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Systematic Review

Isolated Medial Subtalar Joint Dislocation during Sports Activities: A Systematic Review of the Literature with Individual Participant Data Analysis

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Abstract: In athletes, one of the most common injuries is a sprained ankle. If the energy of the trauma is particularly high, this type of injury can lead to an isolated medial dislocation of the subtalar joint (STJ), a rare condition poorly described in the literature. The aim of this study was to verify if a reliable conservative treatment and a specific physiotherapy rehabilitation protocol in isolated medial dislocation of the STJ in athletes is described in the literature. A systematic review of the published literature of the last 11 years was performed by applying the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines using three databases: Pubmed, Scopus, and Web of Science. The keywords used were "(subtalar OR talocalcaneal) AND dislocation". We considered only studies that included professional or amateur athletes (athletic patients). We used the American Orthopedic Foot and Ankle Society (AOFAS) scale, range of motion (ROM) of the subtalar and ankle joint, subtalar and talonavicular joint osteoarthritis, and patient feedback to evaluate their outcomes. A total of 12 studies were included in our review, with a total of 26 athletic patients. Sixteen of them had good results with the correlation between the duration of immobilisation and the outcomes. Nevertheless, due to the small number of patients included in the analysed studies on this subject in the literature, there is not yet a univocal clinical protocol to treat the isolated medial subtalar joint dislocation (STJD) warranting further research in the field.

Keywords: subtalar joint dislocation; talocalcaneal dislocation; sports injuries; ankle; athletes; conservative

1. Introduction

In sports such as football and basketball, ankles injuries are quite common due to the continuous sprinting and jumping involved [1]. Furthermore, in the case of a high energy trauma, a subtalar joint dislocation (STJD) can occur, which consists of the displacement of two joints, namely, the talocalcaneal and the talonavicular. This rare condition represents <1%–2% of all large joint dislocations and approximately 15% of all talar injuries and was first described by DuFaurest and Judcy in 1811 [2,3]. Usually, this kind of injury affects young male patients [1] with a male-female ratio of about 3:1 [4]. The medial dislocation is the most common one, representing about 80% of the isolated dislocation (without fracture) due to its intrinsic instability in inversion. When high energy is applied, forcing supination in a blocked foot, the ligaments that ensure the stability of the STJ break in a specific order: first the dorsal talonavicular ligament, then the interosseous talocalcaneal ligament and finally the calcaneofibular ligament [5,6]. This injury can be caused by repetitive low energy traumas (repetitive jumps and landings [1], hence its vulgar name "basketball foot" due to how prevalent those actions are in that sport) or a single high energy trauma (like a motorcycle crash or falling from heights).

In case of suspected STJD, the first step is to obtain a thorough clinical history: what is the kind of trauma, what is the activity that caused the trauma, timing of the injury, and history of previous ankle trauma or surgery.

The second step is a thorough physical examination: the clinical presentation of a STJD can help with the diagnosis, with a visible deformity of the affected ankle, where the calcaneus is displaced medially, and the talar head is prominent dorsolaterally and associated cutaneous tension of the lateral side of the foot, (Figure 1). Further, it is not unusual to have an open wound associated with the dislocation. In some cases, however, the dislocation reduces spontaneously, leaving a swollen ankle with ecchymosis [1,5–14].

