

Original Article

Intraoperative comparative tests for syndesmosis: Cotton, external rotation stress, valgus, and tap-tests

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Abstract

Objective: To compare the tap-test and other intraoperative tests, such as the Cotton, external rotation stress, and valgus tests, for the evaluation and diagnosis of distal tibiofibular syndesmosis injuries. This analysis is important for improving diagnostic accuracy and, consequently, optimizing the diagnosis of these injuries, which are often underdiagnosed.

Methods: This retrospective cross-sectional study included 111 medical records of patients undergoing surgical treatment for ankle fractures at a referral hospital for orthopedic trauma between March 2023 and June 2024. During data collection, descriptive data were recorded, including trauma mechanism, age, sex, and Weber classification. Intraoperative data were also collected, including the syndesmosis test performed and the injury identification, which determined the need for surgical intervention, such as placement of an inter-tibiofibular screw.

Results: The analysis revealed that older patients had a lower prevalence of syndesmosis injuries. The trauma mechanism did not demonstrate significant statistical relevance regarding this type of injury. The tap-test showed a higher rate of intraoperative positivity and a greater proportion of intraoperative detections than Cotton's, external rotation, and valgus tests. However, no statistically significant difference was found between the tap test and other diagnostic tests.

Conclusion: The tap-test demonstrated a high intraoperative positivity rate and detection ratio, indicating its potential as a promising test for detecting syndesmosis instability.

Level of evidence IV; Retrospective study.

Keywords: Ankle fracture; Ankle joint; Intraoperative complications; Injury severity score.

Introduction

Distal tibiofibular syndesmosis (DTFS) is a complex structure vital for ankle stability, composed of the inferior anterior tibiofibular ligaments, inferior posterior tibiofibular ligaments, transverse tibiofibular ligaments, and the interosseous membrane⁽¹⁾. DTFS injuries are often associated with ankle fractures, with approximately 80% of cases presenting this association^(2,3). The most common injury mechanism involves pronation combined with external rotation, which accounts for

up to 18% of fractures⁽⁴⁾. Patients who present ankle fractures without DTFS ligament injuries tend to have a better clinical evolution compared to those who require surgical repair^(5,6).

Poor reduction was significantly correlated with poorer functional outcomes at two years post-injury, as assessed using the Selective Functional Movement Assessment (SFMA) and the Olerud-Molander Ankle Score (OMAS)⁽⁷⁾. It is also a primary indication for early reoperation, which increases the risk of postoperative infections and surgical wound complications⁽⁸⁾.

Study performed at the Hospital Maria Amélia Lins, Belo Horizonte, MG, Brazil.

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The most common complaints related to distal tibiofibular joint injuries include severe pain, limited ankle range of motion, localized edema, inability to support, and difficulties in walking⁽⁹⁾. The diagnosis of acute syndesmosis injury is based on a detailed clinical examination, complemented by imaging exams and intraoperative evaluation^(7,10). During the physical examination, it is common to observe pain on palpation in the region of the DTFS ligaments or in the proximal third of the fibula, especially in cases of high fractures, such as those classified as Weber C or Maisonneuve type^(4,5).

The main complementary diagnostic tests include simple radiography in the anteroposterior (AP), lateral, and mortise views (AP with 15° internal rotation of the leg)^(6,11). Radiographic changes, such as the opening of the medial clear space greater than 4 mm and the decrease in the overlap of the tibiofibular clear space and increase in the tibiofibular clear space, are indicative of ligament injury^(6,11). Computed axial tomography (CT) provides more detailed imaging of posterior malleolus fractures and aids assessment of the relative position of the tibia and fibula, in addition to assisting in the diagnosis of occult ankle fractures^(6,12). Magnetic resonance imaging (MRI) is considered a method with a high intraoperative positivity rate and detection ratio for examining the DTFS ligament, and it also allows evaluation of associated intra-articular injuries^(9,13). The gold standard for assessing DTFS injury is the arthroscopic measurement of the tibiofibular distance, which should be greater than 2 mm⁽¹⁴⁾.

