One-screw versus two-screw fixation of syndesmosis in bimalleolar ankle fractures associated with syndesmotic injury

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Recommended Citation
DOI: https://doi.org/10.4103/mmj.mmj_88_22

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Introduction

Ankle fractures are one of the most common lower extremity injuries. Ankle fractures can be classified by the Danis–Weber classification, which describes the injury based on the location of the lateral malleolar fracture. Fractures may be classified as A, B, or C with a fracture below, at the level of, or above the syndesmosis, respectively [1]. In addition to treating the fracture itself, it is important to assess the integrity of the ankle syndesmosis as the anatomic relationship between the distal tibia and fibula is critical for maintaining ankle stability and force transmission to the talus [2]. The syndesmosis is a fibrous joint composed of the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, the transverse ligament, and the interosseous tibiofibular ligament. Together, these ligaments maintain the stability between the distal tibia and fibula, thereby providing a deep mortise joint for articulation with the talus. The posterior inferior tibiofibular ligament gives 42% of resistance strength, compared with 35% for the anterior inferior tibiofibular ligament and 22% for the interosseous tibiofibular ligament. When these ligaments are ruptured in a severe high ankle sprain, the distal fibula migrates and can no longer provide a stable lateral buttress for the ankle mortise. If left untreated, patients with this injury may develop chronic pain, instability, and eventually degenerative joint disease of the tibiotalar joint [3]. Syndesmosis integrity and quality of reduction can be assessed using plain radiograph by assessment of the tibiofibular relationship: anteroposterior tibiofibular clear space (TCS) of less than 6 mm, anteroposterior tibiofibular overlap (TFO) greater than 6 mm, mortise TFO greater than 1 mm, and medial clear space (MCS) of less than 5 mm. Any incongruities in any of these parameters is to be judged malreduction [4].

Background

Syndesmotic injuries are common at ankle fractures and there are many modalities for the treatment of such injuries.

Objectives

To compare clinical and radiological results of closed reduction and fixation of syndesmotic injury by a single tricortical screw and two tricortical screws in the case of bimalleolar ankle fractures associated with syndesmotic injury.

Patients and methods

A prospective randomized study was carried out on 30 patients with bimalleolar ankle fracture associated with syndesmotic injury, who attended the Menoufia University Hospital.

Results

The ankle affected in group A shows that seven (46.7%) had the ankle affected in the left side and eight (53.3%) had the ankle affected in the right side while in group B six (40.0%) had the ankle affected in the left side and nine (60.0%) had the ankle affected in the right side.

Conclusion

There was no significant difference regarding the use of one screw or two screws in the fixation of syndesmotic injury in ankle fractures.

Keywords:

ankle fracture, anterior inferior tibiofibular ligament, syndesmosis, syndesmotic injury, syndesmotic screw
this study to compare between applications of one screw versus two screws in the fixation of syndesmotic injury. So, this study aimed to compare clinical and radiological results of closed reduction and fixation of syndesmotic injury by a single tricortical screw and two tricortical screws in the case of bimalleolar ankle fractures associated with syndesmotic injury.

Patients and methods
A prospective randomized study was conducted on 30 patients with bimalleolar ankle fracture associated with syndesmotic injury, who attended the Menoufia University Hospital.

All patients were randomized into two groups using a computerized random-number generator by simple odd–even number randomization technique. All patients got a serial number starting from 1. The first case was allocated into group A, and then all odd serial numbers were included in group A and even serial number in group B. A total of 30 patients with bimalleolar ankle fracture associated with syndesmotic injury was encountered in this study and was categorized randomly into two equal groups at a ratio of 1:1: group A included 15 patients to be fixed by one tricortical 3.5 cancellous screws and group B included 15 patients be fixed by two tricortical 3.5 cancellous screws. The patients were given verbal and written information regarding the ERAS protocol and a signed consent was taken.

Ethical consideration
The study was approved by the Ethics Committee of the Faculty of Medicine, Menoufia University. A written informed consent was obtained from either patient after simple and clear explanation of the research objectives. The consent form was developed according to the standard of Quality and Improvement System in Ministry of Health in Egypt.

Inclusion criteria
Included both sexes patients aged from 20 to 60 years, who had bimalleolar ankle fracture associated with syndesmotic injury without arthritis. Also included were those with closed fractures and patients without general comorbidities [diabetes mellitus (DM), Alzheimer, previous ipsilateral ankle procedures, associated fracture at the same leg] were excluded.