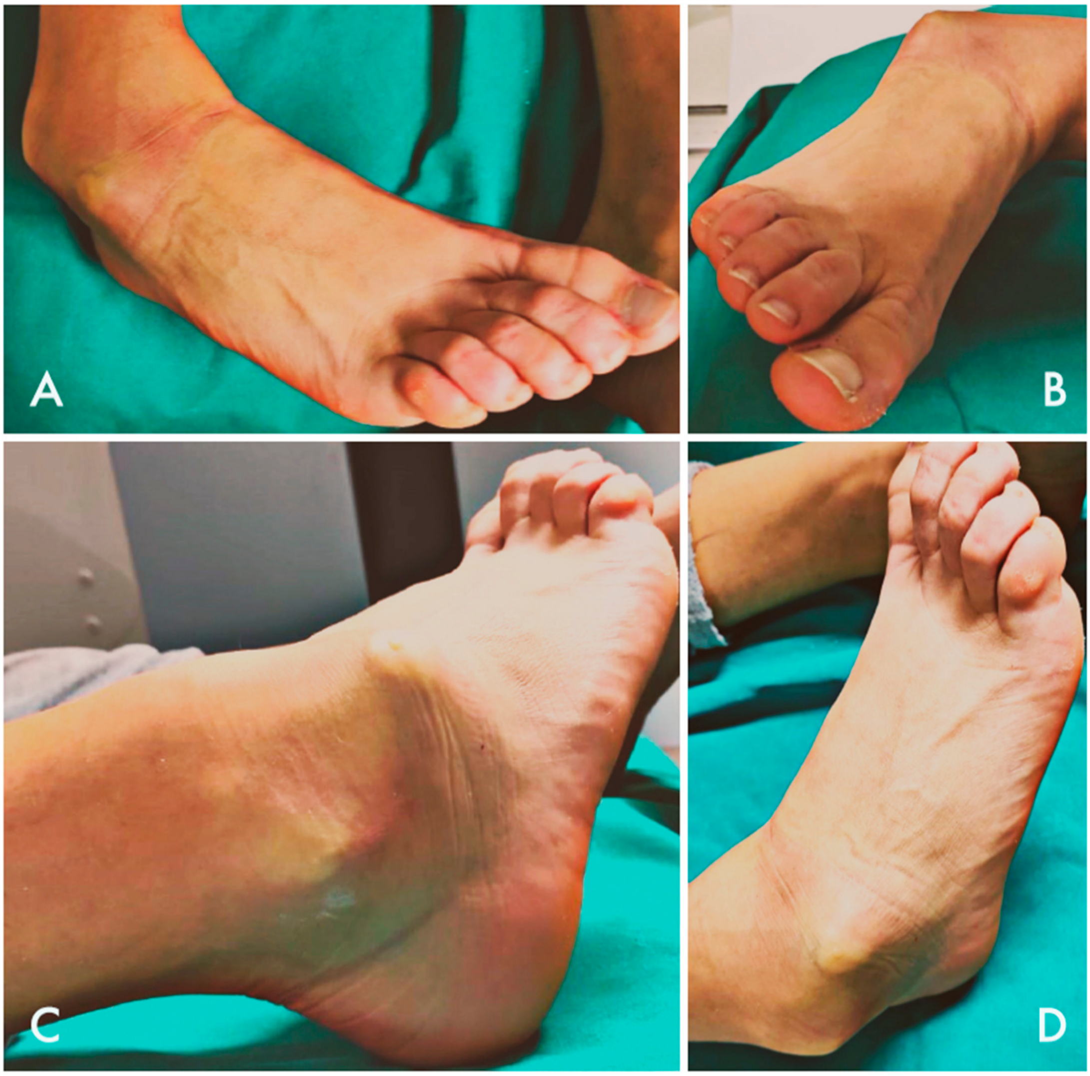

Figure 1. Clinical images of an isolated medial subtalar joint dislocation (STJD) in a 25-year-old female recreational athlete who showed deformity of her right ankle joint upon arrival at the emergency department (ED) (**A**–**D**).

The third and last step is to obtain appropriate imaging: radiological images are important for the diagnosis of STJD: standard antero-posterior and lateral radiographic views can show rotational defects or any relics of lateral displacement. An oblique radiographic projection with an internally rotated foot in order to verify the integrity of the tibiotalar articulation is also suggested. Magnetic resonance imaging (MRI) can be used to evaluate the condition of the ligaments. It is mandatory to always evaluate the neurovascular state of the affected foot and the soft tissue condition [15]; to this end, it is necessary to palpate the posterior tibial pulse and the dorsalis pedis pulse accurately and, comparing the pulse strength between the feet, exclude vascular lesions.

Once all these aspects have been examined, if the dislocation did not reduce spontaneously, the next action is to reduce the displacement; this can be carefully done in the ER with some local anaesthesia, and the knee flexed 90° to reduce tension from the gastrocnemius [16]. It is usually possible to perform a closed reduction in the acute dislocation; however, if the manoeuvre is impossible to perform or there is still some instability, it can be done in an open manner. After obtaining a good reduction, the joint is immobilised, and a CT scan is done to check for hidden fractures. As of now, there is no “gold standard” method to immobilise the affected ankle. The most used is the classic below-knee cast, either open or closed depending on the skin and soft tissue conditions. The duration of the immobilisation can vary depending on the patient’s general condition, age and type of trauma. Usually, the time is about four to six weeks; however, a study by Dr. Lasanianos [17] showed that two to three weeks of cast immobilisation followed by partial bearing on the affected limb and specific physiotherapy could improve the outcome of these patients. While the patient can usually obtain a good recovery, complications must not be underestimated. They can generally be divided into acute and chronic. The first complications are caused by damage to the neurovascular bundle and the soft tissues, while the latter are avascular necrosis of the tarsal bone and osteoarthritis. Due to the rarity of an isolated STJD, there is a paucity of data regarding the best way to treat patients affected by this injury. Hence, the purpose of this systematic review was to compile the current literature about isolated medial STJD occurring in athletes during sports activities to compare the effectiveness of the different conservative types of treatment available and potentially find key factors that could play a role in their outcomes.

2. Materials and Methods

2.1. Search Strategy

The present systematic review with individual participant data analysis and its related procedures were organised, conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines with a PRISMA checklist and algorithm [18,19]. A medical librarian-assisted electronic search was conducted using three different databases: PubMed/MEDLINE, Scopus and Web of Science. In each database, an advanced search was conducted using “(subtalar OR talocalcaneal) AND dislocation” as keywords.

