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ORIGINAL ARTICLE

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Tomographic control of sindesmosis reduction after surgical fixation

Controle tomográfico da redução da sindesmose pós fixação cirúrgica

Allex do Amaral e Castro[1], José Vicente Pansini[1], Elicimar Beltran Martins[1], Adham do Amaral e Castro[2,3], Eduardo Kaiser Ururahy Nunes[2]

1. Hospital de Fraturas Novo Mundo, Curitiba, PR, Brazil.
2. Hospital Israelita Albert Einstein, São Paulo, SP, Brazil.
3. Universidade Federal de São Paulo, São Paulo, SP, Brazil.

ABSTRACT

Objective: To determine percentages of types A (flat) and B (concave) of the distal tibiofibular joint in patients with ankle fractures or chronic ligament instabilities, with syndesmosis lesions; check the shape of the fixation and position of the fibula in this joint; to identify poor fibular reduction and its frequency in types A and B; patients according to the AOFAS criteria.

Methods: 104 patients surgically treated with syndesmosis fixation underwent clinical evaluation using AOFAS functional criteria and tomographic exams to classify the distal tibiofibular joint in types A or B and evaluated the poor position of the fibula in this joint.

Results: Distal tibiofibular joint type A was present in 27 ankles and type B in 77. Non-anatomical reduction of the fibula (17 ankles) was more frequent in type A than in type B and more frequent in fractures than in instabilities. The AOFAS score was 91.79 points in the 87 patients with good reduction and 86.76 points in the 17 patients with poor fibula reduction.

Conclusion: Distal tibiofibular joint type B was more frequent than type A (p=0.00001); there was poor reduction of the fibula in this joint in 17 ankles (16.34%). Poor fibula reduction was more frequent in fractures than in instabilities (p=0.006). The poor reduction was more constant in type A than in type B, without statistical significance (p=0.34). The AOFAS score was 91.79 points in patients with good reduction and 86.76 points in patients with poor fibula reduction in the distal tibiofibular joint.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Ankle; Distal tibiofibular joint; Ankle injuries; Tomography

RESUMO

Objetivo: Determinar percentagens de tipos A (plana) e B (côncava) da articulação tibiofibular distal em pacientes com fraturas de tornozelo ou instabilidades ligamentares crônicas, com lesões da sindesmose; checar a forma da fixação e posição da fíbula nesta articulação; identificar má redução da fíbula e sua frequência nos tipos A e B; avaliar os pacientes de acordo com os critérios AOFAS.

Métodos: 104 pacientes tratados cirurgicamente com fixação da sindesmose foram submetidos à avaliação clínica por critérios funcionais AOFAS e a exames tomográficos para classificar a articulação tibiofibular distal em tipos A ou B e avaliando-se a má posição da fíbula nesta articulação.

Resultados: Articulação tibiofibular distal tipo A estava presente em 27 tornozelos e do tipo B em 77. Redução não anatômica da fíbula (17 tornozelos) foi mais frequente no tipo A do que no tipo B e mais frequente nas fraturas do que nas instabilidades. O escore AOFAS foi de 91,79 pontos nos 87 pacientes com boa redução e 86,76 pontos nos 17 pacientes com má redução da fíbula.

Conclusão: Articulação tibiofibular distal tipo B foi mais frequente que a tipo A (p=0,00001); ocorreu má redução da fíbula nesta articulação em 17 tornozelos (16,34%). A má redução da fíbula foi mais frequente nas fraturas que nas instabilidades (p=0,006). A má redução foi mais constante no tipo A que no tipo B, sem significância estatística (p=0,34). A pontuação AOFAS foi de 91,79 pontos nos pacientes com boa redução e de 86,76 pontos nos pacientes com má redução da fíbula na articulação tibiofibular distal.

Nível de Evidência IV; Estudos Terapêuticos; Série de Casos.

Descritores: Tornozelo; Articulação tibiofibular distal; Traumatismos do tornozelo; Tomografia.

Work performed at the Hospital de Fraturas Novo Mundo, Curitiba, PR, Brazil.

Correspondência: José Vicente Pansini. Av. Comendador Franco, 2795 - CEP: 81520-000 - Curitiba, PR, Brazil. E-mail: pansinijv@gmail.com

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INTRODUCTION

The importance of syndesmosis and its influence on ankle stability has been known for many decades and has been well described in the literature[1].

