ORIGINAL ARTICLE

Arthroscopically assisted reduction of ankle syndesmotic injuries associated with malleolar fractures: Our experience

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ABSTRACT

Background and aim of the work: Malleolar fractures are associated with syndesmotic lesions in up to 40% of cases. Accurate reduction and stabilization of the syndesmosis is crucial to prevent chronic instability, persistent pain and post-traumatic osteoarthritis. Ankle arthroscopy allows direct three-dimensional visualization of the distal tibiofibular joint and might improve the accuracy of reduction. The aim of this study was to evaluate the effectiveness of arthroscopically assisted reduction and fixation in ankle fractures with syndesmosis disruption.
Research design and Methods: Prospective monocentric case–control study including 48 patients with AO/OTA 44B–44C malleolar fractures associated with syndesmotic injury. Group A (n=24) underwent arthroscopically assisted reduction and fixation; Group B (n=24) received conventional reduction and fixation. At a mean follow-up of 30 months, clinical outcomes (AOFAS, OMAS, VAS), specific syndesmotic tests (Squeeze test, External Rotation Stress Test, Cotton test, anterior tibiofibular tenderness) and CT-based measurements (tibio-fibular clear space, fibular rotation angle) were assessed. Non-parametric statistics were applied.
Results: Significantly higher functional scores were recorded in Group A (AOFAS 91.7±9.9 vs 81.8±14.2, p=0.016; OMAS 86.0±14.2 vs 70.6±20.7, p=0.0019) and a significantly lower difference in fibular rotation angle compared with the contralateral ankle (2.71°±3.44 vs 7.41°±4.80, p<0.001). The Squeeze test was positive in 12.5% of Group A vs 45.8% of Group B (p=0.029).
Conclusions: Arthroscopically assisted surgery is associated with more accurate anatomical and rotational reduction and significantly better functional outcomes at mid-term follow-up. Arthroscopy represents

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a valuable adjunct in the surgical management of ankle fractures associated with syndesmotic injury. (www.actabiomedica.it)

Key words: malleolar fractures, syndesmosis, arthroscopy, arthroscopically assisted reduction, computed tomography

Introduction

Ankle fractures account for approximately 10% of all fractures and represent one of the most common traumatic injuries of the lower limb. A distal tibiofibular syndesmotic lesion is associated in up to 40% of these fractures and is recognized as an important negative prognostic factor when not adequately treated (1,2). The syndesmosis plays a key role in maintaining the congruence of the ankle mortise and in distributing load during gait; even small malreductions can lead to altered joint biomechanics, chronic instability, persistent pain and early post-traumatic osteoarthritis (3-7). Conventional open reduction and internal fixation (ORIF) remains the standard treatment for unstable malleolar fractures with syndesmotic involvement. Assessment of syndesmotic reduction and stability is usually based on radiographic measurements and intraoperative fluoroscopic guided stress tests. However, several studies have shown that radiographic evaluation may fail to detect subtle malreductions, particularly in the axial plane, and reported rates of syndesmotic malreduction up to 30–50% when no direct visualization is used (8-11). Ankle arthroscopy enables direct inspection of the tibiotalar joint, the distal tibiofibular space and the articular surfaces, allowing both diagnosis and treatment of associated chondral lesions, removal of loose bodies and dynamic assessment of syndesmotic stability (12-14). Arthroscopically assisted reduction of the syndesmosis (ARIF) has been proposed to improve the accuracy of reduction and to decrease the risk of residual diastasis or malrotation (15-20). Despite growing interest, high-quality prospective data comparing arthroscopically assisted and conventional techniques in malleolar fractures with syndesmotic injury remain limited, and no clear guidelines currently recommend routine use of arthroscopy in this setting. The aim of the present prospective monocentric case–control study was to evaluate the effectiveness of arthroscopically assisted reduction and fixation of the syndesmosis in AO/OTA 44B–44C malleolar fractures, compared with conventional ORIF without arthroscopy, using standardized CT measurements and validated clinical outcome scores at mid-term follow-up.

