

## DISTAL THIRD TIBIAL FRACTURE SURGERY WITH FIBULAR FIXATION: IS IT NECESSARY FOR UNION AND ALIGNMENT?

### DİSTAL TİBİA KIRIKLARINDA FİBULAR FİKSASYON: KAYNAMA VE DİZİLİM AÇISINDAN GEREKLİ MİDİR?

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#### Öz

##### Amaç

Distal 1/3 tibia kırıklarının tedavi yönetimi tartışmalıdır. Bu çalışmanın amacı aynı zamanda yapılan fibular fiksasyonun kaynama oranlarını arttırıp arttırmadığını ve dizilim açısından gerekliliğini değerlendirmektir.

##### Gereç ve Yöntem

Bu çalışmaya distal 1/3 tibia kırığı nedeniyle tek bir merkezde Ocak 2016 ile Haziran 2020 arasında opere edilmiş 106 hasta alındı. Kırıklar plafond seviyesinden 3-12 cm arası mesafede lokalize olarak belirlendi. Hastalar fibulanın durumuna göre üç gruba ayrıldı: Grup 1 (bir fibula kırığı var ancak fibular fiksasyon yapılmamış, 47 vaka), Grup 2 (bir fibula kırığı var, eş zamanlı fibular fiksasyon yapılmış, 38 vaka) and Grup 3 (intakt fibula, 21 vaka). Tüm fibular fiksasyon cerrahileri kilitli kompresyon plakları ile, tibial fiksasyon ise kiltli kompresyon plakları veya intramedüller çivileme ile yapıldı. Primer sonuç ölçütleri kaynama ve dizilim olarak belirlendi. Yaş, cinsiyet, AO sınıflaması, fibula kırık seviyesi, açık kırık varlığı, implant tipi ve cerrahiye kadar geçen süre değerlendirildi.

##### Bulgular

Açık kırık varlığı haricindeki değişkenlerin hem kaynama oranlarını hem de dizilimi etkilemediği izlendi. Kaynama oranı eş zamanlı fibula fiksasyon grubunda açık kırık varlığında anlamlı oranda daha düşük saptandı ( $p<0.001$ ). Kapalı kırıklar lojistik regresyon analizi yapıldığında daha iyi kaynama oranlarına sahipti (OR=5,00 (%95 CI 2,24-11,48)).

##### Sonuç

Mevcut çalışma distal 1/3 tibia kırıklarında eş zamanlı bir fibular fiksasyon ameliyatının ne kaynama oranları ne de dizilim üzerine olumlu etkisi olmadığını gösterdi. Bundan dolayı, daha iyi sonuçlar almak için distal tibia kırıklarında bir fibular fiksasyon cerrahisi zorunluluk değildir ve açık kırık varlığında hem ek cerrahinin getirdiği yük hem de daha düşük kaynama oranı nedeni ile yapılmamasını önermekteyiz.

**Anahtar Kelimeler:** Distal tibia kırığı, Eş zamanlı fibular fiksasyon, Fibula kırığı, Gustilo Anderson sınıflaması, İntramedüller çivileme, Kaynamama

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## Abstract

### Objective

The management of distal third tibial fractures remain controversial. The aim of the present study was to evaluate whether concurrent fibular fixation changes union rates and aids in alignment in the case of distal third tibia fractures.

### Material and Method

The study included 106 distal third tibia fracture operation cases in which the distance from the fracture to the plafond was between 3-12 cm at a single centre between January 2016 and June 2020. The patients were divided into three groups according to the status of the fibula: Group 1 (without fibular fixation with the presence of a fibula fracture, 47 cases), Group 2 (concurrent fibular fixation with the presence of a fibular fracture, 38 cases) and Group 3 (intact fibula, 21 cases). All fibular fixation surgeries were performed with locked plates (LCP) and tibial fixation with either LCP or intramedullary nailing (IMN). The primary outcome measures were union and alignment. Age, gender, AO classification, fibula fracture location, presence of an open fracture, implant type and time delay for surgery were also assessed.

### Results

None of the variables except the presence of an open fracture was significant for the union rates or alignment. The union rate was significantly less if there was an open fracture in the concurrent fibular fixation group ( $p < 0.001$ ). Closed fractures were associated with better union rates according to the logistic regression analysis (OR=5,00 (%95 CI 2,24-11,48)).

