

Syndesmosis assessment in postoperative patients subjected to surgical treatment of supra-syndesmotic fracture

Avaliação da sindesmose no pós-operatório de pacientes submetidos a tratamento cirúrgico de fratura suprasindesmoidal

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ABSTRACT

Objective: To demonstrate the patterns of syndesmosis reconstruction in ankle fractures via the measurement of pre-established and universally accepted parameters.

Methods: In a retrospective study, fractures with radiographic images obtained during the postoperative period showing fixation of the distal tibiofibular syndesmosis were selected. After this selection, fracture reduction and syndesmosis fixation were evaluated by measuring radiographic parameters in the selected cases.

Results: Twenty-three patients (63.8%) were male. Fourteen fractures (38.8%) were operated on by a senior surgeon (foot and ankle specialist). All syndesmoses were fixed with only 1 screw, and 35 patients (97.2%) had syndesmosis fixation involving 3 cortices. The mean syndesmosis fixation height from the articular surface was 2.20cm. Four fractures (11.1%) presented radiographic signs of medial ligament reconstruction. Regarding measurement of the tibiofibular space, in the anteroposterior (AP) view, 33 patients (91.6%) had values within the normal range. Regarding the tibiofibular overlap, in the AP view, 19 patients (52.7%) had measurements with values greater than 10mm (normal). In the evaluation of tibiofibular overlap, in the true AP view, all patients (100%) presented measurements greater than 1mm (normal). Regarding the measurement of the talocrural angle, only 1 patient did not have normal parameters. Regarding the medial clear space, only 2 patients (5.5%) had values above normal during the postoperative period.

Conclusion: The adoption of objective parameters, in a standardized manner and relative to the contralateral side, adds additional value to the evaluation and ensures an accessible and reproducible method for the evaluation of these injuries.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Ankle; Ankle joint; Ankle injuries.

RESUMO

Objetivo: Demonstrar, mediante a mensuração de parâmetros pré-estabelecidos e universalmente aceitos, os padrões de reconstrução da sindesmose nas fraturas de tornozelo.

Métodos: Num estudo retrospectivo, foram selecionadas as fraturas com imagem radiográfica do pós-operatório evidenciando fixação da sindesmose tíbio-fibular distal. Após esta seleção, foram avaliadas redução da fratura e da fixação da sindesmose, mediante a mensuração de parâmetros radiográficos, nos casos selecionados.

Resultados: Vinte e três pacientes (63,8%) são do gênero masculino. 14 fraturas (38,8%) foram operadas por cirurgião sênior (especialista em pé e tornozelo). Todas as sindesmose foram fixadas com apenas 1 parafuso e 35 pacientes (97,2%) tiveram fixação da sindesmose englobando 3 corticais. A média de altura de fixação da sindesmose, a partir da superfície articular foi de 2,20cm. Quatro fraturas (11,1%) apresentaram

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sinais radiográficos de reconstrução ligamentar medial. Na mensuração do espaço tíbio-fibular, na incidência ântero-posterior (AP), 33 pacientes (91,6%) tiveram valores dentro da normalidade. Em relação à sobreposição tíbio-fibular, no AP, 19 pacientes (52,7%) tiveram medidas com valores acima de 10mm (normal). Na avaliação da sobreposição tíbio-fibular, na incidência ântero-posterior verdadeira (APV), todos os pacientes (100%) apresentaram medidas superiores a 1mm (normal). Na medida do ângulo-talocrural, apenas 1 paciente não estava entre os parâmetros normais. Em relação ao espaço livre medial, apenas 2 pacientes (5,5%) tiveram valores acima da normalidade, no pós-operatório.

Conclusão: A adoção de parâmetros objetivos, de modo padronizado, e em comparação com o lado contralateral, agrega valor adicional à avaliação e assegura um método acessível e reprodutível na avaliação destas lesões.

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

Descritores: Tornozelo; Articulação do tornozelo; Traumatismos do tornozelo.

