INTRODUCTION

High ankle sprains involve injury to the ankle syndesmosis and account for 25% of ankle sprains experienced by athletes in contact sports. Although the incidence of these injuries is lower than that of lateral ankle sprains (or low ankle sprains), they burden athletes with significantly more pain and disability. Treatment of high ankle sprains varies depending on severity of injury. Nonoperative management is generally appropriate for injuries with a stable syndesmosis, whereas patients with an unstable syndesmosis are frequently treated surgically. Among patients undergoing surgical management, syndesmotic stabilization is typically performed using either screws or suture buttons for fixation. Reported rates for return to sport for athletes following a high ankle sprain range from 83.6% to 100%. A previous systematic review, which included articles up to the year 2017, showed a 93.8% return to preinjury level of sport following high ankle sprain. This last study reported return to sport (RTS) at an average of 41.7 days for patients who underwent nonoperative management and 55.2 days for patients requiring surgery. These results are undoubtedly important; however, the analysis included athletes competing at various levels of competition and was not specific to elite athletes. Given the high level of performance and demand for RTS of elite and professional athletes, reliable data specific to this population is needed to provide players, coaches, and team physicians with accurate data to guide treatment.

The aim of this systematic review was to systematically assess the existing evidence on return to sport following high ankle sprain injuries in elite athletes and to provide accurate estimates of the time and rate of return to sport in athletes who underwent operative and nonoperative treatment.

METHODS

Search Strategy

Three online databases (MEDLINE, SCOPUS, and SPORTDiscus) were searched for literature reporting rate of return to sport following high ankle sprain injuries in high-level athletes. The database search was conducted on July 30, 2020, and included articles published from inception to 2020. The inclusion criteria for this search were as follows: (1) studies reporting the rate of return to sport following operative and/or nonoperative treatment of high ankle sprains in high-level athletes; (2) high-level athletes of any age competing in the collegiate or professional level and participating in any type of sport; and
(3) studies published in English and in peer-reviewed journals. The exclusion criteria were as follows: (1) studies reporting the outcomes and/or rate of return to sport following high ankle sprain injuries in nonathletes or recreational athletes; (2) studies not reporting the level of competition of the included athletes; (3) studies not reporting the rate of return to sport following high ankle sprain injuries; (4) articles that were not published in English language; and (5) non-peer-reviewed articles.

Multiple combinations of the following search terms were used to retrieve potentially eligible articles from the 3 databases: “athlete,” “ankle,” “sprain,” “high,” “syndesmosis,” “injury,” “return to sport,” “rate,” “outcomes,” “complication,” “return to play,” “operative,” “surgical,” “nonoperative,” “conservative,” “high level,” “elite,” “professional,” “colligate,” “college,” “sport.”

Study Screening

Two reviewers (J.B. and I.K.B.) independently screened the titles and abstracts of the retrieved articles. If any disagreement occurs at either of these 2 screening stages, the article was forwarded to full-text review. Any disagreements at the full-text screening stage were resolved by discussion between the 2 reviewers and consultation with the senior author (E.W.T.). The list of references of each of the eligible articles for inclusion was searched to retrieve additional studies that met the study criteria (cross-reference).

Quality Assessment of the Included Studies

The Methodological Index for Non-Randomized Studies (MINORS) criteria were used for quality assessment of the included articles. Methodological Index for Non-Randomized Studies is a validates scoring tool for nonrandomized studies; each of the 12 items in the MINORS criteria is given a score of 0, 1, or 2—giving a maximum score of 16 points for noncomparative and 24 points for comparative studies. Using the mean MINORS score of the included studies, the characterization of the quality of evidence was based on the following scale: 0 to 6 indicated very low quality of evidence, 7 to 10 indicated low quality of evidence, 11 to 14 indicated fair quality of evidence, and 15 to 16 indicated good quality of evidence. The percent agreement between the 2 independent reviewers was calculated to assess the interrater reliability.

Data Collection

Data were collected using prearranged Excel files (Microsoft Excel 2016) from the final pool of included studies. The following variables were collected: study authors and year of publication, level of evidence (as reported in the article or using the accepted criteria by the American Academy of Orthopaedic Surgeons), type of sport, number of athletes or injuries analyzed, number of athletes or injuries that returned to sport, rate of return to sport, time to return to sport, type of treatment received (operative, nonoperative), surgical technique used (screw vs suture button fixation), and complications.

Definitions

Elite athlete: Athletes competing at the collegiate or professional level.

Return to sport: Return to the preinjury level of sport.

