Original Article

# Syndesmotic Screw Fixation in Tibiofibular Diastasis

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**Abstract**

**Background:** In chronic instability of syndesmosis, osteoarthritis and poor functional outcome were seen more prevalently. To avoid diastasis of ankle joint, the affected distal tibiofibular syndesmosis should be restored. We evaluated the clinical and radiological results of operative treatment of ankle fractures in patients who required syndesmotic stabilization. **Materials and Methods:** Twenty-one patients operated for ankle fracture were evaluated. Patients were followed up for 12 to 81 months, with a mean value of 49 months. Anteroposterior (AP), lateral, and mortise radiographs were taken at the follow-up period, and AP tibiofibular distance, lateral fibular distance, and medial mortise distance were measured on the preoperative, postoperative, and last follow-up radiographs. At the last follow-up, patients were evaluated clinically with Hannover scoring system. **Results:** The decrease in AP tibiofibular distance was statistically significant postoperatively in Weber Type B and C fractures. The mean preoperative AP tibiofibular distance which was 7.1 mm decreased to 3.6 mm after operation. There was no statistically significant relation between the amount of decrease and fracture type, either Weber B or C. At the same time, the AP tibiofibular distance did not change at the last follow-up. At the last follow-up clinical evaluation, patient scores were ranging from 74 to 94, with a mean value of 86, which was designated as a fair result. **Conclusion:** In ankle fractures, if diastasis of distal tibiofibular joint is present, syndesmosis should be fixed for both Weber Type B and C fractures. The most important predictor of good clinical outcome is accurate reduction of the syndesmosis.

**Keywords:** *Ankle fracture, ankle instability, diastasis screw, syndesmosis*

**Date of Acceptance:**
22-Nov-2017

## Introduction

Distal tibiofibular syndesmosis is important for stability of the ankle mortise and for weight transmission and walking.[1,2] During dorsiflexion, the external rotation of talus in the ankle joint allows 1–2 mm of widening normally. The syndesmosis consists of the anteroinferior tibiofibular ligament (AITFL), posteroinferior tibiofibular ligament (PITFL), and the interosseous ligament (IOL).[3-6] This complex stabilizes the mortise by securing the fibula in the fibular notch.[7] In 75% of cases, there are articular facets joining the fibula and tibia, which can be designated as the true synovial joint.[8]

Syndesmosis injuries arise in approximately 10% of all fractures that occur at the ankle,[9] and 2% of these fractures are open fracture or approximately 20% of patients require internal fixation.[10,11] The annual incidence of syndesmosis injury is approximately 15/100,000 in the general population.[9,12-14] The distal tibiofibular syndesmosis is commonly ruptured during an ankle fracture. Fibular fracture and syndesmotic injuries are most commonly caused by pronation external rotation, pronation abduction, and less frequently, a supination external rotation mechanism.[15] But also, sometimes, it can be seen without a fracture as caused by hyperdorsiflexion with external rotation and axial compression of tibiotalar joint.[3-5] This combination of

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**Access this article online**

Quick Response Code:

**Website**: www.njcponline.com

**DOI**: 10.4103/njcp.njcp_5_17

**PMID**: *******



**How to cite this article:** Sipahioglu S, Zehir S, Isikan UE. Syndesmotic screw fixation in tibiofibular diastasis. Niger J Clin Pract 2017;XX:XX-XX.

pathological movements often results in Danis Weber B and C injuries. As the talus abducts or rotates externally in the mortise, one or more syndesmotic ligament disruption occurs.[15] Around 15%–45% of all ankle fractures occur by pronation external rotation injury and most of them are classified as Danis Weber Type C.[16] By this mechanism, first, rupture of the deltoid ligament or fracture of the medial malleolus happens and then if trauma is severe enough, it proceeds to rupture of the AITFL and interosseous membrane. In most severe injuries, spiral fracture of the fibula and fracture of the posterior tibial margin or rupture of the PITFL are involved in the injury.[16,17] As the fracture level of fibula increases, instability of the syndesmosis increases.[17]

To avoid diastasis of ankle joint, the damaged distal tibiofibular syndesmosis should be restored.[15] Osteoarthritis and poor functional outcome are seen more prevalently in patients with widened mortise who had chronic instability of the distal tibiofibular syndesmosis.[3,14,18-21]

The main purpose of this study was to evaluate the clinical and radiological results of operative treatment of ankle fractures in patients who require syndesmotic stabilization.