2.2. Selection Criteria

An 11-year time selection was used, from January 2009 to September 2020. We included only articles written in English, and that met the following PICOS criteria:

(I) Population (P): patients of every age that suffered from an isolated medial STJD during sports activities.
(II) Intervention and Comparison (IC): patients treated in conservative ways and their follow-up.
(III) Outcomes (OS): results were analysed using the American Orthopedic Foot and Ankle Society (AOFAS) scale, quality and quantity of Range of Motion (ROM) of the affected joint after treatment, evidence of osteoarthritis in the subtalar and talonavicular joints and patient feedback.

We included case reports and case series about this topic. We excluded short surveys, letters to the editor, articles about bioengineering, studies performed on animals or cadavers, reviews of the literature, and technical notes.

2.3. Selection Method

The selection was based on the abstract's content; if inclusion or exclusion of the article was not possible based on the abstract, the full-text article was read. Cross-reference research of the selected articles was also performed to obtain other relevant articles for the study. Finally, the selected articles and references were reviewed, assessed and discussed by the authors. If there was disagreement among the investigators regarding the inclusion or exclusion criteria, the senior investigator made the final decision.

2.4. Literature Search

The literature search obtained 188 papers from PubMed/MEDLINE, 258 papers from Scopus and 138 papers from ISI/Web of Science for a total of 584 papers. Of these, 279 were duplicates and so were excluded. Of the remaining 305 manuscripts, we excluded 211 articles as their topics were not the STJ or because they discussed fractures or congenital displacement of the STJ. Out of the remaining papers, 12 relevant reports were identified that met all of our criteria (Figure 2). We compared the outcomes of conservative treatments of the isolated medial STJDs in the 12 selected studies from January 2009 to September 2020 and analysed the outcomes of each study (Table 1). Level of evidence (I, II, III, or IV) was reported for the included studies.

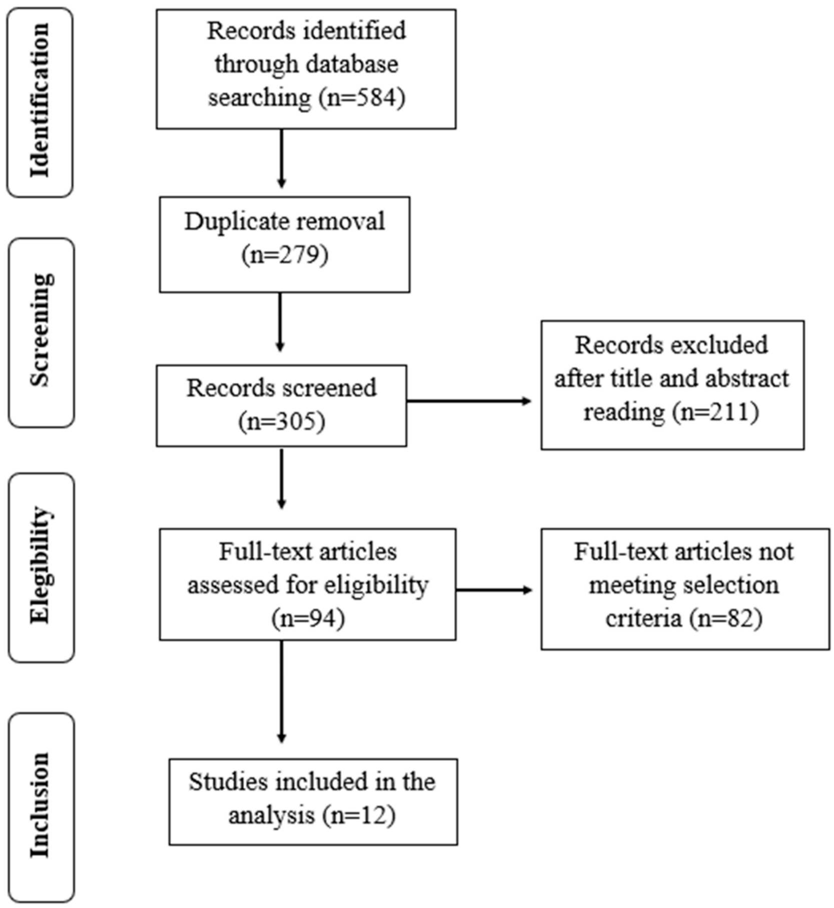

Figure 2. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA): flow chart diagram for inclusion and exclusion of paper process. For this study, 94 papers articles were assessed for eligibility after screening; among these, 12 papers fulfilled the selection criteria and were included in the analysis.

2.5. Quality Assessment

To assess the quality of the selected studies, we used the Downs and Black scale [20]. It assesses methodology using 27 items with a range from 0 to 28 points divided into five sections (Reporting, External validity, Internal validity-bias, Internal validity-confounding or selection bias, and Power). This scale evaluates methodologies and is also indicated for case series. The study methodology is considered excellent (26–28 points), good (20–25 points), fair (15–19 points), or poor (<14 points).