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INTRODUCTION

Ankle and foot fractures have a significant effect on patient quality of life, leading to functional disability for a variety of activities, and are often associated with chronic pain⁽¹⁾.

Syndesmosis injuries can lead to joint pain and degenerative changes when they are not properly treated. Syndesmosis widening with rupture of the distal tibiofibular ligament is an indication for surgery to achieve syndesmosis stabilization and reduce the malleolar mortise⁽²⁻⁴⁾.

Syndesmosis injury is present in approximately 5% to 10% of all ankle sprains and in 23% of all fractures involving this joint⁽⁵⁾.

In addition to treating the fracture itself, it is also necessary to evaluate the integrity of the syndesmosis. It has become evident that an anatomical reduction of this type of fracture is fundamental to obtain good results, with open reduction being the superior method⁽⁶⁾.

Ryan et al.⁽⁷⁾, in a study on the diagnosis of injuries of the distal tibiofibular syndesmosis, observed that all physical examination findings assessed were statistically significant. Pain at the syndesmosis had the highest sensitivity (83%), while pain reproduced with the Pillings test resulted in the highest specificity (89%). The external rotation stress test had the highest positive predictive value (75%).

The aim of this study is to use measurements performed on postoperative radiographs of the selected patients to determine whether the values found are in accordance with the current literature, indicating that they are within the pre-established normal range, as documented in this study. With this study, we sought to confirm the importance of evaluating radiographic parameters obtained during the postoperative period for ankle fractures associated with syndesmosis injury.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 96482518.6.0000.5032.

All ankle fractures followed-up at the foot and ankle surgery clinic of a referral hospital for orthopedic trauma during the period from February 1, 2016 to July 31, 2016 were surveyed. Of these, fractures with postoperative radiographs evidencing fixation of the syndesmosis were selected, for which it was concluded that these fractures would have presented ankle syndesmosis injury that would be identified and fixed during the surgical procedure. A total of 36 fractures were included after applying the following exclusion criteria: patients under 18 years of age, exposed fractures that progressed to bone loss, ankles with previous fractures (consolidated or not), and ankles with deformities secondary to poliomyelitis or cerebral palsy sequelae. In addition, patients with rupture of the fixation at the height of the tibiofibular space (TFS) or with signs of frank osteolysis around the syndesmosis fixation screw were excluded. It was understood that these factors could affect the fixation quality, leading to changes that could eventually compromise the quality of the reduction obtained intraoperatively, with a consequent effect on the results of this study.

After establishing the final number of patients to be evaluated, the following data were collected from the electronic medical records: age, gender, laterality, surgeon qualification, number of screws used, number of cortices, number of affected malleoli, height of syndesmosis fixation in the radiograph, and radiographic signs of medial ligament reconstruction (presence of anchors).

Consistent with the specialized literature⁽⁸⁾ for ankle fractures, the following were used as criteria for the evaluation of the syndesmosis and fracture reduction during

the postoperative period (postfracture syndesmosis injury or inadequate reconstruction of the syndesmosis after surgical treatment):

In the anteroposterior (AP) view:

- Distal tibiofibular overlap (TFO) <10mm.
- Distal TFS >5mm.

In the true anteroposterior (TAP) view - ankle with 15 to 20 degrees of internal rotation:

- Distal TFO <1mm.
- Medial clear space >5mm (indicating lateral displacement of the talus).
- Talocrural angle <8 or >15 degrees, accepting a difference of 2 to 3 degrees compared to the contralateral ankle (Figure 1).

After consulting the image database, the parameters listed above were measured using Kodak Carestream® software (Table 1).

Table 1. Radiographic parameters for syndesmosis evaluation

Measures suggesting syndesmosis injury in the anteroposterior (AP) view	
→	Distal tibiofibular overlap <10mm.
→	Distal tibiofibular space >5mm.
Measurements suggesting syndesmosis injury in the true AP (TAP) view	
→	Distal tibiofibular overlap <01 mm.
→	Medial clear space >5mm (indicating lateral talus displacement).
→	Talocrural angle <8 or >15 degrees, accepting a difference of 2 to 3 degrees compared to the contralateral ankle.

