ORIGINAL ARTICLE

ARTHROSCOPIC ASSESSMENT OF DISTAL TIBIOFIBULAR SYNDESMOSIS IN ANKLE FRACTURES: PREVALENCE BY WEBER TYPE

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Abstract

Introduction: Ankle fractures are common injuries, but the true extent of damage to the distal tibiofibular syndesmosis is often underestimated when only radiographs and standard stress tests are used. Arthroscopy offers a direct and dynamic view of the syndesmosis and may uncover instability that would otherwise be missed in different Danis–Weber fracture types.

Material and methods: This retrospective-prospective, single-center study included 64 adults with unstable ankle fractures treated with routine ankle arthroscopy, followed by open reduction and internal fixation. Fractures were classified as Weber A, B, or C. During arthroscopy, the distal tibiofibular syndesmosis was probed under lateral stress and categorised as stable or unstable. The prevalence of arthroscopically confirmed syndesmotic instability was calculated for the whole cohort and for each Weber type, and the association between Weber type and instability was tested with the chi-square test.

Results: Our patient cohort consisted of 16 Weber A, 29 Weber B, and 19 Weber C fractures. Syndesmotic instability confirmed arthroscopically was found in 23 of 64 patients (35.9%). Instability was present in 1/16 Weber A (6.3%), 9/29 Weber B (31.0%), and 13/19 Weber C fractures (68.4%). The prevalence of instability increased from Weber A to Weber C, and the association between fracture type and arthroscopic instability was statistically significant (χ^2, $p < 0.001$).

Conclusions: In this series of unstable ankle fractures, roughly one in three patients had an unstable distal tibiofibular syndesmosis during arthroscopic testing, with the highest rates in Weber C and intermediate in Weber B fractures. Although uncommon, instability was also seen in one Weber A fracture, showing that fibular fracture level alone does not fully exclude syndesmotic involvement. Surgeons should consider selective or routine arthroscopic evaluation of the syndesmosis, especially in Weber B and C injuries.

Keywords: *ankle fracture; arthroscopy; syndesmosis; tibiofibular joint; Weber classification.*

Introduction

Ankle fractures are among the most frequent fractures treated in orthopaedic trauma practice and are usually managed with open reduction and internal fixation (1,2). Even when fixation is technically adequate, some patients continue to complain of pain, and stiffness, thus giving way, and gradually develop post-traumatic ankle osteoarthritis (1-3). Unrecognised or insufficiently treated injury to the distal tibiofibular syndesmosis is considered one of the important reasons for such unsatisfactory outcomes (1-4).

In daily practice, the stability of the syndesmosis is commonly evaluated by standard radiographs and intraoperative stress tests (3,4). Several studies have shown that radiographic measurements such as tibiofibular overlap, tibiofibular clear space, and medial clear space have limited value, with reported sensitivities around 47–52% and only moderate agreement even among experienced observers (4-7). CT and MRI can improve detection of ligamentous injury, but conventional CT mainly reflects static diastasis and may miss milder forms of instability, while MRI, although highly accurate for identifying torn ligaments, is a non-weight-bearing, static modality that does not necessarily reflect functional tibiofibular instability (5,7–10). Intraoperative fluoroscopic stress views increase the detection rate compared with preoperative imaging, but still rely on indirect widening and side-to-side comparison and do not allow direct assessment of the tibiofibular recess (1,11,12). Arthroscopy, on the other hand, allows direct inspection of the distal tibiofibular recess and real-time observation of tibiofibular motion under stress, and is therefore often used as an intraoperative reference standard for diagnosing syndesmotic instability (1,11-13).

The Danis–Weber classification is simple and widely used, and in practice it is often considered a rough indicator of the risk of syndesmotic involvement (1,2,9). Weber C fractures are usually regarded as highly suspicious for syndesmotic injury, Weber B fractures as having an intermediate probability, and Weber A fractures as having a low probability of damaging the distal tibiofibular ligaments (1,2,9). However, the exact rate of arthroscopically confirmed syndesmotic instability in each Weber subgroup is still not well defined, particularly in consecutive series of unstable fractures treated with a uniform arthroscopy-assisted protocol (11-13,15,16).