2.6. Data Extraction and Elaboration

After downloading the PDF files of each study included in the selections, the data were extracted into a customised database for the subsequent analysis following precise data extraction form:

(I) Study design and level of evidence.
(II) Population: sample size, demographic characteristics (e.g., age and sex), general characteristics (the type of sport practised), and follow up duration.
(III) Type of treatment: the specific conservative treatment chosen.
(IV) Clinical outcomes according to the AOFAS, ROM of the affected joint after the treatment, osteoarthritis, feedback from the patients about their quality of life and sports performance after the injury.

2.7. Statistical Analysis

Only studies that reported the clinical outcomes according to the AOFAS scale were taken into consideration [21]. Descriptive statistics of the eligible studies were performed. Continuous variable data such as age, follow-up time, length of immobilisation and outcome results (according to the AOFAS scale) were reported as mean and range. We carried out descriptive statistics of categorical variable data (gender, side of displacement between right and left ankle, type of reduction, type of immobilisation applied, post-treatment osteoarthritis, and final ROM). Finally, data were pooled together, and individual participant data analysis was performed to obtain a single synthesis measure. Metaregression was conducted to shed light on the determinants of the outcome measure.

Table 1. Details about the type of study, evidence level, score in the Downs and Black (D&B) scale, demographic data, type of sport practiced, and type of treatment applied for each article included in our review. AOFAS: American Orthopedic Foot and Ankle Society; ROM: range of motion (n/a: not available).

Authors	Type of Study	Evidence Level	D&B	Patients (M/F)	Type of Sport	Medium Age (Range)	Type of Treatment	Outcome Measures
Wang et al. [22]	Case Report	IV	9	1 (1/0)	Soccer	37	Closed reduction, casting and external fixation, assisted active exercise	AOFAS
Biz et al. [23]	Case Report	IV	12	3 (1/2)	Volleyball	28 (16–42)	Closed reduction, casting/posterior splint, painkillers, ankle brace physiotherapy	AOFAS
Abdellatif et al. [24]	Case Report	IV	8	1 (1/0)	Basketball	22	n/a	Feedback
Giannoulis et al. [25]	Case Report	IV	7	1 (1/0)	Climbing	36	Closed reduction, casting/posterior splint	ROM, presence of instability, presence of osteoarthritis
Stafford et al. [26]	Case Report	IV	9	1 (1/0)	Soccer	23	Closed reduction, ankle brace, physiotherapy	Return to sport
Atik et al. [27]	Case Report	IV	6	1 (1/0)	Tennis	22	Closed reduction, casting	Feedback
Bryant et al. [28]	Case Report	IV	7	1 (1/0)	Baseball	26	Closed reduction, casting	Presence of osteoarthritis
Pua [29]	Case Report	IV	6	1 (1/0)	Basketball	17	Closed reduction	n/d
Pesce et al. [30]	Case Report	IV	10	1 (1/0)	Military drills	37	Closed reduction, casting/posterior splint	n/d
Kemah et al. [31]	Case Report	IV	11	1 (1/0)	Long Jump	20	Closed reduction, casting, physiotherapy	n/d
Ruhlmann et al. [32]	Retrospective Cohort	IV	15	10 (9/1)	Basketball	38.4 (17–71)	Closed reduction, casting, physiotherapy	AOFAS, ROM, presence of osteoarthritis
Jungbluth et al. [33]	Retrospective Cohort	IV	15	4 (2/2)	Soccer	34.5 (27–41)	Open/closed reduction, external fixation/casting, physiotherapy	AOFAS, ROM

3. Results

3.1. Patient Population

The 12 studies included reported on a total of 26 patients, all athletes (three professionals and 23 amateurs). None of them dropped out during the follow-up. Therefore, a total of 26 patients were considered, corresponding to 26 ankles and 26 isolated medial STJDs. Of those, 20 were males and six females. The mean age at treatment was 32.54 years, ranging from 16 to 71 years [23,32]. The total number of patients for each study ranged between one and 10 [22,24–32]. In one paper, the affected ankle was not specified (for a total of four patients); of the remaining 22 patients, the right ankle was affected 15 times (68.18%) and the left ankle seven times (31.82%). In one study, the type of sports activity practised by the patients was not specified; the isolated medial STDJ appears to be more common in sports such as basketball, football and volleyball. The patients were assessed at a mean follow-up time of 25.38 months, ranging from 0 to 124.8 months [25,27,29,32]. All but one patient [33] underwent closed reduction of the displacement, and all were treated with ankle immobilisation (except in one paper [29] where it was not specified). Noteworthy, none of the patients suffered previously from STJD.

3.2. Type of Treatment

For the selected studies, we analysed different conservative approaches and treatment protocols (Table 2). The first treatment performed in emergency and applied to every patient was closed reduction under anaesthesia (except for one patient who underwent emergency open reduction). The displaced joint was then immobilised for a mean time of 5.13 weeks, ranging from a minimum of four to a maximum of eight weeks. To be more specific, four weeks for seven patients (26.92%), five weeks for one patient (3.85%), six weeks for thirteen patients (50%) and eight weeks for one patient (3.85%); however, we did not have enough data on four patients. Nineteen patients were treated with an open cast (73.08%), three patients with the combined use of a cast and posterior splint (11.54%); one patient was treated with the combination of external fixation, and cast (3.85%), one patient with a posterior splint and an ankle brace (3.85%) and one patient was treated with just external fixation (3.85%). After the immobilisation period, each patient had various treatments, mainly using painkillers and physiotherapy.