Legend: Radiographic parameters used in the investigation of a syndesmosis injury at the level of the ankle.

Source: prepared by the author based on the results of the study.

For comparative purposes, measurements were always performed on the injured ankle and the contralateral ankle.

These data were organized into tables for objective analysis.

For the descriptive analysis, quantitative variables are represented by their means and standard deviations, when their distributions were normal, and by medians and interquartile ranges when non-normal and in the presence of important outliers. Normality was determined by graphical analysis and the Shapiro-Wilk test. Categorical variables are represented by frequencies and percentages.

The analyses were conducted with the IBM Statistical Package for the Social Sciences 20.0 (SPSS®, Chicago, IL, USA)⁽⁹⁾.

RESULTS

The mean age was 42.2 years (Table 2). Twenty-three patients (63.9%) were male, and 13 (36.1%) were female. In fifteen patients (41.7%), the fracture was on the right side, and in 21 (58.3%), the fracture was on the left side.

Regarding the qualification of the main surgeon, 14 fractures (38.9%) were operated on by a senior surgeon (foot and ankle specialist), 6 (16.7%) were operated on by an orthopedic traumatologist with more than 5 years of experience, and 16 (44.4%) were operated on by an orthopedist specializing in foot and ankle surgery or an orthopedics resident, under supervision.

Regarding the number of screws used, 36 patients (100%) had the syndesmosis stabilized by only 1 screw.

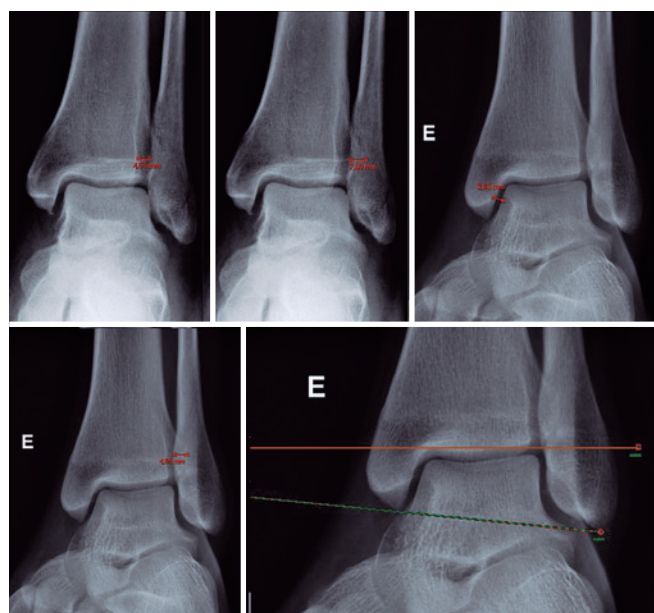


Figure 1. Measurements of radiographic parameters on a normal radiograph. From left to right: distal tibiofibular space and tibiofibular overlap (on AP view); medial clear space and tibiofibular overlap (on TAP view); talocrural angle (on TAP view).

Source: Authors' personal archive.

In the selected cases, the radiographs were performed using a premade medium density fiber (MDF, radiotransparent, derived from wood) mold, where the ankle to be studied was fitted. The patient was placed in dorsal decubitus on the table in the X-ray room to obtain standardized AP and true AP radiographs.

Table 2. General characteristics of the sample.

Characteristic	Number of patients (n=36)	Percentage (%)
Gender		
Female	13	26.1
Male	23	63.9
Age (years)	42.2±14.8	
Mean ± standard deviation	42.2±14.8	
Minimum – maximum	18-70	
Surgeon qualification		
Junior	16	44.4
Traumatologist	6	16.7
Senior	14	38.9
Laterality		
Right	15	41.7
Left	21	58.3
Number of cortices		
3	35	97.2
4	1	2.8
Number of malleoli		
1	20	55.5
2	14	38.9
3	2	5.6
Medial ligamentous injury	4	11.1

All data are shown as n (%) unless otherwise specified.

Source: prepared by the author based on the results of the study.