Lauge-Hansen described a sequence of bone and ligament injuries of the ankle according to the trauma mechanism[2]. Weber, in turn, classified these same fractures according to the fracture height of the fibula and described 100% incidence of syndesmosis injury in Weber type C fractures and a lower incidence (50%) present in Weber type B fractures. His treatment proposal included the fixation of syndesmosis in Weber type C (100% of cases) and Weber type B (50% of cases) fractures with a supra-syndesmotic screw[3].

Maisonneuve fractures are located in the proximal fibula and may cause damage to the ankle with deltoid and syndesmosis injuries[3].

Intraoperative radiographic control does not always show the actual position of the fibula at the distal tibiofibular joint. Computed tomography (CT) better portrays this positioning but is rarely available at the time of surgery. Malpositioning of the fibula at this joint may cause instability, allow lateral translation of the talus, and compromise joint congruence[4-7].

Inadequately treated syndesmosis injuries predispose poor ankle fracture outcomes[8]. In chronic ligament instabilities[9-12], they cause repetitive sprains that make it impossible to participate in sport[13]. Different percentages of this injury in chronic ankle instabilities are also described in the literature[12-16].

The description of type A and type B distal tibiofibular joints, the high percentage of fibular malreduction in these joints in the treatment of syndesmosis injuries reported by several studies, and the large number of patients with these injuries motivated the realization of this study[4-6].

The objectives of the present study were as follows: 1 - determine the percentages of distal tibiofibular joint type A (flat) and type B (concave) 5 in patients with syndesmosis fixation in the treatment of ankle fractures or chronic ligament instability; 2 - determine the form of fixation (number of screws and cortical) and position of the fibula in this joint; 3 - identify the percentage of fibular malreduction in types A and B in the ankles with fractures and in the ankles with chronic instability without fractures; and 4 - evaluate the functional clinical outcome according to the American Orthopedic Foot and Ankle Society (AOFAS) criteria[17,18] in patients with good or poor fibular reduction in this joint.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 59049216.0.0000.0103.

A total of 104 patients with ankle fractures and chronic ligament instabilities who underwent surgical treatment with the fixation of distal tibiofibular syndesmosis injury between May 2007 and April 2017 were included in this study. Patients whose treatment corresponded to the study objectives were included, and they signed an informed consent form for the study.

The patients were clinically examined in our outpatient clinic and underwent CT of the ankle in neutral rotation and flexion positions.

Using the axial images of the CT scans, in the axial section two centimeters proximal to the tibiotalar joint, we evaluated the position of the fibula in the distal tibiofibular joint, the symmetry between the anterior and posterior spaces of this joint, and the lateral spacing of the fibula in relation to the tibia. The clinical and tomographic findings of each patient were computed.

With the use of a ruler, a line was drawn in the lateral cortex of the tibia from the anterolateral point to the posterolateral point of the distal tibiofibular joint, and perpendicularly to it, another line was drawn towards the point of greatest depth of this joint. The measurement of this radius in millimeters determined the depth of the distal tibiofibular joint and allowed its classification as type A (flat) or type B (concave).

We considered as type B (concave) distal tibiofibular joints whose concavity had at least two millimeters of radius at its greatest depth. Type A (flat) distal tibiofibular joints were defined as having a concavity of less than two millimeters in radius at its greatest depth[5].

All patients underwent functional clinical evaluation using the AOFAS scoring criteria that had been validated for Brazilian Portuguese[18], and the results were evaluated for statistical significance.

RESULTS

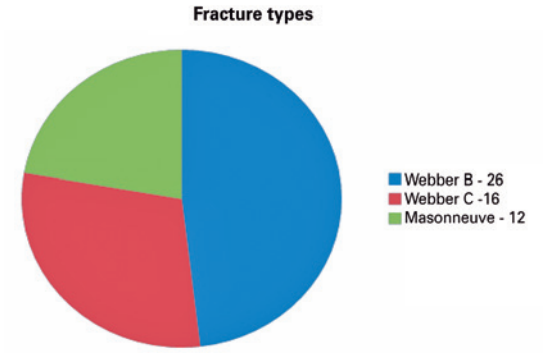
We evaluated 104 patients, including 56 males and 48 females. The mean age for men was 41.8 years and was 36.8 years for women (Table 1).

Fifty-four patients (33 men and 21 women) were treated for ankle fractures, and 50 patients (23 men and 27 women) were treated for chronic ligament instability, all with syndesmosis fixation. The fractures were distributed as follows: 26 Weber type B fractures, 16 Weber type C fractures and 12 Maisonneuve type fractures (Figure 1).

