Somato Publications ISSN: 2643-2692

International Journal of Orthopedics

Research Article

Management of Syndesmotic Ankle Injuries with Suture Button Fixation under Arthroscopic Assistance: Short-Term Clinical and Functional Results

Javier Ignacio Zaourak[1*], Máximo Iguarán Jiménez[1], Beltrán Mateus Héctor[1], Gustavo Arajo Nunes[4-5], Diego Yearson[1-3] and Sofia Carlucci[1]

[1]Climba, Viamonte 1632, Ciudad Autónoma de Buenos Aires, Argentina

[2]Sanatorio Trinidad Ramos Mejía, Ramos Mejía, Buenos Aires, Argentina

[3]Centro Talus, Ciudad Autónoma de Buenos Aires, Argentina

[4]Cote Clinic Brasilia, DF, Brazil

[5]GRECMIP (Groupe de Recherche et d´Etude en Chirugie Mini-Invasive du Pied) Soon MIFAS (Minimally Invasive Foot and Ankle Society), Merignac, France

*Address for Correspondence: Javier I. Zaourak, Climba Viamonte 1632, ZIP: 1055, Ciudad Autónoma de Buenos Aires, Argentina, Tel: (+549) 1161923872; E-mail: zaourak@climba.com.ar

Received: 22 December 2022; Accepted: 01 February 2023; Published: 06 February 2023

Citation of this article: Zaourak, JI., Jimenez, MI., Hector, BM., Nunes, GA., Yearson, D., Carlucci, S. (2023) Management of Syndesmotic Ankle Injuries with Suture Button Fixation under Arthroscopic Assistance: Short-Term Clinical and Functional Results, Int J Orth, 4(1): 01-10.

Abstract

Introduction: There is a scarcity of information in the medical bibliography about the results obtained in the management of syndesmotic ankle injuries with arthroscopic reduction and suture button fixation. This study aimed to determine the short-term clinical, functional and radiographic results in patients managed with this technique.

Material and Methods: Fifteen patients with syndesmotic ankle injuries were managed with anterior arthroscopy of the ankle with a suture button. The results were assessed at a median of 15 months using the Foot and Ankle Ability Measurement

(FAAM) and American Orthopaedic Foot & Ankle Society (AOFAS). Quality reduction was evidenced by computed tomography. Measurements of joint flexo-extension were obtained and compared with the contralateral ankle.

Results: The scores obtained in the AOFAS and FAAM scales were excellent and good, respectively. No significant differences were seen in the range of motion when compared to the healthy ankle. All the patients presented an adequate reduction quality as shown by the computed tomography at the end of follow-up.

Discussion: Arthroscopic assistance is useful to evidence the tibiofibular reduction directly with a lower margin of error. Excellent functional results were obtained with the suture button fixation as compared to other results reported in the literature. More research is needed to assess long-term outcomes.

Conclusions: Our series evidenced good results in the arthroscopic management of syndesmotic injuries of the ankle with suture button fixation.

Level of evidence: 3, prospective cohort study.

Introduction

The term syndesmosis refers to the inferior tibiofibular joint and its stabilizing ligaments, which are the antero-inferior, posteroinferior, and interosseous tibiofibular ligaments, and the interosseous membrane [1-4].

Syndesmotic injuries account for about 10 to 20% of all trauma cases, and the management of this type of lesion is controversial [1-3,5]. Approximately 80% of syndesmotic injuries are associated with ankle fractures [2,5-7], and a small percentage are isolated injuries, many of them undiagnosed [2,8]. Inadequate management may lead to impaired mechanics in the ankle joint, which might trigger early joint degeneration [2,9,10]. Therefore, diagnosis in time and adequate treatment are essential [2,3,5,8,11].

Regardless of the fixing method used, the way to control intraoperative reduction, the most reliable method of assessing syndesmotic stability in all the planes of motion, and which syndesmotic injuries require stabilization, have not been clearly defined yet. These controversies are related to malreduction, ranging from 15 to 50% [3,5,12,13]. Moreover, the percentage of false negative results in radiographic studies to assess syndesmotic stability usually varies [2,6,14-17]. Finally, no studies are available evaluating long-term management results after the detection of an unstable syndesmotic injury, regardless of the method used [3,5,12,13,18].

The objective of this study was to evaluate the short-term clinical, functional and radiographic results in patients with unstable syndesmotic injuries undergoing arthroscopic-assisted reduction and suture button fixation.

Materials and Methods

We evaluated a prospective cohort of 15 patients with more than one year of follow-up, managed by the same surgical team between January 2020 and October 2021. The sample included patients over 18 y-o and with personal history of indirect trauma to the ankle in pronation and external rotation, and a confirmed or suspected syndesmotic injury. Open ankle trauma, pathological fractures, patients older than 65, C3 fractures associated with Bartonicek, Type 2 Rammelt displaced or superior posterior malleolus fractures [13], patients with a history of previous ankle surgery and neuropathy were excluded. All the patients underwent anterior arthroscopy of the ankle within 25 days of the injury.