All patients included in the study were subjected to the following: detailed history taking included patients' age and sex, occupation, ankle affected, time of trauma, mood of trauma, medical comorbidities such as DM, rheumatoid, etc., and past history of previous operative procedure of the ankle of interest. General examination such as blood pressure, pulse, cardiovascular, neurological, and respiration assessment to exclude other injuries, lumbar spine pathology, ipsilateral hip, ankle pathology, and medical disorders. Local examination such as inspection for deformity, edema, skin condition, wounds, palpation: for tenderness, range of motion, and neurovascular examination with examination of the dorsalis pedis artery, posterior tibial artery, common peroneal nerve, and posterior tibial nerve. Radiological investigations included plain radiograph anteroposterior, lateral, and mortise views by assessment of tibiofibular relationship: anteroposterior TCS of less than 6 mm, anteroposterior TFO of greater than 6 mm, mortise TFO greater than 1 mm, and MCS of less than 5 mm. Any incongruities in any above-mentioned parameters were to be judged syndesmotic injury. Laboratory investigations included liver function tests (aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, serum bilirubin, and serum albumin were tested by Bio Systems A25, C/Costa Brava 3008030 Barcelona (Spain), Prothrombin time and international normalized ratio were tested by STA Compact Max, STAGO, France, complete blood count was done by automated hematology analyzer (CELL-DYN Emerald, Germany), HBsAg and HCV Ab were tested by enzyme-linked immunosorbent assay kit (BioKit, Spain). Also, ECG and echocardiography were performed if indicated.

Preparation for surgery
All patients were informed about their fracture, the chosen treatment modalities, operative technique, expected outcomes, and possible complications and their consent was taken. Time of operation: after subsidence of edema. Blood: 1 U of packed red blood cells was reserved for the case before the operation. Medications: analgesics, anti-edematous, and anticoagulant drugs. Laboratory investigations: to evaluate patient fitness for operative intervention: complete blood count, random blood sugar, liver function tests, kidney function tests, bleeding, and coagulation profile.

Operative technique
Patient positioning: supine position, prophylactic antibiotics: first-generation cephalosporins for all cases
of the study; anesthesia: spinal anesthesia or general anesthesia according to the general condition of the patient; tourniquet: was applied for all cases and sterilization and draping (Fig. 1a).

**Lateral malleolus fixation**
Reflection of the periosteum, removal of debris at the fracture site, reduction of the fracture using small pointed reduction forceps, and fixation using plate and screws (Fig. 1b) were performed.

**Medial malleolus fixation**
Standard medial incision distal to the anterior tip of the medial malleolus curving toward the anterior edge of the medial malleolus and in the direction of the middle of distal tibia and fixation using lag screws or tension band (Fig. 1c). Assessment of stability of syndesmosis was done by a stress test using hook. Reduction of syndesmosis was done using a large pointed clamp with the foot in maximum dorsiflexion under image.

**Syndesmosis fixation**
Using the 2.5 mm drill bit in the double drill sleeve end, 2.5 mm hole was drilled on both cortices of the fibula and one of the tibia. A 3.5 mm tap is applied across the lateral tibial surface, while the fibula is held in firm reduction. This screw was placed either through the fibula or through one of the holes in the fibular plate. The screw should be parallel to the joint to avoid displacement of the fibula in an inferior or superior direction (use fluoroscopy). Group A was fixed using one tricortical 3.5 cancellous screw. Group B was fixed using two tricortical 3.5 cancellous screws. C-arm to check reduction by assessment of tibiofibular relationship: anteroposterior TCS less than 6 mm, anteroposterior TFO greater than 6 mm, mortise TFO greater than 1 mm, and MCS less than 5 mm. Any incongruities in any of the above-mentioned parameters were to be judged malreduction (Fig. 1d).

**Postoperative care**
NSAIDs, antibiotics: intravenous first-generation cephalosporins for 3 days followed by oral amoxicillin-clavulanic acid for 10 days, nonweight-bearing and plain radiograph anteroposterior, lateral and mortise views. Postoperative follow-up: patients were to be followed up at 1, 2, 4, 6, and 12 weeks postoperatively for removal of stitches and evaluation of union, compliance with postoperative rehabilitation and complications detection and management, oral anticoagulants, removal of stitches 2 weeks after surgery, and removal of syndesmotic screw/screws 8 weeks after surgery in the operation room. Postoperative evaluation: radiological evaluation: plain radiograph after fixation surgery and after syndesmotic screw removal and computed tomography scan after syndesmotic screw removal (Fig. 2). Clinical evaluation: using Olerud Molander functional score 3 months after fixation surgery. Olerud Molander functional score: it is a functional scoring system after ankle surgery. It consists of nine items: pain (25 points), stiffness (10 points), swelling (10 points), stair climbing (10 points), running (five points), jumping (five points), squatting (five points), support (10 points), and work (20 points) [6]. In the current study, excellent and good results are to be considered satisfying outcomes while fair and poor results are considered to be unsatisfying outcomes.