Table 2. Details about the patient rehabilitation protocol applied in each study (n/a: not available).

Authors	Patients	Rehabilitation Protocol
Wang et al. [22]	1	Active assisted ROM exercises after four weeks, partial weight bearing after six weeks and total weight bearing if tolerated.
Biz et al. [23]	3	Patient 1: painkillers; after two weeks, partial weight-bearing supported with crutches for two weeks; after four weeks, ankle brace, physical therapy, physiotherapy for five months. Patient 2: painkillers; after four weeks, total weight bearing if tolerated, ankle brace for two months; active and passive physiotherapy, physical therapy. Patient 3: painkillers; after four weeks, total weight bearing if tolerated; passive physiotherapy for two months.
Abdellatif et al. [24]	1	n/d
Giannoulis et al. [25]	1	Active and passive ROM exercises and total weight bearing if tolerated after immobilisation.
Stafford et al. [26]	1	Active and passive ROM exercises and total weight bearing if tolerated after immobilisation.
Atik et al. [27]	1	n/a
Bryant et al. [28]	1	n/a

Table 2. *Cont.*

Authors	Patients	Rehabilitation Protocol
Pua [29]	1	n/a
Pesce et al. [30]	1	n/a
Kemah et al. [31]	1	n/a
Ruhlmann et al. [32]	10	Physiotherapy and progressive weight bearing after immobilisation.
Jungbluth et al. [33]	4	Physiotherapy, partial weight-bearing after immobilisation; total weight-bearing after a mean of 10.6 weeks (range 10–11.5)

3.3. Outcomes

3.3.1. Overall Analysis of Clinical Scores

Considering all of the studies, 16 patients showed good clinical outcomes: one patient reported occasional pain after the incident, two patients showed a reduction in STJ ROM, two patients showed a reduction in ROM with associated STJ osteoarthritis, two patients showed a reduction in ROM with associated subtalar and talonavicular joint osteoarthritis on both locations, and for three patients, we do not have information about the outcome. The only patient who underwent open reduction had a good outcome. No patient showed articular stiffness after treatment. The patient that reported occasional pain was treated with closed reduction and casting for four weeks. The patients that showed a reduction in ROM with subtalar and talonavicular arthritis were treated with casting for six weeks, after which they started partial weight-bearing and physiotherapy.

Comparing the different techniques to immobilise the joint after reduction, casting, and external fixation showed a good outcome in one patient; casting without any other device showed good outcomes in 11 patients, a good outcome with occasional pain in one patient, a reduction in ROM without associated osteoarthritis in two patients, reduction of ROM with associated STJ osteoarthritis in two patients, reduction in ROM with associated subtalar and talonavicular joint osteoarthritis in two patients. Casting combined with a posterior splint showed good outcomes in two patients; the use of an ankle brace associated with a posterior splint showed good outcomes in two patients (Figure 3).

Regarding the duration of immobilisation and results, four weeks of immobilisation showed six good results and one good result with occasional pain, five weeks showed one good result, six weeks showed eight good results, two reductions in ROM without osteoarthritis, two reductions in ROM with associated STJ osteoarthritis, two reductions in ROM with associated subtalar and talonavicular joint osteoarthritis, eight weeks showed one good result (Figure 4). Considering follow-up timing, we found one good outcome at three months, one good outcome at six months, one good outcome with occasional pain and two good outcomes at 24 months, one reduction in ROM with associated subtalar and talonavicular joint osteoarthritis at 24.4 months, one reduction in ROM without osteoarthritis at 25.5 months, one good outcome at 30 months, two good outcomes at 36 months, three good outcomes at 46 months, three good outcomes at 49 months, three good outcomes at 53.5 months, one reduction in ROM without associated osteoarthritis at 54.9 months, one good outcome at 56 months, one reduction in ROM with STJ osteoarthritis at 57 months, two good outcomes at 60 months, two good outcomes at 73 months, one reduction of ROM with associated STJ osteoarthritis at 75.6 months, two good outcomes at 107.4 months, two good outcomes at 123.3 months and one reduction in ROM with associated subtalar and talonavicular joint osteoarthritis at 124.8 months.