Patients and Methods

Study design and setting

This was a prospective observational case–control monocentric study conducted at the Orthopedic and Traumatology Department of Santa Maria Hospital, Borgo Val di Taro (Italy). This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee at Parma University, Italy (195/2024/OSS/AUSLPR). All participants provided informed consent prior to participating in the study, after explanation of its anonymous nature. Patients were consecutively enrolled between January 2021 and December 2023 and allocated in an alternated assignment way in the two treatment groups according to the use of intraoperative ankle arthroscopy (Group A) or conventional ORIF alone (Group B).

Eligibility criteria

Patients were identified from the institutional surgical database using ICD-9-CM codes for ankle fractures (824.0–824.9).

Inclusion criteria were: age ≥18 and ≤ 55 years, closed malleolar fracture classified as AO/OTA 44B or 44C (Figure 1), intraoperative evidence of distal

Figure 1. AO/OTA 44B (A) and AO/OTA 44C (B) malleolar fracture.

tibiofibular syndesmotic injury requiring stabilization, treatment with ORIF, with or without arthroscopic assistance, minimum clinical and radiological follow-up of 12 months, ability to provide informed consent.

Exclusion criteria were: age <18 AND > 55 years, previous fracture or surgery on either ankle, pre-existing ankle osteoarthritis, prior syndesmotic instability, bilateral ankle fractures, cognitive impairment precluding informed consent or adherence to follow-up, pregnancy or suspected pregnancy, refusal to participate.

After application of inclusion and exclusion criteria, 48 patients were finally enrolled (24 per group).

Group A (arthroscopy-assisted) comprised 15 females and 9 males; Group B (conventional ORIF) comprised 13 females and 11 males.

Surgical techniques

All procedures were performed by experienced foot and ankle surgeons using standardized techniques.

In both groups, fractures were reduced and stabilized using plates and screws according to fracture morphology. Syndesmotic stabilization was achieved with tricortical 3.5-mm fully threaded titanium screws placed 1.5–4 cm proximal to the tibial plafond, directed approximately 30° from posterior to anterior and parallel to the ankle joint line. Provisional syndesmotic reduction was obtained using a Kirschner wire before definitive screw insertion.

Group A (arthroscopy-assisted): In Group A, standard anteromedial and anterolateral portals were used for ankle arthroscopy. Before syndesmotic stabilization, the distal tibiofibular joint was directly visualized and probed using a shaver inserted between tibia and fibula to assess instability and diastasis (Figure 2). After provisional reduction with a Kirschner wire and placement of the syndesmotic screw, the distal tibiofibular joint was again inspected arthroscopically to confirm the accuracy of reduction and absence of residual diastasis or malrotation, as described in previous arthroscopic studies (12-14). Associated intra-articular lesions (e.g. chondral defects, loose bodies) were documented and treated as appropriate.

Group B (conventional ORIF): In Group B, reduction and stability of the distal tibiofibular syndesmosis were assessed intraoperatively using fluoroscopy and standard stress maneuvers. The final position of the fibula within the incisura fibularis and the tibio-fibular clear space were evaluated on anteroposterior and lateral projections using an image intensifier.

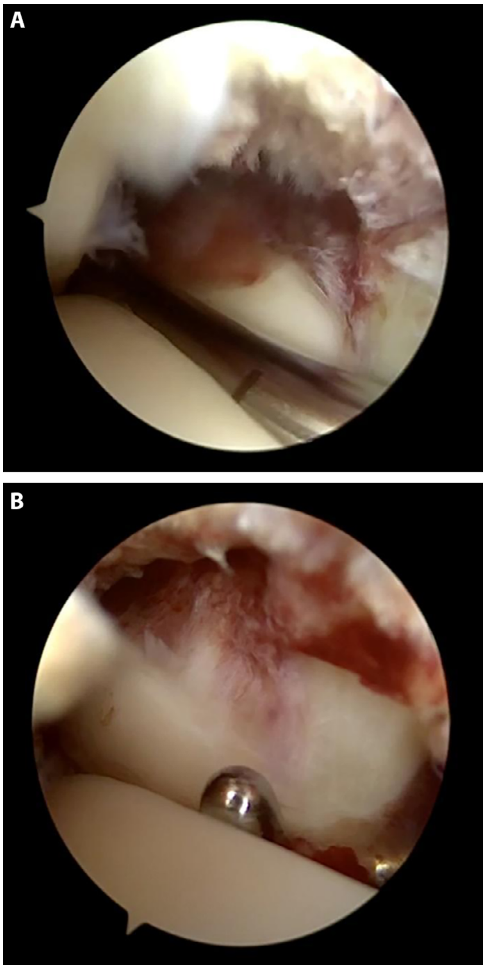

Figure 2. Arthroscopic evaluation of the syndesmosis before (A) and after (B) stabilization.

