary outcome was time to RTS, measured in weeks. Nonparametric statistical tests were used for bivariate analyses to compare time to RTS by grade of injury, level of competition, sport, football position, and treatment.

Statistical analyses included Fisher exact tests, Mann-Whitney *U* tests, and Kruskal-Wallis tests. Where data were sparse, exact tests were conducted. All statistical tests were performed using SPSS Statistics (version 23; IBM). A *P* value of .05 was considered significant. An assessment to determine the risk of bias was also performed.

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RESULTS

The search terms identified 721 studies in the initial search; referenced studies from these, along with gray literature, produced 223 studies (Figure 1). After removing duplicate articles, 858 studies were screened using inclusion/exclusion criteria; of these, 12 studies were identified for the final analysis.^{1-6,10,12-16} Individual participant data were available for 4 case reports^{10,12,13,15} and 5 case series.^{2,3,5,6,14} Aggregate data were collected for 3 studies and inputted for individual participant analysis.^{1,4,16} Grade level was assigned by the research team for 40 of the injuries.

Study Characteristics

Table 1 summarizes the study characteristics. Turf toe injuries occurred in 112 athletes, who ranged in age from 18 to 33 years. A total of 121 turf toe injuries were sustained among these athletes. Of the studies reporting sex, 64 patients were male and 2 were female. A variety of sports were noted: football (n = 112), baseball (n = 1), basketball (n = 2), soccer (n = 1), taekwondo (n = 1), and track/sprinting (n = 3); the sport type was not listed in 1 case. Sport position was highly variable and sparse, and level of competition included high school through professional. Overall, 58 (47.9%) of the turf toe injuries were treated nonoperatively, while 63 (52.1%) required surgery. There was 1 (0.8%) grade I injury, 9 (7.4%) grade II injuries, and 55 (45.4%) grade III injuries; 56 (46.3%) of the injuries did not have information available to classify the grade of injury.

Characteristics of Turf Toe Injuries by Time to RTS

Results of the bivariate analyses associated with RTS time are shown in Table 2. The 56 injuries we were unable to classify were excluded from the analysis.^{2,12} Another study did not record RTS for their 9 injuries.¹ The median time to RTS for patients (n = 2) treated nonoperatively was 5.85 weeks versus 14.70 weeks for patients (n = 47) treated surgically ($P < .001$). Similarly, patients who sustained a grade II injury returned to sport quicker (8.70 weeks) than patients who had a grade I (13.04 weeks) or grade III injury (16.50 weeks) ($P = .016$). The amount of time required to RTS was significantly influenced by the athlete's level of play (16.50 weeks for both high school and college levels, and 14.70 weeks for professional level) ($P = .018$).

Because time to RTS differed significantly by grade of injury, we also examined differences in treatment by both competition level and grade. Here, we focused on the 47 athletes who underwent operative treatment. There were 17 professional athletes who were managed surgically: 1 was classified as grade I (5.9%), 3 were grade II (17.6%), and 13 were grade III (76.5%). For the 24 surgically treated college athletes, 2 were grade II (8.3%), and 22 were grade III (91.7%). There were 4 surgically treated high school athletes: all were grade III. The remaining cases did not report the grade of injury. When further evaluating by the grade of injury per the athlete's level of play, the 1 grade I injury was a professional athlete with an RTS time of 13.04

weeks. The RTS time was not found to be statistically significantly different for grade II injuries at the high school (3.00 weeks), college (13.00 weeks), or professional levels (7.00 weeks) ($P = .276$). However, when only looking at grade III injuries, there was a statistically significant difference in RTS time by level of play (16.50 weeks for both high school and college levels, and 14.70 for professional level) ($P = .005$).

The median time to RTS was not significantly different when evaluating between types of sport (6.00 weeks for basketball, 14.70 weeks for baseball, 14.70 weeks for football, 23.90 weeks for soccer, 13.04 weeks for taekwondo, and 26.07 weeks for track). Similarly, the RTS time was not significantly different by skilled football positions versus linemen (18.00 weeks for tailback and fullback vs 16.44 weeks for offensive and defensive lineman). However, it needs to be noted that the reported football position and type of sport were sparse in the literature.