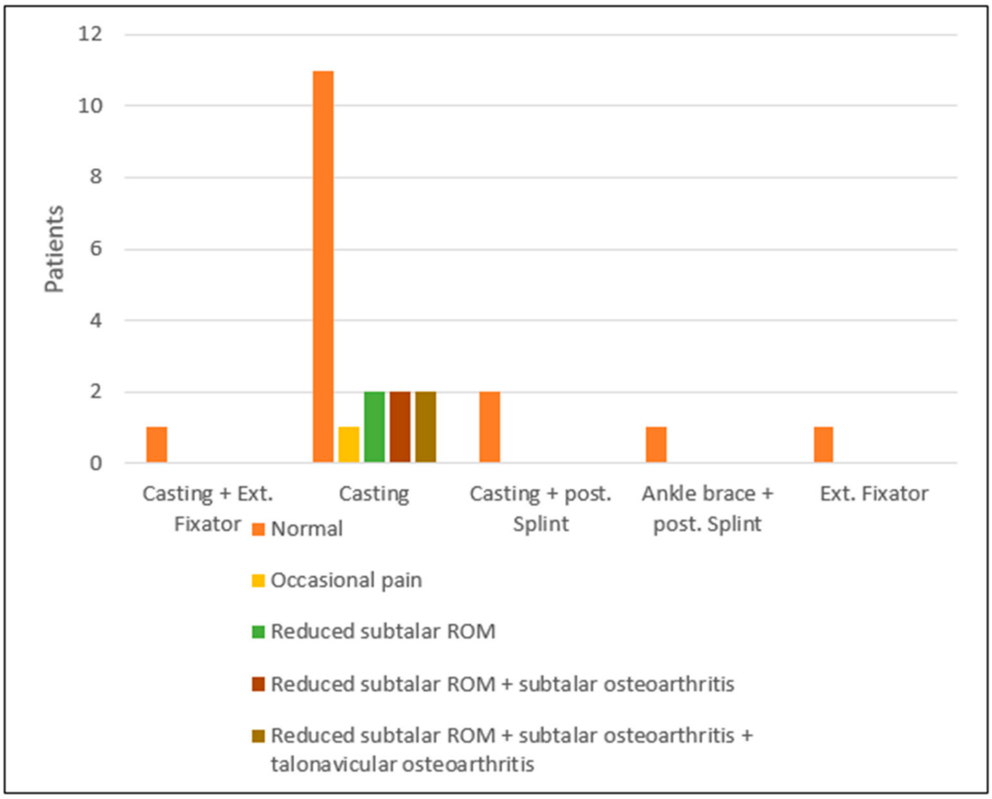

Figure 3. Outcome depending on the type of immobilisation used.

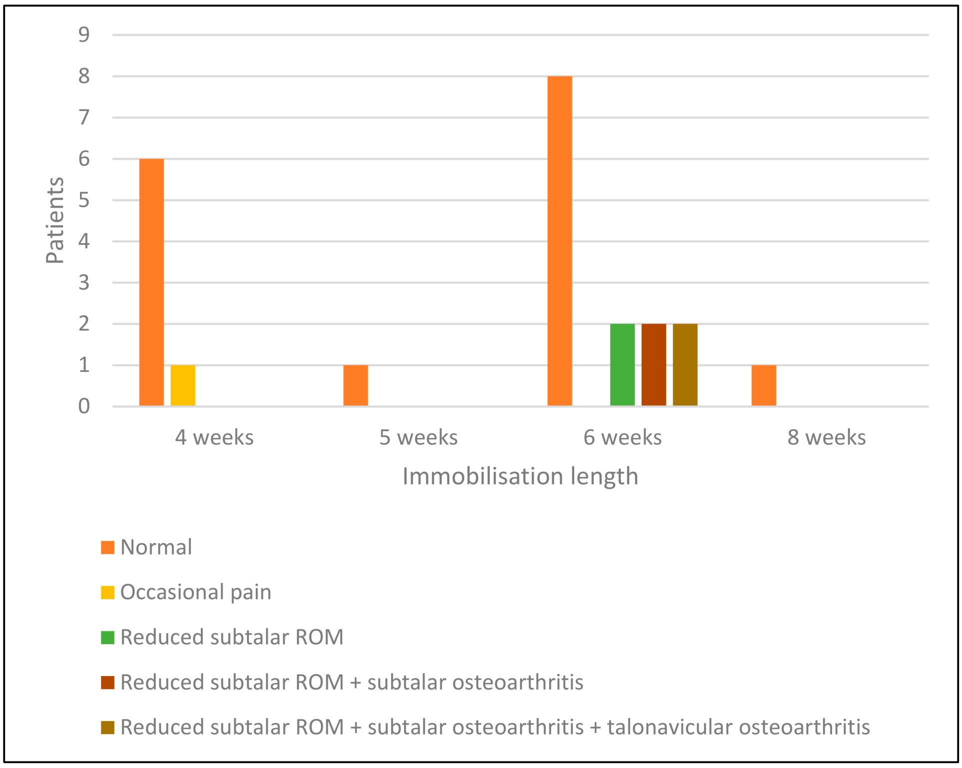

Figure 4. Results obtained in our cohort of patients depending on immobilisation length.