Postoperative management and rehabilitation protocols were comparable in the two groups. No type of ankle immobilization was applied in the postoperative period. Assisted active and passive rehabilitation without weight bearing started immediately after surgery. Partial and protected weight bearing with crutches started one month after surgery, following the execution of x-rays. Progressively increasing weight bearing was permitted 2 months after surgery. Full load was allowed at 3 months. Removal of the syndesmotic screw under local anesthesia was performed in selected patients in case of screw mobilization or clinically relevant limitation of dorsiflexion at follow-up.

Clinical evaluation

All patients underwent standardized clinical evaluation at follow-up (minimum 12 months, mean 30 months; range 12–52 months). Functional outcome was assessed using (6,7):

- *American Orthopedic Foot and Ankle Society – Ankle Hindfoot Scale (AOFAS-AHS),* which considers pain, function and alignment (0–100, higher scores indicate better function);
- *Olerud-Molander Ankle Score (OMAS)*, based on nine items including pain, stiffness, swelling, stair climbing, running, jumping, squatting, support and work/activities (0–100, higher scores indicate better function);
- *Visual Analogue Scale (VAS)* for pain (0–10, 0=no pain, 10=worst pain imaginable).
- Syndesmotic-specific clinical tests were systematically performed (10-11):
- Squeeze test;
- External Rotation Stress Test;
- Cotton test;
- pain and/or tenderness on palpation of the anterior tibiofibular region.

Test results were recorded as positive or negative.

Radiological evaluation

Bilateral ankle CT scans were obtained at follow-up. Standardized axial slices at 1 cm proximal to the tibial plafond were used to measure:

- *Tibio-fibular clear space (TFCS):* distance between a line tangential to the most medial point of the fibula and a line tangential to the most medial point of the tibial incisura (Figure 3A);
- *Fibular rotation angle (FRA):* angle between a line connecting the anterior and posterior tibial tubercles and a line along the longitudinal axis of the fibula (Figure 3B).

Measurements were performed for both the operated and contralateral healthy ankles, and the difference between sides was used as the main radiological parameter for comparison between groups.

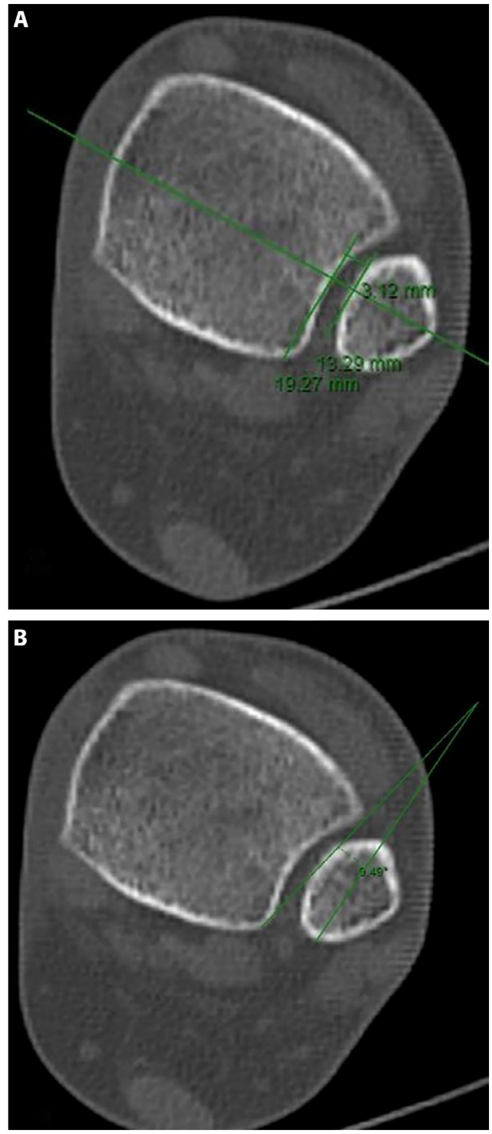

Figure 3. Tibio-fibular clear space (TFCS) (A) and fibular rotation angle (FRA) (B). CT scan evaluation.