The purpose of this study was to determine how often arthroscopic instability of the distal tibiofibular syndesmosis is present in unstable ankle fractures and how this prevalence changes across Weber A, B, and C fracture types. Our working hypothesis was that instability would be most frequent in Weber C fractures, less common in Weber B fractures, and rare, but not completely absent, in Weber A fractures.

Material and Method

Study Design

This observational study had a combined retrospective–prospective design and was conducted at a single tertiary orthopaedic trauma center between January 2021 and December 2024. Patients treated between 2021 and 2022 were identified retrospectively from institutional databases, while patients treated between 2023 and 2024 were prospectively enrolled according to predefined inclusion criteria. All procedures were performed by the same surgical team, following a uniform protocol consisting of

diagnostic ankle arthroscopy immediately, followed by open reduction and internal fixation.

Inclusion and Exclusion Criteria

Patients were eligible if they met the following criteria: age 18 years or older; acute, unstable ankle fracture with an indication for operative treatment according to AO principles; and performance of diagnostic ankle arthroscopy directly before open reduction and internal fixation. An ankle fracture was considered unstable when operative treatment was indicated according to AO principles, including bimalleolar or trimalleolar fractures, fractures associated with widening of the medial clear space suggestive of deltoid ligament incompetence, talar shift, or positive stress radiographs indicating mechanical instability.

Exclusion criteria were: heavily contaminated open fractures; previous surgery on the affected ankle; acute infection of the limb; severe soft-tissue compromise that made arthroscopy unsafe; and polytrauma that did not allow adherence to the standardised protocol.

Fracture Classification

All patients underwent standard ankle radiographs (anteroposterior, lateral and mortise views), and computed tomography was obtained in selected complex fracture patterns when considered necessary by the surgeon (1,2). Fractures were classified according to the Danis–Weber system as type A, B or C, depending on the level of the fibular fracture in relation to the syndesmosis (1,2,9).

Arthroscopic Technique and Assessment of Syndesmotic Stability

Ankle arthroscopy was performed with the patient in the supine position using standard anteromedial and anterolateral portals, without the use of distraction (11,12). After evacuation of the hematoma and minor synovectomy when needed, a systematic inspection of the joint was performed (11,17).

The distal tibiofibular syndesmosis was evaluated from the anterolateral portal. A probe was introduced into the syndesmotic region, and lateral stress was applied to the fibula while the relationship between the tibia and fibula was observed under direct arthroscopic vision (11-13,17).

For the purposes of this study, arthroscopic syndesmotic instability was defined as visible widening of the distal tibiofibular joint sufficient to allow free passage of the probe between the tibia and fibula under applied stress, and/or clear lateral translation of the fibula relative to the tibia during stress manoeuvres (11-13,17). Arthroscopic instability was assessed using a standardised probing technique. A 3-mm probe was introduced into the distal tibiofibular recess, and lateral stress was manually applied to the fibula. Instability was defined as visible widening allowing free passage of the probe between tibia and fibula under stress, and/or clear lateral translation of the fibula relative to the tibia. To ensure consistency, the assessment was performed by the senior operating surgeon in all cases.

Surgical Treatment of the Syndesmosis

Following arthroscopic evaluation, open reduction and internal fixation of the ankle fracture was performed according to AO principles, aiming to restore fibular length, rotation and alignment (1,2). When arthroscopy showed syndesmotic instability,

tibiofibular fixation with one or more cortical screws was carried out at the discretion of the operating surgeon, in accordance with the department's standard practice and current recommendations (1,2,9,10).

Outcomes and Statistical Analysis

The main outcome measure was the proportion of patients with arthroscopically unstable distal tibiofibular syndesmosis in the entire cohort and within each Weber type. Descriptive statistics were used to summarise the data as absolute numbers and percentages. The association between Weber type (A, B, C) and arthroscopic syndesmotic instability (stable vs unstable) was analysed using the chi-square test, with a significance level set at $p < 0.05$. All analyses were performed using SPSS for Windows, v. 29.0.

