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ANKLE

Treatment of chronic syndesmotic injury: a systematic review and meta-analysis

George Parlamas · Charles P. Hannon · Christopher D. Murawski · Niall A. Smyth · Yan Ma · Gino M. Kerkhoffs · C. Niek van Dijk · Jon Karlsson · John G. Kennedy

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Abstract
Purpose The purpose of this study is to systematically review and meta-analyse the available literature on the treatment of chronic syndesmotic injuries of the ankle.
Methods A systematic review of the PubMed/MEDLINE and EMBASE databases was conducted in August 2012 utilizing the keywords (treatment OR intervention) AND (injury OR sprain OR rupture) AND (syndesmosis OR syndesmotic OR "high ankle" OR "anterior inferior tibiofibular ligament" OR AITFL OR "posterior inferior tibiofibular ligament" OR PITFL OR tibiofibular diastasis). Studies that reported the outcomes of the surgical treatment of chronic syndesmotic injury were included in our review. Chronic was defined as symptoms longer than 6 months. Meta-analysis based on random-effects models was performed to pool the rates of success for different treatment methods.
Results The search yielded 416 publications from PubMed/MEDLINE and 473 publications from EMBASE. After abstract and full-text review, 15 articles were included in this review. Treatment methods were placed into three broad surgical treatment categories: screw fixation, arthrodesis and arthroscopic debridement. The most common treatment strategy employed was screw fixation. The pooled rates of success for screw fixation, arthrodesis and arthroscopic debridement were 87.9, 79.4 and 78.7 %, respectively.
Conclusion The current evidence on the treatment of chronic syndesmosis injuries in the ankle is limited to prospective and retrospective case series. The pooled success rates for screw fixation, arthrodesis and arthroscopic debridement each exceeded 78 %. Future high-level studies are required to discern the most appropriate treatment strategy(ies) for chronic syndesmotic injuries of the ankle.

Keywords Syndesmosis · Ankle · Chronic injury · Syndesmotic

Introduction

Injuries to the syndesmosis between the distal tibia and fibula occur in approximately 1–18 % of all ankle sprains, particularly after external rotation or dorsiflexion injuries [19]. Patients commonly present with pain just above the ankle joint and describe difficulty "pushing off" when running. However, syndesmotic injuries are difficult to detect with few sensitive clinical diagnostic tests available [21, 23]. A recent systematic review by Sman et al. [21] evaluated eight clinical diagnostic tests and concluded that while the squeeze test may be useful as a prognostic tool, there currently is not a single reliable clinical test that can definitively diagnose syndesmosis injuries. Furthermore, these injuries may not be visible on plain radiographs and typically require different views such as stress radiographs

G. Parlamas · C. P. Hannon · C. D. Murawski · N. A. Smyth · Y. Ma · J. G. Kennedy (✉)
Department of Foot and Ankle Surgery, Hospital for Special Surgery, New York, NY, USA
e-mail: kennedyj@hss.edu

C. D. Murawski
e-mail: murawskic@hss.edu

G. M. Kerkhoffs · C. N. van Dijk
Department of Orthopaedic Surgery, Orthopedic Research Center Amsterdam, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

J. Karlsson
Department of Orthopaedic Surgery, Sahlgrenska University Hospital, Mölndal, Sweden

with the foot in external rotation [3]. Therefore, diagnosis of syndesmotic injuries usually requires more advanced modalities, such as magnetic resonance imaging, which has been reported to have a sensitivity of 90 %, specificity of 95 % and accuracy of 93 % [8, 16, 17]. Arthroscopy is often used to confirm the diagnosis [13, 24]. As a result, these injuries may remain undiagnosed, thereby causing long-term disability, longer recovery periods and chronic ankle instability.

Chronic syndesmotic injuries are defined as injuries that present with symptoms exceeding 6 months after the initial trauma [11]. Symptomatic chronic syndesmotic injuries are not typically amenable to non-surgical treatment and often times require surgical intervention to facilitate normal ankle function. Surgical treatment methods include arthroscopic debridement, screw fixation, anatomical reconstruction of syndesmotic ligaments and arthrodesis. The treatment of these injuries is variable and depends on the length and severity of the symptoms [14]. Often, these methods are combined to provide both bony and ligamentous stability, which is critical in active patients and athletes.

