Original Article Ann Med Res 2023;30(9):1013–1018

Current issue list available at AnnMedRes

Ann Med Res

Annals of Medical Research

journal page: www.annalsmedres.org

# A new technique for syndesmotic screw placement in ankles

Mesut Uluoz[a,*], Mehmet Yigit Gokmen[a]

[a] *University of Health Sciences, Adana City Training and Research Hospital, Department of Orthopedics and Traumatology, Adana, Türkiye*

ARTICLE INFO

**Keywords:**
Syndesmosis
Syndesmosis diastasis
Screw placement
Ankle trauma
Computed tomography

Received: Jul 14, 2023
Accepted: Sep 08, 2023
Available Online: 27.09.2023

DOI:
10.5455/annalsmedres.2023.07.158

**Abstract**

**Aim:** Screw used in the treatment of ankle syndesmosis diastasis can be placed in malposition. Our aim in the study is to define a new technique for sending the screws in the right direction.

**Materials and Methods:** The ankle tomography of 188 patients was evaluated. First, the medial malleolus root was divided into three equal parts in axial CT section. Then, a screw model was drawn to fit the fibula to the concave surface in the tibia in another axial CT section where the syndesmosis joint is prominent.These two axial CT sections were placed on top of each other with computer program. Results are noted.

**Results:** While 95.7% of the screw simulations were passing through the front 1/3, 4.3% through the middle 1/3, the screw did not pass through the rear 1/3 in any simulation. 187 of these lines passed between the most lateral peak of the fibula and 3 mm posterior.

**Conclusion:** During diastasis surgery, the insertion site of the drill should be chosen between the sharp peak of the fibula and the 3mm posterior. When the drill is placed in this way and directed 1/3 anterior to the medial malleolus, our screw will be sent in the correct position. Our study revealed that the surgical treatment of syndesmos dissociation with screws is a landmark independent of the patient's position and the skill of the surgeon. There is no other study like this study. However, considering the consistency of our results with the literature, we believe that our study can guide surgeons in practical applications.



## Introduction

Ankle syndesmosis injury is a common pathology in high-energy ankle traumas [1]. It is associated with 13% of ankle fracture cases [2,3]. A commonly adopted technique is the fixation of syndesmosis diastasis using a screw. In this technique, fixation is provided with a cortical screw, which is guided at an anterior angle of 30 degrees from the fibula, parallel to the tibial plafond [4,5]. Many clinical studies have been conducted on how to guide the screw into the syndesmosis joint. Although the incidence of syndesmosis malreduction has been found to be at different rates in various publications, screw malposition is generally reported at a rate of 50% [5,6]. Therefore, studies are ongoing to reduce complications associated with this procedure, such as malposition of screws. In this study, we aimed to reduce this complication by trying to develop a systematic for the correct application of the syndesmosis screw.

## Materials and Methods

The study protocol conformed to the ethical guidelines of the Declaration of Helsinki and was approved by the Ethics Review Board of our hospital (Adana City Training and Research Hospital Clinical Research Ethics Committee, Ethic form no: 728 Date: 27/02/2020). Between November 15, 2019 and February 15, 2020, ankle CT scans taken in the emergency department of our hospital were analyzed. Sample size was calculated with the G*Power Version 3.1.9.2. The scans of a total of 200 patients that consecutively underwent computed tomography (CT) of the ankle in the radiology clinic of our hospital were reviewed by a single radiologist retrospectively (128 detector Mdct system, Philips ingenuity 128,Eindhoven, Netherlands, 120kvp,100-400mAs,pitch 0.6, thickness 1mm). Of these patients, 188 who were eligible for the evaluation were included in the study. Patients with fractures that damaged the ankle joint beyond a level that allows for the measurement, those with tumoral formation causing deformation in the ankle, and those that had a history of surgery or fractures that impaired the ankle anatomy were excluded from the study. Individuals aged under 18 were also excluded since they had not yet completed their anatomic development. In axial CT sections, the anterior and posterior points of the base of the medial malleolus were combined with a line divided into three equal zones: anterior 1/3 (1), middle 1/3 (2), and posterior 1/3 (3)