Statistical Analysis

A random-effects model was used for meta-analysis, regardless of study heterogeneity. Study heterogeneity was reported using the I² statistic. Under the random effects model, the true effects in the studies are assumed to vary between studies, and the summary effect is the weighted average of the effects reported in the different studies. Estimated rates were reported as a pooled proportion with 95% confidence interval (CI). Data symmetry and evidence of publication bias were assessed using a funnel plot. The MedCalc (Version 19.1.3) software was used for statistics and generation of pictures.

RESULTS

Literature Search and Quality Assessment

We identified 10 articles that reported the rate of return to sport following high ankle sprain injury in elite (collegiate or professional level) athletes, and they were included in the meta-analysis. Figure 1 (PRISMA flow chart) depicts the study selection process and the reasons for full-text exclusion.

The percent agreement between the reviewers was >90% at all stages of screening, which is acceptable. The mean MINORS score was 13.8 (range: 9-21), indicating fair quality of evidence. There was no evidence of study heterogeneity (Q = 4.9; P = 0.835) in this meta-analysis. In addition, there was no evidence of publication bias in this meta-analysis, as demonstrated by the symmetric funnel plot in Figure 2. The level of evidence was IV in all of the included studies.

Study Population

Among the 10 included studies (Table 1), a total of 440 high-level athletes who sustained an ankle syndesmosis injury were analyzed. The mean age was 24 (range, 17-29) years. Most athletes participated in soccer (143 of 440, 33%) followed by ice-hockey (123 of 440, 28%), football (109 of 440, 25%), rugby (50 of 440, 11%), and other sports (15 of 440, 3%).

Return to Sport

The estimated rate of return to sport was 99% (95% CI, 95.5-99.9) (Figure 3). All but 1 study (9 of 10, 90%) reported that the mean time to return to sport was estimated as 38 ± 18 (range, 14-137) days for the entire study population. Of the 440 athletes, 269 (269 of 440, 61%) were treated non-operatively (nonoperative group). The rate of return to sport was 99.6% in the nonoperative group, and the athletes returned at a mean time of 29 ± 14 (range, 13-45) days. One athlete did not return due to recurrence of pain with sport participation. A total of 171 athletes (171 of 440, 39%) underwent surgical treatment of the high ankle sprain injury (operative group). All athletes in the operative group returned to sport at a mean time of 50.3 ± 13 (range, 41-137) days.

Screw Fixation versus Suture Button Fixation

The majority of athletes who underwent surgery for the management of high ankle sprain had fixation with suture button (164 of 171 athletes, 96%). The mean time of return to sport in these athletes was 50.5 days (~7 weeks). All studies reporting on the surgical management of the high ankle sprain...
injury (5 of 5, 100%) commented on postoperative complications.3,5,12–14 The postoperative complication rate in athletes who underwent suture button fixation was 9.1% (Table 1). Only 7 of 171 athletes (4%) who were surgically managed underwent stabilization of the ankle syndesmosis injury with screw fixation.

**Rehabilitation**

Table 1 presents the nonoperative and postoperative rehabilitation protocols in each of the included articles. All but 1 (9 of 10, 90%) of the included studies reported the rehabilitation protocol following conservative and/or operative treatment of ankle syndesmotic injuries. There was notable variability among the rehabilitation protocols used among the studies and the reported return to sport criteria.