Table 1. Relationship between nature of injury and sex of patients (total sample)

Sex	Fractures	Chronic ligament instability	Total
Male	33	23	56
%	61.11	46.00	
Female	21	27	48
%	38.89	54.00	
Total	54	50	104

There was no significant difference between the nature of the injury and the patients' sex (p=0.46). There was no significantly higher incidence of male or female patients among the 104 patients (p=0.27).
Source: Prepared by the authors based on the results of the study.



Weber type B fracture was significantly more frequent than types A and C (p=0.048).
Figure 1. Types of ankle fracture in the studied patients.
Source: Authors' personal archive.

The patients with chronic ligament instability presented isolated syndesmosis injury or associated injuries of the anterior talofibular ligaments and/or of the fibulocalcaneal ligament. Diagnoses were made with clinical exams, ankle stress radiographs, and distal tibiofibular joint stress CT scans and magnetic resonance imaging of the ankle.

Distal tibiofibular joint type A was present in 16 fractures (nine men and seven women) and in 11 ligament instabilities (four men and seven women). Distal tibiofibular joint type B was present in 38 fractures (24 men and 14 women) and in 39 chronic ligament instabilities (19 men and 20 women).

There were 27 type A joints (14 women and 13 men), totaling 25.96% of the sample, whereas there were 77 type B joints (43 males and 34 females), totaling 74.04% of the sample (Table 2).

The type A (flat) joints presented a mean radius length of 0.57mm (0 to 1.5mm) that measured the concavity of the joint (perpendicular line from the lateral border to the most medial point of the concavity of the distal tibiofibular joint). The mean length of the radius measuring this concavity was 2.75mm (2 to 6mm) in type B (concave) joints.

Regarding the form of syndesmosis fixation, 50 patients with ligament instability received fixation with two screws—a smooth tunnel in the fibula and anchored in the medial cortex of the tibia (four cortices). Patients with ankle fractures received different forms of syndesmosis fixation: 46 ankles - 2 screws/4 cortices; 1 ankle - 2 screws/3 cortices; 5 ankles - 1 screw/3 cortices; and 2 ankles - 3 screws/4 cortices. The patients with 3 screws had diabetes (in our practice, syndesmosis injuries of osteopenic or diabetic patients are fixed with 3 screws/4 cortices). The different forms of syndesmosis fixation did not affect the results (Table 3).

The incidence of non-anatomical fibular reduction was 17 ankles (16.34%) and was more frequent in type A

Table 2. Distal tibiofibular joint types

Type	f	%
A	27	25.96
B	77	74.04
Total	104	100

Type B is significantly more frequent than type A (p=0.00001), with no significant difference regarding sex.
Source: Prepared by the authors based on the results of the study.

Table 3. Patients with fractures - number of screws used in syndesmosis fixation and number of fixed cortices

Number of patients	Screws	Number of cortices
46	2	4
5	1	4
2	3	4
1	2	3

Source: Prepared by the authors based on the results of the study.

(22.22%) than in type B (14.28%) joints. Non-anatomical reduction was also more frequent in ankle fractures (82.35%) than in chronic ligament instabilities (17.65%) (Table 4).

The mean AOFAS score was 91.79 points for the 87 patients with good fibular reduction and 86.76 points for the 17 patients with malreduction of the fibula in the distal tibiofibular joint.

Fibular malreduction in fractures occurred in eight Weber type B fractures, one Maisonneuve type fracture and five Weber type C fractures (four type A and one type B distal tibiofibular joints) (Figure 2).

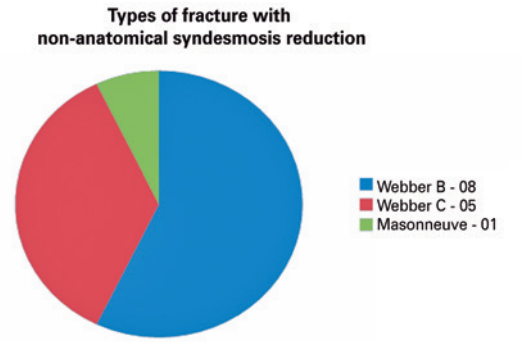
The fibular malreductions in the distal tibiofibular joints were as follows: 1 increased lateral displacement; 1 anterior opening greater than the posterior opening; and 15 posterior openings greater than the anterior openings of the joint. Three of these patients also had a slightly anteriorly subluxed fibula one millimeter above the upper border of the tibia in this joint space.