3.3.2. Comparison of Clinical Scores

The AOFAS scale was used in 5 studies (41.67%) to evaluate clinical and functional results after treatment for a total of 19 patients. This scale represents the combination of both objective and subjective parameters with a score between 0 and 100 (the higher the score, the better the outcome). The AOFAS scale has been validated over time, with different studies confirming its reliability. The Italian version was recently validated [21]. The mean score was 86, with a range from 66 to 100. Good results were obtained with laser therapy and ultrasound therapy after the immobilisation period, using an ankle-brace with crutches and partial weight bearing on the affected limb even during the immobilisation period [23,26] and targeting physiotherapy on the muscular reinforcement of the peroneus longus and the brevis muscles starting after the immobilisation period [22,23,25,26,31–33]. In three studies, it is specified that all of the patients were able to return to their sports activities with a mean of 4.53 months of rest, range 4–5.67 months [22,23,31].

3.3.3. Statistical Analysis

Statistical analysis was performed considering only the studies that used the AOFAS scale score to evaluate the outcomes. Table 3 shows descriptive statistics of continuous variables such as age, follow-up, immobilisation duration and outcome score. For each variable, we report the minimum and maximum value, the median and mean value, the relative standard deviation and corresponding percentile.

Table 3. Descriptive statistics of continuous variables of the articles included in the analysis.

	Minimum	Maximum	Mean	Median	Standard Deviation	25–75 Percentiles
Age	16.0	71.0	34.9	31.0	14.3	26.0–41.8
Follow-up Time	3.0	124.8	54.2	49.0	34.1	26.6–69-8
Immobilisation length (weeks)	4.0	6.0	5.4	6.0	0.9	4.2–6.0
AOFAS score	66.0	100.0	86.0	85.0	8.9	82.0–90.0

Table 4 shows the descriptive statistics of categoric variables for the cohort of athletic patients included in the analysis, while Table 5 shows the meta-regression results of the independent variables. The only relevant variable is the immobilisation time: the meta-regression coefficient was –5.5580, showing how increasing immobilisation time worsens the results.

Table 4. Descriptive statistics of categoric variables of the papers chosen for our review (sex (0 = female; 1 = male); affected side (0 = left; 1 = right); type of immobilisation used (0 = external fixator; 1 = casting; reduction technique performed (0 = open; 1 = closed); presence of subtalar and talonavicular joint osteoarthritis (0 = absent; 1 = present); STJ ROM quality after treatment (0 = reduced; 1 = conserved).

	0	1	Total
Sex	5 (26.3%)	14 (73.7%)	19 (100%)
Affected side	4 (26.7%)	11 (73.3%)	15 (100%)
Type of immobilisation	1 (5.3%)	18 (94.7%)	19 (100%)
Type of reduction	1 (5.3%)	18 (94.7%)	19 (100%)
Subtalar osteoarthritis	14 (73.7%)	5 (26.3%)	19 (100%)
Talonavicular osteoarthritis	17 (89.5%)	2 (10.5%)	19 (100%)
STJ ROM	6 (42.9%)	8 (57.1%)	14 (100%)

Table 5. Meta-regression of the independent variables presented in the articles included in the analysis.

	Coefficient	Standard Error	t. Statistics	*p*-Value	$r_{partial}$	$r_{semipartial}$
(Constant)	117,76					
Immobilisation length	−5.56	2.11	−2.63	0.027	−0.66	0.4
Age	−0.03	0.11	−0.28	0.789	−0.09	0.04
Follow-up	−0.01	0.05	−1.18	0.106	−0.51	0.27
Affected side	6.11	3.61	1.69	0.125	0.49	0.26
Sex	−0.07	3.95	−0.02	0.986	−0.01	0.003

3.4. Quality Assessment

The mean value of the Down and Black scale [20] was 9.58 points, showing that the mean quality of the included studies was poor. Among the 12 studies considered, 10 had poor results [22–31] and two had fair results [32,33]; more specifically, two papers had six points [27,29], two papers had seven points [25,28], one paper had eight points [24], two papers had nine points [22,26], one paper had 10 points [30], one paper had 11 points [31], one paper had 12 points [23], and two papers had 15 points [32,33].

4. Discussion

Isolated medial STJD is a rare and complex injury whose most common cause is a fall from height as a result of jumping [32]. In our review, the most represented causes of STJD were basketball (12 cases), soccer (six cases), volleyball (three cases) and one case for other causes (tennis, climbing, baseball, military drills, and long jump). Dislocation of this joint is usually caused by the application of a high-energy force that causes the rupture of the strong joint capsule and ligaments, such as the deltoid complex, which plays an important role as a stabiliser of the head of the talus and the SBJ with the tibionavicular section of the tibiocalcaneonavicular ligament. As a result, it represents a rare injury in low- or medium-energy trauma, such as sports injuries, whereas it is more common following motor vehicle accidents [23,34].