Regarding the number of cortices, 35 patients (97.2%) had syndesmosis fixation involving 3 cortices, and 1 (2.8%) had fixation including 4 cortices.

Regarding the number of affected malleoli, 20 (55.5%) were fractures of the lateral malleolus, 14 (38.9%) were associated lateral and medial malleolus fractures, and 2 (5.6%) were trimalleolar fractures, both of which underwent posterior malleolus fixation.

The mean fixation height of the syndesmosis from the articular surface was 2.20 cm (Figures 2 and 3).

Four fractures (11.1%) presented radiographic signs of medial ligament reconstruction, according to the visualization of anchors in the evaluated radiographs.

In the measurement of the TFS, in the AP view, 33 patients (91.7%) had values within the normal range, and 3 (8.3%) presented values greater than 5.0mm. Compared to the operated side, in all 3 patients who had changes in the TFS, the measurement on the contralateral side was within the normal range (Figure 4).

Regarding the TFO in the AP view, 19 patients (52.8%) had measurements with values greater than 10mm and, therefore, within the normal range. However, 17 patients

(47.2%) presented values less than 10mm, which indicates a possible inadequate reconstruction of the relationship between the distal tibia and fibula. On the contralateral side, the standardized radiographs obtained showed that the 17 patients who presented TFO less than 10mm on the operated side also had TFO less than 10mm on the opposite side.

In the evaluation of the TFO in the true AP view, all patients (100%) presented measurements greater than 1mm, which would denote an adequate relationship between

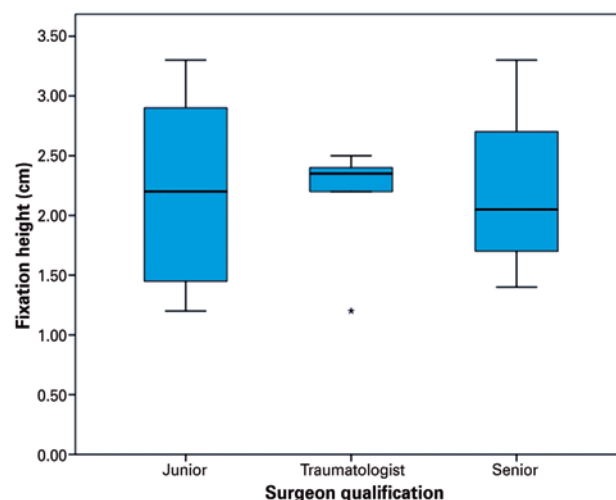


Figure 2. Fixation height according to surgeon qualification ($p=0.973$).

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

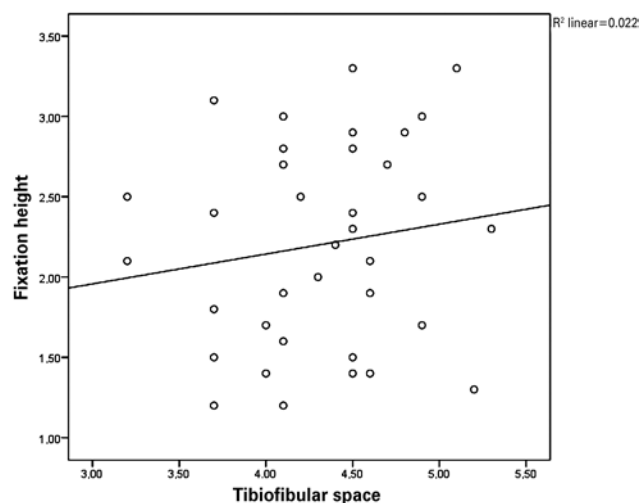


Figure 3. Fixation height x tibiofibular space

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

the distal tibia and fibula and, consequently, adequate syndesmosis reduction. On the contralateral side, all patients also presented measurements within the normal limit.

In the evaluation of the talocrural angle (TCA), 3 (8.3%) patients presented measurements less than 8mm, but of these, only 1 patient (2.7%) diverged by more than 2 to 3 degrees with the contralateral side, which suggests that only this patient was outside the expected normal values.

