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Two-Stage Surgery for the Malleolar Fracture–Dislocation With Severe Soft Tissue Injuries Does Not Affect the Functional Results

Oğuzhan Tanoğlu, MD[1], Mehmet Burak Gökgöz, MD[2], Ahmet Özmeriç, MD[3], Kadir Bahadır Alemdaroğlu, MD[4]

[1] *Specialist in Orthopedics, Department of Orthopedics and Traumatology, Erzincan University Mengucek Gazi Research and Training Hospital, Erzincan, Turkey*
[2] *Resident Doctor in Orthopedics, Department of Orthopedics and Traumatology, University of Health Sciences, Ankara Research and Training Hospital, Ankara, Turkey*
[3] *Associate Professor in Orthopedics, Department of Orthopedics and Traumatology, University of Health Sciences, Ankara Research and Training Hospital, Ankara, Turkey*
[4] *Professor in Orthopedics, Department of Orthopedics and Traumatology, University of Health Sciences, Ankara Research and Training Hospital, Ankara, Turkey*

A R T I C L E   I N F O

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A B S T R A C T

Soft tissue injuries associated with malleolar fracture–dislocations may increase postoperative rates of wound complication. Ankle-spanning frame plays a fundamental role in the local damage control orthopedics while gaining time for definitive surgery. The objective of this study was to evaluate the effect of a 2-stage surgery for the unstable malleolar fracture–dislocations with severe soft tissue injuries compared to a 1-stage surgery in terms of the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot–ankle and Olerud-Molander ankle scores (OMAS). We analyzed 45 patients who met our study criteria. The patients were divided into 2 groups according to staged surgeries. Demographic data of patients, comorbidities, alcohol and tobacco use, Tscherne soft tissue injury scores, the AOFAS hindfoot–ankle and OMAS, postoperative complications, total hospitalization times, waiting time between stages, and waiting time from admission to surgery times were investigated. There was a statistically significant difference between the groups in terms of the mean total hospitalization times ($p = .007$), waiting time from admission to surgery ($p < .001$), gender ($p = .005$), and Tscherne soft tissue injury scores ($p < .001$). The mean AOFAS hindfoot–ankle and OMAS of the groups did not differ statistically at a minimum of 12 months of the follow-up period ($p = .094$ and $p = .126$, respectively). A 2-stage surgery can be performed safely in the carefully selected patients with the unstable malleolar fracture–dislocations with Tscherne grades 2 and 3 soft tissue injuries, and this surgery does not affect the postoperative AOFAS hindfoot–ankle and OMAS statistically compared to a 1-stage surgery at a minimum of 12 months of the follow-up period.

Malleolar fractures are 1 of the most common injuries to the lower extremity that require operative treatment, and they represent approximately 9% of all fractures (1–3). This incidence in the adult population has increased by 300% in the past 30 years (4). Immediate open reduction and internal fixation are viewed as the gold standard treatment for displaced malleolar fractures (2,5), but the acute surgical treatment of malleolar fracture–dislocation is not always possible, owing to the accompanying severe soft tissue injuries (6–8). Severe soft tissue injury associated with ankle fracture is an important factor affecting the prognosis and postoperative complication rates (9,10). The timings of the definitive surgery for the ankle fractures with soft tissue injuries are still controversial (11–13). Temporary bridging with an ankle-spanning frame, which is a commonly used and a safe treatment option, plays a fundamental role in the local damage control orthopedics while waiting for definitive surgery (5,7,9,14–16). In these cases, the use of a temporary external fixator allows the fracture dislocation to be reduced by ligamentotaxis and promotes the healing of the soft tissue injuries (5,8,12,14–17).

To the best of our knowledge, there are only a few studies about the results or complication rates of a 2-stage surgery for the malleolar fracture–dislocation with severe soft tissue injuries (7,9,16,17). We hypothesized that we would achieve satisfying ankle scores with a 2-stage surgery using a temporary external fixator until the soft tissue healing is obtained for the malleolar fracture–dislocation with substantial soft tissue injuries.