Quantitative Bias Analysis

The risk of bias assessment for the 12 studies analyzed is shown in Figure 2. All studies included in this literature review were either case series or case reports (highest level of evidence, 4), creating a high risk for bias. There were no randomized controlled trials evaluating the management of turf toe; thus, there was a lack of concealment, blinding, and randomization. Recall bias was also present, as some studies were retrospective.^{2,4,6,8}

DISCUSSION

A sprain of the first MTP joint or "turf toe" is an injury that can be quite devastating to athletes. This study illustrates that the RTS prognosis can be significantly affected by injury severity, treatment, and athlete competition level. There was a slight difference in RTS times when comparing among football positions and sport types; however, this information was sparse and was not found to be statistically different.

Only 1 case study evaluated the management of grade I injuries. Thus, we were unable to determine the ideal management, prognosis, and RTS in athletes with this grade of injury.¹⁵ The majority of injuries reported in the literature were grade III (55 athletes) or grade II (9 athletes). Even among these, not all reported the time to RTS. In studies reporting a faster RTS time, the patients had suffered a grade II injury versus grade III injury. While by definition a grade III injury is more severe,⁹ this increased recovery time for grade II injuries may have been confounded by treatment type.

Indeed, the literature shows that the majority of turf toe injuries can be treated nonoperatively using RICE (rest, ice, compression, elevation) and orthotics.^{2,3} The study by Clanton et al² is the largest case series in the current literature, and their results are classically quoted to support the nonoperative treatment of turf toe injuries. Unfortunately, they did not illustrate the severity of injuries that they treated, thus making it difficult for a physician to use their

