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Original Article

Comparison of Skeletal Traction and Splinting as a Temporary Stabilization Method in the Initial Treatment of Ankle Fracture-Dislocations

Ayak Bileği Kırıklı Çıkıklarının Başlangıç Tedavisinde Geçici Stabilizasyon Yöntemi Olarak İskelet Traksiyonu ve Atel Uygulamasının Karşılaştırılması

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ABSTRACT

Objective: We aim to compare of effectiveness, functional results, and complication rates of splinting and skeletal traction at initial management of ankle fracture-dislocations.

Methods: Patients who applied for ankle fracture-dislocation between 2013 and 2021, who could not be treated with acute definitive surgery, and who underwent short leg splint or calcaneal skeletal traction in the period up to definitive surgery were evaluated retrospectively. Of the 84 patients included in the study, 48 (57%) were followed up with short leg splint and 36 (43%) with calcaneal skeletal traction. Comparisons between groups were made by collecting demographic data, waiting time until surgery, and preoperative and postoperative complications. In addition, the American Orthopedic Foot and Ankle Association score was used to evaluate functional outcomes.

Results: The rate of loss of reduction was significantly higher in those who underwent calcaneal skeletal traction ($P=.034$). The number of patients who developed skin necrosis in the period until definitive surgery was higher in those who underwent calcaneal skeletal traction ($P=.048$). When the ankle range of motion was evaluated in the postoperative follow-up period, the number of patients with limited range of motion was significantly higher in those who underwent calcaneal skeletal traction ($P=.012$). No significant correlation was found between the postoperative 12th month American Orthopedic Foot and Ankle Association scoring and the temporary stabilization method.

ÖZ

Amaç: Ayak bileği kırıklı çıkıklarının başlangıç tedavisinde atelleme ve iskelet traksiyonunun etkinliğini, fonksiyonel sonuçlarını ve komplikasyon oranlarını karşılaştırmayı amaçladık.

Yöntemler: 2013-2021 yılları arasında ayak bileği kırıklı-çıkığı nedeniyle başvuran, akut nihai cerrahi ile tedavi edilemeyen, nihai cerrahiye kadar geçen süreçte kısa bacak atel (KBA) veya kalkaneal iskelet traksiyonu (KİT) uygulanan hastalar geriye dönük olarak değerlendirildi. Çalışmaya alınan 84 hastanın 48'i (%57) KBA, 36'sı (%43) KİT ile takip edildi. Demografik veriler, ameliyata kadar bekleme süresi, ameliyat öncesi ve sonrası komplikasyonlar toplanarak, gruplar arası karşılaştırmalar yapıldı. Ayrıca fonksiyonel sonuçları değerlendirmek için Amerikan Ortopedik Ayak ve Ayak Bileği Derneği (AOFAS) skoru kullanıldı.

Bulgular: KİT yapılanlarda redüksiyon kaybı oranı anlamlı olarak daha yüksekti ($P=,034$). Nihai cerrahiye kadar geçen sürede cilt nekrozu gelişen hasta sayısı KİT uygulananlarda daha fazlaydı ($P=,048$). Ameliyat sonrası takipte ayak bileği hareket açıklığı değerlendirildiğinde, hareket açıklığı kısıtlı olan hasta sayısı KİT uygulananlarda anlamlı olarak daha yüksekti ($P=,012$). Ameliyat sonrası 12. ay AOFAS skorlaması ile geçici tespit yöntemi arasında anlamlı bir ilişki bulunmadı.

Sonuç: Ayak bileği kırıklı çıkığı olan hastalarda, geçici tespit yöntemi olarak KİT uygulananlarda ameliyat öncesi dönemde

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Conclusion: There was a significant increase in reduction loss, skin necrosis development rate, and limitation in postoperative joint range of motion in the preoperative period compared to short leg splint in patients who underwent calcaneal skeletal traction as a temporary stabilization method in ankle fracture-dislocation patients.

Keywords: Ankle, fracture-dislocation, temporary management, splint, skeletal traction

redüksiyon kaybı, cilt nekrozu gelişme oranı ve ameliyat sonrası dönemde eklem hareket açıklığında kısıtlılık oranında anlamlı artış saptandı.