Despite the many treatments utilized, there is no evidence-based consensus as to the most appropriate surgical intervention for treating chronic syndesmotic injuries. To our knowledge, this is the first systematic review and meta-analysis on the treatment of chronic syndesmotic injuries. As such, and in the place of definitive high-level evidence, we sought to determine the effectiveness of currently utilized surgical treatment strategies.

Materials and methods

Search strategy

The PubMed/MEDLINE and EMBASE databases were searched from July 1967 to August 2012, utilizing the keywords (treatment OR intervention) AND (injury OR sprain OR rupture) AND (syndesmosis OR syndesmotic OR "high ankle" OR "anterior inferior tibiofibular ligament" OR AITFL OR "posterior inferior tibiofibular ligament" OR PITFL OR tibiofibular diastasis). The search was carried out in August 2012. Studies that reported the outcomes of the treatment of chronic syndesmotic injuries were included in our review. In this study, an injury was classified as chronic if symptoms persisted for 6 months or longer. Exclusion criteria included studies not published in English, case reports, studies that reported outcomes after acute syndesmotic injury or studies that did not provide radiographic or functional outcome scores.

Two authors independently performed the search to identify studies appropriate for this review. Abstracts were screened initially for inclusion in the full-text review. Studies qualifying for full-text review were subsequently evaluated and either included or excluded based on the established inclusion criteria. Disagreement between the reviewers was resolved by consensus or after review with the senior author. In addition, the reference lists of all included studies were reviewed to determine whether additional studies not identified in the initial search met the inclusion criteria.

Data extraction

A data collection sheet was created with a list of standardized variables and was used to evaluate each study included in this review. Two independent observers, 1 of whom was the lead author, completed data extraction in an unblinded fashion. The lead author validated the extracted data by reviewing the included studies a second time after data extraction. Consensus involving the senior author resolved any conflicts. Variables collected from each study include number of patients, mean age, percent male or female, mean follow-up time, mean duration of symptoms, functional outcomes and success rate.

For this purposes of this study, treatment methods were placed into three broad categories: screw fixation, arthrodesis and arthroscopic debridement. These methods were determined to be the main modalities of treatment because they were most commonly reported in the literature.

For this analysis, the American Orthopaedic Foot and Ankle Society Scale, the Karlsson Score and the West Point Ankle Score were considered when evaluating outcome scores. The AOFAS scores were categorized as follows: Excellent, 95–100; Good, 85–94; Fair, 65–84, Poor: <65 [24]. The Karlsson scores were categorized as follows: Excellent, >90; Good, 81–90; Fair, 60–80, Poor: <60 [6]. The West Point Ankle scores were categorized as follows: Excellent, >90; Good, 80–89; Fair, 70–79; Poor, <70 [26]. A successful outcome was determined to be an "Excellent" or "Good" outcome score following treatment. With these benchmarks, a percentage of successful outcomes were calculated in each study.

Methodological quality

The Newcastle Ottawa Scale (NOS), modified for case series, was used to assess the quality of articles included in the present study. The scale was originally created for the quality assessment of non-randomized studies (with case controls or cohort studies) in systematic reviews [22]. The NOS designates quality ratings that are based on (a) selection of study groups; (b) comparability of study groups; and (c) ascertainment of either the exposure (case control) or the outcome of interest (cohort study). The scale

employs a rating system in which a study can receive a maximum of 4, 1 and 3 stars in the categories described above, respectively. Hence, a study of the highest methodological quality can receive a total of 8 stars. While this scoring system has not been validated for assessing studies on syndesmotic injuries, it has been used in prior systematic reviews to assess the potential for the introduction of bias into these studies [27].

The studies available for analysis in this study are limited to case series. Therefore, we utilized a modified NOS described by Zengerink et al. [27] to evaluate the methodological quality of the included studies ("Appendix"). In this modification, studies were rated based on study design, selection and assessment of outcome. The maximum number of stars a study could receive in each of the categories was 2, 1 and 2, respectively, resulting in a total of 5 possible stars for a case series of the highest quality.