### Conclusion

The present study suggests that a concurrent fibular fixation in the case of distal third tibia fractures improves neither the union rates nor the alignment. Therefore, we conclude that a fibular fixation is not a necessity in achieving better results and should not be performed in case of an open fracture considering the lesser union rate and the burden involved with an additional surgery.

**Keywords:** Concurrent fibular fixation, Distal tibia fracture, Fibula fracture, Gustilo Anderson classification, Intramedullary nailing, Nonunion

## Introduction

The management of adult distal third tibial fractures is an ongoing debated issue. These fractures are stabilised with different surgical procedures, including plate osteosynthesis, intramedullary nailing (IMN) or external fixation, except those not amenable for surgery. All treatment methods have advantages and disadvantages. Coexistence of fibular fracture is as high as 80% and indicates a higher energy trauma which can lead to an open fracture and more soft tissue injury (1). The treatment for a concurrent fibular fracture in extra articular distal tibia fractures is another controversial issue regarding whether it should be necessarily fixed, except for pilon fractures, where fibular fixation has evidence of improving both clinical and radiological outcomes (2). Nonunion and malunion are among the most common complications of distal third tibial fractures, and fibular fixation mainly aims to prevent these consequences (3). The effects of fibular fixation have been investigated in several clinical and biomechanical studies, but no clinical guidelines or a consensus have been established (4). The researchers examined the effects of fibular

fixation on distal tibia healing and reached different conclusions, both in favour of and against it. Kumar et al. and Strauss et al. stated in their cadaveric biomechanical studies that an ipsilateral fibular fixation or the absence of a concomitant fibular fracture brings more stability when distal tibial fractures are stabilised with an IMN or a locked plate (5, 6). Contrarily, some researchers found an increased nonunion rate in distal tibia fractures when the fibula was intact or fixated (7, 8). The osteosynthesis of the fibula leads to higher operation morbidity which also leads to extra soft tissue problem, increased cost, and longer operation time. Therefore, inconsistent results have led surgeons to uncertainty, and new studies questioning the necessity of a fibular fixation are required to clearly define the indications.

This study was performed to research whether a concurrent fibula fixation in the treatment of distal third tibia fractures improve union rates and provide better alignment and to evaluate the variables affecting the outcomes. We hypothesize that an additional fibular fixation surgery would not improve the outcomes in case of union and alignment.

## Material and Method

The present study was performed after receiving approval from the local ethics committee (10/21/2020-397) and after all participants had signed the consent form. A total of a consecutive 168 patients who had sustained distal third tibia fractures at a single center between January 2016 and June 2020 were evaluated for this retrospective study. The inclusion criteria were as follows: (1) distal third extraarticular tibia fracture (AO 42A, AO 42B, AO 42C), (2) distance from the fracture to plafond should be between 3-12 cm, (3) the presence of skeletal maturity, (4) acute fracture, (5) having no previous surgery in the ipsilateral leg and (5) having at least a six-month follow-up. The exclusion criteria comprised: (1) pilon tibia fractures (AO 43A, AO 43B, AO 43C), (2) Gustilo Anderson type IIIB-C fractures, (3) primarily operated with an external fixation, (4) refractures and (5) pathologic fractures. The definition of a distal tibial fracture is not certain in the literature, and there are different suggestions regarding which site is an AO 42 fracture or an AO 43 fracture. We included distal tibia fractures located between 3 to 12 cm for more objective results regarding previous articles, and all were extra articular (4). Distal third tibial fracture patients who met the inclusion and exclusion criteria after reviewing our hospital database and demographic data, including patients' age, gender, injury mechanisms, surgical records, time delay to surgery, complications and additional procedures, were obtained from a chart review. Time delay was defined as the total number of days until surgery from the initial date of trauma.

All surgeries were performed in a standard manner under general or spinal anaesthesia. All patients had venous thromboembolism prophylaxis with low molecular weight heparin and infection prophylaxis with first generation cephalosporins. LCPs were used as the implant type in all fibular fixation surgeries. Fibular fixation was always initially performed prior to tibial surgery. Tibia fractures were fixed with a reamed IMN, which included at least two interlocking distal screws or an LCP. The decision regarding a fibular fracture fixation and the choice of implant for distal tibial fractures were not randomized and were based on the preference of the surgeon preoperatively.