Static non weight bearing radiographs of both ankles were obtained looking for radiographic signs of syndesmotic injury such as width of the medial clear space, tibiofibular overlapping, and tibiofibular clear space. In cases of suspected unstable syndesmotic injury with negative static radiographs, MRI was taken searching for signs of syndesmotic injury, such as presence of anteroinferior tibiofibular ligament rupture, increased joint fluid buildup in the tibiofibular incisura, fibrillary edema or partial tear of the posteroinferior tibiofibular ligament and/or bone edema with or without fracture in the posterior malleolus, all of them associated with deep deltoid ligament injury involving the anterior fascicle (Figure 1). If these signs were present, injury stability was assessed by performing the dorsiflexion and external rotation test of the ankle using an image intensifier [2]. The injury was considered unstable when there was an increase of over 2 mm in the medial clear space or lateral translation of the talus and the fibula during the maneuver. Contralateral ankle was assessed for comparison (Figure 2). Injuries were classified as occult or evident in terms of instability. Evident instability was considered when we had positive static radiographs without any load; an occult unstable injury was defined as shown on MRI and positive image intensifier test.

Moreover, syndesmotic stability was classified as mild or severe during arthroscopic evaluation using a blunt instrument through the tibiofibular space. When only the 2 mm palpator could be introduced, the syndesmotic injury was considered mild. On the contrary, if a 4 mm blunt chisel could be introduced, the syndesmotic injury was considered severe (Figure 3).

Functional evaluation was performed by comparative goniometric measurement of the flexion- extension range, as compared to the contralateral uninjured ankle.

The AOFAS [19] (American Orthopaedic Foot and Ankle Society) scale for the ankle-hindfoot and the FAAM Score [20] (Foot and Ankle Ability Measurement) were used at the end of follow-up. FAAM is a patient self-reported questionnaire including 21 questions about activities of daily living (ADLs). Results in both questionnaires are expressed as a score based on 100 points. A score between 90 and 100 was considered excellent; 80 to 89, good; 60 to 79, fair; and 59 or below, poor [21]. The AOFAS scale was used for pain evaluation, including a patient self-reported pain score.

Also, complications occurring during the first year of follow-up were recorded.

CT scans of the tibiofibular reduction were obtained for an objective assessment and comparison to the contralateral healthy side, at final follow-up.

The measurement method described by Mukhopadhyay, et al. was

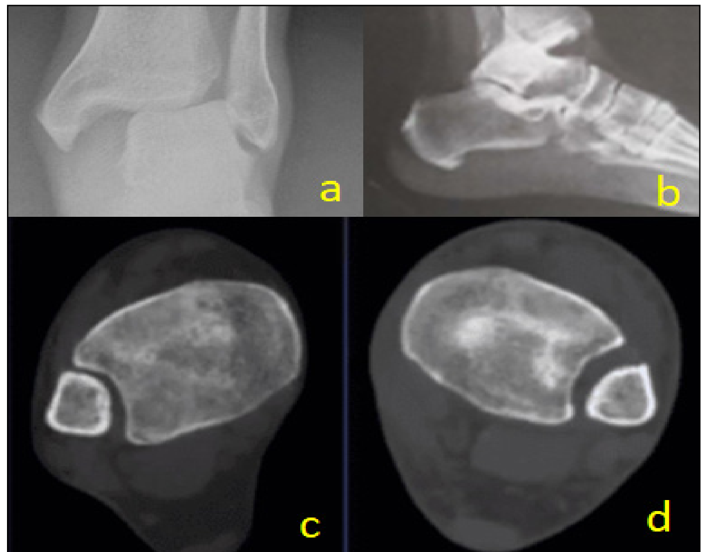

Figure 1: A-b: 44C3 ankle fracture with loss of fibular reduction in the fibular incisura. C-d: CT scan for comparison. The CT of the injured ankle was obtained after reduction in the Emergency Department.