*Corresponding author:
*Email address:* mesutuluoz@hotmail.com (Mesut Uluoz)

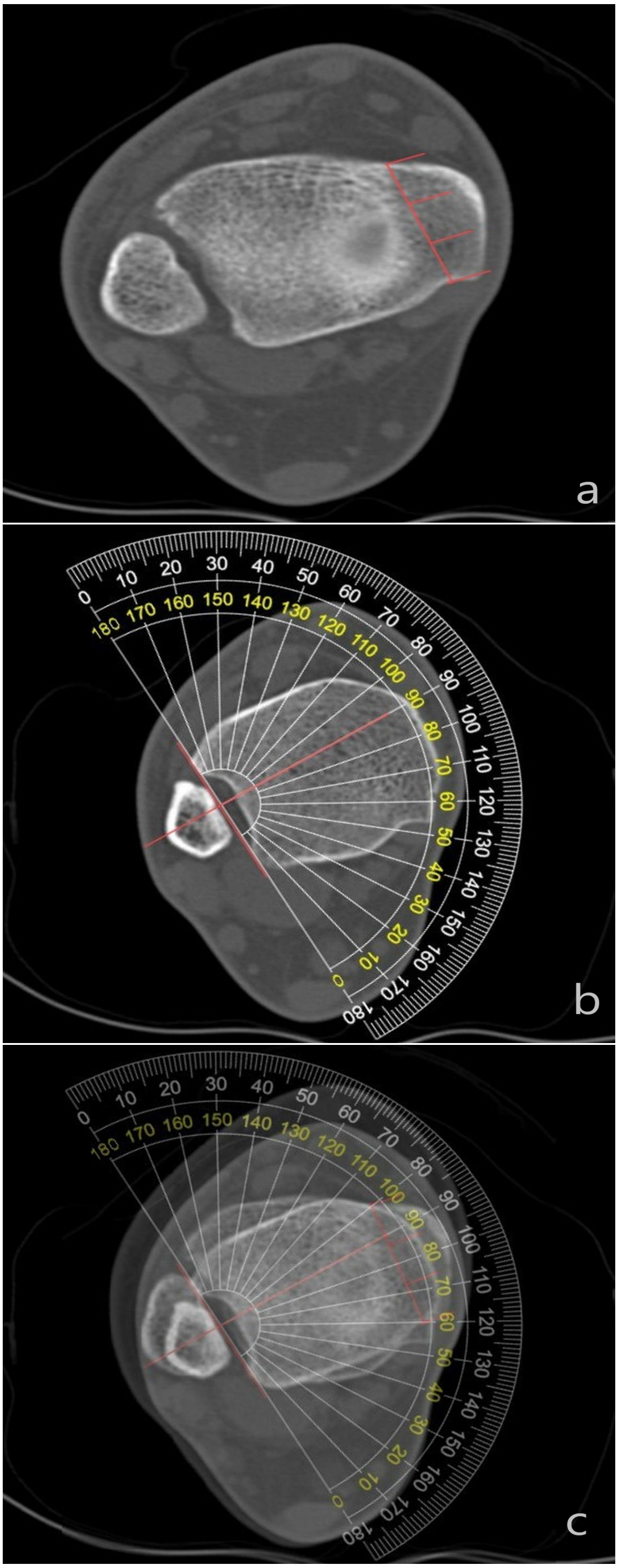


**Figure 1.** Axial CT images: a) base of the medial malleolus divided into three zones, b) screw simulation drawn perpendicular to the syndesmosis joint, and c) images in a and b superimposed using SketchBook-Draw and Paint software.


