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ORIGINAL ARTICLE

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Rate of unsatisfactory syndesmotic reduction by means of a postoperative tomographic study

Índice de redução insatisfatória das lesões da sindesmose por meio de estudo tomográfico pós-operatório

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ABSTRACT

Objective: To analyse the rate of unsatisfactory reduction in syndesmosis injuries by means of a postoperative tomographic study.

Methods: This was a prospective study conducted from March to December 2017. Thirty patients with syndesmosis injury were selected, and ankle tomography was performed during the first postoperative period. A form developed for the study was used to collect demographic data (sex and age in years) and postoperative data (operated side, Weber classification, computed tomography results and need for surgical reoperation). The images were evaluated using tomographic criteria. The intraoperative analysis was performed through radioscopy and by direct visualization of the syndesmosis.

Results: The majority of the patients were male (56.7%), ranging in age from 17 to 51 years; 53.3% of the patients were operated on the left side; 66.7% were classified as type C; and 66.7% did not undergo reoperation. Regarding the rate of unsatisfactory syndesmosis reduction, it was found that 25.9% of the analyses of the established variables presented unsatisfactory results. It was observed that 74.1% of the criteria presented satisfactory results; however, criterion B presented a significant rate (37%) of unsatisfactory results.

Conclusion: Based on the computed tomographic scans, there was a high percentage of unsatisfactory reductions in syndesmosis injuries. Thus, it was concluded that, even using the correct fixation techniques and adequate intraoperative scopic monitoring, distal tibiofibular joint incongruence can still be observed when investigated using postoperative tomography.

Level of Evidence II; Diagnostic Studies.

Keywords: Ankle Injuries; Tomography; Wounds and injuries.

RESUMO

Objetivo: Analisar o índice de redução insatisfatória das lesões da sindesmose por meio de estudo tomográfico pós-operatório.

Métodos: Trata-se de um estudo prospectivo no período de março a dezembro de 2017. Foram selecionados 30 pacientes que apresentavam lesão da sindesmose e no primeiro pós-operatório foi realizada tomografia de tornozelo. Foi utilizado um protocolo de investigação, constando dados demográficos (sexo e idade em anos) e os dados pós-operatório (lado operado, classificação Weber, resultados das tomografias computadorizadas e a necessidade de reoperação cirúrgica). As imagens foram avaliadas através dos critérios tomográficos. A análise do intra-operatório foi realizada através da radioscopia e por visualização direta da sindesmose.

Resultados: A maioria dos pacientes era do sexo masculino (56,7%), com idade variando entre 17 e 51 anos; 53,3% dos pacientes operaram o lado esquerdo; 66,7% foi classificado no tipo C e 66,7% não reoperaram. Quanto ao índice, verificou-se que 25,9% das análises das variáveis estabelecidas apresentaram resultados insatisfatórios. Observou-se que 74,1% dos critérios apresentaram resultados satisfatórios; contudo, o critério B apresentou um índice significativo (37%) de resultados insatisfatórios.

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Conclusão: A partir das análises das tomografias, foi possível verificar um percentual elevado de reduções insatisfatórias das lesões da sindesmose. Nesse sentido, concluiu-se que, mesmo utilizando as técnicas corretas de fixação, controle intra-operatório por meio de scopia, e estes estando adequados, ao realizarmos a tomografia pós-operatória, encontramos casos com incongruência da articulação tibiofibular distal.
Nível de Evidência II; Estudos Diagnósticos.

Descritores: Traumatismo do tornozelo; Tomografia; Ferimentos e lesões.

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INTRODUCTION

Ankle injuries are common and may include rupture of the distal tibiofibular syndesmosis. Injury of the ankle syndesmosis can occur as a soft tissue injury alone or combined with a fractured ankle. The accurate identification of injuries in the distal tibiofibular syndesmosis is of critical importance, since the rupture and widening of the distal syndesmosis results in lateral displacement of the talus. A cadaveric study suggested that 1mm of lateral talar displacement reduces the tibiotalar contact area by 42%[1].

Classical radiographic measurement of the syndesmosis was imprecise in evaluating the distal tibiofibular relationship. Computed tomography (CT) evaluation was found to be a much more sensitive instrument for assessing the integrity of the syndesmosis[2].

Despite the differences in methods for syndesmosis fixation regarding screw number, type and cortical penetration, one of the major challenges is achieving anatomic reduction in the syndesmosis intraoperatively. Hsu et al. mentions that established anatomical parameters, such as tibiofibular clear space and overlap along with medial clear space on anteroposterior and mortise radiographs, may be used to help guide reduction, but iatrogenic malreduction may still occur despite adequate intraoperative fluoroscopy[3].