**DISCUSSION**

According to the results of this meta-analysis, elite athletes return to the preinjury level sport at an extremely high rate (almost 100%) following ankle syndesmosis injuries that are treated operatively or nonoperatively. The mean time to...
| Study, yr | Study Population (No. of Athletes, Sport) | Return to Sport Rate and Time (Mean Time in d) | Treatment | Rehabilitation | Complications |
|----------|------------------------------------------|-----------------------------------------------|-----------|----------------|---------------|
| D’Hooghe et al, 2019 | 110 Soccer | 100%, 103 | Operative suture button fixation | Partial weight-bearing: boot for 10 days | Delayed wound closure ($n = 5$) |
| | | | | Full weight-bearing without boot (after d 10) | |
| Mollon et al, 2019 | 105 Ice hockey | 100%, 22.5 | NR | NR | NR |
| Latham et al, 2017 | 18 Rugby | 100%, 64 | Operative suture button fixation | 7-week protocol | Scar infection ($n = 2$) |
| | | | | | Persistent ankle stiffness ($n = 2$) |
| | | | | | Progression to ROM and strengthening exercises, and antigravity treadmill |
| | | | | | Posterior calf tightness ($n = 1$) |
| | | | | | Sport-specific functional and plyometric exercises |
| | | | | | Pain with return to run ($n = 1$) |
| | | | | | Medial button site irritation ($n = 1$) |
| Calder et al, 2016 | 64 Multiple sports (rugby, soccer, cricket, hockey, netball, football) | 100%, 45 days if nonoperative and 65 days if operative treatment | Nonoperative, operative suture button fixation ($n = 36$) | Week 1: Non–weight-bearing using a boot | Lateral skin irritation from suture button ($n = 3$) |
| | | | | Week 2: Partial weight-bearing | |
| | | | | Week 3 and 4: Full weight-bearing if pain-free. Discontinue boot at 4 weeks | |
| | | | | ROM exercises at d 10 | |
| | | | | | Proprioceptive and impact activities after 3 weeks and 5 weeks, respectively |
| Sikka et al, 2012 | 36 Football | 100%, NR | Nonoperative | Initial relative immobilization, ROM, and progressive strengthening exercises. Limiting dorsiflexion with taping/bracing | 3 underwent arthroscopic debridement at the end of the season |
| Howard et al, 2012 | 16 Football | 100%, 30 | Nonoperative | Boot immobilization with increased weight-bearing as tolerated | NR |
| | | | | ROM (except external rotation) and progressive strengthening and proprioceptive training | |
| | | | | Running in water followed by dry land, sprinting, and cutting maneuvers | |
| | | | | Return to sport when able to perform football activities pain-free and recover from training | |
return was 4 weeks and 7 weeks for athletes who underwent nonoperative and operative treatment, respectively. Suture button fixation was performed in the majority of athletes (96%) who underwent surgery for high ankle sprain injury, and only 4% of the athletes underwent fixation with a screw. Suture button fixation appeared to be associated with 9% complication rate. There was no evidence of publication bias or study heterogeneity in this study.

A previous systematic review had reported the rate and time to return to sport following ankle syndesmotic injury in athletes.9 However, both recreational and high-level athletes were included in the analysis. The overall rate of return to sport in this study was 94%, which was slightly lower than our estimated rate of 99% in the elite (collegiate and professional) athletic population.9 Nonetheless, these findings confirm the extremely high rate of return to sport following high ankle sprain injury in athletes. We were unable to analyze the return to sport outcomes (rate and time) based on the severity of injury and/or the type of rehabilitation protocol due to the lack of this information in the included articles. Future studies should

| Study, yr | Study Population (No. of Athletes, Sport) | Sport | Return to Sport Rate and Time (Mean Time in d) | Treatment | Rehabilitation | Complications |
|-----------|------------------------------------------|-------|-----------------------------------------------|-----------|----------------|---------------|
| Wright et al, 20043 | 14 Ice hockey | 92.9%, 38 | Nonoperative, operative screw fixation (n = 1) | Weight-bearing as tolerated, ROM, and strengthening exercises. Simple skating when pain-free and regained full ROM and normal strength | Ankle stiffness (n = 1) | |
| Miller et al, 201210 | 20 Football | 100%, 15 | Nonoperative | Standardized rehabilitation protocol | | NR |
| Taylor et al, 200717 | 6 Lacrosse, hockey, football | 100%, 32 | Operative screw fixation | Split immobilization for 1 wk, followed by gradual weight-bearing in boot then ankle brace | Screw breakage (n = 1) | |
| Nussbaum et al, 200112 | 60 Multiple (football, lacrosse, soccer, rowing, wrestling, gymnastics, swimming, track, hockey, cheerleading, basketball) | 100%, 13 | Nonoperative | Three-phase rehabilitation protocol | Heterotopic ossification, ankle stiffness, recurrent ankle sprains (n = non specified) | |
include details on the severity of injury and/or the nonoperative or postoperative rehabilitation protocol followed (eg, time elapsed until full weight-bearing was permitted) to identify potential risk factors for suboptimal outcomes in the management of high ankle sprains in elite athletes.