Statistical analysis

Continuous variables (AOFAS, OMAS, VAS, TFCS, FRA) were summarized as mean ± standard deviation, median, interquartile range and range. Normality of distributions was assessed with the

Shapiro–Wilk test, which revealed deviations from Gaussian distribution in several variables.

Therefore, non-parametric tests were applied:

- Wilcoxon signed-rank test for paired comparisons (operated vs contralateral ankle within each group);
- Mann–Whitney U test for independent comparisons between Group A and Group B (differences in TFCS, FRA, VAS, AOFAS, OMAS).

Categorical variables (positivity of clinical tests) were expressed as absolute numbers and percentages and compared between groups using the chi-square test or Fisher's exact test when appropriate.

Statistical significance was set at $P < 0.05$ (two-tailed). Exact P-values are reported.

Results

Functional outcomes

AOFAS-AHS scores were significantly higher in Group A compared with Group B. Group A achieved a mean AOFAS score of 91.7±9.9 (range 88–100), whereas Group B showed a mean of 81.8±14.2 (range 71–90); the difference was statistically significant ($P = 0.016$). Similarly, OMAS scores favored the arthroscopy-assisted group. Group A had a mean OMAS of 86.0±14.2 (range 80–95), compared with 70.6±20.7 (range 55–86) in Group B ($P = 0.0019$). Overall, both groups achieved good to excellent functional results, but the distribution of scores was more homogeneous and shifted toward higher values in the arthroscopy-assisted group.

Radiological outcomes

When comparing treated and healthy contralateral ankles, the difference in tibio-fibular clear space (TFCS) was similar between the two groups. Group A showed a mean TFCS difference of 1.33±1.30 mm (range 0.40–1.71 mm), while Group B had a mean difference of 1.15±0.74 mm (range 0.62–1.49 mm). The between-group comparison did not reveal a statistically significant difference ($P = 0.90$). By contrast, data about fibular rotation angle (FRA) were markedly different between the groups. In Group B (conventional ORIF), the mean FRA difference between treated and contralateral ankle was 7.41±4.80° (range 3.52–12.07°), indicating a relevant residual malrotation of the fibula. In Group A (arthroscopy-assisted), the mean FRA difference was 2.71±3.44° (range 0.61–2.77°). This difference between groups was highly significant ($P < 0.001$), demonstrating a more accurate rotational reduction of the fibula within the tibial incisura when arthroscopy was used.

Clinical syndesmotic tests

The Squeeze test was positive in 3/24 patients (12.5%) in Group A and in 11/24 patients (45.8%) in Group B. This difference was statistically significant ($P = 0.029$), suggesting less residual syndesmotic irritation or instability in the arthroscopy-assisted group. The External Rotation Stress Test was positive in 2/24 patients (8.3%) in Group A and 5/24 (20.8%) in Group B. Although the proportion was numerically higher in Group B, the difference did not reach statistical significance ($P = 0.417$). Anterior tibiofibular tenderness was reported in 10/24 patients (41.7%) in Group A and 12/24 (50.0%) in Group B ($P = 0.57$), indicating a non-significant trend toward greater residual discomfort in the conventional ORIF group. The Cotton test was positive in 1/24 patients (4.2%) in Group A and 3/24 (12.5%) in Group B ($P = 0.61$).

Pain

Mean VAS scores at follow-up were low in both groups, reflecting minimal residual pain. Group B reported slightly higher pain levels (1.75±1.80, range 0–6) compared with Group A (0.88±1.48, range 0–5), but this difference did not achieve statistical significance ($P = 0.078$).