Radiologic data were obtained from X-ray views using the picture and archiving system. Fracture type, initial postoperative alignment, loss of alignment and fracture union evaluations were based on the preoperative, immediate postoperative and the end of the six-month visit anteroposterior and lateral views. Each fracture was classified based on the preoperative

X-rays according to the AO/OTA Müller long bone classification (9). Open fractures were classified according to the Gustilo Anderson classification. Fibular fractures were further analyzed for fracture location according to tibial fractures. Immediate postoperative views were analyzed regarding initial alignment. Loss of coronal and sagittal alignment was assessed by comparing immediate postoperative views and follow-up views. Malalignment was accepted as more than five degrees of angulation in coronal plane and more than 10 degrees of angulation in the sagittal plane (10).

The patients were examined routinely at six weeks, 12 weeks, and 24 weeks. Range of motion of ankle and knee exercises began immediately after the operation, and the patients were encouraged to undergo rehabilitation. Partial weightbearing with crutches began at six weeks after tibial plating if a visible callus occurred as a sign of consolidation on x-rays. The IMN patients were permitted to walk with partial weightbearing on the first postoperative day. A fracture union was the primary outcome, and it was assessed both radiologically and clinically. A fracture union was confirmed if a bridging callus of at least three cortices of four cortices were observed at the end of the sixth-month orthogonal views radiologically with no tenderness or pain clinically.

### Statistical Analysis

The statistical analyses of the study were performed using SPSS 20.0 (IBM Inc, Chicago, IL, USA). The descriptive statistics were presented as mean  $\pm$  SD and frequency (percentage) for continuous and categorical variables. The normality was checked by the Kolmogorov-Smirnov test. The comparison of the variables according to the status of the fibula was performed by the Kruskal-Wallis test. The post-hoc K-W tests were performed for significant results, and the results were shown by the same symbols. The relation between categorical variables was determined by the Monte Carlo Exact Chi-square test. A univariate logistic regression model was established for the status of the fibula. In all analyses, a  $p < 0.05$  value was considered a statistically significant result by taking the type-I error as 5%.

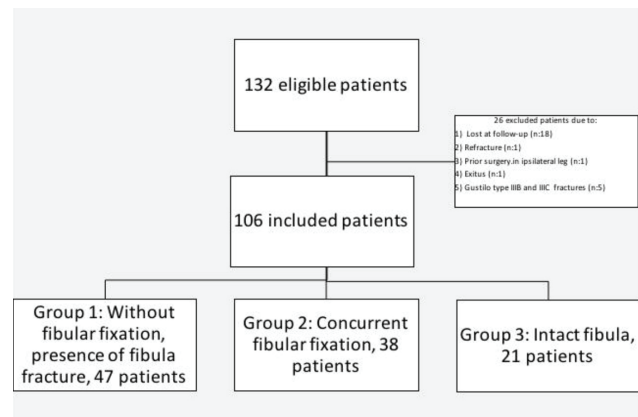
### Power Analysis

The power analysis was performed by G-Power 9.1.2 (Universitaet Kiel, Germany). The analytic tests were chosen by the chi-square test, and the statistical test was detected as Goodness-of-fit test: Contingency tables. The effect size was considered 0.4, with an error of 5% and a power of 0.90. The sample size was calculated as 103 with critical  $X^2 = 11.07$ .

### Results

There were 132 eligible patients who met the inclusion criteria for this study, and 26 of them were excluded during the follow-up period for various reasons (Figure 1). Eventually, 106 patients who underwent surgery for distal third tibia fractures were included for further analyses. These patients were divided into three groups according to the status of the fibula: Group 1, presence of a fibular fracture without its fixation – 47 cases; Group 2, presence of a fibular fracture with its fixation – 38 cases; and Group 3, intact fibula – 21 cases.

Age ranged from 16 to 65 years, and the mean age of the participants was 43,28±17,23. A total of 63.2% (n:67) were male and 36.8% (n:39) female. Age and gender distribution were not significantly different among study groups (p:0.134, p:0.143, respectively);



**Figure 1** Included patients who were divided into groups.

however, the distance from the distal extent of the tibial fracture to the plafond was significantly shorter in Group 2 compared with the other groups (p:0.001),