Results

Patient Characteristics and Fracture Distribution

A total of 64 patients met the inclusion criteria and had complete arthroscopic and radiographic data available for analysis. According to the Danis–Weber classification, 16 fractures (25.0%) were classified as type A, 29 (45.3%) as type B, and 19 (29.7%) as type C.

Overall Prevalence of Arthroscopic Syndesmotic Instability

Arthroscopic evaluation identified distal tibiofibular syndesmotic instability in 23 of 64 patients, corresponding to an overall prevalence of 35.9%.

Table 1. Arthroscopic syndesmotic instability by Weber fracture type

Weber type	*Total (n)*	*Instability n (%)*	*Stable n (%)*
A	16	1 (6.3%)	15 (93.7%)
B	29	9 (31.0%)	20 (69.0%)
C	19	13 (68.4%)	6 (31.6%)
Total	64	23 (35.9%)	41 (64.1%)

Prevalence According to Weber Type

When stratified by fracture type, the frequency of arthroscopically confirmed instability differed markedly between groups. Instability was observed in:

- 1 of 16 Weber A fractures (6.3%)
- 9 of 29 Weber B fractures (31.0%)
- 13 of 19 Weber C fractures (68.4%)

Thus, the absolute risk of instability increased progressively from Weber A to Weber C fractures (Table 1).

Association between Weber Type and Instability

Chi-square analysis demonstrated a statistically significant association between fracture type and arthroscopic syndesmotic instability (χ^2 test, $p < 0.001$).

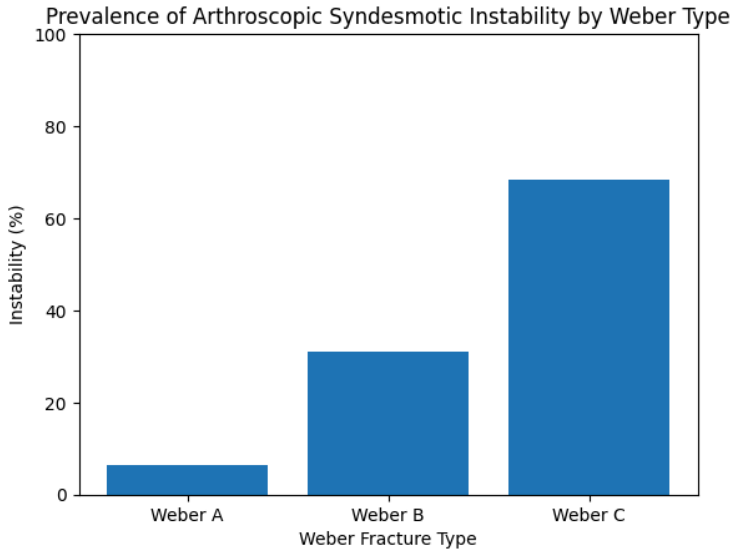

Figure 1. Arthroscopic syndesmotic instability by Weber fracture type

Effect Size (Odds Ratio Analysis)

Odds ratio analysis revealed a stepwise increase in the likelihood of instability across Weber categories.

Compared with Weber A fractures, Weber B fractures had approximately 6.8-fold higher odds of arthroscopic instability. Weber C fractures demonstrated more than 30-fold higher odds of instability. Furthermore, Weber C fractures had nearly 5-fold higher odds of instability compared with Weber B fractures.

Table 2. Odds ratios for arthroscopic syndesmotic instability

Comparison	***Odds Ratio (OR)***
Weber B vs A	6.75
Weber C vs A	32.5
Weber C vs B	4.8

Discussion

The principal finding of this study is that arthroscopic examination identified syndesmotic instability in more than one-third of surgically treated unstable ankle fractures. Importantly, the probability of instability increased progressively across Weber types, suggesting a biological gradient between fracture level and syndesmotic disruption.