Overall, the combination of clinical examination, plain radiography, and CT is often used to determine the need for and schedule surgical treatment of ankle fractures^(6,11). However, several tests can be performed during surgery for this purpose. During surgery, fracture reduction and DTFS stability can be evaluated using stress tests under radioscopic and direct visualization, which confirm joint congruence and stability⁽¹⁵⁻¹⁹⁾.

In the Cotton test, a distracting force is applied to the fibula with a bone hook to try to separate it from the tibia. An opposite force is applied to the tibia to try to prevent tibial movement. If the syndesmosis ligaments are intact, no significant movement between the distal tibia and fibula will be noticed. The test is positive if there is an increase or opening in the intertibial space⁽¹⁵⁾.

In the tap-test, at the syndesmosis level, a drill hole is made through both distal cortices of the fibula with a drill bit. The male is then introduced progressively, applying pressure to the near-unperforated tibial cortex, thereby opening the intertibial space. In this case, it is positive for instability⁽¹⁶⁾.

When performing the external rotation stress test, a force is applied to the medial face of the forefoot while stabilizing the hindfoot through another force applied to its lateral face. The proximal tibia should also be stabilized manually by an assistant. The ankle is held in neutral flexion at 90° between the tibia and the foot. An increase in inter-tibiofibular diastasis is a positive finding for instability⁽¹⁷⁾.

Accurate diagnosis and appropriate treatment of these injuries are fundamental, as they often require prolonged

recovery periods and complex interventions^(2,6). Inadequately treated syndesmosis ligament injuries can result in unsatisfactory outcomes in ankle fractures, leading to complications such as ligament instability, edema, chronic pain, and joint cartilage injuries, in addition to increasing the risk of recurrent sprains and degenerative diseases secondary to chronic ankle instability^(3,5).

Therefore, the objective of this study is to compare the tap-test and the other intraoperative tests, such as the Cotton, external rotation stress, and valgus tests, for the evaluation and diagnosis of DTFS at a public teaching hospital specializing in orthopedics and traumatology.

Methods

This study was approved by the Institutional Review Board, in accordance with the ethical requirements established by Resolution No. 466 of December 2012 of the National Health Council.

All patients aged 16 years or older, of both sexes, with closed physical growth plates, admitted to the public teaching hospital specializing in orthopedics and traumatology, were included in the study. The information analyzed in the medical records included age, sex, trauma mechanism (sprain, direct trauma, high-energy motorcycle accident), Weber classification, date of trauma, date of surgery, intraoperative tests performed for the syndesmosis injury, evaluation of the presence of injury in the CT performed, and the need for intervention to treat the injury.

The sample calculation was performed for a descriptive study of a dichotomous variable. The literature indicates that approximately 20% of ankle fractures present with syndesmosis injury⁽⁶⁾. To estimate the number of patients required for an analysis with a 95% confidence interval and a total confidence width of 20%, 61 patients would need to be assessed.

Data were collected from 111 patients who underwent surgical treatment for ankle fractures and met the study inclusion criteria. It was considered positive for syndesmosis injury if any of the three clinical tests were clearly positive during intraoperative radiographic assessment with an image intensifier, or if the preoperative CT showed evident widening or incongruity.

The CAT analysis was performed 1 cm above the distal tibial plateau, where measurements of the anterior, middle, and posterior tibiofibular widths were obtained⁽²⁰⁾. During intraoperative evaluation, the tests were performed as previously described in this article. Peroneal fracture fixation was performed before testing, and all three were performed in all cases.

Data were obtained from the electronic medical record system used across the hospital network and were recorded in an electronic questionnaire on the Epi Info® platform, where the database was created, and statistical analysis was performed using Fisher's exact test, Spearman's correlation, and logistic regression, adopting a p-value of 0.05 and a 95% confidence interval.

Results

Data from 111 medical records were analyzed, of which 64 were male, and 47 were female. The mean age of the patients was 39 years (SD = 13.6 years). The trauma mechanism that resulted in ankle fracture included 39 cases (35.1%) of motorcycle accidents, 59 (53.1%) due to sprain, and 13 (11.7%) due to direct trauma.