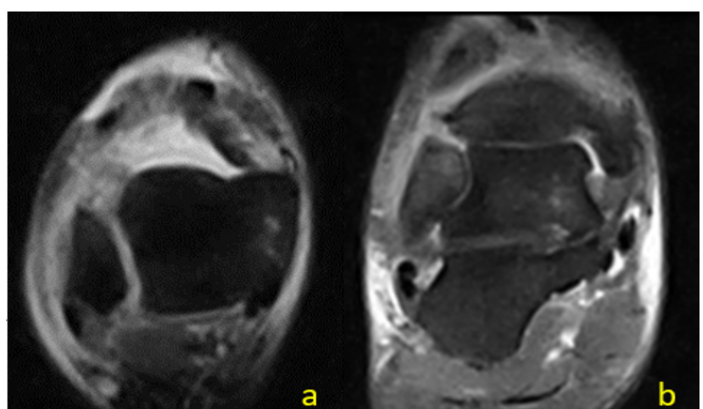

Figure 2: a: Axial view showing anteroinferior tibiofibular ligament rupture, and heterogeneity of the posteroinferior tibiofibular ligament.b: Heterogeneity and fibrillary pattern loss of the deep deltoid ligament.

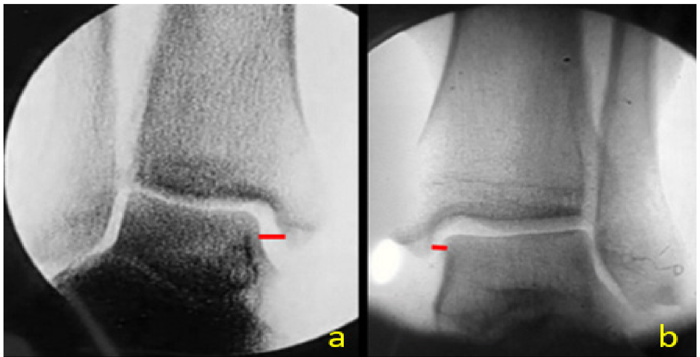

Figure 3: a: 4 mm opening of the medial clear space in dorsiflexion and external rotation.b. Absence of clear medial space opening during the maneuver.

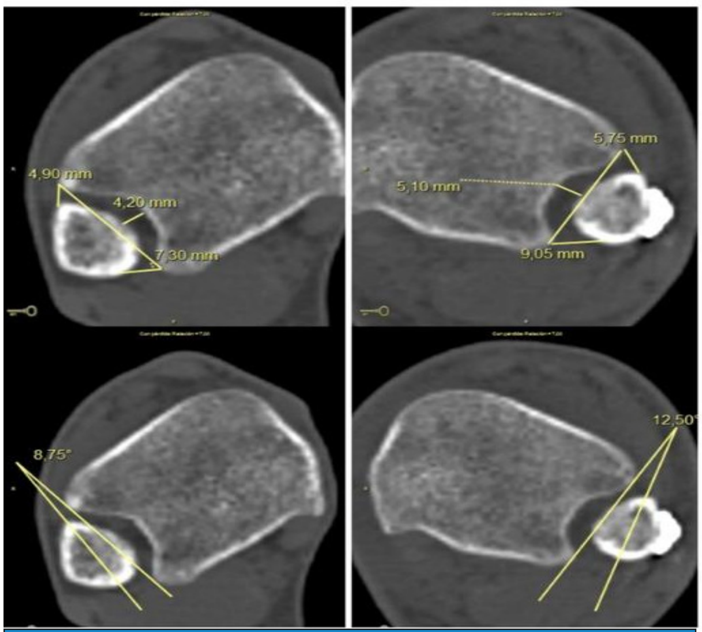

Figure 4: Post-operative CT scan to assess the post- operative reduction of the left ankle for comparison using the Mukhopadhyay method (16).

Figure 5: Anteroinferior tibiofibular ligament rupture as viewed from the anteromedial portal.

used [7,16], that is, the distance between the anterior and posterior border of the fibula to the facets of the fibular incisura, both on the healthy side and the injured side in axial 2 mm CT slices, starting 1 cm proximal from the tibial plateau [7,9,12,17]. Diastasis is calculated considering the difference in distance between the injured side and the healthy side. [(anterior injured side – anterior healthy side) + (posterior injured side – posterior healthy side)]/2 (Figure 4). Results over 2 mm are suggestive of tibiofibular diastasis or malpositioning of the fibula in the incisura [16].

Statistical analysis

Normal variables appear as a mean value with the corresponding standard deviation, otherwise as a median value and an interquartile range. The categorical variables are reported as a ratio. The differences between the injured and non-injured sides were analyzed with a t-paired test. The statistically significant value was set at <0.01. The STATA software (Stata Corp. 2017 Stata Statistical Software: Release 15. College Station, TX: Stata Corp LLC) was used for the statistical analysis.

Description of the arthroscopic-assisted reduction technique

Patients were placed in a supine position with a sandbag under the ipsilateral hip to avoid external rotation of the lower limb. Local anesthesia was administered by both popliteal and femoral peripheral nerve blocks, together with neuroleptanalgesia. A hemostatic cuff at an average pressure of 300 mmHg was used.