A patient with Weber type C unimalleolar fracture had discrete signs of arthrosis, with a posterior opening greater than the anterior opening of this joint.

Table 4. Ankles with non-anatomical reduction of the fibula in type A and type B joints - in fractures and ligament instabilities

Nature of the injury	Type A	Type B	Total
Fractures	5	9	14
Chronic ligament instability	1	2	3
Total	6	11	17

The incidence of non-anatomical reduction of the fibula was significantly higher in fractures than in ligament instabilities (p=0.006), and the incidence was also higher in type A (22.22%) than type B (14.02%) joints but was not statistically significant (p=0.34).
Source: Prepared by the authors based on the results of the study.



There was no significantly higher incidence of fibular malreduction among the three types of fractures (p=0.22). Note: The Fisher test was applied.
Figure 2. Types of fractures with non-anatomical reduction of the fibula in the distal tibiofibular joint.
Source: Authors' personal archive.

The remaining 16 patients had no complaints of loss of ankle function, disabling pain, sensation of instability when walking or history of sprains.

Good reduction of the distal tibiofibular joint was reported in 87 patients, two of whom had a proximal screw fracture: one with a Maisonneuve fracture and the other with a Weber type C unimalleolar fracture. Both patients had no complaints. One patient presented a screw passing posterior to the cortex of the tibia, without securing the syndesmosis, which was well-reduced and properly fixed by the other screw (Figure 3).

Two patients with good fibular reduction presented signs of incipient arthrosis with occasional ankle pain: one with Weber type C fracture and one with Maisonneuve fracture.

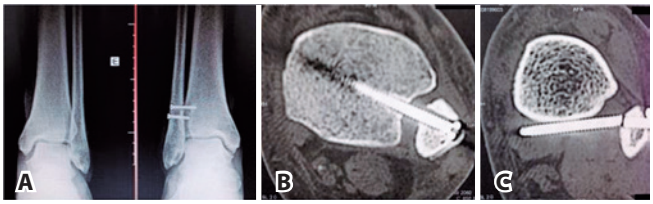


Figure 3. Radiograph depicting very short lower screw and well-positioned fibula (A). Tomography in the axial plane depicting a well-positioned upper screw (B) and the lower screw located posterior to the tibia (C), with the fibula well-centered in the joint but with a slight lateral displacement.
Source: Authors' personal archive.

The CT scans were performed at a mean of 20.42 months (eight to 60 months) after surgery; 15 ankles had the suprasyndesmotic screws still present and 89 did not have the screws; however, in these patients the paths of the screws were evident in the images.

The mean AOFAS scores were 91.79 points (80 to 100) for the 87 patients whose fibulas were well-positioned and 86.76 points (80 to 95) for the 17 patients whose fibulas were not well-positioned in the distal tibiofibular joint.

DISCUSSION

Restoring good function to a fractured ankle requires restoring not only the fractured bone structures but also restoring the ligament structures. The literature reports that the syndesmosis and the deltoid ligament may also be damaged by the same trauma that causes the fracture[1,2,4].

Uys and Rijke described a high incidence of syndesmosis injury in ankle sprains[12], and Pansini reported the

presence of the same injury in chronically unstable ankles without fractures whose reconstruction guaranteed a stable ankle that enabled a return to sports practice[13].

Previous studies have shown that syndesmosis fixation is not enough; the correct positioning of the fibula in the distal tibiofibular joint is also necessary, but this does not always occur[4-6].

The present case series had 16.34% fibular malreduction, not only in fractures (14 ankles) but also in instabilities (three ankles). Although small in number, this malreduction of the fibula in the nonfractured ankles surprised us.

Manjoo et al.[5] described two types of distal tibiofibular joints: type A (flat) and type B (concave) but did not describe their depth, making it difficult to understand the exact nature of type A or type B. The present study measured and found important variations (0 to 6mm) in this depth. We classified joints that had less than two millimeters of depth as type A (flat) and those with two millimeters or more as type B (concave). This measurement allowed us to standardize and properly evaluate the tomographic images, which was necessary to ensure the accuracy of the results.