**Statistical analysis**
Results were collected, tabulated, and statistically analyzed using SPSS software, and the chi-square test was used to compare the results. The results were statistically significant at p ≤ 0.05.

![Figure 1](image1.png)
(a) Sterilization and free limb draping. (b) Fixation of lateral malleolus through the lateral approach. (c) Fixation of medial malleolus through medial incision. (d) C-arm to check syndesmosis reduction and fixation.

![Figure 2](image2.png)
Postoperative evaluation: radiological evaluation: plain radiograph after fixation (a and b) surgery and after syndesmotic screw removal and (c) computed tomography scan after syndesmotic screw removal (d).
analyzed by IBM personal computer and statistical package SPSS, version 23 (IBM Corp., Armonk, New York, USA). Descriptive statistics included percentage, mean, and SD and analytic statistics included χ² test and Student’s t test. P value less than 0.05 was considered statistically significant.

Results
In the current study, age of the patients in group A ranged from 23 to 59 years with mean 37.47 ± 11.59 years, while in group B it ranged from 21 to 60 years with a mean of 40.27 ± 12.68 years. There were no statistically significant differences between the studied groups regarding their age with P = 0.533 (Table 1).

Regarding the mode of trauma, eight (53.3%) patients of group A had accident, three (20.0%) patients falling from a height and four (26.7%) patients were twisting. While in group B nine (60.0%) patients had accident, five (33.3%) patients falling from a height, and one (6.7%) patient was twisting. There were no statistically significant differences between groups with P = 0.307. Regarding symptoms, nine (60.0%) patients in group A had deformity, eight (53.3%) patients had edema, and eight (53.3%) patients had tenderness. While in group B 10 (66.7%) patients had deformity, six (40.0%) patients had edema, and five (33.3%) patients had tenderness. There were no statistically significant differences between the studied groups regarding symptoms with P = 0.307. Regarding satisfaction, 86.7% of group A needed rehabilitation, while 40% of group B needed rehabilitation with no statistically significant differences between the studied groups (P = 1.000). Regarding complications, 6.7% of group A had pain and nonunion, while in group B, 6.7% had infection, 13.3% had pain, and 6.7% had nonunion with no statistically significant differences between the studied groups (P = 0.00). Regarding Olerud Molander functional score, 81.67 ± 3.619 in group A, while it ranged from 80 to 85 with a mean of 82.33 ± 2.582 in group B, with no statistically significant differences between the studied groups (P = 0.547). Regarding satisfaction, 86.7% of group A were satisfied versus 93.3% in group B with no statistically significant differences between the studied groups (P = 1.000) (Table 2).

Discussion
Persistent ankle pain, poor functional outcomes, and early osteoarthritis are potential complications of misdiagnosed or inadequately treated syndesmotic injuries. Therefore, it is important to maintain syndesmotic reduction after such injuries [7]. The aim is to achieve anatomical reduction of the ankle joint, which is described as the most important predictor of good clinical outcomes. Traditionally, syndesmotic screws were considered the gold standard for treating syndesmotic injuries [8].

In the current study, age of patients in group A ranged from 23 to 59 years with a mean of 37.47 ± 11.59 years, while in group B it ranged from 21 to 60 years with a mean of 40.27 ± 12.68 years. In addition, 53.3% of group A had accident, 20.0% falling from a height, and 26.7% were twisting. While 60.0% of group B had accident, 33.3% falling from a height, and 6.7% were twisting with no statistically significant differences between the studied groups (P = 0.307). This is similar to the study of Laflamme et al. [9]; most of the included patients in the study who underwent syndesmotic screw