Conclusions

Ankle fractures account for approximately 10% of all fractures and represent one of the most common traumatic injuries of the lower limb. Up to 40% of all ankle fractures have concomitant syndesmotic disruption and resultant instability. Disruption of the syndesmosis or of the deltoid ligament may compromise the ultimate clinical outcome, particularly if the talus is allowed to subluxate with respect to the tibia (1,2). Surgical intervention aims to obtain an anatomic reduction of the ankle, preserve normal contact forces at the tibiotalar joint, and reduce the risk of post-traumatic arthritis. Historically, rigid fixation under fluoroscopic control with trans-syndesmotic screw with as-needed deltoid ligament repair was the gold-standard for treatment of syndesmotic injury. A precise syndesmotic reduction is difficult to obtain with mini-fluoroscopy or C-arm fluoroscopy alone (8-12). With the increased use of ankle arthroscopy, the role of this technique in the treatment of acute ankle fractures is becoming more appreciated as it enables for better visualization of syndesmotic lesions with direct evaluation of ligamentous stability. Furthermore, ankle arthroscopy allows for visualization of the tibial and talar articular surfaces for diagnosis and treatment of osteochondral defects, loose bodies, or additional ligamentous injury (12-14). In this prospective monocentric case-control study, arthroscopically assisted reduction and fixation of the distal tibiofibular syndesmosis in malleolar fractures (AO/OTA 44B-44C) demonstrated clear clinical and radiological advantages over conventional ORIF. Patients treated with arthroscopic assistance achieved significantly higher AOFAS and OMAS scores, indicating a more homogeneous and functionally superior recovery. These findings are consistent with data reported in recent systematic reviews and meta-analyses, which highlighted improved outcomes and comparable complication rates in arthroscopy-assisted procedures (15,17). Radiologically, while tibio-fibular clear space (TFCS) differences were similar between groups, fibular rotation angle (FRA) showed marked discrepancies. The significantly greater residual malrotation observed in the conventional ORIF group aligns with evidence from and Lepojärvi et al. (8), who emphasized that subtle rotational malreductions often escape detection on standard fluoroscopy but strongly correlate with impaired function and long-term joint degeneration. Conversely, the much smaller FRA differences in the arthroscopy-assisted group suggest that direct intra-articular visualization facilitates more precise anatomical and rotational reduction, as previously suggested by Warner et al. (7) and van Dijk et al. (2). Clinical assessment supported these observations. The significantly lower proportion of positive Squeeze tests in the arthroscopy group mirrors reports of its high specificity but limited sensitivity (10). Pain levels (VAS) were low across both groups, with a slight non-significant trend toward less pain in the arthroscopy cohort; a finding in line with studies showing that differences in pain may emerge predominantly in long-term analyses or larger samples (15). Overall, these results reinforce the concept that arthroscopy constitutes a valuable adjunct in the management of malleolar fractures with syndesmotic injury. By allowing direct visualization of the incisura tibialis, dynamic testing of syndesmotic stability and detection of associated intra-articular lesions (11-14), arthroscopy reduces the likelihood of unrecognized malreductions, particularly rotational discrepancies, which have been repeatedly associated with inferior clinical outcomes (17). This study presents some limitations, including its monocentric design, moderate sample size and mid-term follow-up, which does not allow definitive conclusions regarding long-term osteoarthritic evolution. The absence of advanced dynamic imaging modalities (e.g., weightbearing CT or functional gait analysis) may also limit the detection of subtle malreductions under load. Nevertheless, the coherence of clinical, functional and radiological results, combined with the strong literature support, underscores the value of arthroscopically assisted techniques in achieving more anatomical reductions and improved outcomes. Future multicenter prospective trials with larger cohorts and extended follow-up are needed to confirm these findings and clarify the potential role of arthroscopy in mitigating the development of early post-traumatic osteoarthritis. Based on good results observed in this study and in literature Authors are confident that routine integration of arthroscopy into surgical protocols for malleolar fractures with syndesmotic involvement may represent a meaningful shift toward more accurate, personalized and function-oriented ankle trauma care.

Conflicts of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.)

that might pose a conflict of interest in connection with the submitted article.

Author's Contribution: Authors were responsible for the study's conception and design, data collection, statistical analysis, interpretation of findings, and manuscript writing and revision. Authors approved the final version of the manuscript.

Data Availability: All data supporting the findings of this study are available from the author upon reasonable request and approval of the ethical committee.

Ethics Approval: This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee at Parma University, Italy (195/2024/OSS/AUSLPR).

Consent for Participation: All participants provided informed consent prior to participating in the study, after explanation of its anonymous nature; thus, no personally identifiable data will be collected.

Declaration on the Use of AI: Authors declare that AI was not used.

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