Statistical analysis

Meta-analyses were performed to pool the proportion of success for screw fixation, arthrodesis and arthroscopic debridement. In each case, to determine the pooled proportion, the variances of the raw proportions were stabilized by using a Freeman–Turkey-type arcsine square root transformation [5]. The pooled proportions were calculated as the back-transform of the weighted mean of the transformed proportions, using fixed- or random-effects models [4]. A Forest plot was utilized for the presentation of the proportions and confidence intervals from individual studies along with the pooled proportion and test for homogeneity. Meta-regression based on random-effects logistic model was conducted for rate of success after screw fixation, to identify the effects of gender, age, average follow-up, mean duration of symptoms and method of diagnosis. Due to the small number of studies found in the literature for arthrodesis and arthroscopic debridement, we were not able to perform meta-regression for these treatment methods.

Results

The search yielded 416 publications from PubMed/MEDLINE and 473 publications from EMBASE. We screened abstracts for those that studied chronic syndesmotic injuries and identified 18 articles that met the inclusion criteria. After subsequent full-text review of these articles, 15 articles were deemed appropriate based on the inclusion/exclusion criteria and therefore included in this study (Table 1) [1, 2, 6, 7, 10, 12, 15–18, 20, 24–26].

Of the 15 included studies, screw fixation was the most common modality of treatment and was utilized in 11 studies. Additionally, there were two studies that utilized arthrodesis and two studies that utilized arthroscopic debridement only for treatment of chronic instability. Study population characteristics of each treatment group are described in Table 2.

Several prognostic factors were also present in the included studies. Medial clear space was assessed in 6 out of 15 included studies. Two studies assessed diastasis only and one study examined total clear space. Tibiofibular overlap was assessed in 5 studies, and tibiofibular space was evaluated in 2 studies. In terms of radiographic projections utilized to observe the syndesmosis, anterior-posterior (AP) and lateral projections were most commonly used, both occurring in 8 studies. These projections were utilized together in 6 of the included studies. Plain and mortise projections were used in six of the included studies.

Several different scoring systems were utilized by the included studies. The most common was the American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scale (AOFAS), which was used to evaluate 8 of the 15 studies included.

Quality assessment of included studies

The total Newcastle Ottawa Scale for each study included in the review is listed in Table 1. On "study design," a total of 6/30 stars were awarded to the 15 studies. There were three studies that were prospective in design, while the remaining 12 studies were retrospective case series. Four studies described and followed a protocol totalling 4 stars out of a possible 15 for the group. The majority of studies did not describe a protocol. On "outcome," a total of 15/30 stars were awarded to the 15 studies. While a majority of studies had excellent follow-up, most studies did not utilize blind assessment. The average Newcastle Ottawa Scale for each study was 1.8 (SD 1.26) stars out of a possible 5 stars.

Meta-analysis

The pooled rates of success for screw fixation, arthrodesis and arthroscopic debridement were 87.9 % (95 % CI 77–95.7 %), 79.4 % (95 % CI 34.4–100 %) and 78.7 % (95 % CI 62–91.6 %), respectively (Figs. 1, 2, 3). The meta-regression indicated that gender, age, average follow-up, mean duration of symptoms and method of diagnosis were not significant in affecting rate of success after screw fixation.

Discussion

The most important finding of this study is that the current literature on the treatment of chronic syndesmotic injuries