Anahtar Kelimeler: Ayak bileği kırıklı çıkığı, geçici tedavi, atel, iskelet traksiyonu

INTRODUCTION

Ankle fracture-dislocations are among the most common orthopedic injuries that can cause serious complications in the postoperative period and negatively affect patients' quality of life.[1-3] According to the literature data, 21%-36% of ankle fractures are accompanied by tibiotalar dislocation.[4,5] These are orthopedic injuries that require special attention, as they may cause open injuries, joint disorders, intra-articular cartilage damage, and osteoarthritis that may occur in the postoperative period.[6,7]

In ankle fracture-dislocations, emergency intervention is the basic principle.[8-10] Studies have found a lower rate of infection and wound complications with definitive surgical treatment applied in the early period.[11,12] On the contrary, it has been observed that there is a strong correlation between severe complications and delayed intervention.[8,9] It is possible to find studies in which extremity circulation was impaired and very serious outcomes such as amputation were reported in cases of delayed reduction.[13]

In cases where acute definitive treatment cannot be performed for ankle fracture-dislocations, proper alignment is ensured with a splint, external fixator, or skeletal traction, and it is expected that the conditions preventing surgery can be eliminated.[14] However, reduction loss may occur despite the methods applied to preserve the reduction. This causes more pain, skin complications, osteochondral lesion development, and prolongation of the time for definitive fixation.[15]

Although ankle fractures are very common injuries, studies on ankle fracture-dislocations are limited. The temporary stabilization method is critical for these injuries with serious complication risks, especially in the period until definitive treatment. In our literature review, we did not find any studies comparing short leg splinting (SLS) and calcaneal skeletal traction (CST) which are temporary stabilization methods. Our study was, therefore, designed firstly to determine the radiological and clinical results of SLS and CST which are used as temporary stabilization methods for individuals with ankle fracture-dislocations who cannot immediately undergo definitive surgery in the acute period and then to compare the frequency of complications.

MAIN POINTS

- A higher rate of skin necrosis was found in patients who underwent calcaneal skeletal traction (CST) as a temporary stabilization method compared to those who underwent short leg splint (SLS).
- A higher rate of reduction loss was found in patients who underwent CST than those who underwent SLS.
- It was determined that the frequency of range of motion limitation in postoperative follow-up was higher among patients who had undergone CST compared to SLS.

METHODS

In this retrospective comparative study, which was approved by the relevant ethics committee (Date: 06.09.2021, No:2021/KK/226), patients who were treated and followed up with the diagnosis of ankle fracture-dislocation between 2013 and 2021 were evaluated. The inclusion criteria of the study are as follows: (i) patients who could not undergo emergency surgery due to ankle fracture-dislocation and were followed up with SLS or CST until definitive surgery, (ii) patients between the ages of 18 and 65, and (iii) patients with a follow-up period of at least 1 year. The fracture types included in the study were lateral malleolar, bimalleolar, and trimalleolar fractures. Cases where the talus was displaced by more than 50% compared to the tibia on radiographs were considered an ankle dislocation.[15] Patients who underwent acute definitive treatment, those with a follow-up period of less than 1 year, and those with open fractures or ipsilateral lower extremity fractures were excluded from the study. The patients included in the study were divided into 2 groups according to the temporary stabilization methods employed in the study; those who underwent SLS were considered Group 1 and those who underwent CST were considered Group 2. Demographic characteristics of the patients such as age, gender, and comorbidities were recorded. In addition, the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopedic Trauma Association (AO/OTA) classification system was used to classify fracture types and injury mechanisms.[16]

Data on preoperative and postoperative complications were collected by examining the hospital's digital archive,

and comparisons were made between the groups. Loss of reduction and development of skin necrosis in the examined fracture area before definitive surgery were considered complications, while skin infection and revision surgery were considered complications after definitive surgery. In order to evaluate the postoperative functional outcomes of the patients, the American Orthopedic Foot and Ankle Association (AOFAS) score was routinely applied to the patients with ankle fracture-dislocation at the postoperative 12th month. The AOFAS protocol is a scoring system that uses clinical parameters to numerically evaluate a patient's outcome, including pain, functional assessment, and alignment. The obtained results were reported as good or bad. Scores above 70 out of 100 were considered good results and scores below 70 were considered bad results.[17]