Regarding the medial clear space (MCS), only 2 patients (5.5%) had values above normal during the postoperative period, whereas all patients presented normal values in the measurement of the contralateral side (Table 3).

DISCUSSION

Fritschy et al.⁽¹⁰⁾ reported only 12 cases of isolated rupture of syndesmosis in a series of more than 400 ankle ligament ruptures. An isolated lesion of the syndesmosis is not always easily identified. Complete and isolated ruptures (not associated with fractures or other ligaments) are uncommon.

Although universally accepted, radiographic parameters indicating diastasis of the syndesmosis are controversial due to the significant number of biases to be considered.

Carlos et al.⁽¹¹⁾, in a study of the correlation between radiographic and anatomical measurements (dissection of cadavers fixed with formalin), concluded that such measurements are reliable and easily reproducible for the diagnosis of ankle syndesmosis injuries, especially when used in comparison with radiographs of the contralateral joint. This fact strengthens the results of the present study, since, seeking greater reliability, measurements were also made comparatively between the affected side and the contralateral side.

Ramsey and Hamilton⁽¹²⁾, in a comparative series of cases, demonstrated that widening of the ankle mortise by 1mm decreases the area of tibiotalar contact by approximately 42%. This widening represents lateral talar displacement, which may indicate a residual opening of the ankle mortise, denoting malreduction and inducing the occurrence of chronic pain and early arthrosis.

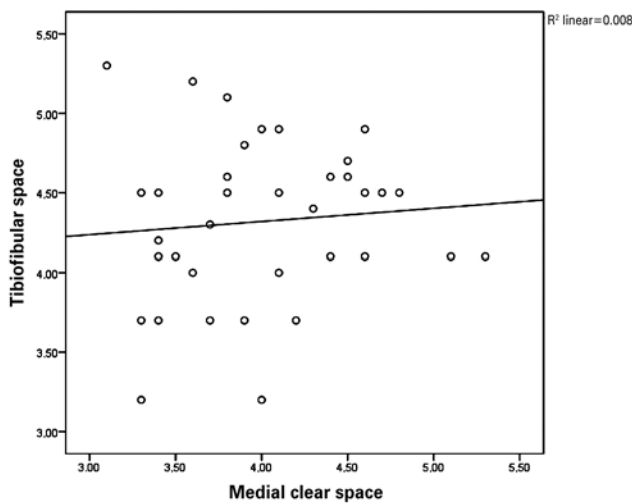


Figure 4. Tibiofibular space x medial clear space.
Source: Prepared by the author based on the results of the study.

Table 3. Data evaluated during the postoperative period.

Characteristic	Mean ± standard deviation	Minimum – maximum
Fixation height	2.2±0.6	1.2-3.3
Tibiofibular space	4.3±0.5	3.2-5.3
Contralateral tibiofibular space	4.2±0.4	3.4-5.0
Tibiofibular overlap (AP)	9.3±1.4	6.7-11.6
Contralateral tibiofibular overlap (AP)	9.0±1.6	6.0-13.2
Tibiofibular overlap (TAP)	5.3±1.6	3.0-9.2
Contralateral tibiofibular overlap (TAP)	5.7±1.6	3.4-9.0
Talocrural angle	11.0±1.8	7.2-13.8
Contralateral talocrural angle	11.4±1.7	7.6-14.0
Medial clear space	4.0±0.6	3.1-5.3
Contralateral medial clear space	3.9±0.4	3.0-4.7

All data are shown as n (%) unless otherwise specified.
Source: prepared by the author based on the results of the study.