Our study demonstrated that the overall time to return to sport following high ankle syndesmotic injury in high level athletes was approximately 1 week shorter compared with the mean time to return reported in the study by Vancolen et al\(^9\) (5.4 weeks vs 6.5 weeks, respectively). This last study included athletes competing at various levels of competition. This difference may be attributed to the physical conditioning of the athletes, which might be improved in those competing at the professional level compared with recreational athletes. In addition, high-level athletes typically undergo accelerated rehabilitation protocols and are closely supervised by the team’s medical team.\(^{15}\) Furthermore, this difference in time to return to sport may be attributed to socioeconomic factors, considering the financial impact of the time missed from competition in high-level athletes.\(^{16,17}\)

When calculating the mean time to return to sport between high-level athletes who underwent operative and nonoperative treatment for the high ankle syndesmotic injury, those who were managed nonoperatively required less time to return to sport. The mean time to return was 50.3 days in the operative group and 29 days in the nonoperative group. Although Vancolen et al\(^9\) found a similar time for return to sport following nonoperative management of the high ankle sprain injury in their study was 46 days, which was longer than ours. It is worth noting that apart from differences in the study population characteristics between our study and the review by Vancolen et al,\(^9\) their analysis was limited to articles published up to the year 2017. This systematic review provides an updated and focused summary of the existing literature describing the management of ankle syndesmotic injuries in athletes competing at the collegiate or professional level.

We also examined the surgical techniques used to treat high ankle sprain injuries in the elite athletic population and we found that 96% of the included athletes underwent suture button fixation. Screw fixation was used in only 4% of the subgroup of athletes who underwent operative management in this study. In a comparative meta-analysis of the functional and radiographic outcomes following suture button fixation versus screw fixation in the treatment of distal tibiofibular syndesmosis injuries, which included 5 randomized controlled trials, Xie et al\(^{18}\) demonstrated no difference in any of the postoperative radiographic outcomes (medial clear space, tibiofibular clear space, tibiofibular overlap) between patients who received suture button versus screw fixation.\(^{18}\) However, suture button fixation resulted in significantly higher American Orthopaedic Foot and Ankle Society scores.\(^{24}\) In addition, patients who underwent suture button fixation experienced a lower rate of postoperative complications (RR, 0.12; 95% CI, 0.04-0.34; \(P = 0.000\)) and were full weight-bearing at an earlier time (SMD = -0.72; 95% CI, -1.06 to -0.38; \(P = 0.000\)) compared with those who were treated with screw fixation. In a recent meta-analysis, dynamic stabilization of ankle syndesmosis was found to result in decreased complication and reoperation rates, compared with static fixation with a screw.\(^{19}\) This last study included randomized trials that did not exclusively focus on the athletic population.\(^{19}\) Based on the above, suture button fixation seems to be the gold standard surgical approach of ankle syndesmosis injuries requiring operative management in athletes and nonathletes. We were unable to compare the complication rate between athletes who underwent suture button versus screw fixation of ankle syndesmosis injury due to the very small population size in the screw fixation subgroup.

It is worth mentioning that the present analysis aimed to report the outcomes of operative and nonoperative treatment of high ankle sprain injuries in elite athletes by conducting an independent analysis of the return to sports rate in each of these subgroups. It is important to highlight that the indications of operative and nonoperative management of
ankle syndesmosis injuries were distinct in each of the included articles. Thus, there was no comparison of the RTS rate between athletes who underwent operative versus nonoperative management of the “same type of injury,” given that in the included articles, athletes with severe injuries underwent surgical treatment and those with less severe injuries were treated with conservative measures.

This meta-analysis constitutes an update on the outcomes of nonoperative and operative treatment of ankle syndesmotic injuries in high-level athletes. Although there was no evidence of publication bias or study heterogeneity among the included articles, all of the included articles were of level of evidence IV. We were unable to report the rate and time to return to sport based on the severity of injury and/or the rehabilitation protocols used because this information was often inadequately reported in the included articles. A major limitation of this analysis was the small number of athletes included in the screw fixation group, which made any comparison against the suture button fixation group impossible. The main outcome of this study (rate of return to sport) was based on the percentage of athletes who returned to the preinjury level of sport postoperatively, in each of the included articles. The term “preinjury level of sport” was used in this review based on the definition given by each of the individual studies. We observed that there was consistency across the articles reporting whether the athletes returned at the preinjury level of sport or a different level, and therefore, setting a new definition would not have an impact on the results of this study. Finally, it is important to mention that the outcomes of each of the included studies may have been affected by variability in the surgical technique used, the surgeons’ expertise and the postoperative rehabilitation protocol followed.

CONCLUSIONS

Elite athletes with ankle syndesmosis injury return to sport at an extremely high rates, following operative or nonoperative treatment. Return to the preinjury level of competition should be expected at 4 weeks and 7 weeks in high-level athletes who undergo nonoperative and operative management, respectively. Suture button fixation was used by the majority of the included articles, athletes with severe injuries underwent surgical treatment and those with less severe injuries were treated with conservative measures.

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