Our results showed false trajectory of a posterior screw without securing the distal tibiofibular joint, whereas the other screw was adequately positioned to fix the joint (Figure 3). Fortunately, the fibula, with slight lateral displacement, was already within the joint space maintained by the first screw. Thus, we emphasize the importance of the correct screw direction: 20 degrees of angulation from posterior to anterior, from lateral to medial. A malpositioned screw, whether fixed first or a single screw, can cause the joint to dislocate. In chronic instabilities, fibular malreduction may also occur if the screw direction is not adequate. The present case report found three fibular malreductions in syndesmosis fixation for the treatment of chronic instability, which in our view confirms the importance of the correct direction of the screws for this fixation.

The number of malpositioned fibula reported in the literature is high[4-6]. Although only a small number, this was also observed in the present study. A surprising finding was reported by Song et al.[6], who described an improvement of the fibular position after removal of the syndesmotic screws. This was not observed in the present case series. Both the literature reports and the present results demonstrate that fixation of the fibula in an anatomical position is not an easy task[4-6].

The present case series shows 17 situations in which the fibula was not anatomically positioned in the distal tibiofibular joint. Intraoperative radiographic control did not identify this poor positioning, confirming the superiority of tomography for this control[4-6]. However, tomography is not always available in the operating room.

The amount of fibular malreduction identified in this study (16.34%) is 50% lower than that described by Song et al.[6], by Manjoo et al.[5], and by Ribeiro et al.[19] and is much lower than that described by Gardner et al.[4]. However, this value was surprising to us, as we expected to find an even lower percentage based on the high AOFAS score found in the initial clinical evaluations before the tomography. These patients had few complaints and reported stable and functional ankles, which indicate that small changes in the position of the fibula in the distal tibiofibular joint may still allow good ankle function.

We believe that the intraoperative radiographic controls of our series, in anteroposterior and absolute profile view, with neutral ankle rotation and flexion positions, contributed to our lower percentage of fibular malreduction.

Contrary to other studies, we evaluated all the patients using the AOFAS scoring criteria and were able to compare patients with anatomically well-positioned syndesmoses with those with non-anatomical reductions. Fixing the syndesmosis in its anatomical position is the ideal objective, but the fixation, even if not anatomical, fulfills the role of healing the syndesmosis ligaments, restoring some stability to the ankle; this is supported by the mean AOFAS score of 86.76 points for these 17 patients. The finding of good functional results, even with non-anatomical fixations, cannot be compared with that of studies such as Gardner et al.[4] and Manjoo et al.[5] who did not describe evaluation by the AOFAS criteria in their patients with non-anatomical reductions.

Of the 17 fibular malreductions observed in this study, six involved type A joints (22.22%) and 11 involved type B joints (14.28%). This difference in incidence, although not significant (p=0.34), shows that there is a greater risk of fibular malreduction in type A than type B joints.

Unlike the previous studies[4-6], we documented only the affected ankle. Our tomographic examination was performed at an average of 20.42 months after surgery, which was different from Ribeiro et al.[19] who performed tomography on the first postoperative day.

Only three patients with syndesmosis malreduction had ligament injuries, while the others had fractures, which may indicate that the intensity of the fracture trauma produces greater damage to the ankle, making it difficult to correctly reposition the fibula in this joint.

CONCLUSION

The results of the present study lead to the following conclusions:

- Type B distal tibiofibular joints were significantly more frequent than type A joints (p=0.00001), with no"significant differences between sexes".
- A total of 17 ankles showed malreduction of the fibula in the joint (16.34%), with no influence from the different forms of fixation.
- Fibular malreduction was more significantly frequent in fractures than in ligament instabilities (p=0.006).
- Fibular malreduction was more frequent in type A than in type B joints (14.02%), but this difference was not statistically significant (p=0.34).
- The mean AOFAS score was 91.79 points in patients with good reduction and 86.76 points in patients with fibular malreduction in the distal tibiofibular joint.

Authors' contributions: Each author contributed individually and significantly to the development of this article: AAC *(https://orcid.org/0000-0001-5948-3957) wrote the article and participated in the review process; JVP *(https://orcid.org/0000-0003-1445-9464) conceived and planned the activities that led to the study, wrote the article, participated in the review process and approved the final version; EBM *(https://orcid.org/0000-0003-3989-5385) wrote the article and participated in the review process; AAC *(https://orcid.org/0000-0003-0649-3662) wrote the article and participated in the review process; EKUN *(https://orcid.org/0000-0002-0233-0041) wrote the article and participated in the review process.

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