## Materials and Methods

Twenty-one patients with ankle fracture who were admitted to our hospital were included in this study. Patients with multiple injuries, late diagnosis, and open fractures were not included. All patients received ankle radiographs that included anteroposterior (AP), AP 15° internal rotation (mortise), and lateral views, bilaterally, for comparison and determination of whether there was a tibiofibular diastasis.

Syndesmotic distance (AP tibiofibular distance) was determined by measuring the horizontal distance between the medial cortical border of fibula and radiodense line of the tibiofibular notch 1 cm above the ankle joint [Figure 1]. Again on the AP radiographs, the distance between the medial malleoli lateral articular side and talus medial side was designated as medial mortise distance (medial clear space). On the lateral radiographs, the distance between fracture ends of the fibula was recorded as lateral fibular distance [Figure 2]. Three plane radiographs of the ankle (AP, lateral, and mortise) were taken bilaterally for comparing and deciding if there was tibiofibular diastasis. These radiographs were taken by radiology technicians with the traditional tube–cassette distance of 100 cm (1 m) [Figure 3].

Medial malleolus was fixed in one patient by tension band technique and in the rest of them, it was fixed with a malleolar screw and washer or a screw without washer. Plate fixation was used for all fibular fractures. Malleolar screw was used for tibiofibular diastasis as syndesmotic screw. All screws used were of stainless steel (4.0 mm malleoli screw), and tricortical fixation with only one screw was used for syndesmosis fixation. The diastasis screws were placed parallel and 2 –3 cm above the ankle joint 20°–30° anteromedially [Figure 4]. Meanwhile, no indication for fixation of posterior malleoli in trimalleolar fractures was seen. A tourniquet was used perioperatively and antibiotic prophylaxis was begun preoperatively. Short-leg plaster splint was applied postoperatively to all patients. And this was switched to short-leg walking cast at the 2nd week postoperatively and allowed for weight bearing except in the trimalleolar group. Trimalleolar group was allowed for weight bearing at the 3rd week. Totally, at the 6th week, all the patients' casts were ended and diastasis screws were removed under local anesthesia. Thereafter, ankle motions were begun for all patients. Immediate full weight bearing was advised for bimalleolar group and after 2 weeks, it was also allowed for trimalleolar group.

The follow-up period ranged from 12 to 81 months, with a mean value of 49 months. At the follow-up examinations, all the patients' radiographs were taken, and AP tibiofibular distance, lateral fibular distance, and medial mortise distance were measured on the preoperative, postoperative, and last follow-up radiographs. At the last follow-up, the patients were evaluated clinically according to Hannover scoring system which is used for evaluating ankle function score, where the maximum score is designated as 100. In this functional score, patients are evaluated according to subjective, objective, and activity scores and classified as excellent, good, satisfactory, and poor as the worst score.

## Results

In this study, 21 (6 females [28%] and 15 males [72%]) patients who were admitted to our hospital and were operated for ankle fractures were evaluated. Patients had a follow-up period ranging from 12 to 81 months (mean ± standard deviation [SD]: 49.5 ± 20.9). The ages of patients ranged from 22 to 67 years, with a mean age of 42.8 (SD: 13.1) years The etiology of fracture was attributed to sprain in 14 patients (66.6%), traffic accident in 3 patients (14.28%), sports injury in 3 patients (14.28%), and crushed under construction in 1 patient (4,76%). The type of fracture in the study group was bimalleolar in 15 patients (71%), trimalleolar in 4 patients (19%), lateral malleolar fracture in 1 patient (5%), and medial malleolar fracture in 1 patient (5%), where in all patients, there was also distal tibiofibular diastasis. Two patients