**Figure 2.** Coronal CT images: Syndesmosis joint length measurement.

(Figure 1a). The posterior and anterior points of the concave surface of the tibiofibular joint were also combined with a line to obtain the joint line. A straight line was drawn perpendicular to the joint line to fit the fibula in the syndesmosis joint. A vector was created that pushed the fibula toward the middle of the joint (Figure 1b). This screw simulation was designed to divide the fibula into two in order to apply strong force to it. Using this technique, syndesmotic screw placement was simulated under CT guidance. These two CT sections were superimposed using SketchBook-Draw and Paint software (Figure 1c). The transition points of this line segment at the base of the medial malleolus were determined and statistically evaluated. The entry point of this line segment into the lateral fibula was noted. In the coronal plane, the length of the cross-section where the contact surfaces of the two bones were the longest in the tibiofibular joint was measured (Figure 2).

*Statistical analysis*

All data were statistically analyzed using SPSS-23 software (Statistical Package for the Social Sciences, SPSS Inc., Chicago, Il, USA).Pearson's chi-squared test used to compare categorical variables. Independent student t-test analysis applied for binary variables, controlling for distributions in the comparison of continuous measurements between groups. Mean, standard deviation, median lowest, highest, frequency and ratio values were used in the descriptive statistics of the data.

## Results

The ankle CT images of 200 patients were reviewed. Two patients with osteosarcomas that damaged the joint, three patients with a history of ankle surgery, one patient under 18, and six patients with fragmented ankle fractures that prevented measurement were excluded. As a result, the study included 188 patients, 139 (%73.9) male and 49 (%26.1) female. The mean age of the patients was 37.1 years. In the simulation, screw passed through the anterior 1/3 (95.7%) in 180 of the patients and through the middle 1/3 (4.3%) in eight while there was no case in which the screw passed through the posterior 1/3. Eighty-seven (46%) of the lines passed through the most lateral peak of the fibula, and 91 (48%) were clustered between the peak and 3 mm posterior of the fibula. Ten lines passed a few millimeters posteriorly, while no line passed anterior to the peak. The contact surface of the bones in the tibiotalar joint varied between 14 and 21 mm, and the mean value was calculated as 17 mm.

## Discussion

The syndesmosis joint is a very important anatomical structure for the ankle. Approximately, 23% of ankle fractures are accompanied by injuries of the syndesmosis joint [7]. Van Staa et al. [8] reported that syndesmosis injury was seen even in patients with ankle sprains at a rate of 5-10%. In some biomechanical studies, it was observed that the tibiotalar contact pressure significantly increased, especially in external rotation, as a result of the axial loading of the ankle after syndesmotic ligament injury. In addition, it has been reported that a 1-mm lateral biomechanical shift of the talus can increase the loading by 42% [9,10] . A poorly reduced or overlooked syndesmosis diastasis can cause persistent pain, leading to early post-traumatic arthritis due to increased loading. Tibiotalar joint diastasis can be overlooked on direct radiographs. However, the widespread use of tomography has not only provided convenience in diagnosis but also increased treatment success. The routine method is to provide fixation with a cortical


**Figure 3.** Planning the insertion point of the screw; The front and back border of the fibula is determined and divided vertically into two.


**Figure 4.** Planning the orientation of the screw; Medial malleolar root is palpated and a horizontal line is drawn. This line is divided into three equal parts. The points separating these sections are extended proximally.

screw placed at an angle of 30 degrees from the fibula, parallel to the tibial plate [4,11]. However, in their study on 45 cadavers, Putnam et al. [12] measured the angle between the line drawn perpendicular to the syndesmosis joint from the lateral of the fibula and the distal mediolateral axis of the tibia in the axial sections of the ankle tomography and reported it to be 21 ± 5 degrees. In the same study, the lateral ankle radiographs of the cadaver ankles were taken and the distal of the tibia was divided into three sections on fluoroscopy images. The authors reported that in cases where the syndesmosis screws were accurately oriented, 93% were directed toward the anterior 1/3. The accurate screw angle being determined as 21 ± 5 degrees shows that there is an angle difference of 10 degrees. In addition, variables such as the surgeon's skill, experience, and the patient's ankle anatomy may affect the outcome of the surgery. In a study by Igrek et al. on syndesmos fixation, it was shown that correct technique of screw placement provided success in joint reduction [13]. This is why the error rate can be high in the application of the previously defined traditional method. In this study, we proposed a technique to obtain a triangulation point that will not change from one patient to another, using less fluoroscopy.