All the patients underwent an anterior arthroscopy of the ankle with a 4.0-diameter and 30˚ angle fiberoptic scope through the classical anteromedial and anterolateral portals [22]. The anterior chamber and the medial and lateral gutters were explored systematically for associated injuries.

An anteroinferior tibiofibular ligament tear is observed from the anterior chamber (Figure 5). Any associated injury, if present, was also treated.

Osteochondral injuries (Figure 6) were managed with unstable fragment resection and microfractures of the remnant roof. Injuries in the lateral ligament complex and deep deltoid ligament were managed with the all-inside repair technique with knotless suture anchoring [23-25] before treating the syndesmotic injury. Syndesmotic stability was assessed via the sequential introduction of a 2 mm palpator and a 4 mm blunt chisel (Figure 7A and B). When only the 2 mm palpator could be introduced the syndesmotic injury was considered mild. In these cases, injury stabilization was performed with one trans-syndesmotic flexible button (Figure 8A). In cases of more instability with the introduction of the 4 mm blunt chisel, the injury was considered severely unstable. For pure syndesmotic injuries, after reduction, the injury was stabilized with 2 syndesmotic buttons in divergent directions (Figure 8B) [5,26]. If the injury was associated with a C3 fracture, a 2-hole locking plate and 2 syndesmotic buttons were placed (Figure 8C) [4,5,18]. A clamp in the distal fibula and tibia was placed for tibiofibular reduction. Longitudinal traction and internal rotation of the fibula were performed to obtain a correct reduction of the fibula in both coronal and sagittal planes. A second clamp was used to place the fibula in the tibial incisura (Figure 9A-C). An arthroscopic inspection of the medial tibiotalar space for correct closure was performed; the 2 mm palpator could not be introduced [3]. We checked that the lateral aspect of the talus and the medial aspect of the fibula were parallel. Also, relative fibular retropulsion in the anterolateral region was evaluated as a parameter for satisfactory reduction of the fibula in the notch under arthroscopic visualization (Figure 10A-C). Then, definite stabilization was performed.

Results

A total of 15 patients underwent anterior ankle arthroscopy and suture button fixation of syndesmotic unstable injuries between January 2020 and June 2021. The average follow-up time was 15 months (SD, 2.2). Demographic data is shown in Table 1. The patients underwent surgery within 16 days after injury (range, 14 to 25). All procedures were ambulatory. Six were occult unstable injuries (mild) and 9 were evident and unstable (severe). Four cases of occult fractures in the posterior malleolus were assessed on MRI.

At final follow-up, a comparative tomography of both ankles was performed. The syndesmosis reduction was similar to the uninjured contralateral ankle in all cases.

The mean range of motion of the surgically treated ankle was 19˚ of plantar flexión (range, 16˚ to 21˚), and 46˚ of dorsiflexion (range 42˚ to 51˚). As compared to the contralateral healthy side, there were no significant differences evidencing a lack of flexo-extension ($p = 0.03$). None of the patients reported instability of the ankle or presented laxity on physical examination.

The AOFAS scale showed an average value of 94 (SD 5.4), which was considered excellent. As for the FAAM score, the average re-

Figure 6: Osteochondral injury in the medial slope of the talar dome.

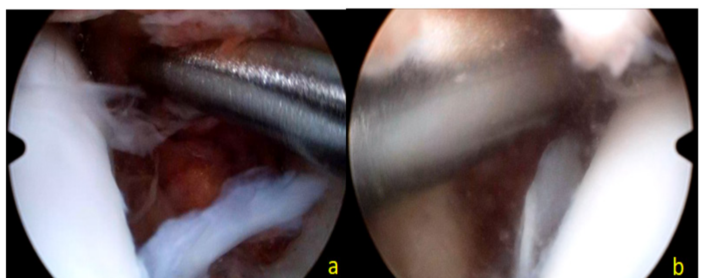

Figure 7a: Introduction of the 2 mm palpator at the level of the tibiofibular incisura. b: Introduction of the 4mm blunt chisel at the level of the tibiofibular incisura.

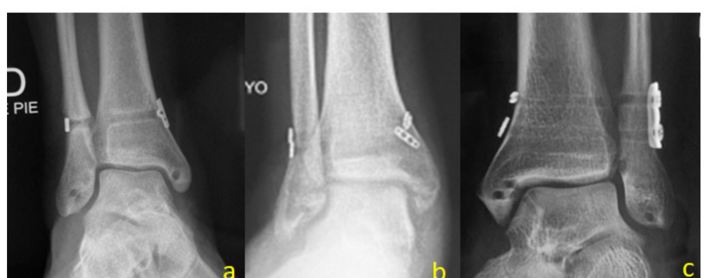

Figure 8a: Stabilization of the unstable occult syndesmotic injury with 1 flexible syndesmotic button. b: Stabilization of the unstable syndesmotic injury with 2 divergent syndesmotic buttons. c: Stabilization of the severe unstable syndesmotic injury associated with a C3 fracture with a plate and 2 syndesmotic buttons.

corded value was 82 (SD 5.2), which was considered good.