Patients and Methods

This study was conducted after obtaining the approval of the institutional review board. A total of 65 adult patients with malleolar fracture–dislocation, who were

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Address correspondence to: Oğuzhan Tanoğlu, MD, Department of Orthopedics and Traumatology, Erzincan University Mengucek Gazi Research and Training Hospital, Basbaglar Mah, 24100, Erzincan, Turkey.
E-mail address: drtanoglu@gmail.com (O. Tanoğlu).

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operated in Ankara Research and Training Hospital between January 2015 to January 2018, were reviewed via medical records by 2 surgeons (O.T. and M.B.G).

Twenty (30%) patients were excluded from the study owing to incomplete medical records, lost to follow-up visits, polytraumatized patients, and having neurologic or locomotor comorbid diseases that affected the walking and the motion of the lower extremities.

In our study, the main surgical indication for a 2-stage surgery was the tibiotalar incongruity in a short leg splint after closed reduction of fracture dislocation accompanying Tscherne grade 2 or 3 soft tissue injuries. Tscherne grade 2 injury was defined as deep abrasions, with skin or muscle contusion, and Tscherne grade 3 injury was defined as extensive skin contusion, with the destruction of the subcutaneous tissue avulsion or muscle destruction (Fig. 1).

Patients who met the study criteria were divided into 2 groups according to the staged surgeries. In the first group, there were 25 patients who were treated with a 1-stage definitive surgery owing to a stable ankle fracture dislocation with mild soft tissue injuries. In the second group, there were 20 patients who were treated with a 2-stage surgery owing to an unstable ankle fracture dislocation with severe soft tissue injuries.

Thromboembolic prophylaxis with 4000 IU low-molecular-weight heparin subcutaneously was begun at admission and continued until the end of the postoperative first month for all patients. All the interventions were performed by 2 different surgeons (O.T. and A.Ö.). Preoperative intravenous prophylaxis with 1000 mg of first-generation cephalosporin was administered to all patients 30 minutes before the surgery and continued 24 hours postoperatively. All interventions were performed under pneumatic ipsilateral thigh tourniquet hemostasis.

All patients in the 1-stage-surgery group were mobilized in 2 days postoperatively with the help of a walker, without weightbearing on the operated extremity. Splints were removed at the second postoperative week, and active range-of-motion exercises were initiated. Patients could bear weight as tolerated on the operated extremity at postoperative week 6.

All patients in the 2-stage group were operated within 24 hours of admission. All external fixator applications were performed using Prefix 2® (Orthofix, Lewisville, TX). First, a middle-portion self-threaded 4-mm transfixing pin was placed in the body of calcaneus from medial to lateral by using image-intensifier guidance. From the anteromedial surface of the tibia, two 5-mm self-drilling Schanz screws (Orthofix) were placed at approximately 12 cm and 15 cm, respectively, proximal to the ankle joint. Two connection rods were placed to configure the delta formation (Fig. 2). Gently, traction from the calcaneal Schanz screw was applied to provide the alignment by ligamentotaxis. Using an image intensifier, in the anteroposterior and lateral views, reduction was obtained, and the pin clamps were locked (Fig. 3). No open reduction was required in any patients. All patients in the 2-stage group were discharged from the hospital after delta-frame application according to the soft tissue condition, and follow-up visits were arranged at least 1 time in a week for the soft tissue healing process before the second-stage surgery.

After the second-stage surgery, splints were removed at the second postoperative week, and active range-of-motion exercises were initiated. At the sixth postoperative week after the second-stage surgery, the patients could bear weight as tolerated.

In January 2018, after the completion of a minimum 12-month postoperative follow-up period, the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot−ankle score and the Olerud-Molander ankle scores (OMAS) were measured by 2 surgeons (M.B.G. and K.B.A.).