While there are publications stating that the screw insertion point should be 30-40 mm from the plafond in cases of syndesmosis diastasis, there are also researchers suggesting that screws should be placed 20 mm proximally. However, it has been reported that guiding screws 2 cm below may result in coinciding with the joint, and this very tight fixation will increase the joint pressure [14,15]. In this respect, the longitudinal length of the joint is important. In our study, the longitudinal length of the syndesmosis joint was

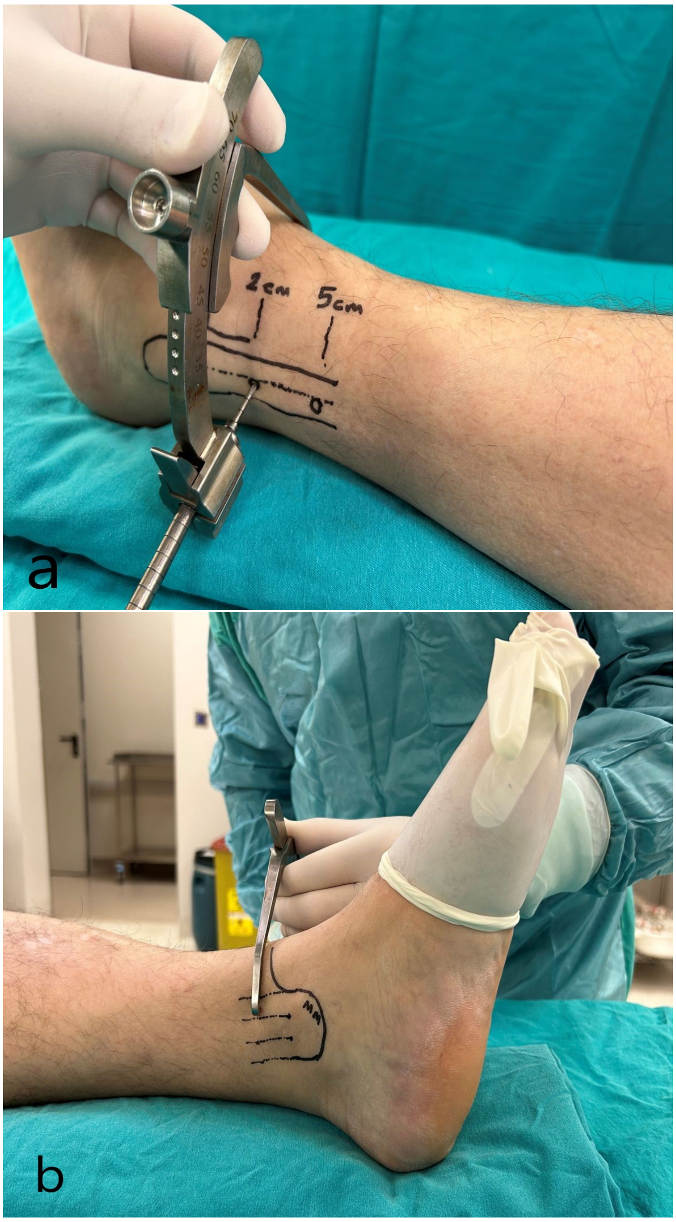


**Figure 5.** a)The drill is placed anterior to the posterior part of fibula and sent to the target b)The tibial guide used in ACL operation is placed in the 1/3 anterior region in the medial malleolus drawing.

found to be 17 mm (14-21 mm).