Post-reduction CT scans have suggested that the reduction may not be as good as previously believed. CT scans are particularly useful in identifying distal fibular rotation at the syndesmosis level. CT scan was found to be appropriate for the detection of up to 3 mm of diastasis and up to 30 degrees of external rotation of the distal fibula[4]. In this sense, CT provides more detail of the injury and has been widely used to evaluate these fractures, especially those that are more complex[3].

Intraoperative control by simple radiographs is usually not able to provide actual information about the positioning of the fibula (rotation and diastasis) relative to the tibia in syndesmotic injuries. In this context, the use of CT is an important tool for cases of doubt about the syndesmotic reduction at the end of the surgical procedure[2,4].

In view of the above information, the objective of this study was to analyse the rate of unsatisfactory reduction in syndesmosis injuries by means of a postoperative tomographic study.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 82820118.4.0000.0066.

The collected data were only used for analysis, interpretation and dissemination in the health field through scientific publications, and the confidentiality of the participants was maintained throughout the study period.

This was a prospective study conducted from March to December 2017. The study sample consisted of 30 patients with syndesmosis injury who underwent surgery for syndesmosis fixation using suprasyndesmotic screws placed from the fibula to the tibia, parallel to the tibiotalar joint, with the ankle in neutral position, and for whom the surgery was monitored by intraoperative radioscopy and an ankle CT scan was performed during the first postoperative period. Patients who did not present radiographic criteria or borderline criteria for syndesmosis injury and patients with a history of anterior ankle fracture were excluded. It should be emphasized that control during surgery was performed by radioscopy and previous visualization of the syndesmosis. Figure 1 shows a postoperative X-ray in the anterior-posterior view, whereas Figures 2 and 3 show postoperative CT scans.

It is noteworthy that in all cases of unsatisfactory reduction, patients underwent further surgery and CT scans until the syndesmosis was reduced.

Sex and age in years were collected as demographic data, and the following postoperative data were collected: operated side, Weber classification, CT results and the need for surgical reoperation. The images were evaluated using the tomographic criteria established by Nault et al.[5]

The authors described new tomographic parameters for evaluating the syndesmosis based on 6 new measures and 2 angles (Figure 4). All measurements, except angle 2 (Figure 4), were performed at 9.45mm proximal to the tibial pilon (or CT axial sections of 15.63mm). From these measurements, 1 ratio and 1 difference were calculated to assess the translational and rotational positions. The first ratio was between the tibiofibular region anterior to distance (a) and the posterior distance (b). This represented the third rotational parameter. The ratio between D and E represented a description of the anteroposterior position of the fibula related to the incisura and determined the translation (Figure 4).

Figure 1. Postoperative X-ray of a case with no syndesmosis reduction.
Source: Author's personal archive.

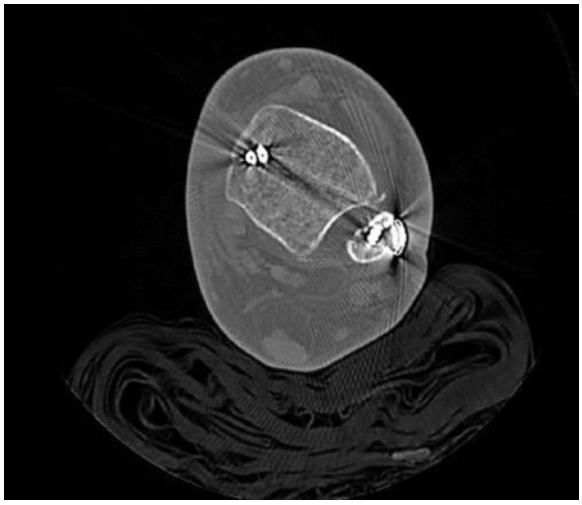
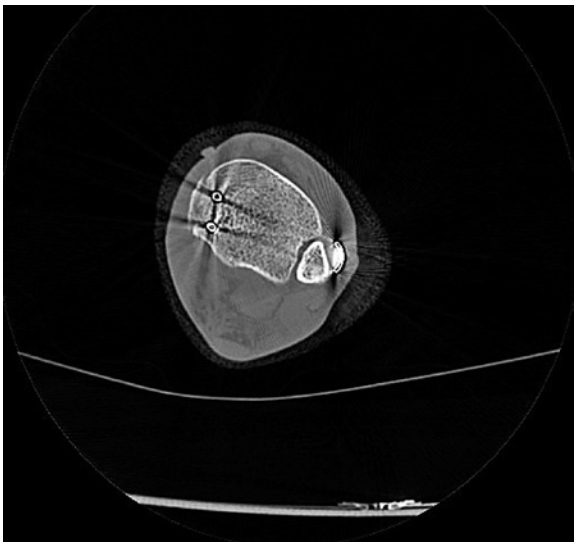


Figure 2. Postoperative tomography of a case with no syndesmosis reduction.
Source: Author's personal archive.