Table 1 Studies included in the review with major variables recorded

Authors	Name of study	Treatment	New Castle Ottawa Scale	Number of patients	Follow-up time (months)	Functional outcomes	Critical appraisal
Wagener et al. [24]	Chronic instability of the anterior tibiofibular syndesmosis of the ankle. Arthroscopic findings and results of anatomical reconstruction	Screw fixation	3	12	25	AOFAS: 50 % Excellent, 42.67 % Good, 8.33 % Fair	Small number of patients and absence of a control group
Han et al. [8]	Chronic tibiofibular syndesmosis injury: the diagnostic efficiency of magnetic resonance imaging and comparative analysis of operative treatment	There were two groups (both with their own average AOFAS score) evaluated in this study. Group I received arthroscopic marginal resection, and Group II received arthroscopic marginal resection and screw fixation	5	20	22	AOFAS Average Group I Score: 87, AOFAS Average Group II Score: 90	Included a small number of patients with short follow-up. Limited in that cause of pain and proper treatment of syndesmosis injury are not identified
Yasui et al. [25]	Anatomical reconstruction of the anterior inferior tibiofibular ligament for chronic disruption of the distal tibiofibular syndesmosis	Screw fixation	2	6	38	AOFAS Median Score: 95, range 90–100	Small number of patients limited to patient-reported outcome measurements without imaging follow-up. Variation in initial treatment method prior to treatment of chronic injury
Grass et al. [6]	Peroneus longus ligamentoplasty for chronic instability of the distal tibiofibular syndesmosis	Screw fixation	1	16	39	Karlsson Average Score: 88	Small number of patients with variation in mechanism of initial injury
Harper [10]	Delayed reduction and stabilization of the tibiofibular syndesmosis	Screw fixation	1	6	16	AOFAS average: 91	Small number of patients with variation in mechanism of initial injury
Beumer et al. [1]	Late reconstruction of the anterior distal tibiofibular syndesmosis	Screw Fixation	1	9	23	Sefton Score: 33.33 % Grade 1, 33.33 % Grade 2, 33.33 % Grade 3, Karlsson Score: 22.22 % Excellent, 44.44 % Good, 11.11 % Fair, 22.22 % Poor	Small number of patients with absence of a control group

Table 1 continued

Authors	Name of study	Treatment	New Castle Ottawa Scale	Number of patients	Follow-up time (months)	Functional outcomes	Critical appraisal
Beumer et al. [2]	Kinematics before and after reconstruction of the anterior syndesmosis of the ankle	Screw fixation	4	5	45	AOFAS: 40 % Excellent 60 % Fair, Sefton Score: 60 % Grade 1, 20 % Grade 2, 20 % Grade 3, Karlsson: 40 % Excellent, 20 % Good, 40 % fair	Small number of patients with absence of a control group and short follow-up time
Zamzami and Zamzam [26]	Chronic isolated distal tibiofibular syndesmotic disruption: diagnosis and management	Screw fixation	2	11	6	West Point Ankle Score Average: 95.1	Variation in treatment method prior to treatment of chronic injury. Small number of patients limited to only males
Schuberth et al. [20]	Arthroscopy-assisted repair of latent syndesmotic instability of the ankle	Screw fixation	1	6	37	AOFAS; 33.33 % Excellent, 50 % Good, 16.66 % Fair	Small number of patients with short follow-up time. Lack of a control group
Grass and Zwipp [7]	Peroneus longus tenodesis for chronic instability of the distal tibiofibular syndesmosis	Screw fixation	1	10	32	Karlsson Average Score: 88	Small number of patients with variation in mechanism of initial injury and short follow-up time
Morris et al. [15]	Distal tibiofibular syndesmosis reconstruction using a free hamstring autograph	Screw fixation	1	8	11	AOFAS: 25 % Excellent, 37.5 % Good, 25 % Fair, 12.5 % Poor	Retrospective review of a small number of patients. No prospective scoring was conducted
Katznelson et al. [12]	Ruptures of the ligaments about the tibiofibular syndesmosis	Arthrodesis	1	5	39	5/5 patients had no pain, 4/5 had full range of motion	Small number of patients and length of follow-up not recorded. No standardized outcome scoring method utilized
Olson et al. [18]	Salvage of chronic instability of the syndesmosis with distal tibiofibular arthrodesis functional and radiographic results	Arthrodesis	1	10	41	AOFAS: 40 % Excellent, 20 % Good, 40 % Fair, Kellgren and Moore: 20 % Grade 1, 10 % Grade 2, 30 % Grade 3, 20 % Grade 4, 20 % Grade 5	Retrospective examination of a small number of patients. Lack of long-term follow-up and a variety of concomitant procedures performed in combination with the reconstruction
Ogilvie-Harris and Reed [16]	Disruption of the ankle syndesmosis: diagnosis and treatment by arthroscopic surgery	Arthroscopic debridement	1	17	24	14 patients out of 17 were satisfied with the surgical intervention	Small number of patients with no standardized method of evaluating outcomes