At the 2 to 4 cm proximal part of the plafond, the screw insertion point should be determined between the most lateral of the fibula and 3 mm to its posterior (Figure 3). According to the proposed technique, the anterior and posterior points of the base of the medial malleolus in the ankle are divided into three equal parts and the boundaries of the anterior 1/3 part are extended proximally, parallel to the tibia axis (Figure 4). If the screw is guided from this insertion point to the anterior 1/3 of the lines drawn upward from the medial malleolus, a vertical screw is successfully oriented toward the syndesmosis joint at a rate of 95.7%. At this stage, after the target point has been determined, using an anterior cruciate ligament (ACL) guide, as applied in a study, significantly increases the accurate insertion rate of the screw [6] (Figure 5a-b). If the ACL

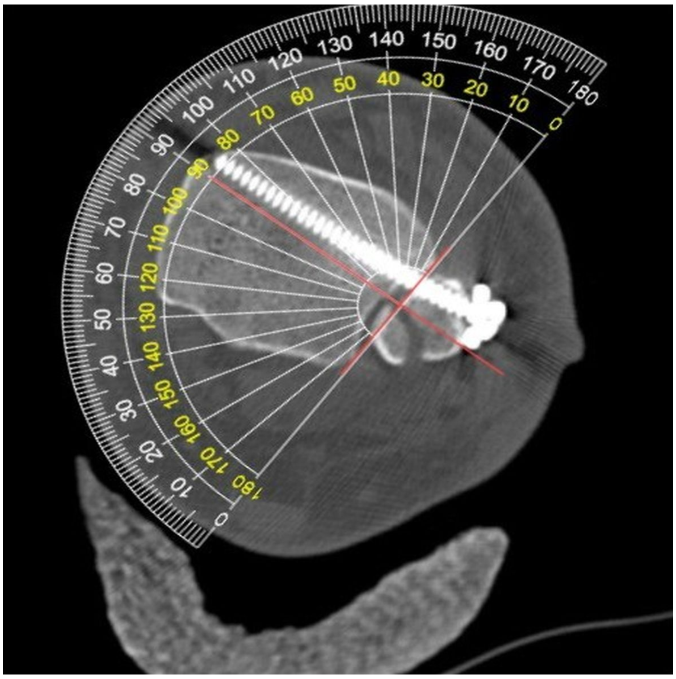

**Figure 6.** Screw applied over the plate placed anterior to the fibula.

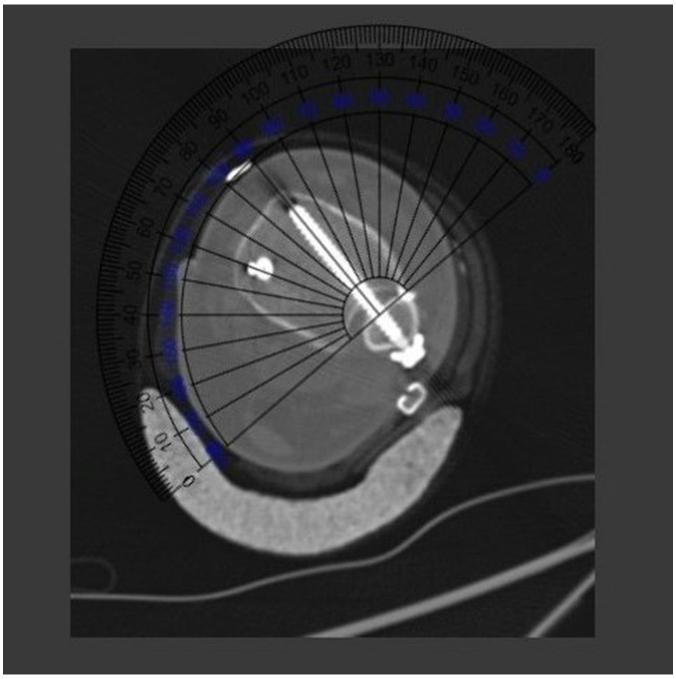

**Figure 7.** Axial CT images Syndesmos screw applied in accordance with the landmarks we defined.

guide is not available, after exiting the medial through the predetermined point from using a thin K-wire, a screw hole can be prepared with a cannulated drill and fixation can be performed with a cortical screw.