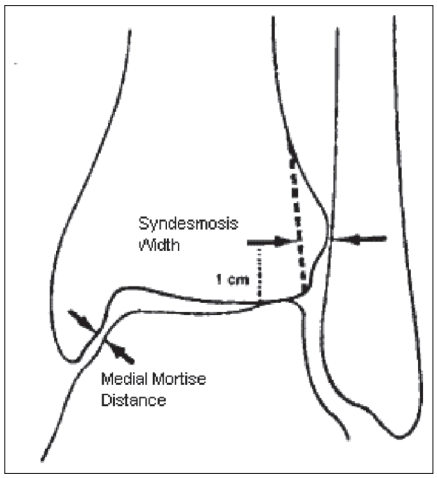


**Figure 1:** Syndesmosis width and medial mortise distance measurement

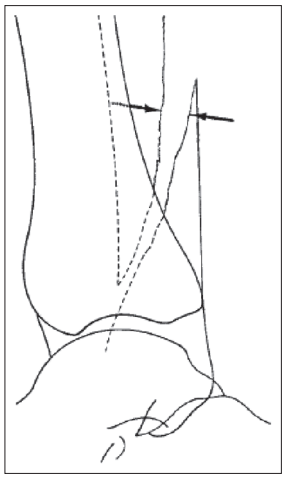

**Figure 2:** Lateral fibular distance measurement

**Figure 3:** Preoperative radiography of a patient

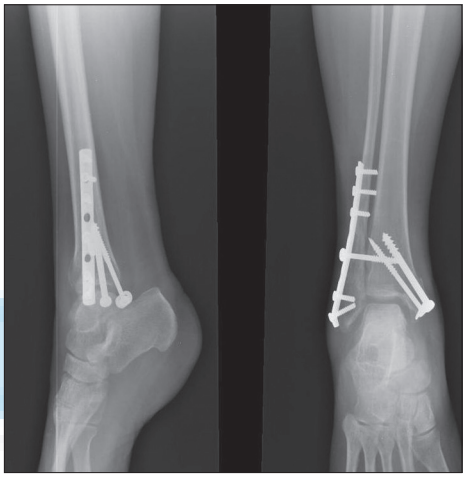

**Figure 4:** Postoperative radiography of a patient

had Type 1 open fracture, one patient also had ipsilateral tibial open fracture, and one patient had contralateral hand phalanx fracture at the same time. Six of the patients were classified as having Weber Type B and 15 were classified as Weber Type C fractures. Nine patients were operated at 0–5$^{th}$ days of fracture and the rest of them were operated at and after the 6$^{th}$ day [Table 1].

AP tibiofibular distance had been measured between 3 and 13 mm with a 7.1 mm average value (SD: 2.4) preoperatively and was measured between 2 and 6 mm with a 3.6 mm average value (SD: 0.9) postoperatively. Since there was a 50% decrease in tibiofibular distance [Table 2], pre- and postoperative difference in AP tibiofibular distance, lateral fibular distance, and medial mortise distance were analyzed by one-way analysis of variance and paired *t*-test. $P < 0.05$ was considered statistically significant.

In Weber Type B fracture group, the decrease in AP tibiofibular distance was statistically significant; meanwhile, the difference between pre- and postoperative lateral fibular distance and medial mortise distance values was not statistically significant ($P > 0.05$). However, in Weber Type C fractures, the difference between AP tibiofibular distance and lateral fibular distance was found to be statistically significant postoperatively ($P < 0.05$); on the other hand, change in medial mortise distance was not statistically significant ($P > 0.05$).

Also, as expected by the reduction of the fracture, decrease in lateral fibular distance had been achieved in both Weber Type B and C groups, but it was significant only in Type C group. Medial mortise distance decreased or did not change postoperatively and so the change was not statistically significant postoperatively in both Weber Type B and C groups. As the medial malleolus was fractured in all of the patients, medial mortise distance was not changed as we expected. The important point on the follow-up control radiographs that we noticed was that the tibiofibular and lateral fibular distance had not been changed. At the same time, medial mortis distance