Table 1 continued

Authors	Name of study	Treatment	New Castle Ottawa Scale	Number of patients	Follow-up time (months)	Functional outcomes	Critical appraisal
Ogilvie-Harris et al. [17]	Chronic pain following ankle sprains in athletes: the role of arthroscopic surgery	Arthroscopic debridement	2	9	33	7 patients out of 9 were satisfied with the surgical intervention	Small number of patients with no standardized method of evaluating outcomes

Table 2 Descriptive analysis of treatment groups

	Screw fixation	Arthrodesis	Arthroscopic debridement
Number of studies	11	2	2
Total number of patients	109	15	26
Mean age and SD (years)	35 ± 7	37 ± 24	30 ± 1
Average percent male (%)	53	45	56
Average follow-up and SD (months)	27 ± 12	28.5 ± 18	41 ± 6
Mean duration of symptoms and SD (months)	21 ± 13	9 ± 0.53	18 ± 9
Total number of functional outcome scores used	7	2	2

does not support one treatment modality over another due to a lack of high-quality studies. The aim of this study was to pool the data on the treatment of chronic syndesmotic injuries and determine what is the most effective treatment option for these injuries based on the available literature. The results from this study indicate that screw fixation is a successful treatment method for chronic syndesmotic injuries with an 87.9 % pooled rate of success. It remains to be seen whether other treatment options such as arthrodesis or debridement alone are as effective, as there is limited literature available on these topics.

While screw fixation was the most common primary treatment strategy, it was utilized in conjunction with arthroscopy and reconstructive methods focusing on anatomically repairing the ligaments of the syndesmosis in 8 of the 11 studies. Several different anatomical ligament repairs were utilized with screw fixation. In a series of 6 patients, Yasui et al. [25] reported a 42-point improvement in the mean AOFAS at 38-month follow-up after an anterior inferior tibiofibular ligament reconstruction with a gracilis tendon autograft in addition to screw fixation. In a separate study, Grass et al. [6] reported an average Karlsson score of 88 (range 70–100, SD not reported) after anterior tibiofibular ligament and posterior tibiofibular ligament reconstruction using a peroneus longus tendon graft and syndesmotic screw fixation for 16 patients with a 16-month average follow-up time. Similar successful outcomes utilizing a semi-tendinosus autograft and arthroscopic debridement were reported by Zamzami and Zamzam [26].

While most studies reported good outcomes with screw fixation and a form of anatomical reconstruction, Beumer et al. [1, 2] in two separate studies reported success rates of only 67 and 40 % according to the Karlsson Score and AOFAS with their own reconstruction technique. Even within the syndesmotic fixation group with anatomical graft reconstruction and arthroscopy, there is a lack of homogeneity within the literature. It is important to note that screw fixation without anatomical reconstruction has also been reported as successful in treating chronic syndesmotic instability. Han et al. [9] reported excellent AOFAS outcomes in 20 patients at 22 months following arthroscopic debridement of the tibiofibular joint and screw fixation with a 3-cortical screw.

When combining all studies that utilized screw fixation, the meta-regression found that gender, age, average follow-up and mean duration of symptoms had no effect on treatment outcomes. This study suggests that there are other factors that may be more important in determining treatment outcomes after screw fixation, such as the extent of injury, as well as other patient-related factors. Based on the available research, it is unclear whether screw fixation alone is sufficient in the treatment of these chronic injuries or whether additional arthroscopic debridement or graft reconstruction is required. Future research is warranted to identify when it is appropriate to utilize screw fixation alone and when arthroscopic debridement and anatomical reconstruction is required.