Figures 3. Postoperative tomography of a case with satisfactory reduction.
Source: Author's personal archive.

A - Distance between the most anterior point of the incisura and the most anterior point of the fibula.
B - Distance between the most posterior point of the incisura and the most posterior point closest to the fibula.
C - Distance between the tibia and the fibula in the middle of the incisura
D - 3-step measures;
A line is drawn between the most anterior and posterior point of the incisura.
A perpendicular line is drawn in the middle of the first line.
Distance between the anterior part of the fibula and the perpendicular.
E - Distance between the posterior part of the fibula and the perpendicular in line with the anterior measure (d).
F - The same perpendicular line is brought to the level of the most anterior point of the incisura. Distance between this line and the most anterior point of the fibula.
Angle 1 - Angle between a line drawn between the anterior and posterior point of the incisura and a line drawn on the fibula that represents its orientation (the internal rotation is a negative angle).
Angle 2 - This angle is a measure at the level of the talar dome. The angle is between the talar side of the 2 malleoli.

Figure 4. Tomographic criteria for syndesmosis analysis.
Source: Nault et al.[5]

Based on the analysis criteria, Nault et al.[5] developed values to indicate the new tomographic parameters for evaluating a normal syndesmosis, as shown in Table 1. It should be noted that this study was conducted directly with patients, since it was focused on analysis of CT scans.

The data were tabulated in a Microsoft® Office Excel worksheet (Excel 2007) and evaluated using the program SPSS 20 (USA). The non-parametric Chi-square test of independence (χ^2) or Fisher's exact test was used to evaluate the association of the categorical variables with the habit of performing or not performing physical activity. To evaluate whether the classifications in each variable have the same frequencies, the Chi-square test of goodness of fit was performed. The level of significance to reject the null hypothesis was 5%, that is, a value of $p<0.05$ was considered statistically significant.

RESULTS

A total of 30 patients who underwent ankle tomography were selected. Most patients were male (56.7%), and their ages ranged from 17 to 51 years. In total, 53.3% of the patients underwent surgery on their left side, 66.7% were classified as type C, and 66.7% did not undergo reoperation (Table 2).

The criteria of Nault et al. regarding the irreducibility of the syndesmosis were used when an altered variable and an altered angle were observed. A new surgical intervention was not an option when only angle 2 was altered, since this angle only shows the shortening of the fibula. Regarding the rate of the results of the syndesmotic reduction analysed by means of a postoperative tomographic study of the established variables, 33.3% presented unsatisfactory results (Figure 2).

Table 1. Values of established criteria for tomographic parameters for syndesmosis evaluation.

Criteria	Values
A	4mm varying 1 point +/-
B	8mm varying 1.7 points +/-
C	2.8mm varying 0.9 points +/-
D	10.4mm varying 1.4 points +/-
E	7.1mm varying 1.3 points +/-
F	2.3mm varying 1 point +/-
Angle 1	-8.7° varying 3.1 points +/-
Angle 2	6.9° varying 3.8 points +/-

Source: Nault et al.[5]

Figure 5 shows that most of the criteria presented satisfactory results; however, criterion B presented a significant rate (37%) of unsatisfactory results.

DISCUSSION

Ankle injuries are the most common of all fractures, with Weber type C ankle fracture being considerably associated with syndesmotic injuries. In the present study, it was found that the fractures of most patients were classified as type C, consistent with the studies of Dressler et al.[6], Mohammed et al.[7] and Sipahioglu et al.[8].

Previous studies underscored the importance of anatomic syndesmotic reduction for positive clinical results, since a post-surgical malreduction of the syndesmosis can

Table 2. Characteristics of the patients studied, according to demographic and postoperative data.

Variables		Percentage
Gender	Female	13 (43.3)
	Male	17 (56.7)
Age	17-20	3 (10.0)
	21-29	5 (16.7)
	30-39	6 (20.0)
	40-49	5 (16.7)
	50 or more	11 (36.6)
Side	Right	14 (46.7)
	Left	16 (53.3)
Classification	B	10 (33.3)
	C	20 (66.7%)
Re-operated	Yes	10 (33.3)
	No	20 (66.7%)

Source: Prepared by the author based on the results of the research.