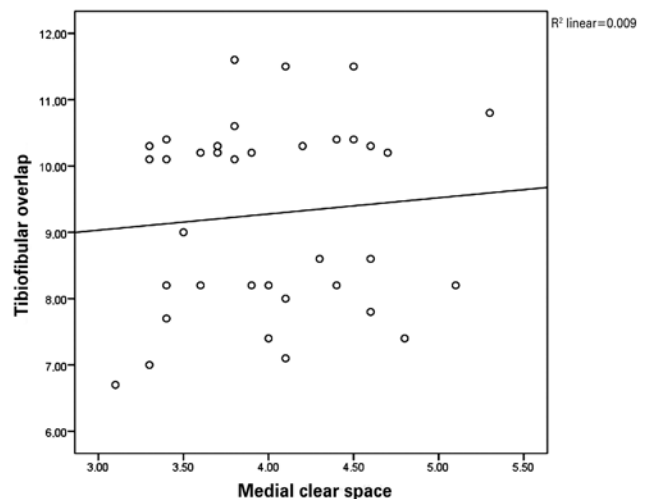


Figure 5. Tibiofibular overlap x medial clear space.
Source: Prepared by the author based on the results of the study.

It is essential to restore the distal tibiofibular syndesmosis anatomically. Since nonsurgical treatment cannot effectively stabilize the distal tibiofibular syndesmosis during the healing process, surgical fixation is often recommended. Numerous surgical techniques have been described for this stabilization; however, few studies have focused on the reduction technique, which is always the most important step before fixation.

According to Yang et al.⁽⁶⁾, the anatomic reduction and stable fixation of the syndesmosis provide favorable clinical outcomes. Direct visualization, debridement, open reduction and reconstruction of the syndesmosis are indicated in Weber type C ankle injuries to ensure a stable joint.

It is believed that internal fixation must be preceded by an open reduction technique by direct visualization to re-establish, in the most physiological manner possible, the fibular length and reconstruct the ankle mortise^(3,6).

Sakaki et al.⁽¹⁾, in a case series of 73 surgically treated malleolar fractures found that, based on the AO classification, the most frequent type was B, with 41 cases, followed by C, with 27 cases, and A, with 5 cases. The finding of 37.0% of type C fractures is important because it is a fracture of the fibula with syndesmosis injury, and the treatment is more complex than that of type B fractures, which are not always accompanied by syndesmosis injury.

According to Renström⁽²⁾, protected weight-bearing is required for approximately six weeks after surgery, when the screw must be removed. A functional rehabilitation program should be started.

In this study, 100% of the patients maintained syndesmosis fixation beyond six weeks; progressive weight-bearing occurred on the operated limb with no case of loss or breakage of the fixation.

Restoration of the anatomical bone relationships of the ankle is a difficult challenge, and malreduction often results in irregular contact pressures, which can lead to arthrosis and unfavorable clinical outcomes⁽¹³⁻¹⁶⁾.

Rigid screw fixation has become controversial, since it may contribute to syndesmosis malreduction and alteration of the dynamic relationship between the distal tibia and fibula^(15,17). More recent fixation techniques with flexible implants are reported to be less susceptible to malreduction than screw fixation⁽¹⁸⁾. Schon et al.⁽¹⁹⁾, in a comparative study of syndesmosis fixation methods, found that both a single 3.5-mm cortical screw and endobutton (TightRope®) reconstruction are equivalent for stabilization.

In this study, 36 patients (100%) had a syndesmosis stabilized by only 1 screw. Of these, 35 patients (97.2%) had

syndesmosis fixation involving 3 cortices, and only 1 (2.8%) patient had syndesmosis fixation including 4 cortices. It is believed that a fixation encompassing 3 cortices would provide a more flexible fixation (less rigid than the fixation of 4 cortices) and, therefore, would be more similar to the physiological condition before the injury.

In a biomechanical study comparing the syndesmosis fixation with one 3.5-mm cortical screw, 1 endobutton or 2 divergent endobuttons, Thomas et al. concluded that all repairs provided rotational stability comparable to the syndesmosis. However, no repair technique completely restored rotational stability or the tibiofibular anatomical relationships of the pre-injury state⁽²⁰⁾.

Zalavras et al.⁽²¹⁾ reported in a study performed in cadavers with syndesmosis fixation using 4.5-mm screws that fixation encompassing 3 cortices allows greater physiological movement. However, fixation encompassing 4 cortices would improve the stability but would not necessarily result in any difference with regard to the clinical outcome⁽²²⁾.