**Table 1** Baseline characteristics of the patients.

		Group 1 (n=47)	Group 2 (n=38)	Group 3 (n=21)	
<b>Variables</b>	<b>Unit</b>	<b>Mean±SD</b>			<b>p</b>
<b>Age</b>	<b>year</b>	42,36±14,05	47,53±20,97	37,67±14,89	0,134
<b>Distance to plafond</b>	<b>cm</b>	7,96±2,45 <sup>+</sup>	5,90±2,50 <sup>+,‡</sup>	8,18±2,96 <sup>‡</sup>	0,001*
<b>Time delay</b>	<b>day</b>	1,09±1,23	1,34±1,56	1,33±1,56	0,745
<b>Categories</b>		<b>N (%)</b>	<b>N (%)</b>	<b>N (%)</b>	
<b>Gender</b>	<b>Male</b>	14 (29,8)	15 (39,5)	10 (47,6)	0,143
	<b>Female</b>	33 (70,2)	23 (60,5)	11 (52,4)	
<b>AO class</b>	<b>42A</b>	33 (70,2)	23 (60,5)	17 (81,0)	0,413
	<b>42B</b>	11 (23,4)	13 (34,2)	4 (19,0)	
	<b>42C</b>	3 (6,4)	2 (5,3)	0	
<b>Open/closed fractures</b>	<b>Closed</b>	39 (83,0)	32 (84,2)	19 (90,5)	0,439
	<b>Type I</b>	2 (4,3)	3 (7,9)	1 (4,8)	
	<b>Type II</b>	5 (10,6)	3 (7,9)	0	
	<b>Type IIIA</b>	1 (2,1)	0	1 (4,8)	
<b>Injury mechanism</b>	<b>Simple fall</b>	12 (26,1)	12 (31,6)	9 (42,9)	0,055
	<b>Vehicle accident</b>	28 (60,9)	24 (63,2)	11 (52,4)	
	<b>Sports injury</b>	3 (6,5)	1 (2,6)	1 (4,8)	
	<b>Work accident Assault</b>	2 (4,3) 1 (2,2)	1 (2,6) 1 (2,6)		

\*: significant at 0.05 level according to Kruskal-Wallis test

+,‡: same symbols denote the significant pairwise comparison according to K-W post-hoc test

which showed that an adjunctive fibular fixation was more preferred as expected when the fracture was closer to the plafond in this cohort. The most common injury mechanism was a simple fall (59,4%) while the others were listed as vehicle accident, work accident, sports injury or assault. No significant differences were found among treatment groups according to the AO fracture types and the Gustilo Anderson open fracture types. Sixteen fractures were open: there were six type I, eight type II and two type IIIA fractures according to the Gustilo Anderson classification. The baseline characteristics (age, gender), distance of fracture to plafond, injury mechanism, AO classification and Gustilo Anderson open fracture classification were shown in Table 1.

A total of 18 patients had nonunions, and of those, eight were in Group 1, eight in Group 2 and two in Group 3. The independent variables, which were listed as age, gender, the distance from the fracture to the plafond, AO classification of tibia fracture, fibula fracture location, implant type (IMN vs. plating) and presence of an open fracture, were evaluated in each group to determine whether they had an effect on union. A closed fracture was associated with a

higher union in Group 2 ( $p < 0.0001$ ), although it was not significant in Groups 1 or 3 ( $p > 0.05$ ). The other researched parameters were not significantly different (Table 2).

### Assessment of Alignment

Malalignment was accepted as more than five degrees of angulation in a coronal plane and more than 10 degrees of angulation in a sagittal plane (10). When comparing malalignments, there were no significant differences between the groups ( $p > 0.05$ ). Initial malalignment was observed in 13 patients (12,2%). Twelve (11 valgus and 1 varus deformity) were a coronal malalignment and one was a recurvatum deformity in the sagittal plane. None of these patients were undergone further revision surgery. Four patients had additional surgeries in the first postoperative six-month period. Loss of initial alignment occurred in just one patient due to the failure of the plating fixation, and the revision plating had been done in the third month. Two patients with IMN for a distal tibia fracture had received dynamization of the nails for the lack of union in the fourth month after the initial surgery. The other patient had a wound problem, and the wound was healed with debridement, a fasciocutaneous