During follow-up, the complications reported were 2 button removals due to a foreign body granuloma related to the suture knot. Both complications were managed upon diagnosis and had no impact on the final outcome.

Discussion

The syndesmotic complex provides essential dynamic support for the normal biomechanics of the ankle. Syndesmotic injuries occur in 1 to 18% of ankle sprains, so it is very important to identify and treat these injuries [1,2,33].

Isolated syndesmotic injuries may be stable or unstable; they are stable when the deltoid ligament is intact and unstable when the ligament is injured [2,33]. Although the classification seems simple, the diagnostic process in clinical practice may be complex, including diagnostic tests with different specificity and sensitivity

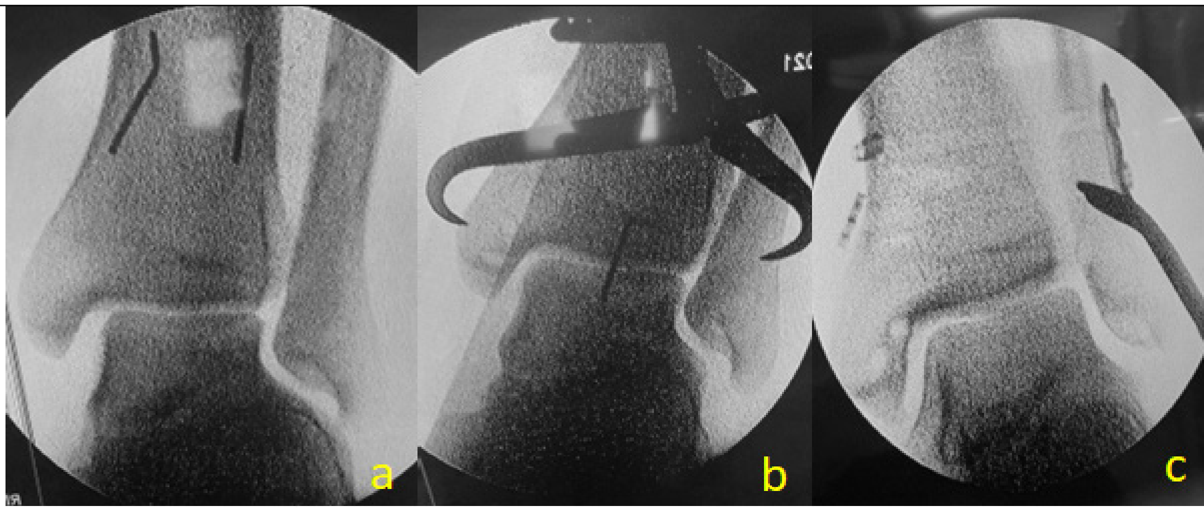

Figure 9a: Open medial clear space, distal tibiofibular diastasis. b: Closure of the inferior tibiofibular space with a clamp. c: Lateral approach, tweezers used for traction and internal rotation of the fibula during the final fixation with 1 plate and 2 syndesmotic buttons.