Statistical analysis was performed using SPSS software version 20.0 (IBM, Armonk, NY) by 2 authors (O.T. and K.B.A.). The numeric variables were given as mean and standard deviation, whereas the categoric variables were given as frequencies and percentiles. The comparison of means was performed by the Student's *t* test or the Mann-Whitney *U* test according to the Shapiro-Wilk normality test. The comparison of frequencies was performed by the Pearson chi-square test. Probabilities of the null hypothesis $\leq$ .05 were statistically significant. Post hoc power analysis was performed using G-Power version 3.1.9.2 (Düsseldorf University, Düsseldorf, Germany), and the power of the study (β) was found to be 80.6%.

Fig. 1. Closed ankle fracture accompanying Tscherne grade 2 soft tissue injury.

Fig. 2. Delta configuration of the external fixator.

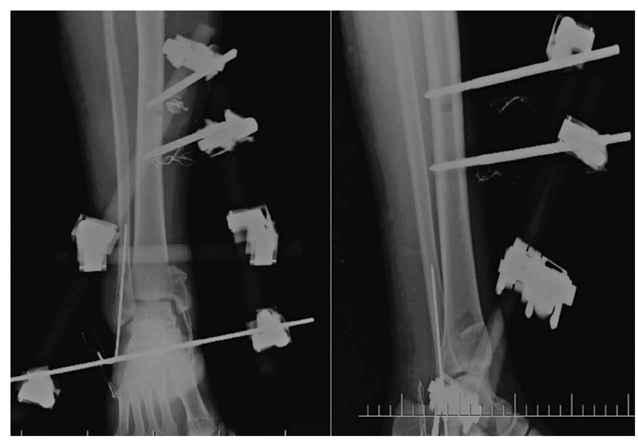

Fig. 3. X-ray images of the temporary stabilization of an ankle fracture−dislocation with an ankle-spanning fixator.

Results

A statistical description of the data for the patients is given in Table 1.

There were no statistically significant differences between the treatment groups in the terms of age, trauma mechanism, diagnosis, Lauge-Hansen classification, Arbeitsgemeinschaft für Osteosynthesefragen - Orthopaedic Trauma Association classification, and duration of the follow-up period. However, there were statistically significant differences between the treatment groups in terms of gender, Tscherne soft tissue injury scores, waiting time from admission to surgery, and total hospitalization times ($p = .005$, $p < .001$, $p < .001$, and $p = .007$, respectively). The mean waiting time between stages in the 2-stage surgery group was 15.7 $\pm$ 6.6 days.

The comorbidities of the patients are shown in Table 2. None of the patients in either group had peripheral vascular disease. No statistically significant differences were noted with regard to these exposures between the treatment groups.

Table 1
Demographic data of patients (N = 45)

	1-Stage Surgery (n = 25)	2-Stage Surgery (n = 20)	*p* Value
Age, y	46.8 ± 13	50.8 ± 17.3	.396
Gender			.005*
Female	19 (76%)	7 (35%)	
Male	6 (24%)	13 (65%)	
Trauma mechanism			.226
Simple	20 (80%)	15 (75%)	
Sports injury	2 (8%)	1 (5%)	
Traffic accident	1 (4%)	4 (20%)	
Fall from height	2 (8%)	-	
Diagnosis			.134
Bimalleolar	22 (88%)	14 (70%)	
Trimalleolar	3 (12%)	6 (30%)	
Lauge–Hansen classification			.951
SAD	2 (8%)	1 (5%)	
SER	14 (56%)	12 (60%)	
PAB	2 (8%)	1 (5%)	
PER	7 (28%)	6 (30%)	
AO–OTA classification			.920
44A	2 (8%)	1 (5%)	
44B	16 (64%)	13 (65%)	
44C	7 (28%)	6 (30%)	
Tscherne classification			<.001*
0	9 (36%)	-	
1	9 (36%)	-	
2	7 (28%)	17 (85%)	
3	-	3 (15%)	
Waiting time from admission	2.8 ± 2.7	1	<.001*
Duration of follow-up	21.7 ± 7.1	19.2 ± 4.4	.185
Total hospitalization time	6.5 ± 3.6	9.9 ± 4.2	.007*

Mean and standard deviations for the terms of age, waiting time from admission, duration of follow-up and total hospitalization time were given. Percentages were given for the other variables.
Abbreviations: AO-OTA, Arbeitsgemeinschaft für Osteosynthesefragen - Orthopaedic Trauma Association classification; PAB, pronation-abduction; PER, pronation-external rotation; SAD, supination-adduction, SER, supination-external rotation.
* Statistically significant.