Thordarson et al.⁽²³⁾ concluded that the use of a 4.5-mm bioabsorbable or stainless steel screw for syndesmosis fixation in a model cadaver showed no difference regarding the fixation stiffness or risk of synthesis failure.

McBryde et al.⁽²⁴⁾, in a clinical study of the syndesmosis fixation height, found no difference in outcomes in patients who had a fixation at 2cm or at 3 to 5cm proximal to the ankle joint.

In the present study, the height of syndesmosis fixation was, on average, 2.20cm from the articular surface, which is considered to be within the universally accepted standards for such fixation.

Symeonidis et al.⁽²⁵⁾ emphasized the importance of three critical points in the management of these injuries: to suspect injury, to document the stability or instability of the syndesmosis and to reduce the fibula anatomically. Palm et al.⁽²⁶⁾ showed a higher rate of reoperation when the procedure was performed by junior surgeons.

The TCA represents the quality of fibular fracture reduction and the consequent fibular length reestablishment. Fibular fracture osteosynthesis, through an open reduction technique and internal fixation, is a determining factor for obtaining adequate parameters. It should be emphasized that exposed fractures with bone loss or comminuted fractures may increase the difficulty of obtaining an adequate reduction, which would lead to a change in the TCA⁽⁶⁾. In the present study, of the 3 patients (8.3%) who had measurements smaller than 8mm, only 1 patient diverged more than 2 to 3 degrees with the contralateral side and was the only patient not within the normal range.

Kortekangas et al.⁽²⁷⁾ performed a comparative study between two groups of patients with ankle fractures due to an external supination/rotation mechanism (Weber B), with one group with ankle fractures associated with syndesmosis injury and the other group without this injury. The incidence of ankle osteoarthritis on plain radiographs was not significantly different between the groups. After 4 to 6 years of follow-up, clinical and radiological outcomes were not different in patients with syndesmosis injury compared to patients with stable syndesmosis.

In long-term follow-up, however, chronically unstable syndesmosis increases the risk of cartilage defects in the tibia and talus^(28,29).

Shah et al.⁽³⁰⁾, in a study of 392 healthy patients for the radiographic evaluation of normal distal tibiofibular syndesmosis, concluded that the mean TFO was 8.3mm on the AP view and 3.5mm on the TAP view. The smallest overlap in the AP view was 1.8mm. On the TAP view, a subgroup of patients had a complete lack of overlap. The MCS was 4.3mm on the TAP view.

In our series, we observed a mean TFO of 9.3mm on the AP view and 5.3mm on the TAP view. The patients who presented TFO on the AP view of less than 10mm on the operated side, which could indicate reconstruction failure, also presented values less than 10mm on the contralateral side. These values suggest that, even though altered, they are consistent with the side without injury, reinforcing the affirmation that the reconstruction was adequate.

In this study, the mean MCS was 4.0mm, which is within the normal range. In absolute numbers, only 2 patients (5.5%) of 36 showed above normal values, suggesting lateral talar displacement with probable residual opening of the ankle mortise.

In a study performed by Ayllón⁽³⁾, of 120 surgically treated patients presenting a previous diagnosis of syndesmosis injury, 35 maintained open syndesmosis on radiographic evaluation during the postoperative period. The main causes for surgical syndesmosis reduction failure included lack of comprehensive knowledge of the ankle region, particularities of the injury, and lack of intraoperative evaluation of the syndesmosis.

We consider that this study fulfilled its objective regarding the examination of fractures associated with syndesmosis injuries. The results obtained, which are consistent with the literature, support the importance of adopting radiographic parameters in the initial evaluation, surgical treatment planning, and analysis of the results obtained during the postoperative period.

CONCLUSION

Many challenges exist in the management of cases of ankle fracture with syndesmosis injury. However, the adoption of objective parameters, in a standardized manner and relative to the contralateral side, adds additional value to the evaluation and ensures an accessible and reproducible method for the evaluation of these injuries.

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