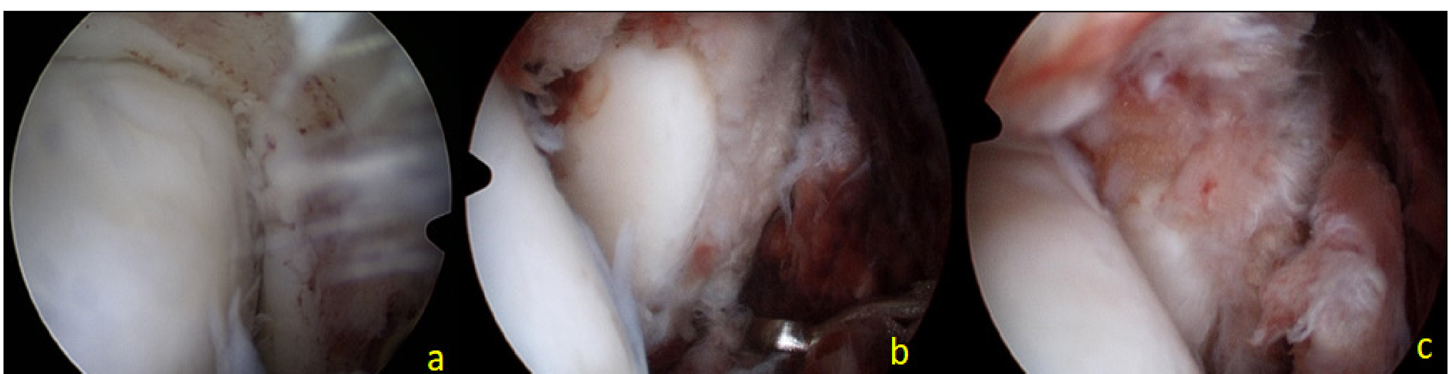

Figure 10a: Joint inspection before the final stabilization. Note the closed medial tibiofibular space. b: Figure before fibula reduction in the incisura. Note parallelism loss between the fibula and the talus; fibular cartilage displaced to lateral and anteversion of the fibula. c: Internal rotation and placement of the tibiofibular clamp after traction; retroversion of the fibula and hiding of the joint cartilage can be seen; both parameters are indicative of successful fibula reduction in the incisura.

levels [2,8,29,30].

The surgical management of syndesmotic injuries via arthroscopic assistance and button suture fixation has shown excellent functional results in our series. At the end of follow-up, all the patients had a satisfactory reduction.

Although arthroscopic–assisted syndesmosis reduction is more reliable, Logioco and Batista have reported a 4.26% of non-satisfactory reductions, which is a low percentage [34].

Moreover, in our series, we observed better results than previously reported in the literature, with high malreduction ranging from 24 to 52%, which leads to early re -intervention or poor functional outcomes [15,27-29]. Of note, these results were obtained with trans-syndesmotic screws; however, we used the suture button system.

Treatment of acute syndesmotic injuries includes several items for discussion, such as diagnosis, management, and fixation methods. We prefer to perform ankle arthroscopy as an adjuvant method to diagnose and treat these injuries. As reported by Takao M., arthroscopic evaluation is able to diagnose 100% of syndesmotic injuries [35,36].

Consequently, in our opinion, it is a useful tool to understand the severity and complexity of unstable syndesmotic injuries and assess reduction quality. Some other authors recommend routine use of this technique for this purpose [3,30].

Another advantage of arthroscopy is the direct visualization to evidence, document, and manage associated injuries concomitantly [3,31]. The literature reports 19% of associated injuries. In our series, we also found and repaired associated injuries, which are not described in this paper as it is not the objective of the study.

In terms of fixation, we consider that the suture-button technique has many advantages. As opposed to trans-syndesmotic screws, it is not necessary to remove the suture routinely. Furthermore, the position does not need to be as accurate as the position of the screws, which makes placement less complex and reduces the possibility of error [5,17].

Another important advantage is that suture button fixation allows a certain level of micromovement, which mimics the physiological movement and can be advantageous for ligament healing [18].

Table 1: Demographics

	Total (N= 15)
Gender F/M	13/2
Age /years/ mean (range)	30 (18-42)
Type of injury	
Occult	6
Evident	9
Intraoperative stability	
Mild	6
Severe	9

Finally, this system is associated with a lower complication rate and re-intervention rate in general [5]. No severe complications were observed in our series. However, the systems were removed in two patients due to a granulomatous reaction in the anchoring knot site, which is usually bulky. We estimate that this complication is directly related to the implant design used in our setting. This complication has not been reported in other publications, since a different type of knotless implant from other manufacturers has been used.

Finally, the long-term functional and clinical results reported seem to be better in our patients with the suture button system, and fewer arthritic changes [4,32]. Our follow-up is short so no conclusions can be made yet. Long term follow-up of our cohort is essential to confirm or deny what has been reported previously.

Considering the small number of patients and the short follow-up of our series as the main limitations, we believe our work pioneered in terms of result reporting with this detailed description of the technique, which is novel and is constantly evolving.

Conclusions

Our series evidenced that the management of syndesmotic ankle injuries via arthroscopic-assisted reduction and stabilization with the suture button technique is a safe and reproducible option, with excellent functional results in the short term.

We underscore the use of arthroscopic assistance as a tool to confirm the presence of instability in cases of a suspected diagnosis. Further studies are needed with a longer follow-up to evaluate the evolution in the middle and long term.

Authors' contributions

Each author contributed individually and significantly to the development of this article.

Javier Zaourak: performed the surgeries, conceived, and planned the activities that led to the study, wrote the paper, participated in the reviewing process, and approved the final version.

Máximo Iguarán Gimenez: conceived and planned the activities that led to the study, wrote the paper, participated in the reviewing process.

Héctor J. Beltrán Mateus: interpreted the results of the study, wrote the article, participated in the reviewing process.

Gustavo Araujo Nunes: interpreted the results of the study, participated in the reviewing process, and approved the final version.

Diego Yearson: interpreted the results of the study, participated in the reviewing process, approved the final version.

Sofia Carlucci: conceived and planned the activities that led to the study, wrote the paper, statistical analysis, participated in the reviewing process, and approved the final version.