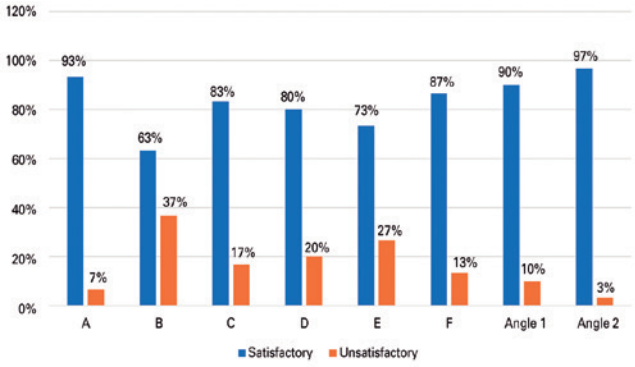


Figure 5. Percentage of satisfactory and unsatisfactory results, according to the established criteria for tomographic parameters for syndesmosis evaluation.
Source: Prepared by the author based on the results of the research.

lead to significant harm to the patient, including reduced range of motion, pain, feeling of instability in the ankle joint and even early arthrosis. Such compromises, when presented and not identified early, may require further and more difficult surgeries. In addition, in terms of public health costs, the expense associated with hospitalization time and the possibility of not correcting the problem in only one procedure will be higher[9,10].

The present study found a significant percentage of unsatisfactory syndesmotic reductions, demonstrating that CT was a fundamental method to analyse these results, since the means for diagnosing this injury and evaluating the reduction are topics of constant debate. We observed cases in which there was no syndesmotic reduction presented with non-anatomic reduction of the fibula, shortened fibula and malpositioning of the syndesmotic screw; the majority of cases were in the posterior third of the tibia and not parallel to the joint surface. Therefore, it has been suggested that anatomic reduction of the fibula should be performed, and in comminuted cases, the length of the fibula should be maintained, consequently avoiding malposition of the syndesmotic screw.

The use of CT has been highlighted in several studies such as those by Fitzpatrick et al.[11], Morellato et al.[12] and Elgafy et al.[13], which demonstrated that the analysis of CT scans is an important factor for the verification of inefficient results in the reduction and stabilization of syndesmosis injury.

Yang et al.[14] stated that syndesmotic injury is still a challenge for diagnosis, and its reduction is critical to obtaining good results, especially in the postoperative period. In that study, radiographic images were used to analyse the injury reduction; however, despite the X-rays, syndesmosis stability was observed. That is, it was not possible to observe if a malreduction was ignored or misinterpreted without detection by direct visualization of the affected structures. In addition, rotation cannot be corrected by inspection with this type of imaging alone. Therefore, the use of radiographic images is not ideal for the evaluation of syndesmotic integrity.

In this context, CT has shown superior results when compared with X-ray. This device enables the professional to analyse the evaluation parameters during the postoperative period of syndesmosis injury and consequently obtain a better image of the syndesmotic malreduction in the intraoperative period; thus, correction of the reduction can be performed without the need for additional surgery. Despite this advantage of CT, X-ray is still the most used and accessible imaging modality[14].

Krähenbühl et al.[15] argued that CT has several advantages compared with X-ray. These advantages include the fact that this method does not present image overlap, making the evaluation more accurate; the tibiofibular joint can be visualized directly, which positively influences the result of the analysis; and a better verification of the incorrect rotation of the distal fibula can be achieved.

It is emphasized that in a single axial image, variations in coronal and sagittal translation and fibular rotation can be easily detected. The ability to clearly assess fibular rotation with CT is critical, since it has been difficult, if not impossible, to use plain radiographs[15,16].

Thus, despite the higher cost of CT, the use of this method makes the procedure more feasible, due to the early diagnosis of injury malreduction, thus reducing the possible complications that may occur[9,10].

This study has some limitations, such as the number of analysed images and the scarcity of studies investigating and evaluating syndesmotic reductions using the criteria established by Nault et al. [5]. In the studies that analysed the syndesmosis after surgery,[2, 4, 8, 14] the number of cases with syndesmotic incongruence was not reported, thus suggesting that other studies on the same topic should be performed.

CONCLUSION

Based on analysis of the CT scans, a significant percentage of unsatisfactory syndesmotic reductions was found. In this sense, we concluded that even when using the correct fixation techniques and adequate intraoperative scopic monitoring, distal tibiofibular joint incongruence can still be observed on postoperative tomography.