The two other treatment groups in this study, arthrodesis and arthroscopic debridement, had good success rates of 79.4 and 78.7 %, respectively, but were supported by fewer studies than screw fixation. Only two studies were present in the literature that reported outcomes on each of these treatment strategies. Ogilvie-Harris and Reed reported

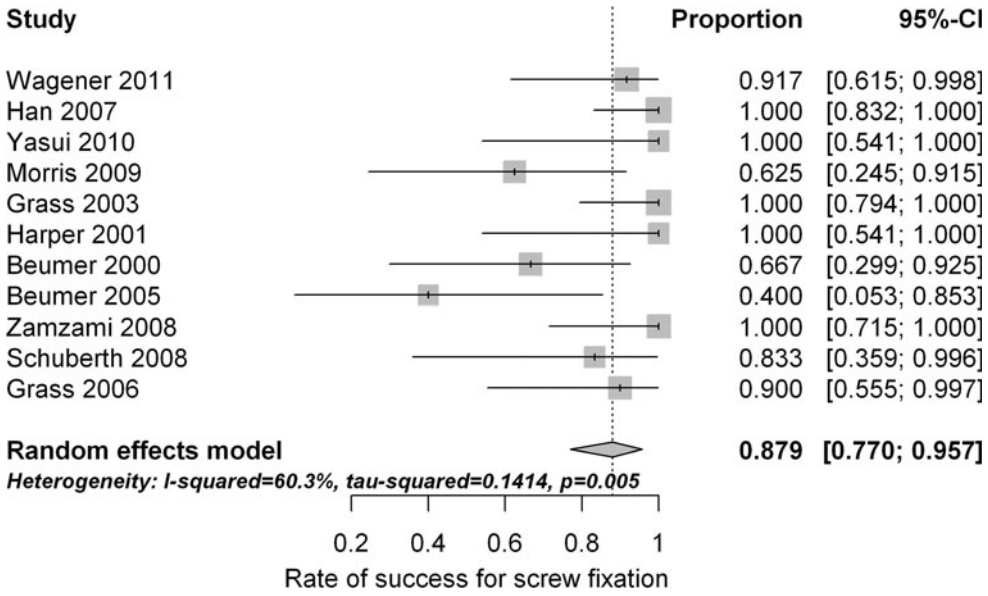

Fig. 1 Forest *plot* of rate of success for screw fixation studies

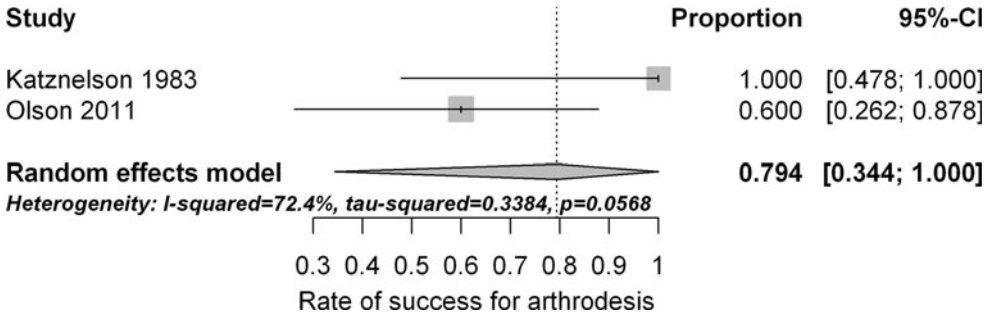

Fig. 2 Forest *plot* of rate of success for arthrodesis studies

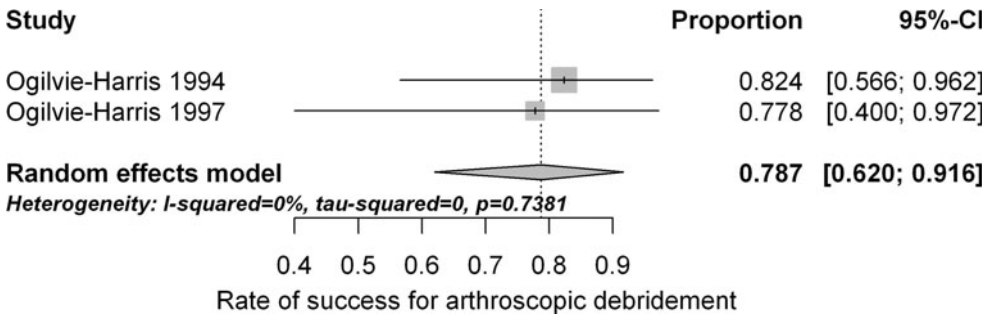

Fig. 3 Forest *plot* of rate of success for arthroscopic debridement studies

good functional outcomes and patient satisfaction in 14 out of 17 patients who underwent arthroscopic debridement of the interosseous ligament [16, 17]. The only comparative study to date on chronic syndesmotic injuries by Han et al. [8] found that arthroscopic debridement alone may be appropriate if the distal tibiofibular chronic syndesmosis injury is not combined with any medial ankle instability or lateral displacement of the talus. Their study suggests that arthroscopic debridement may be appropriate for more isolated and less severe chronic injuries, but this remains to be validated by additional studies.