**Table 2** Comparison of the variables on union for each group.

Variables	Unit	Group 1		p	Group 2		p	Group 3		p
		Nonunion (n=8)	Union (n=39)		Nonunion (n=8)	Union(n=30)		Nonunion (n=2)	Union(n=19)	
		Mean±SD			Mean±SD			Mean±SD		
Age	year	42,50±13,92	42,33±14,25	0,923	43,25±17,41	48,637±21,94	0,61	26,00±14,14	38,89±14,79	0,238
Distance to plafond	cm	9,23±2,74	7,70±2,35	0,111	6,18±3,06	5,83±2,39	0,902	11,00±0,28	7,88±2,96	0,19
Time delay	day	1,13±0,99	1,08±1,28	0,667	0,63±0,74	1,53±1,67	0,183	2,00±0,00	1,26±1,36	0,343
Categories		N (%)	N (%)		N (%)	N (%)		N (%)	N (%)	
Gender	Male	2 (25,0)	12 (30,8)	0,748	1 (12,5)	14 (46,7)	0,083	0	10 (52,6)	0,167
	Female	6 (75,0)	27 (69,2)		7 (87,5)	16 (53,3)		2 (100,0)	9 (47,4)	
AO class	42A	7 (87,5)	26 (66,7)	0,225	2 (25,0)	21 (70,0)	0,063	2 (100,0)	15 (78,9)	0,482
	42B	1 (12,5)	10 (25,6)		4 (50,0)	9 (30,0)		0	4 (21,1)	
	42C	0	3 (7,7)		2 (25,0)	0		...	...	
Open/closed	Closed	5 (62,5)	34 (87,2)	0,208	3 (37,5) <sup>a</sup>	29 (96,7) <sup>a</sup>	<0,001*	2 (100,0)	17 (89,5)	0,677
	Typel	2 (25,0)	0		2 (25,0) <sup>b</sup>	1 (3,3) <sup>b</sup>		0	1 (5,3)	
	Typell	0	5 (12,8)		3 (100,0) <sup>c</sup>	0 <sup>c</sup>		...	...	
	TypellIA	1 (12,5)	0		...	...		0	1 (5,3)	
Tibial implant	LCP	5 (62,5)	25 (64,1)	0,932	7 (87,5)	29 (96,7)	0,309	1 (50,0)	11 (57,9)	0,834
	IMN	3 (37,5)	14 (35,9)		1 (12,5)	1 (3,3)		1 (50,0)	8 (42,1)	
Fibula fracture level	Same	4 (50,0)	13 (33,3)	0,377	8 (100,0)	25 (83,3)	0,252	...	...	
	Above	4 (50,0)	26 (66,7)		0	3 (10,0)		...	...	
	Below	...	...		0	2 (6,7)		...	...	

\*: significant at 0.05 level according to Monte Carlo Exact Chi-square test  
a, b, c: same superscript letters denote the significant pairwise comparison

flap and a semi-thickness split graft operation. All the patients who received additional procedures had a complete union.

### Logistic Regression Analysis

The aim of a rigid fixation of the fibula using a LCP is a stable. In a further analysis, Group 2 and Group 3 were combined considering this aim and compared with Group 1. Group 1 was determined as the reference category to determine the effect of the variables on union. A univariate logistic regression model was created using the 'Forward LR' method. The results of the goodness of fit were significant ( $-2LL=84,97$ ;  $R^2$  Nagelkerke =0,513). A closed fracture had a significantly positive effect, and  $OR=5,00$  (%95 CI 2,24-11,48) was calculated. The other variables were not significant.

### Discussion

The factors influencing the union of distal third tibial fractures can be classified as patient related (BMI, age, gender, smoker/nonsmoker), surgery related (surgical technique, implant type) and the nature of injury (energy level, soft tissue injury, fracture complexity, fracture location and concomitant fibula fracture). One of the most debated risk factors is a concomitant fibular fracture accompanying a distal third tibia fracture, which is an indication of a high-energy level trauma. The subject of debate is whether it should be stabilized. The most important findings of the present study demonstrate that the union rate of distal third tibia-fibula fractures is not associated with a concurrent fibular fixation. Several clinical studies have underscored the importance of the benefits of fibular fixation. Taylor et al. stated that fibular fixation had no positive effect postoperatively both for short-term and long-term follow-up and underlined the implant cost and the increase in additional operative time (11). Javdan et al. researched whether a concurrent fibula fixation was advantageous in their randomized study on 49 AO 43A1-3 extra articular distal tibia fractures and did not observe any advantages regarding malunion, union time or complications in favour of a fixation of the fibula (12). Rouhani et al. also concluded that a concurrent fibular fixation did not add any advantages for distal tibia fractures (13). A cadaveric study, which confirms the present study, reached a conclusion unlike other cadaveric studies that no improved stability could be obtained when multidirectional screws were used in the IMN of distal tibia fractures and proposed the fixation of the fibula if needed for aid reduction (14). Kumar et al. stated as a conclusion in their cadaveric biomechanical study that an ipsilateral fibular fixation brings more rotational

stability when a distal tibial fracture is stabilized with an IMN (5). In another biomechanical study, Morin et al. similarly found increased resistance to torsional forces in distal third tibia fractures when concurrent fibula plating was added, although they stated that their findings could be irrelevant in vivo (15). Strauss et al. stated in their cadaveric biomechanical study that an ipsilateral fibular fixation or the absence of a concomitant fibular fracture brings more stability when distal tibial fractures are stabilized with an IMN or a LCP (5, 6).