The most frequently identified fractures in the study are described in Table 1. Through Weber classification, it was possible to identify that 90 (81.0%) of the cases were classified as Weber B, 11 (9.9%) as Weber A and 10 (9.0%) as Weber C.

The mean time between the date of trauma and definitive surgical treatment was 12 days (SD = 8.39). During the intraoperative procedure, 48 (43.24%) patients presented with syndesmosis injury, whereas 63 (56.76%) did not. All patients with identified injuries underwent inter-tibiofibular screw placement. The analysis of the medical records revealed that, in 58 patients, the valgus test was performed; in 62, the external rotation test; in 26, the Cotton test; and in 22, the tap-test. Table 2 presents the tests performed for

Table 1. Prevalence of identified ankle fracture patterns

Fractures	Frequency	Percentage
Isolated lateral malleolus	27	24.32%
Isolated medial malleolus	13	11.71%
Lateral malleolus + medial malleolus	37	33.33%
Lateral malleolus + posterior malleolus	6	5.41%
Medial malleolus + posterior malleolus	1	0.90%
Lateral malleolus + medial malleolus + posterior malleolus	26	23.42%
Lateral malleolus + medial malleolus + Chaput fragment	1	0.9%

Table 2. Relationship between intraoperative tests and syndesmosis injury

Intraoperative	With injury	Without injury	Sensibility	Specificity	Fisher test (p-value)
Valgus test					
Positive	25	0	0.96	1	0.0000
Negative	1	32			
External rotation test					
Positive	27	0	0.90	1	0.0000
Negative	3	32			
Cotton test					
Positive	19	2	0.90	0.77	0.0005
Negative	2	7			
Tap-test					
Positive	19	0	1	1	0.0500
Negative	0	1			

intraoperative injury identification, showing that the tap-test showed a higher rate of intraoperative positivity and a greater proportion of intraoperative detections than the other tests. However, when correlating the tap-test with other diagnostic tests, no statistically significant association was observed (Fisher's exact test at the 95% confidence interval), as shown in Table 3.

During the statistical analysis, the results from the various intraoperative tests used to evaluate DTFS stability were compared, considering each test's intraoperative positivity rate and detection proportion.

The tap-test showed a higher rate of intraoperative positivity than Cotton's, external rotation, and valgus tests, although this difference did not reach statistical significance (Fisher's test, $p > 0.05$). This finding suggests that the tap-test may be a useful intraoperative method for identifying syndesmotic instability, even in small samples.

In addition, clinical and demographic variables were analyzed to characterize the sample and verify possible factors associated with syndesmosis injury. The ANOVA test showed a significant association between the Weber classification and the occurrence of syndesmosis injury ($p = 0.0007$), with rates of 0% in Weber A, 44% in Weber B, and 80% in Weber C (Table 4). These results are consistent with the literature, which reports greater syndesmotic impairment in fractures located above the distal tibiofibular joint.

Table 3. Correlation between the tap-test and other intraoperative tests

Tap-test and Cotton test			
Tap-test	Cotton test Positive	Cotton test Negative	Fisher test (p-value)
Positive	11	0	0.83
Negative	0	1	
Tap-test and external rotation test			
Tap-test	External rotation test Positive	External rotation test Negative	Fisher test (p-value)
Positive	10	3	0.28
Negative	0	1	
Tap-test and valgus test			
Tap-test	Valgus test Positive	Valgus test Negative	Fisher test (p-value)
Positive	8	1	0.20
Negative	0	1	

Table 4. Relationship between trauma mechanism and syndesmosis injury

Trauma mechanism	Percentage of patients with syndesmosis injury
Sprain	45.6%
Direct trauma	38.4%
Motorcycle accident	41.0%

The chi-square test (χ^2) was used to correlate sex and syndesmosis injury, resulting in a ratio of 1.02 (0.66-1.58) with $p = 0.00$ (Table 5). Because the confidence interval includes 1, this result indicates no significant difference between the groups analyzed, despite the reported p -value.

Finally, when correlating the trauma mechanism with syndesmosis injury, ANOVA yielded $p = 0.84$, indicating no statistically significant association.