**Table 1: Patient demographics**

| | Weber B | Weber C | Total |
|---|---|---|---|
| Number of patients | 6 | 15 | 21 |
| Mean age±SD | 43.1±14.1 (22-61) | 42.7±13.1 (23-63) | 42.8±13.1 (22-67) |
| Sex (female/male) | 2/4 | 4/11 | 6/15 |
| Cause | | | |
| Sprain | 4 | 10 | 14 |
| Traffic accident | - | 3 | 3 |
| Sport injury | 2 | 1 | 3 |
| Crush injury | - | 1 | 1 |
| Follow-up (months) | 40.8±11.0 (28-56) | 53.1±23.1 (12-81) | 49.5±20.9 (12-81) |
| Clinical score | 85.8±9.1 (74-94) | 83.8±9.1 (63-94) | 83.4±8.5 (62-91) |

SD=Standard deviation

**Table 2: Values of patient's talofibular, lateral fibular, and medial mortise distances (mm)**

| Serial number | Anteroposterior tibiofibular distance | | | Lateral fibular distance | | | Medial mortise distance | | |
|---|---|---|---|---|---|---|---|---|---|
| | Preoperative | Postoperative | Follow-up | Preoperative | Postoperative | Follow-up | Preoperative | Postoperative | Follow-up |
| 1 | 6 | 4 | 4 | 2 | 1 | 1 | 2 | 2 | 2 |
| 2 | 6 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 2 |
| 3 | 8 | 4 | 4 | 3 | 1 | 1 | 3 | 2 | 2 |
| 4 | 6 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 2 |
| 5 | 11 | 4 | 4 | 3 | 1 | 1 | 4 | 2 | 2 |
| 6 | 13 | 6 | 6 | 2 | 0 | 0 | 2 | 2 | 2 |
| 7 | 7 | 4 | 4 | 1 | 1 | 1 | 2 | 2 | 2 |
| 8 | 6 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| 9 | 7 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 2 |
| 10 | 6 | 3 | 3 | 1 | 0 | 0 | 3 | 2 | 2 |
| 11 | 9 | 4 | 4 | 3 | 1 | 1 | 4 | 3 | 3 |
| 12 | 8 | 6 | 6 | 2 | 0 | 0 | 3 | 2 | 2 |
| 13 | 9 | 4 | 4 | 4 | 2 | 2 | 3 | 2 | 2 |
| 14 | 5 | 3 | 3 | 6 | 3 | 2 | 5 | 3 | 3 |
| 15 | 7 | 4 | 4 | 1 | 1 | 1 | 2 | 2 | 2 |
| 16 | 8 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| 17 | 9 | 4 | 4 | 3 | 2 | 2 | 10 | 3 | 3 |
| 18 | 4 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| 19 | 6 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 2 |
| 20 | 5 | 3 | 3 | 1 | 1 | 1 | 3 | 2 | 2 |
| 21 | 3 | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 3 |
| Total (mean±SD) | 7.1±2.4 | 3.6±0.9 | 3.6±09 | 2.2±1.3 | 1.3±0.8 | 1.1±0.6 | 3.1±1.5 | 2.3±0.4 | 2.1±04 |

SD=Standard deviation

was decreased as a result of reduction and had kept its value on the control radiograms.

We did not see any late or early soft-tissue infection, and range of motion of the patients was sufficient for daily activities of the patients. On follow-up examinations, delayed union was seen in two patients and Sudeck atrophy developed in four patients and appropriate treatments were given to these patients.

At the last follow-up clinical examinations, patients' scores according to the Hannover scoring system were ranging from 62 to 91, having a mean value of 83 (SD: 8.5), which may be designated as a good result. As none of the patients had any complaint relevant to their ankle and going on their normal daily life, results can be concluded as good.

## Discussion

It is a debate if the treatment of ankle fractures should be surgical or conservative treatment is sufficient after the reduction of fracture. Generally, two indications are accepted for surgical treatment. The first one is joint incongruity on weight-bearing surfaces seen in pilon fractures and known as static incongruity. And, the other is dynamic incongruity or instability. Studies show that the important fact in ankle instability is external rotation

of talus. Tear of anterior talofibular ligament alone is not enough for instability, and deep deltoid ligament tear must also be added to this injury. These data suggest that the primary stabilizers of the ankle are medials rather than laterals.[22]