Treatment Protocol

Short leg splint was applied for patients in the emergency department by a senior orthopedic resident after a closed reduction. After reduction, a medial interval of <5 mm and a compatible ankle joint line on radiographs were accepted as evidence of adequate reduction (Figure 1).[18] Reduction was attempted up to 2 times to achieve radiographic alignment. Soft tissue evaluation was performed daily with the wrinkle test to determine surgical suitability.[19] In the case of suspicion of reduction loss, bedside radiographs were taken, and an evaluation was made. Closed reduction was performed by a senior orthopedics and traumatology resident before the CST application, and then the application was begun. A line was drawn from the posterior end of the calcaneus to the medial malleolus. Following this, the drawn line was divided into 3 equal parts. The outer point was the optimal position of the percutaneous Kirschner wire (K-wire) (Figure 2).[20] After applying local anesthesia to the entrance area, a K-wire was extended parallel to the ground from the medial to the lateral of the calcaneus. A puller was then connected to the K-wire. The weight was adapted to the traction system to be less than 1/10 of the body weight.[20] Anteroposterior and lateral radiographs were taken to observe the reduction after the procedure (Figure 3). Daily bedside assessments were performed to observe the reduction and ensure the satisfactory alignment of the fracture without shortening or lengthening. In case of suspicion of reduction loss, bedside follow-up radiographs were taken and an evaluation was made.

The same protocol was used for the postoperative follow-up process of both patient groups. The patients were followed up with SLS for the first 2 weeks postoperatively after definitive surgery. In the second postoperative week, SLS was removed, and ankle joint active motion was started. Weight-bearing was started at 6 weeks postoperatively. Ankle radiographs were taken routinely at the 2nd week, 6th week, 3rd month, 6th month, and 12th month postoperatively to evaluate the union status of the patients.



Figure 1. (A) Photograph of stabilization with short leg splint after closed reduction. (B) Pre-reduction lateral x-ray of a 36-year-old male with left ankle fracture-dislocation after ankle sprain. (C) Initial post-reduction lateral x-ray after closed reduction using a short leg splint.



Figure 2. Photograph of calcaneal skeleton traction pin landmark.



Figure 3. (A) Photograph of stabilization with calcaneal skeletal traction after closed reduction. (B) Pre-reduction lateral x-ray of a 25-year-old male with right ankle fracture-dislocation after ankle sprain. (C) Initial post-reduction lateral x-ray after closed reduction using calcaneal skeletal traction.

Statistical Analysis

IBM Statistical Package for the Social Sciences software for Windows v22.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. The Student's *t*-test was used to compare continuous data. The chi-square test was used to compare frequencies for categorical variables. The Student's *t*-test or Mann–Whitney U-test was used to compare continuous data according to the Kolmogorov–Smirnov normality test. The statistical significance level was accepted as $P < .05$.

RESULTS

A total of 246 patients with ankle fracture-dislocation s were identified via hospital records and evaluated, and then 162 patients who met the exclusion criteria were excluded from the study. Among the excluded patients, 108 patients had ankle fracture-dislocations in which acute open reduction internal fixation was applied, 12 patients had open fractures, 36 patients had a follow-up period of less than 1e year, and 6 patients had accompanying lower extremity fractures. The remaining 84 patients were included in the study, 48 (57%) of whom were included in Group 1 and 36 (43%) of whom were included in Group 2. The mean age of the patients was 38.09 ± 13.86 (range: 18-63) years, and 58 (69%) of whom were men while 26 (31%) of whom were women. The mean waiting time until surgery was 4.87 ± 2.62 (range: 2-11) days in Group 1 and 3.69 ± 1.4 (range: 2-10) days in Group 2.