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Group A (N=15)</th>
<th>Group B (N=15)</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum-maximum</td>
<td>23–59</td>
<td>21–60</td>
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<td>0.533</td>
</tr>
<tr>
<td>Means±SD</td>
<td>37.47±11.594</td>
<td>40.27±12.680</td>
<td>n (%)</td>
<td>n (%)</td>
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<td>Mode of trauma</td>
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<td>Falling from high</td>
<td>Twisting</td>
<td>Total</td>
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<tr>
<td></td>
<td>8 (53.3)</td>
<td>3 (20.0)</td>
<td>4 (26.7)</td>
<td>15 (100)</td>
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<tr>
<td></td>
<td>9 (60.0)</td>
<td>5 (33.3)</td>
<td>1 (6.7)</td>
<td>15 (100)</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Deformity</td>
<td>Edema</td>
<td>Tenderness</td>
<td>Rehabilitation</td>
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<tr>
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<td>8 (53.3)</td>
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</tr>
<tr>
<td></td>
<td>10 (66.7)</td>
<td>6 (40.0)</td>
<td>5 (33.3)</td>
<td>10 (66.7)</td>
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<td></td>
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<td>χ²=1.90</td>
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<td>0.715</td>
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<td>Pain</td>
<td>Nonunion</td>
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<td>1.000</td>
<td>0.966</td>
<td>1.000</td>
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</table>

Table 1 Comparison between two groups as regards patient’s age (years), mode of trauma, symptoms, rehabilitation, and complications
fixation were males (70%); the mean age was 39.82. Left side was more affected (57%). However, slipped ankle was the most common mode of injury (30.4%), followed by sports injury (26.1%). This difference may be attributed to the higher incident of car accidents in our country.

Besides the use of syndesmotic screws, which is the most widespread method, sutureting of the syndesmosis, syndesmosis hooks, bioabsorbable screws, Endo Buttons (Smith and Nephew Endoscopy, Andover, Massachusetts, USA), and the TightRope device (Arthrex, Naples, Florida, USA), which in particular became popular in the last decade, are also used for syndesmotic fixation [10]. In biomechanical studies, 3.5- and 4.5-mm cortical screws showed comparable biomechanical characteristics. In cadaveric studies, the influence of the numbers of syndesmotic screws has been investigated. There is evidence that two screws provide a better construct biomechanically compared with one diastasis screw alone [11]. Another study by van der Eng et al. [12] concluded that a possible disadvantage of the syndesmotic screw is the need for implant removal. In general, syndesmosis takes from 8 to 12 weeks to heal, and afterward removal of the hardware is recommended by most authors.

In our study also 33.3% of group A needed rehabilitation, while 40% of group B needed rehabilitation. Regarding complications, 6.7% of group A had pain and nonunion, while in group B, 6.7% had infection, 13.3% had pain, and 6.7% had nonunion. Also, Olerud Molander functional score ranged from 75 to 85 with a mean of 81.67 ± 3.619 in group A and ranged from 80 to 85 with a mean of 82.33 ± 2.582 in group B. Finally, 86.7% of group A were satisfied versus 93.3% in group B. These data conclude that there was no significant difference regarding outcome, satisfaction, or complications in the two compared techniques. Cortical screws in general are considered an effective method for such fractures.

We build our study on the fact that a majority of surgeons prefer the use of only a syndesmotic screw for syndesmotic stabilization and most of them prefer to engage three (58.7%) cortices and a greater number of them use small fragments of 3.5 mm (50.3%) than large fragment (32.3%) screws [13]. However, we found no significant difference while using tricortical rather than bicortical fixation. Another prospective study by Yawar et al. [14] compared suture-button versus syndesmotic screw fixation of ankle FA on a total of 53 patients who underwent syndesmotic stabilization during this period. In total, 34 patients underwent fixation with TightRope and 19 underwent syndesmotic screw fixation. Rediastasis was reported in one (5.2%) patient with syndesmotic screws. The median duration of follow-up was 82 days in the syndesmotic screw group compared with 77.5 days in the TightRope group that report a lower incidence of implant-related problems and the need for implant removal with the use of TightRope. Quicker return to weight-bearing and slightly better radiographic stabilization was noted as well. From all the aforementioned data, we can conclude that there was no significant difference concerning the use of bicortical or tricortical screws in the fixation of desmotic screws. We recommend further studies regarding comparing the outcome of using screws in comparison with novel techniques like TightRope.

**Conclusion**

Although metal screw fixation has been the most popular stabilizing method used in ankle syndesmosis, a controversy still exists regarding the size and number of screws, number of cortices engaged, level of screw placement above the tibial plafond, need for routine removal, and timing of the screw removal. Malreduction of tibiofibular syndesmosis also has been reported to be a significant problem with screw fixation. There was no significant difference regarding the use of one screw or two screws in the fixation of syndesmotic injury at ankle fractures.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**