According to classical knowledge, if >1 mm displacement of talus is present at mortise radiograph compared to the contralateral extremity, surgical treatment is mandatory.[23] A residual lateral displacement of the talus of >2 mm is associated with a 49% increase in articular mean pressure and a >90% chance of degenerative changes and a poor outcome.[18,24] However, the key point in the surgical treatment of ankle fractures is anatomic restoration of lateral malleolus as reported by many studies.[25] Writers advocating transyndesmotic fixation[26] and also contrary proponents claiming it does not gather an additional gain to treatment,[27] are present. If the distance between tibia and fibula is >4–5 mm, it is termed as diastasis.[22,28] In these circumstances, we operated the patients who are thought of as having distal tibiofibular diastasis. Since two patients had comminuted fracture, we performed tension band technique for them. And in the rest of the patients, malleolar screw was used for fixation with or without washer. The reduction of tibiofibular diastasis is supplied only by a malleolar screw, since a great care was given to ankle dorsiflexion while performing diastasis fixation.

Fibula fractures that begin above tibia plafond are named as syndesmosis injury. It is generally accepted that these syndesmosis injuries must be fixed. However, as explained in Boden's[1] cadaver study, if deltoid ligament is healthy, whatever the level of fibular fracture, diastasis did not occur. In the deltoid torn group, diastasis had occurred if the fibula fracture was above the 4.5 cm of the joint. Solari *et al*.[29] in their cadaver study reported that pathologic talar rotation and syndesmotic diastasis were seen in medial instability group. And, they proposed that after a rigid medial fixation had been done on these injuries, syndesmotic screw did not have any support, especially against rotational forces. Moreover, Mostert *et al*.[30] in their study presented two cases without lateral malleolus and syndesmotic ligament, claiming that lateral malleolus and tibiofibular ligament have no role primarily in stability.

Findings in this study support the importance of medial side in stability. In all of the cases, medial malleolus was fractured. However, it does not mean that after rigid fixation of medial malleolus, we accepted the position of lateral malleolus as it is. Likewise, in our study, the decrease seen in distal tibiofibular distance after operation was statistically significant both in Weber Type C and in Weber Type B fractures. Wuest[15] reported that in syndesmosis injuries, healing takes much time than without syndesmosis injury and has a longer disability period for the patient. As the patient is already on operation table, extra work to do is using a transfixation screw by a small lateral incision. However, real extra work is removal of this screw by local anesthesia after a while. In our study, there was no significant difference between tibiofibular distance of Weber Type C and Weber Type B fractures pre- and postoperatively. Therefore, we offer using diastasis screw, whatever the fracture type is, if diastasis is seen.

The decrease in medial mortise and lateral fibular distance was not statistically significant postoperatively. We evaluated this as in the operation because of the reduction of both sydesmosis and talus and also medial malleolus at the same time, these changes were not statistically significant.

In classical treatment protocol, weight bearing is not allowed for 6–8 weeks.[28,31] Early mobilization and weight bearing is encouraged as it affects the outcome positively, as described in the literature.[31] In this study, we permitted weight bearing in bimalleolar fractures after 2 weeks of operation and in trimalleolar fractures after 3 weeks of operation using a walking cast. After 6$^{th}$ week in bimalleolar fracture and 8$^{th}$ week in trimalleolar fracture, we allowed full weight bearing without any aid. We did not see any complication resulting from early weight bearing and we observed high moral as the weight bearing started early.

Removal of fixation screw is recommended at the 8$^{th}$ or 9$^{th}$ week.[22,28,32] Burgert and Jones in their case presentation reported that 6-week duration was not sufficient.[33] In this study, we removed syndesmosis screw at 6$^{th}$ week routinely. After removal of fixation and at the 3rd month follow up, we had not see an increase in tibiofibular and medial mortise distance. We presume that 3–month duration is adequate for soft-tissue healing. Also, fracture healing was completed in most of the patients, and only in two patients, fracture healing of fibula had been delayed. At the follow-up of controls, it was seen that all the fractures healed properly.

## Conclusion

We believe that in ankle fractures, if diastasis is present with fracture, syndesmosis stabilization must be done whatever the fracture type is and this fixation material can be removed at the 6$^{th}$ week of operation easily.

### Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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