Table 2
Comorbidities of patients (N = 45)

	1-Stage Surgery	2-Stage Surgery	*p* Value
Diabetes mellitus	4 (16%)	5 (25%)	.453
Hypertension	5 (20%)	7 (35%)	.258
Tobacco	8 (32%)	7 (35%)	.832
Alcohol	1 (4%)	3 (15%)	.198
Open fracture*			
Type 1	1 (4%)	-	
Type 2	1 (4%)	2 (10%)	.423

Percentages were given for all variables.
* Gustilo-Andersen classification.

The postoperative ankle scores and the complications of the patients are shown in Table 3. One (5%) patient in the 2-stage surgery group displayed methicillin-sensitive *Staphylococcus aureus* on wound culture, associated with a prolonged drainage at the wound site 3 months postoperatively. Owing to the completion of the fracture healing at the third month, implant removal and debridement were performed. At the last follow-up visit of the patient, at 25 months postoperatively, there were no signs of infection or osteomyelitis. The other postoperative scores and complications are depicted in Table 3, and no statistically significant differences were noted with regard to these outcomes between the treatment groups.

Discussion

The ankle region is prone to complications owing to the thin and vulnerable soft tissue envelope (5,7,13). The most frequently encountered complications after ankle fractures are wound complications (11). Soft tissue injuries accompanying malleolar fractures increase the risk of infectious wound complications and cause a decrease in functional ankle scores (11,17). Therefore, an appropriate treatment of the accompanying soft tissue injuries is of crucial importance for the correct surgical planning and the timing of the definitive surgery (8,10,17).

Table 3
Postoperative ankle scores and complications of patients (N = 45)

	1-Stage Surgery	2-Stage Surgery	*p* Value
AOFAS hindfoot–ankle score	88.64 ± 13.4	84.6 ± 9.8	.094
Olerud-Molander ankle score	87.8 ± 14.2	83.2 ± 13.3	.126
Prolonged drainage	2 (8%)	1 (5%)	.688
Surgical site infection	-	1 (5%)	
Delayed union	2 (8%)	3 (15%)	.458
Algoneurodystrophy	2 (8%)	3 (15%)	.458
Implant removal	1 (4%)	2 (10%)	.423
Revision surgery requirement	1 (4%)	-	
Fasciotomy	-	1 (5%)	

The mean and standard deviations for the terms of AOFAS hindfoot-ankle and Olerud-Molander scores were given. Percentages were given for the other variables.
Abbreviation: AOFAS, American Orthopaedic Foot and Ankle Society.

According to our results, there was a statistically significant difference between groups in terms of gender distribution ($p = .005$). The percentage of female patients in the 1-stage surgery group was 76%. In contrast to this result, the percentage of male patients in the 2-stage group was 65%. Similar to the results of previous studies, we believe that the main reason for the high percentage of female patients in the 1-stage surgery group is that ankle fractures may occur more commonly in women with low energy trauma owing to osteoporosis. This became evident in women earlier than expected and was not entirely a postmenopausal phenomenon (18,19).

Temporary external fixation is a commonly used and safe treatment option for ankle fractures with severe soft tissue injuries until the soft tissue healing is obtained (5,7–9,12,14,16,17). Calcaneal traction is a temporary treatment option to obtain the alignment in an acute situation but does not provide an adequate stabilization (5,14). External fixation provides the stability of the reduction with ligamentotaxis, especially in an acute situation with or without limited internal fixation (5,14,16). Ankle-spanning frames have the advantages of pin placement outside the zone of injury with the greatest soft tissue compromise, provide more stability than immobilization in a cast, allow patients to mobilize without weightbearing immediately after surgery, and provide an easier observation of the soft tissue condition (5,14,16). Ankle fractures treated with immediate ankle-spanning fixator are less prone to blistering, swelling, and postoperative wound infections (5,12,17). Therefore, we decided to use an ankle-spanning fixator for the immediate treatment of the unstable malleolar fracture–dislocations with Tscherne grades 2 and 3 soft tissue injuries, to avoid wound problems and postoperative complications in our study.