A previous CT-based study similar to ours described a method in which the true lateral view of the ankle was obtained using fluoroscopy [9]. However, surgery for malleolar fractures is performed under fluoroscopy guidance. Obtaining a true lateral view of the ankle and applying the recommended procedures afterwards increases the radiation load taken by the patient and the surgical team. The success of this technique depends on the surgeon's skill. In our technique, after determining the distance of the screw from the joint, a syndesmosis screw can be guided using less fluoroscopy. Because it is only used in the evaluation of the screw insertion site and coronal plane. Thus, it is considered to be an easier and more applicable method.

In a study by Bafna et al. [1] on the revision of syndesmosis screws, 160 patients were screened, and it was determined that revision surgery had been performed in only 13 cases, and the rate of diastasis recurrence in these patients was 92.3%. The authors underlined the importance of strong and accurate stabilization. If the joint cannot be centralized, the stabilization of the joint will remain weak, and the rate of diastasis recurrence will naturally increase.

In a review of studies conducted between 1950 and 2014 on the evaluation and treatment of tibiofibular syndesmosis injuries, Magan et al. [16] stated that screw diameters were not important, but placing two screws parallel to each other provided significantly superior results to the use of a single screw, and there is a need to develop a surgical technique to achieve adequate reduction in syndesmosis without exposure to radiation. We consider that the method we have defined can partially meet these needs.

Xenos et al. [17] also recommended stabilization with two parallel screws in tibiofibular syndesmosis injuries. While the first screw provides reduction and stabilization, the second screw supports the stabilization. However, if the first screw is mispositioned, the second screw will cause stabilization in malreduction. Therefore, we consider that orienting the first screw in an appropriate direction is much more important than the number of screws to be inserted or the screw diameter. Unfortunately, there is no method that can show whether we sent the sindezmos screw correctly during surgery. However, as can be understood from our study, when we place the screw exactly in the center of the fibula and direct it to the 1/3 anterior of the medial malleolus, our margin of error is considerably reduced.

In our proposed simulation, when the screw that directs the fibula to the syndesmosis joint is drawn by centering the fibula, the line passes mainly between the apex of the fibula and its 3 mm posterior. Therefore, we recommend selecting the point between the peak of the fibula and its 3mm posterior as the screw insertion site. In addition, if osteosynthesis with plating is planned due to a fibular fracture, it should be taken into consideration that screws may be placed in the syndesmosis, and thus the plate should not be placed close to the anterior; otherwise, the screw insertion point may slide forward and cause malreduction. If the plate has to be placed anteriorly due to the location of the fracture, the syndesmosis screw should be directed freely from the posterior of the plate, not over the plate. If the plate is placed anteriorly, fixation will not be appropriate even if you throw the screw in the right direction (Figure 6). If the syndesmosis screw is applied according to the landmarks we defined, the screw position will be correct (Figure 7). A limitation of our study is that the technique we described has not been tested on cadavers. This technique, which we have described, needs to be developed with cadaver studies.

## Conclusion

Screw application in ankle syndesmos injuries is still a serious problem technically. Our study revealed that the surgical treatment of syndesmos dissociation with screws is a landmark independent of the patient's position and the skill of the surgeon. There is no other study like this study. However, considering the consistency of our results with the literature, we believe that our study can guide surgeons in practical applications.

*Highlights*

1. The syndesmosis screw insertion site should be chosen between the lateral apex of the fibula and 3mm posterior.
2. While drilling before the screw, the drill direction should be 1/3 anterior of the medial malleolus.
3. In the decomposition of syndesmos with lateral malleolus fracture, the plate should be placed as posterior as possible. If the plate has to be placed anteriorly, the syndesmos screw should not be thrown over the plate.
4. The syndesmos joint extends approximately 1.7 cm proximal from the tibiotalar joint surface. It would be appropriate not to insert screws up to 2 cm proximal from the joint in order to avoid excessive compression in the joint.

*Acknowledgements*

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

*Ethical approval*

This study was approved by the Adana City Training and Research Hospital Clinical Research Ethics Committee (Ethics form no: 728 Date: 27/02/2020).

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