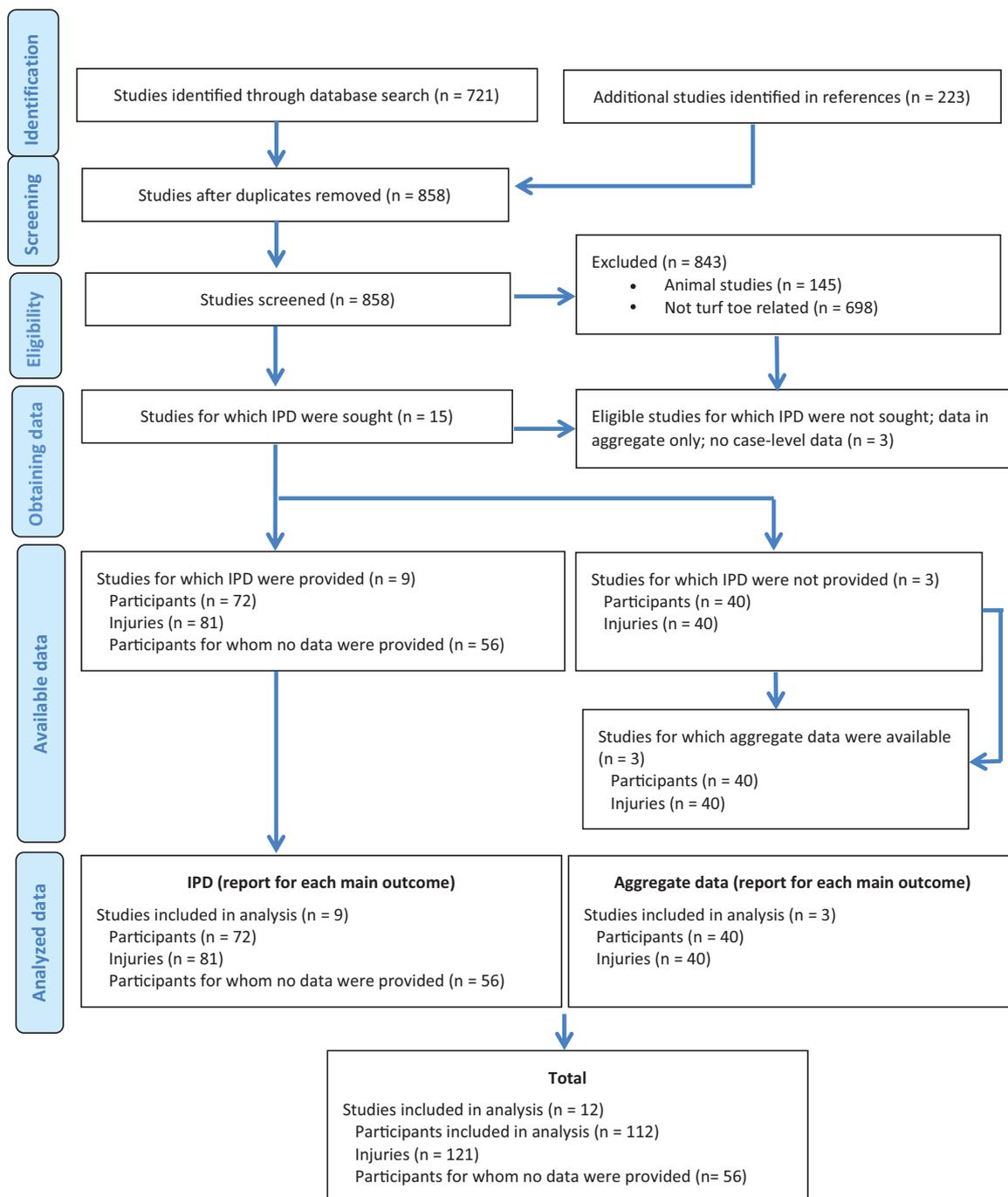


Figure 1. Flow diagram for study selection with individual participant data (IPD). This is our flowchart following the PRISMA-IPD (Preferred Reporting Items for Systematic Meta-Analyses of Individual Patient Data) guidelines.¹⁷

results to help provide a prognosis for their patient's injury. Additionally, there is wide variability in how people treat these injuries nonoperatively and the length of treatment. For example, Faltus et al⁶ reported on 1 patient with a grade II injury treated with 2.5 weeks of nonweightbearing with plantarflexion taping of the first MTP joint and a CAM boot, whereas Drakos et al⁵ reported 1 grade III injury treated nonoperatively with 5 weeks of nonweightbearing with cast immobilization with the great toe in maximal

plantarflexion. Hence, further studies are needed to help standardize and justify these nonoperative treatment protocols for each particular grade of injury. Even though there are a lot of recommendations supporting nonoperative treatment for the majority of turf toe injuries, there need to be higher level studies to support these claims and show the grade of injury and/or level of play of the athletes, in addition to the protocol for nonoperative treatment and their outcomes.

TABLE 1
Study Characteristics^a

First Author	Study Design	Level of Evidence	No. of Injuries	Sex (male/female), n	Mean Age, y	Sport, n	Position in Sport, n	Level of Competition, n	Grade of Injury, n	Treatment, n	Mean Time to RTS, wk
Smith ¹⁶	Case series	4	15	15/0	19	Football: 15	OL: 3; OS: 5; DL: 5; DS: 2	Professional: 1; college: 11; high school: 3	Grade III: 15	Surgery: 15	16.5
Covell ⁴	Case series	4	19	19/0	24.4	Football: 18; baseball: 1	RB: 5; FB: 1; LB: 3; S: 2; OT: 1; OG: 1; WR: 3; DE: 1; QB: 1; 3B: 1	Professional: 12; college: 6; high school: 1	Grade III: 19	Surgery: 19	14.7
Anderson ¹	Case series	4	9	8/1	N/A (range, 18-33)	Football: 8; N/A: 1	N/A	College/professional: 9	Grade III: 9	Surgery: 9	N/A
Roche ¹³	Case report	5	1	1/0	31	Soccer: 1	N/A	Elite: 1	Grade III: 1	Surgery: 1	23.9
Drakos ⁵	Case series	4	3	3/0	20.3	Football: 3	RB: 1; OL: 1; LB: 1	College: 3	Grade III: 3	Surgery: 3	26.1
Faltus ⁶	Case series	4	5	5/0	20.4	Football: 5	RB: 1; FB: 1; OL: 2; DL: 1	College: 5	Grade II: 1; grade III: 4	Surgery: 5	14.6
Clanton ²	Case series	4	55	N/A	N/A	Football: 53; track: 2	N/A	College: 55	N/A: 55	Surgery: 1; nonoperative: 54	0.9
Lohrer ¹⁰	Case report	5	1	0/1	26	Sprinting: 1	Sprinter: 1	Professional: 1	Grade II: 1	Surgery: 1	26.1
Coker ³	Case series	4	7	7/0	N/A	Football: 6; basketball: 1	RB: 4; QB: 1; N/A: 2	Recreational: 1; college: 1; high school: 1; N/A: 4	Grade II: 3; grade III: 4	Surgery: 3; nonoperative: 4	44.6 ^b
Rodeo ¹⁴	Case series	4	4	4/0	22.75	Football: 4	TE: 2; TB: 1; OL: 1	Professional: 3; college: 1	Grade II: 4	Surgery: 4	7.0
Sahin ¹⁵	Case report	5	1	1/0	19	Taekwondo: 1	N/A	Professional: 1	Grade I: 1	Surgery: 1	13.0
Mullis ¹²	Case report	5	1	1/0	18	Basketball/baseball: 1	N/A	High school: 1	N/A: 1	Surgery: 1	30.4
Total			121	64/2		Football: 112; soccer: 1; track: 3; basketball: 2; baseball: 1; taekwondo: 1; N/A: 1	OL: 7; OS: 5; DL: 6; DS: 2; RB: 11; FB: 2; LB: 4; S: 2; OT: 1; OG: 1; WR: 3; DE: 1; QB: 2; Sprinter: 1; 3B: 1; TE: 2; TB: 1; N/A: 69	Professional: 18; college: 82; high school: 6; recreational: 1; elite: 1; N/A: 13	Grade I: 1; grade II: 9; grade III: 55; N/A: 56	Surgery: 63; nonoperative: 58	