Authors' contributions: Each author contributed individually and significantly to the development of this article: EJCR *(https://orcid.org/0000-0003-1471-1068) conceived and planned the activities that led to the study, wrote the article, interpreted the results of the study, participated in the review process; SDP *(https://orcid.org/0000-0002-8677-3981) conceived and planned the activities that led to the study, participated in the review process, approved the final version; MAR *(https://orcid.org/0000-0002-7424-9074) conceived and planned the activities that led to the study, participated in the review process, approved the final version; AMGP *(https://orcid.org/0000-0002-7657-9173) wrote the manuscript, wrote the article; DLPC *(https://orcid.org/0000-0003-2383-8335) wrote the manuscript, wrote the article. *ORCID (Open Researcher and Contributor ID).

REFERENCES

1. Shah AS, Kadakia AR, Tan GJ, Karadsheh MS, Wolter TD, Sabb B. Radiographic evaluation of the normal distal tibiofibular syndesmosis. Foot Ankle Int. 2012;33(10):870-6.
2. Ebraheim NA, Lu J, Yang H, Mekhail AO, Yeasting RA. Radiographic and CT evaluation of tibiofibular syndesmotic diastasis: a cadaver study. Foot Ankle Int. 1997;18(11):693-8.
3. Hsu AR, Gross CE, Lee S. Intraoperative O-arm computed tomography evaluation of syndesmotic reduction: case report. Foot Ankle Int. 2013;34(5):753-9.
4. Knops SP, Kohn MA, Hansen EN, Matityahu A, Marmor M. Rotational malreduction of the syndesmosis: reliability and accuracy of computed tomography measurement methods. Foot Ankle Int. 2013;34(10):1403-10.
5. Nault ML, Hébert-Davies J, Laflamme GY, Leduc S. CT scan assessment of the syndesmosis: a new reproducible method. J Orthop Trauma. 2013;27(11):638-41.
6. Dressler HB, Magalhães JMB, Gomes BR, de Almeida Pinto RZ, Lopes FAS. Avaliação retrospectiva de pacientes com fratura de tornozelo tratados cirurgicamente em um hospital terciário. Revista ABTPé. 2015;9(2):71-5.
7. Mohammed R, Syed S, Metikala S, Ali S. Evaluation of the syndesmotic-only fixation for Weber-C ankle fractures with syndesmotic injury. Indian J Orthop. 2011;45(5):454-8.
8. Sipahioglu S, Zehir S, Isikan E. Weber C ankle fractures with tibiofibular diastasis: syndesmosis-only fixation. Acta Ortop Bras. 2017;25(3):67-70.
9. Dikos GD, Heisler J, Choplin RH, Weber TG. Normal tibiofibular relationships at the syndesmosis on axial CT imaging. J Orthop Trauma. 2012;26(7):433-8.
10. Van Heest TJ, Lafferty PM. Injuries to the ankle syndesmosis. J Bone Joint Surg Am. 2014;96(7):603-13.
11. Fitzpatrick E, Goetz JE, Sittapairoj T, Hosuru Siddappa V, Femino JE, Phisitkul P. Effect of posterior malleolus fracture on syndesmotic reduction: a cadaveric atudy. J Bone Joint Surg Am. 2018;100(3):243-48.
12. Morellato J, Louati H, Bodrogi A, Stewart A, Papp S, Liew A, Gofton W. The effect of varying tension of a suture button construct in fixation of the tibiofibular syndesmosis-evaluation using stress computed tomography. J Orthop Trauma. 2017;31(2):103-10.
13. Elgafy H, Semaan HB, Blessinger B, Wassef A, Ebraheim NA. Computed tomography of normal distal tibiofibular syndesmosis. Skeletal Radiol. 2010;39(6):559-64.
14. Yang Y, Zhou J, Li B, Zhao H, Yu T, Yu G. Operative exploration and reduction of syndesmosis in Weber type C ankle injury. Acta Ortop Bras. 2013;21(2):103-8.
15. Krähenbühl N, Weinberg MW, Davidson NP, Mills MK, Hintermann B, Saltzman CL, Barg A. Imaging in syndesmotic injury: a systematic literature review. Skeletal Radiol. 2018;47(5):631-648.
16. Westermann RW, Rungprai C, Goetz JE, Femino J, Amendola A, Phisitkul P. The effect of suture-button fixation on simulated syndesmotic malreduction: a cadaveric study. J Bone Joint Surg Am. 2014;96(20):1732-8.