An intact fibula and an added fibular fixation are also considered a contributing factor to a nonunion or delayed union in the literature (16). Thus, an extra group of intact fibula was added to the study, but none of the patients in Group 3 had an adverse effect, such as nonunion or malalignment, compared to the other groups.

A postoperative malalignment is another discussed subheading. Several authors emphasised the importance of fibular plating to avoid malalignment during distal tibia fracture surgery. Egol et al. recommended fibular plating to achieve better alignment and to maintain the alignment in the long-term for unstable distal tibia-fibula fractures, which were between 4 to 11 cm to the plafond (17). Taylor et al. modelled this study and conversely found no benefits of the concurrent fixation of the fibula in preventing loss of coronal or sagittal malalignment (11). Kariya et al. found a better rotational alignment and AOFAS score when the fibular fixation was done, although no positive effect on coronal and sagittal alignment was observed (18). The authors of this study argue that alignment is not related to the fibular fixation and is a consequence of accepting the malalignment during surgery. In this study, we observed an initial malalignment in 13 patients, and all underwent an operation with a closed reduction technique for IMN. Loss of alignment was observed in just one patient; inadequate stabilisation was the main reason, and it was revised with an adequate length of plate and screws. Open reduction and internal fixation with a plate were the most preferred techniques in the cohort of this study, which could explain why we observed less malalignment and loss of alignment issues. Intramedullary nailing is associated with more malunion compared to plating (19).

Tibia fractures are prone to nonunion, and it is the most common bone associated with nonunion (20). An open distal tibia fracture that shows the presence of a high-energy trauma is one of the common causes for nonunion, which results in challenges for trauma

surgeons due to the probable complications and the management of patients (21). This trauma leads to wound contamination, decreases the blood supply, harming the periosteum and muscle, and creates an inappropriate environment for bone healing. Thakore et al. determined that the Gustilo grade of fractures was the greatest predicting factor for nonunion development (22). Open fractures were shown to be the only associated factor with nonunion in this study regardless of how the fibula was treated, as shown by the logistic regression analysis. One of the most striking results of the present study was that the union rate was significantly lower if fibular fixation had been done in case of an open fracture in Group 2. This result may have been caused by additional fibular fixation harming and disrupting circulation in the lower leg.

There are several limitations of the present study. First, its retrospective nature caused difficulty in data collection and led to a group of non-included patients being lost in a six-month follow-up period. The limitations of databases precluded us to investigate smoking status, which is one of the patient-related factors for nonunion. The treatment methods were not randomized, and the decisions were not unified for the same characteristic fractures because multiple surgeons were involved in the study. The number of nonunion patients is also small, which could be a misleading factor for conclusions.

The surgical treatment of distal third tibial fractures still a controversial issue in orthopedics and traumatology. Also, the necessity and efficacy of a concurrent fibular fixation is much less clear. According to the results of this study, fibular fixation had no beneficial effect regarding tibial union rate or alignment. The authors of this study believe that it may not need to perform a fibular fixation considering probable wound problems and increased cost of an additional surgical procedure except the syndesmosis or ankle mortise is injured. Future randomized prospective studies are needed to provide insights into this issue.

#### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

#### Ethical Approval

The study was conducted in line with the principles of the Helsinki Declaration. The current study was approved by the local ethical committee (10/21/2020-397) of Suleyman Demirel University.

#### Consent to Participate and Publish

Written informed consent to participate and publish

was obtained from all individual participants included in the study.

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#### Availability of Data and Materials

Data are available on request due to privacy or other restrictions.

#### Authors Contributions

N.T: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Visualization; Writing-original draft, Writing-review & editing.

A.İ: Formal analysis; Investigation; Methodology; Validation; Writing-original draft

A.M.Ü: Methodology, Supervision, Writing-original draft; Writing-review & editing.

#### Editorial

Although AMÜ, one of the authors of the article, is editorial board member of the journal, he has not taken part in any stage of the publication processes of this article.

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