References

1. Gardner, MJ., Graves, ML., Higgins, TF., Nork, SE. (2015) Technical Considerations in the Treatment of Syndesmotic Injuries. J Am Acad Orthop Surg, 23(8): 510–518.

2. van Dijk, CN., Longo, UG., Loppini, M., Florio, P., Maltese, L., Ciuffreda, M., et al. (2016) Classification and diagnosis of acute isolated syndesmotic injuries: ESSKA-AFAS consensus and guidelines. Knee Surg Sport Traumatol Arthrosc, 4(4): 1200–1216.

3. Chan, KB., Lui, TH. (2016) Role of Ankle Arthroscopy in Management of Acute Ankle Fracture. Arthroscopy, 32(11): 2373–2380.

4. Gan, K., Xu, D., Hu, K., Wu, W., Shen, Y. (2020) Dynamic fixation is superior in terms of clinical outcomes to static fixation in managing distal tibiofibular syndesmosis injury. Knee Surgery, Sport Traumatol Arthrosc, 28(1): 270–280.

5. Grassi, A., Samuelsson, K., D'Hooghe, P., Romagnoli, M., Mosca, M., Zaffagnini, S., et al. (2020) Dynamic Stabilization of Syndesmosis Injuries Reduces Complications and Reoperations as Compared with Screw Fixation: A Meta-analysis of Randomized Controlled Trials. Am J Sports Med, 48(4): 1000–1013.

6. Knops, SP., Kohn, MA., Hansen, EN., Matityahu, A., Marmor, M. (2013) Rotational malreduction of the syndesmosis: Reliability and accuracy of computed tomography measurement methods. Foot Ankle Int, 34(10): 1403–1410.

7. Gardner, MJ., Demetrakopoulos, D., Briggs, SM., Helfet, DL., Lorich, DG. (2006) Malreduction of the tibiofibular syndesmosis in ankle fractures. Foot Ankle Int, 27(10): 788–792.

8. Guyton, GP., DeFontes, K., Barr, CR., Parks, BG., Camire, LM. (2017) Arthroscopic Correlates of Subtle Syndesmotic Injury. Foot Ankle Int, 38(5): 502–526.

9. Warner, SJ., Fabricant, PD., Garner, MR., Helfet, DL., Lorich, DG., Schottel, PC. (2014) The Measurement and Clinical Importance of Syndesmotic Reduction after Operative Fixation of Rotational Ankle Fractures. J Bone Jt Surg, 97(23): 1935–1944.

10. Clanton, TO., Campbell, KJ., Wilson, KJ., Michalski, MP., Goldsmith, MT., Wijdicks, CA., et al. (2014) Qualitative and Quantitative Anatomic Investigation of the Lateral Ankle Ligaments for Surgical Reconstruction Procedures. J Bone Joint Surg Am, 96(12): e98.

11. Gerber, JP., Williams, GN., Scoville, CR., Arciero, RA., Taylor, DC. (1998) Persistent Disability Associated with Ankle

Sprains: A Prospective Examination of an Athletic Population. Foot Ankle Int, 19(10): 653–660.