Thus, variables such as age (Spearman, $p = 0.43$), sex, trauma mechanism, and Weber classification were considered descriptive and did not directly influence the comparative performance of intraoperative tests—the central focus of this study.

Discussion

Syndesmosis injuries are often associated with ankle fractures, but these injuries are often not properly diagnosed due to the lack of consensus regarding diagnostic criteria^(2,6,9). This can lead to unsatisfactory postoperative results and the development of chronic symptoms^(2,6). In this study, the epidemiological characteristics of patients who underwent surgical treatment for ankle injuries were evaluated to identify risk factors associated with syndesmosis injury. The data indicated that older patients had a lower prevalence of injuries. However, variables such as sex and trauma mechanism showed no statistically significant correlation.

The literature indicates that syndesmosis injuries are generally associated with high-energy and rotational traumas, particularly when the foot is in external rotation and dorsal flexion⁽³⁻⁶⁾.

The Weber classification, which categorizes fractures according to the height and pattern of the fibular injury in relation to the anterior syndesmosis, divides injuries into three types: A (distal to the syndesmosis), B (at the syndesmosis level), and C (proximal to the syndesmosis)⁽³⁻¹¹⁾. Syndesmotic membrane injuries are often found in type C injuries, can be observed in type B, and rarely occur in type A^(3,6). Comparing these findings with those of our study, we observe convergence with the existing evidence in the literature^(5,11).

Table 5. Logistic regression related to variables associated with syndesmosis injury

Variable	Odd ratio	Confidence interval width	p-value
Weber classification	12.25	56.1	0.0013
Trauma mechanism	0.81	1.43	0.47
Sex	1.32	3.76	0.61
Age	0.96	0.99	0.02
Fractures	0.89	1.03	0.13

A systematic review by Sman et al.⁽⁹⁾ evaluated the effectiveness of several clinical tests for detecting syndesmosis injuries, including the Cotton test and the external rotation test. The results of this review indicated a limited intraoperative positivity rate and detection ratio for these tests⁽⁹⁾. However, our study demonstrated that the intraoperative positivity rate and detection ratio of the tests were comparable, although lower than those of the valgus test and tap-test.

The results showed that the tap-test, compared with other intraoperative tests, exhibited a non-significant statistical correlation, despite its high intraoperative positivity rate and detection ratio^(10,19). However, the number of patients submitted to the test was relatively low, suggesting that a larger sample may be necessary for a more accurate assessment of the correlation between the tap-test and other intraoperative tests⁽²⁾. In a study performed on cadavers, the intraoperative positivity rates of the tap-test and Cotton test for coronal instability of the syndesmosis were 70% and 73.3%, respectively, and the intraoperative detection rates were 80% and 86.7%, which differed from the values reported in this study⁽¹⁹⁾.

Among the study limitations, it should be noted that this study was conducted at a trauma referral hospital; there may be selection bias favoring patients with more severe injuries and, consequently, a higher risk of syndesmotic injury^(2,6). There was a low frequency of intraoperative test records in the medical records, which may have affected the statistical analysis and comparisons among the tests. In addition, our study considered syndesmosis injuries only those patients positively identified by orthopedists and who did not have MRI or arthroscopy reports confirming the injury, methods recognized for their high rates of intraoperative positivity and intraoperative detection^(9,13). This may result in false-negative findings during intraoperative evaluation.

Conclusions

The results of this study reinforce the importance of systematic intraoperative evaluation of distal tibiofibular syndesmosis injuries during surgical treatment of ankle fractures. Although no statistically significant correlation was observed between the tap-test and the other intraoperative tests evaluated, the tap-test showed a high intraoperative positivity rate and detection proportion, indicating it is a promising test for detecting syndesmosis instability.

Given these findings, more stringent intraoperative documentation protocols and the routine use of standardized clinical tests to detect syndesmosis injuries are emphasized. Future studies with larger samples, standardized analysis of all tests, and diagnostic confirmation by imaging or arthroscopy are essential to validate the findings presented here and to improve the diagnostic and therapeutic approaches to these injuries.

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