The AOFAS hindfoot–ankle score and OMAS systems are highly reliable and easy to use clinical scales that not only assess symptom and function but also assess the ability of patients to return to work (11,20,21). In our study, we used the Turkish translated and culturally adapted version of the AOFAS hindfoot–ankle score and the OMAS, which showed a high reliability and validity for Turkish-speaking individuals (3,20,22). These scoring systems have a limited application for the patients with nerve injuries or peripheral neuropathy (23). Therefore, to not affect the results, the patients with nerve injuries or peripheral neuropathy were excluded from our study.

In recent studies, the postoperative complications and a delay owing to severe soft tissue injuries accompanying ankle fractures were identified as risk factors for poor outcomes (11,24). In our study, the mean scores of the AOFAS hindfoot−ankle score and the OMAS were found to be lower in the 2-stage surgery group compared to the 1-stage surgery group. Despite these results, there were no statistically significant differences between the 1-stage and 2-stage surgery groups in terms of the AOFAS hindfoot−ankle score and the OMAS.

In the 1-stage group, the mean waiting time from admission to surgery was 2.84 ± 2.7 days, which was shorter than that reported in other studies in the literature (11,24). We decided the optimal time for the definitive treatment in the 1-stage group according to the edema status, skin wrinkling, and skin recovery from blisters.

In our study, the mean waiting time between stages in the 2-stage surgery group was 15.7 days, and this result was consistent with the results reported by Oh et al (16). Our results showed a statistically significant difference between the 1-stage and 2-stage surgery groups in terms of the mean total hospitalization times (6.52 days and 9.95 days, respectively; $p = .007$). The main reasons for the surgical delay and prolonged hospitalization times were the unavailability of the operating theater and prolonged soft tissue swelling between the stages and after the second-stage surgery.

Comorbid diseases, which may potentially affect the clinical scores, according to the data obtained from previous studies, were examined in our study (9,17,25,26). Besides, the frequency of diabetes mellitus and hypertension did not significantly differ between our study groups. Furthermore, the rates of tobacco and alcohol use were similar between our study groups.

The Tscherne classification of soft tissue injuries serves as a valuable clinical tool to categorize and predict the extent of soft tissue injury associated with fractures (8). In our study, a 2-stage surgery was performed only for the unstable malleolar fracture−dislocations, which are thought to be unsuitable for an immediate definitive surgery, owing to accompanying Tscherne grades 2 and 3 soft tissue injuries. For this reason, we found a statistically significant difference between Tscherne grades of patients between the 2 groups.

There are some limitations of our study. Our study was designed retrospectively, and ankle scores were evaluated prospectively. The number of patients in the 2-stage surgery group was not high, owing to the severe soft tissue injuries accompanying the unstable malleolar fracture−dislocations, which were relatively less common than the stable ankle fractures. The main reason for the statistically significant difference between the groups in terms of Tscherne soft tissue injury grades was that the 2-stage surgery group consisted only of patients with Tscherne grades 2 and 3 soft tissue injuries. Different results may be obtained with groups, which include similar Tscherne soft tissue injury grades treated with the 1-stage and 2-stage surgeries. Further randomized-controlled studies or prospective cohort studies, including a larger number of patients, are needed in the literature.

In conclusion, a 2-stage surgery is an option that can be performed safely in the carefully selected patients for the treatment of the unstable malleolar fracture−dislocations with Tscherne grades 2 and 3 soft tissue injuries. According to our study results, the postoperative AOFAS hindfoot−ankle score and OMAS were comparable between the 1-stage and 2-stage surgery groups, despite the initial worse Tscherne scores in the 2-stage surgery group, at a minimum of 12 months of the follow-up period.

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