Two studies on arthrodesis also reported successful outcomes. Katznelson et al. [12] reported in his case series of 5 patients that all patients had no pain postoperatively. Olson et al. [18] conducted a retrospective study of 10 patients with an average follow-up time of 41 months (range 29–54 months) and reported excellent or good AOFAS outcomes in 6 patients. While the few studies on arthrodesis and arthroscopic debridement show promising results, the lack of literature on both of these treatment groups limits the ability to draw any conclusions on their efficacy in treating chronic syndesmotic injury.

There are several limitations to this systematic review and meta-analysis. Studies published exclusively in databases other than MEDLINE and EMBASE or published in a language other than English are not represented in this review. In addition, the strength of this meta-analysis is limited by a lack of high-level evidence on the treatment of chronic syndesmotic injuries. All of the studies included in this meta-analysis were case studies, and the majority of them were retrospective. While a meta-analysis was conducted for all three treatment groups, arthroscopic debridement and arthrodesis only had 2 studies in each group. Assessment of the quality of included studies in the review by the adjusted Newcastle Ottawa Scale showed that overall studies scored poorly, which indicates a higher probability for the introduction of bias.

This meta-analysis and systematic review showed that several studies report successful outcomes after treatment of chronic syndesmotic injuries with screw fixation, arthrodesis and arthroscopic debridement. However, there is a distinct lack of scientific information on arthrodesis and arthroscopic debridement, and future research is warranted to investigate the utility of these modalities in treating chronic syndesmotic injuries. In contrast, there are several reports of the use of screw fixation with many reporting concomitant procedures such as arthroscopic debridement and anatomical ligament reconstruction. As a group, studies of screw fixation have a high rate of success in treating chronic syndesmotic injuries. Due to the lack of homogeneity of the literature on the treatment of chronic syndesmotic injuries, no conclusions can be drawn and a gold standard remains to be established. Future high level of evidence studies are required to directly compare these treatment modalities and determine the optimal treatment of chronic disruption of the ankle joint syndesmosis. The results from this study indicate that the currently utilized surgical strategies for treating chronic injuries of the syndesmosis are good, but data are not available to support one treatment strategy over another. Future studies on the surgical treatment of these chronic injuries are required such that clear clinical guidelines can be established.

Conclusion

The current evidence on the treatment of chronic syndesmosis injuries in the ankle is limited to prospective and retrospective case series. The pooled success rates for screw fixation, arthrodesis and arthroscopic debridement each exceeded 78 %. Future high-level studies are required to discern the most appropriate treatment strategy(ies) for chronic syndesmotic injuries of the ankle.

Appendix: Newcastle Ottawa Quality Assessment Scale

Adjusted for case series by Zengerink et al. [27]

Study design

1. Type of study
   a. Prospective
   b. Retrospective
   c. Other
   d. Not described
2. Set-up
   a. According to protocol
   b. Without protocol
   c. No protocol described

Selection

1. Representatives of included patients
   a. Truly representative of the average chronic syndesmosis patient in the community
   b. Somewhat representative of the average chronic syndesmosis patient in the community
   c. Selected group of patients by surgeon
   d. No description of the derivation of the patient group

Outcome

1. Assessment of outcome
   a. Independent blind assessment
   b. Record linkage
   c. Self-report
   d. No description
2. Adequacy of follow-up of series
   a. Complete follow-up—all subjects accounted for
   b. Subjects lost to follow-up unlikely to introduce bias—small number loss (<5 %)
   c. Follow-up rate is <95 % and no description of those lost
   d. No statement

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