^a3B, third base; DE, defensive end; DL, defensive lineman; DS, defensive skill; FB, fullback; LB, linebacker; N/A, not available; OG, offensive guard; OL, offensive lineman; OS, offensive skill; OT, offensive tackle; QB, quarterback; RB, running back; RTS, return to sport; S, safety; TB, tailback; TE, tight end; WR, wide receiver.

^bHigh variability.

When conservative management fails or in the case of severe grade III injuries, surgery may be indicated.^{1,16} For example, turf toe injuries with at least 1 of the following characteristics may require surgery: large capsular avulsion, diastasis of a bipartite sesamoid, diastasis of a sesamoid fracture, retraction of a sesamoid, vertical instability, traumatic hallux valgus deformity, loose body, chondral injury, and failed conservative treatment.¹⁶ As such, the observed increase in the median time to RTS observed in this study is probably related to the fact that the more severe (grade III) injuries are the ones that usually undergo surgical interventions. However, as stated above, most of these recommendations come from case reports and case series. Further studies are needed to justify these indications for surgery versus other nonoperative treatment modalities for athletes suffering from turf toe injuries. Last, while there was no statistically significant difference in RTS when evaluating by sport or football position, there was a statistically significant difference when comparing

the athlete's level of play, with professional athletes returning much sooner than at both the high school or the college level. This finding is likely because of the wider array of resources and amount of time that professional athletes have in their recovery period and their financial motivation to return to play. It should be noted that the reported football position and type of sport were sparse in the literature.

There were several limitations to this study. First, there are very few studies related to RTS after a turf toe injury. Second, few studies included functional outcomes and reported residual pain scores; thus, we were unable to analyze these variables. Specifically, there was limited information on outcomes after the nonoperative management of turf toe injuries. Additionally, 40 of the injuries were classified according to our interpretation of the description of each injury. We acknowledge that this introduces another level of bias to the final results of this meta-analysis. Additional bias may have been introduced by our use of the Anderson¹ grading system as the primary means for

TABLE 2
Time to Return to Sport^a

Variable	n	RTS, Median (Range), wk	P
Grade of injury			.016 ^b
Grade I	1	13.04 (13.04-13.04)	
Grade II	7	8.70 (3.00-26.07)	
Grade III	41 ^c	16.50 (10.00-156.43)	
Level of competition			.018 ^d
High school	5	16.50 (3.00-26.10)	
College	25	16.50 (8.70-26.10)	
Professional	17	14.70 (6.00-26.07)	
Treatment ^e			<.001 ^b
Nonoperative	2	5.85 (3.00-8.70)	
Surgery	47	14.70 (6.00-156.43)	
Sport ^e			N/A ^d
Basketball	1	6.00 (6.00-6.00)	
Baseball	1	14.70 (14.70-14.70)	
Football	44	14.70 (3.00-156.43)	
Soccer	1	23.90 (23.90-23.90)	
Taekwondo	2	13.04 (13.04-13.04)	
Track	1	26.07 (26.07-26.07)	
Football position			N/A ^b
Tailback and fullback	1	18.00 (18.00-18.00)	
Offensive and defensive lineman	19	16.44 (7.00-26.10)	

^aPatients unable to be classified by grade of injury were excluded from this analysis. N/A, not available; RTS, return to sport.