12. Lepojärvi, S., Pakarinen, H., Savola, O., Haapea, M., Sequeiros, RB., Niinimäki, J. (2017) Posterior translation of the fibula may indicate malreduction: CT study of normal variation in uninjured ankles. J Orthop Trauma, 28(4): 205–209.
13. Bartoníček, J., Rammelt, S., Tuček, M., Naňka, O. (2015) Posterior malleolar fractures of the ankle. Eur J Trauma Emerg Surg, 41(6): 587–600.
14. Beumer, A., Van Hemert, WLW., Niesing, R., Entius, CAC., Ginai, AZ., Mulder, PGH., et al. (2004) Radiographic measurement of the distal tibiofibular syndesmosis has limited use. Clin Orthop Relat Res, 423(423): 227–234.
15. Miller, AN., Carroll, EA., Parker, RJ., Boraiah, S., Helfet, DL., Lorich, DG. (2009) Direct Visualization for Syndesmotic Stabilization of Ankle Fractures. Foot Ankle Int, 30(5): 419–426.
16. Sanders, D., Schneider, P., Taylor, M., Tieszer, C., Lawendy, AR. (2019) Improved Reduction of the Tibiofibular Syndesmosis with TightRope Compared with Screw Fixation: Results of a Randomized Controlled Study. J Orthop Trauma, 33(11): 531–537.
17. Lee, JS., Curnutte, B., Pan, K., Liu, J., Ebraheim, NA. (2021) Biomechanical comparison of suture-button, bioabsorbable screw, and metal screw for ankle syndesmotic repair: A meta-analysis. Foot Ankle Surg, 27(2): 117–122.
18. Ibrahim, T., Beiri, A., Azzabi, M., Best, AJ., Taylor, GJ., Menon, DK. (2007) Reliability and Validity of the Subjective Component of the American Orthopaedic Foot and Ankle Society Clinical Rating Scales. J Foot Ankle Surg, 46(2): 65–74.
19. Martin, RRL., Irrgang, JJ., Burdett, RG., Conti, SF., Van Swearingen, JM. (2005) Evidence of validity for the Foot and Ankle Ability Measure (FAAM). Foot Ankle Int, 26(11): 968–983.
20. de Souza, LJ., Gustilo, RB., Meyer, TJ. (1985) Results of operative treatment of displaced external rotation-abduction fractures of the ankle. J Bone Joint Surg Am, 67(7): 1066–1074.
21. Van Dijk, CN., Scholte, D. (1997) Arthroscopy of the ankle joint. Arthroscopy, 13(1): 90–96.
22. Guelfi, M., Vega, J., Malagelada, F., Dalmau-Pastor, M. (2020) The arthroscopic all-inside ankle lateral collateral ligament repair is a safe and reproducible technique. Knee Surg Sport Traumatol Arthrosc, 28(1): 63–69.
23. Vega, J., Allmendinger, J., Malagelada, F., Guelfi, M., Dalmau-Pastor, M. (2020) Combined arthroscopic all-inside repair of lateral and medial ankle ligaments is an effective treatment for rotational ankle instability. Knee Surg Sport Traumatol Arthrosc, 28(1): 132–140.
24. Vega, J., Golanó, P., Pellegrino, A., Rabat, E., Peña, F. (2013) All-inside Arthroscopic Lateral Collateral Ligament Repair for Ankle Instability With a Knotless Suture Anchor Technique. Foot Ankle Int, 34(12): 1701–1709.
25. Cottom, JM., Hyer, CF., Philbin, TM., Berlet, GC. (2009) Transosseous Fixation of the Distal Tibiofibular Syndesmosis: Comparison of an Interosseous Suture and Endobutton to Traditional Screw Fixation in 50 Cases. J Foot Ankle Surg, 48(6): 620–630.
26. Sagi, HC., Shah, AR., Sanders, RW. (2012) The functional consequence of syndesmotic joint malreduction at a minimum 2-year follow-up. J Orthop Trauma, 26(7): 439–443.
27. Franke, J., Recum, JV., Suda, AJ., Grutzer, PA., Wendl, K. (2012) Intraoperative Three-Dimensional Imaging in the treatment of acute unstable syndesmotic injuries. J bone Jt Surg Am, (94): 1386–1390.
28. Marmor, M., Hansen, E., Han, HK., Buckley, J., Matityahu, A. (2011) Limitations of standard fluoroscopy in detecting rotational malreduction of the syndesmosis in an ankle fracture model. Foot Ankle Int, 32(6): 616–622.

29. Lui, TH., Ip, K., Chow, HT. (2005) Comparison of radiologic and arthroscopic diagnoses of distal tibiofibular syndesmosis disruption in acute ankle fracture. Arthroscopy, 21(11): 1370.

30. Vopat, ML., Vopat, BG., Lubberts, B., DiGiovanni, CW. (2017) Current trends in the diagnosis and management of syndesmotic injury. Curr Rev Musculoskelet Med, 10(1): 94–103.

31. Raeder, BW., Figved, W., Madsen, JE., Frihagen, F., Jacobsen, SB., Andersen, MR. (2020) Better outcome for suture button compared with single syndesmotic screw for syndesmosis injury: Five-year results of a randomized controlled trial. Bone Joint J, 102(2): 212–219.

32. Rammelt, S., Zwipp, H., Grass, R. (2008) Injuries to the Distal Tibiofibular Syndesmosis: an Evidence-Based Approach to Acute and Chronic Lesions. Foot Ankle Clin, 13(4): 611–633.

33. Logioco, L., Batista, J. (2018) Rol de la artroscopia en las lesiones agudas de la sindesmosis puras o asociadas a fracturas de tobillo TT - The role of arthroscopy in acute pure lesions of syndesmosis or associated tibiofibular fractures. Artrosc, 25(4): 118–123.

34. 35. Takao, M., Ochi, M., Naito, K., Iwata, A., Kawasaki, K., Tobita, M., et al. (2001) Arthroscopic diagnosis of tibiofibular syndesmosis disruption. Arthroscopy, 17(8): 836–843.

35. 36. Takao, M., Ochi, M., Oae, K., Naito, K., Uchio, Y. (2003) Diagnosis of a tear of the tibiofibular syndesmosis. The role of arthroscopy of the ankle. J Bone Joint Surg Br, 85(3): 324-329.