In the literature, the medial STJD is described as a rare condition, representing <1%–2% of all foot dislocations [2,3]. Due to this fact, there is a lack of a gold standard conservative treatment; in the present study, outcomes with different types of conservative treatment and time of immobilisation were compared to highlight the best conservative treatment. The incidence is typically higher in males than in females, in particular in young men, with an estimated ratio reported of 6–9:1 [33,35]. However, a recent review performed by Hoexum and Heetveld in 2014 [8] reported a male-female ratio of 3:1. In our review, the incidence of STJD was in line with this latter ratio, being as expected considerably higher in young male patients than female patients, but not as high as the 6–9:1 ratio reported in the other studies [33,35]. The mean age of the patients was 32.54 years, and out of 26 patients, there were 20 males and six females (with a male-female ratio of 3.3: 1); of 26 patients, all of the patients were athletes, but a higher number of patients were recreational athletes (23 patients) compared to professional ones (three patients).

High-energy mechanisms are often associated with open dislocations, although Bibbo et al. [36] did not find this more frequent with medial or lateral dislocation. Goldner et al. [37] reported that open dislocations tended to occur more commonly with the lateral STJD pattern. Surprisingly, no case of open dislocation during sports activities was found in this literature review, and only in one was an open reduction described. Several indicators of prognosis have been defined in the literature, mostly regarding the type of treatment and duration of immobilisation [16]. Different treatment for the management of the isolated medial STJD was also identified in this study, especially concerning the method and time of immobilisation. However, immediate reduction of the STJD was performed in all cases, either in a closed or open way. An emergency reduction is essential to avoid the risk of secondary cutaneous necrosis by ischemia over the prominence of the talar head [38]. All patients included in this study underwent emergency closed reduction, except one patient in the study by

Jungbluth et al. [33] who was treated with open reduction and external fixation. An External Fixator was also used in the patient in the study by Wang et al. [22] after immobilisation in a short leg cast for two weeks. The method of immobilisation that was most used in this review was a below-knee cast, used by six authors to treat 19 patients. The posterior splint combined with the short leg cast was the second most frequent method of immobilisation, used by three authors to treat three patients. All of the patients (100%) treated with immobilisation with posterior splint and cast achieved good results after the treatment, whereas a satisfactory result was achieved by 61.11% of patients immobilised in a short leg cast only. Both methods appear to be valid, but they are not comparable due to the very limited data available, so it was not possible to find a statistically significant difference between the two treatments. As shown in Figure 3 of our review, the patients that complained of worsening of ROM of the STJ or presented some degree of osteoarthritis after the injury were all treated with just casting. Out of a total of 18 patients, 11 had good results; one complained of occasional pain; two showed reduced ROM of the STJ; four presented subtalar or talonavicular joint osteoarthritis. This evidence is probably linked to the greater number of patients that belong to this category, but our data suggest that another method of immobilisation should be used.

Regarding immobilisation length, some authors [16] state that decreasing immobilisation time also decreases the incidence of joint stiffness after treatment. This was confirmed by the data we provided in Table 5, where we show the meta-regression of the independent variables present in the studies. As can be seen in Table 5, we obtained a coefficient of −5.56 regarding the immobilisation length, meaning that longer immobilisation corresponded with worse outcomes. Thus, short immobilisation (4 weeks or less) seems to be preferred. None of the studies reviewed had an immobilisation time of fewer than four weeks, so it is not possible to recommend immobilisation of fewer than four weeks based on this review of the literature. Most patients in our review regained normal ROM of the STJ after six weeks of immobilisation; that was also the most common immobilisation time, with a total of 14 patients. However, as shown in Figure 4, out of those patients, 2 showed reduced ROM of the STJ, and four patients showed some degree of osteoarthritis of the subtalar or talonavicular joint. Meanwhile, out of the eight patients who were immobilised for fewer than six weeks, all had good outcomes except one who complained of occasional pain.

This review is limited by the level of evidence of the studies included, consequently presenting some drawbacks: firstly, the studies included are not homogenous for the outcome scores. The poor homogeneity of clinical evaluation scores has played an important role, lowering the possibility of obtaining a precise comparison between the different conservative treatments available. Also, the quality of the included studies made it difficult to undertake a full and statistically reliable comparison of the published data. Unfortunately, our selection included mainly case reports and case series, with a small sample size, lack of control groups, and restricted statistical comparison. Hence, all studies in the series had low levels of evidence (IV). Due to these different aspects, there is a risk of reporting bias in the present study. Finally, additional Randomised Controlled Trials (RCT) are needed to definitively determine the most beneficial method of immobilisation. Duration of immobilisation has been shown to be pivotal in prognosis [16], so it deserves further study to delineate the best course of action in professional and recreational athletes affected by isolated medial STJD.

5. Conclusions

Based on the currently available scientific literature as appraised in the present study, conservative treatment is the first choice for isolated medial subtalar dislocation occurring during sports activities, both for professional and recreational athletes. However, there is no "gold standard" regarding the rehabilitation protocol for athletic patients that have suffered this kind of injury. Our review highlights that the immobilisation length is the most impactful elements on the biological outcome and should not exceed four weeks due to the risk of stiffness and post-traumatic osteoarthritis, especially in athletic patients.

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