^bMann-Whitney U test.

^cTwo patients had bilateral injuries.

^dKruskal-Wallis test.

^eOne patient was a multisport athlete, resulting in n = 49 for treatment and n = 50 for sport.

determining the severity of injury. The overall low level of evidence of studies that met the inclusion criteria for this study created a high risk for bias. However, even with these limitations, this study helps provide physicians with a specific RTS prognosis that they can provide to their patients suffering from turf toe injuries. This review also highlights the need for studies with a higher level of evidence on the management of turf toe injuries, outcomes, and RTS to determine the most appropriate nonoperative management procedure.

CONCLUSION

The time to RTS for an athlete who suffers from a turf toe injury is significantly influenced by the severity of injury and the athlete's level of competition. Professional athletes who suffer from turf toe injuries will RTS sooner than both high school and college athletes. However, there are a limited number of high-level studies evaluating turf toe in the athletic population. Further research is necessary to clearly define the appropriate treatment and RTS protocols based on sport, position, and level of play.

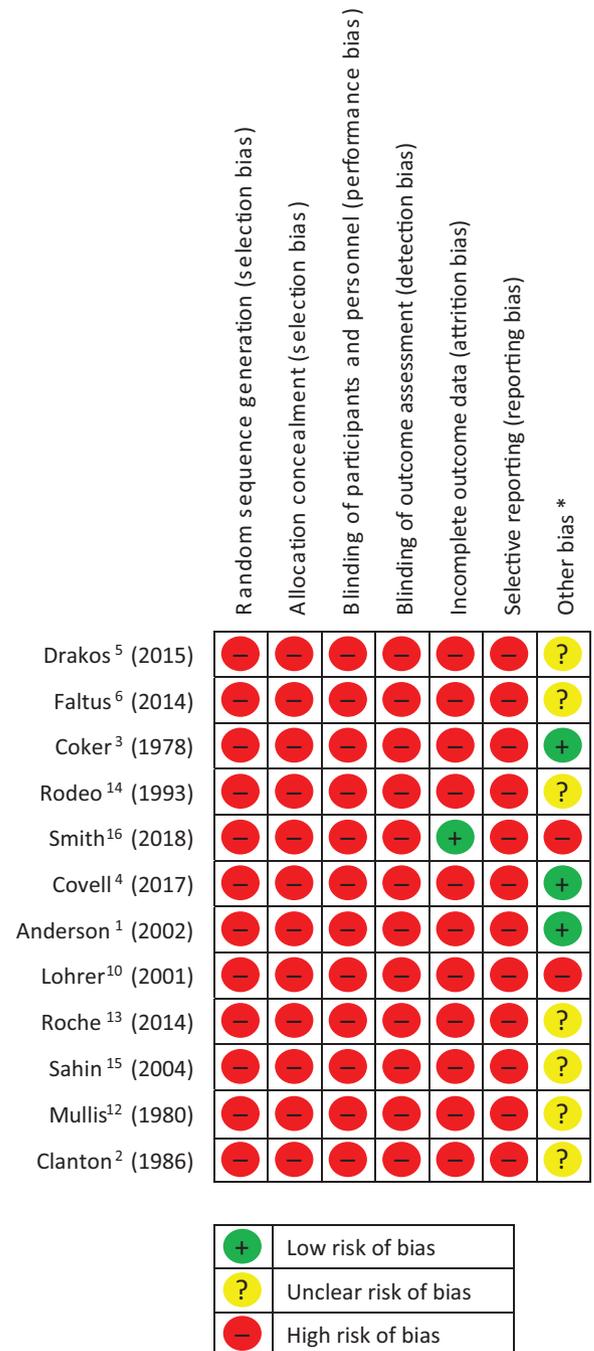


Figure 2. Quantitative bias analysis table. This table shows the bias for each study reviewed using the Cochrane Collaboration tool.⁸ *Other bias: Coker³ (1978), reporting bias; Covell⁴ (2017), recall bias; and Anderson¹ (2002), recall bias.

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