These results support the widely held view that suprasyndesmotic fractures carry the highest risk of syndesmotic damage, but they also show that a substantial proportion of transsyndesmotic Weber B fractures harbour clinically relevant instability when assessed arthroscopically (1,11,13,14,17). Previous studies have reported that standard radiographs and intraoperative stress tests can underestimate syndesmotic injury, especially in Weber B patterns, and that arthroscopy may reveal additional cases of instability (11-16,17). Radiographic parameters such as tibiofibular overlap and clear space are strongly influenced by ankle rotation and projection, and correlate poorly with

the true extent of syndesmotic damage on MRI, with reported sensitivities around 47–52% in some series (4-6). CT allows better visualization of bony detail and can detect diastasis more reliably than plain radiographs, however, conventional static CT and even weight-bearing CT have shown limited ability to distinguish between stable and unstable syndesmotic injuries (5,7–10). MRI is highly accurate for identifying torn ligaments, yet it provides a static, non-weight-bearing snapshot and does not capture dynamic instability under load (5,7-10). Intraoperative fluoroscopic stress views increase the detection rate compared with preoperative imaging, but still rely on indirect widening and side-to-side comparison and do not allow direct assessment of the tibiofibular recess. By contrast, arthroscopy directly visualises diastasis and translation during stress manoeuvres (4,8,12). Our series adds to this body of evidence by quantifying the prevalence of arthroscopically confirmed instability in a consecutive group of unstable fractures stratified by Weber type (1,11-13,15-17).

Although Weber A fractures are considered infrasyndesmotic and generally thought to spare the distal tibiofibular ligaments, arthroscopy identified instability in one patient in this subgroup (6.3%) (1,14,15). This low, but non-zero, rate suggests that syndesmotic involvement in Weber A fractures is possible, particularly in higher-energy injuries or in the presence of associated ligamentous damage (1-3). From a practical point of view, this means that a Weber A label alone should not lead to an automatic assumption of a completely normal syndesmosis.

The very high prevalence of instability in Weber C fractures (68.4%) observed in this study is consistent with earlier reports and underlines that such injuries should be approached with a strong suspicion of syndesmotic disruption (1,2,9). In this setting, arthroscopy can be helpful not only to confirm the indication for syndesmotic fixation, but also to assess reduction and stability after fixation (1,2,11-13,17).

From a clinical standpoint, these findings indicate that fracture level according to the Danis–Weber classification should be regarded as a risk indicator rather than a definitive determinant of syndesmotic integrity. Although Weber C fractures showed the highest prevalence of instability, nearly one third of Weber B fractures demonstrated arthroscopic instability, suggesting that reliance solely on fracture classification may lead to underdiagnosis in this subgroup. Therefore, additional intraoperative assessment beyond standard fluoroscopic stress testing may be warranted, particularly in Weber B injuries. Even in Weber A fractures, the presence of occasional instability underscores the importance of considering the overall injury pattern rather than fracture level alone when deciding on syndesmotic exploration and fixation.

This study has limitations. It is a single-center series with a relatively small sample size, which may limit the generalisability of the results. Only unstable fractures treated operatively with arthroscopy were included, so the findings cannot be directly extrapolated to all ankle fractures, including stable or non-operatively managed cases. Furthermore, the analysis focused on the binary outcome of stable versus unstable syndesmosis and did not address more detailed patterns of ligamentous injury, imaging correlations or long-term functional results.

Despite these limitations, the strengths of this study include the use of arthroscopy as an intraoperative reference for syndesmotic stability, and explicit stratification by Weber type in a consecutive cohort of unstable fractures.

Conclusion

In a retrospective - prospective series of 64 unstable rotational ankle fractures, arthroscopic examination showed distal tibiofibular syndesmotic instability in 35.9% of patients. The prevalence increased clearly from Weber A to Weber C fractures, with instability being rare in Weber A, present in approximately one third of Weber B, and common in more than two thirds of Weber C injuries. These findings indicate that fracture level according to the Danis–Weber classification is related to the risk of syndesmotic instability but does not fully replace direct intraoperative assessment. Selective or routine arthroscopic evaluation of the syndesmosis, particularly in Weber B and C fractures, may improve decision-making regarding syndesmotic stabilisation.

Ethical Approval: The research protocol was reviewed and approved by the Ethics Committee for Research Involving Human Subjects of the Faculty of Medicine - Skopje, Ss. Cyril and Methodius University, approval number 03-391/2, 09.02.2022.

Consent for publication: Written informed consent was obtained from all patients prior to inclusion in the study.

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