The distribution of gender, age, affected side, duration of follow-up, smoking status, and presence of diabetes mellitus of the 2 groups were compared, and no statistical differences were found between the groups (Table 1). Also, there was no difference between the fracture classifications, and the most common fracture type was 44B-3 (Group 1=24 (50%), Group 2=22 (61%)) according to the AO/OTA classification in both groups (Table 1). As a result of the analysis, there was no difference between the groups in the waiting time until definitive surgery (Table 2).

When the relationship between the type of stabilization before definitive surgery and reduction loss was

Table 1. Demographic Characteristics and Clinical Details of the Groups

Variables	Group A (n=48)	Group B (n=36)	*P*
Age (years) (mean ± SD)	36.37 ± 14.26 (18-61)	40.4 ± 9.97 (27-63)	.138
Gender			
Female n (%)	16 (33%)	10 (28%)	.585
Male n (%)	32 (67%)	26 (72%)	
Affected side			
Right n (%)	28 (58%)	22 (61)	.797
Left n (%)	20 (42%)	14 (39%)	
Follow-up time (months) (mean ± SD)	34.79 ± 20.31 (12-69)	26.22 ± 18.83 (12-70)	.082
Smoking n (%)			
Smoker	19 (39.6%)	20 (55.5%)	.146
Non-smoker	29 (60.4%)	16 (44.5%)	
Diabetes mellitus n (%)			
Yes	6 (12.5%)	4 (11%)	.845
No	42 (87.5%)	32 (89%)	
AO/OTA classification n (%)			
44B-2	16 (34%)	10 (28%)	.773
44B-3	24 (50%)	22 (61%)	
44C-1	4 (8%)	2 (5.5%)	
44C-2	4 (8%)	2 (5.5%)	

AO/OTA, Arbeitsgemeinschaft für Osteosynthesefragen/Orthopedic Trauma Association, PER, pronation-external rotation; SD, standard deviation; SER, supination-external rotation.

Table 2. Comparison of Time Between Trauma and Definitive Surgery, Complications Before and After Definitive Surgery, Postoperative Joint ROM Limitation, and AOFAS Score

Variables	Group A (n = 48)	Grup B (n = 36)	*P*
Waiting time until definitive surgery (days) (mean ± SD)	4.87 ± 2.62 (2-11)	3.69 ± 1.4 (2-10)	.67
Complications before the definitive surgery n (%)			
Loss of reduction	11 (23%)	17 (47%)	**.034**
Skin necrosis	3 (37.5%)	8 (17%)	**.048**
Complications after definitive surgery n (%)			
Skin infection	2 (8.3%)	3 (11%)	.647
Revision surgery	0 (0%)	0 (0%)	-
Limitation in postoperative joint ROM n (%)	4 (17%)	10 (55.5%)	**.012**
AOFAS score n (%)			
Good result	44 (91.6%)	34 (94.5%)	.696
Bad result	4 (8.4%)	2 (5.5%)	

AOFAS, American Orthopedic Foot and Ankle Society; ROM, range of motion; SD, standard deviation.

examined, it was observed that the number of patients who lost reduction with CST was significantly higher than that of those who underwent SLS ($P = .025$). In the analysis performed to evaluate the relationship between the development of skin necrosis in the preoperative period and the type of stabilization, it was found that the rate of development of skin necrosis before the operation was significantly higher among patients who underwent CST ($P = .034$) (Table 2). No statistically significant relationship was found between stabilization type and postoperative complications (Table 2).

In the evaluation made at the last postoperative follow-up, the number of patients with limited joint range of motion (ROM) was significantly higher in patients who underwent CST than in those who underwent SLS ($P = .012$) (Table 2). There was no significant relationship between AOFAS scores and stabilization type.

DISCUSSION

This study aimed to determine the effects of SLS and CST as temporary stabilization methods before definitive surgery for ankle fracture-dislocations on the development of complications and postoperative functional results. The most important finding of this study was the high rate of skin necrosis and reduction loss among patients who underwent CST as a temporary stabilization method. In addition, it was determined that the frequency of ROM limitation in postoperative follow-up was higher among patients who had undergone CST compared to SLS.

There are multiple causes of recurrent reduction loss, which is detected at a high rate in cases of temporary stabilization with splints for ankle fracture-dislocations.[6,21,22] When the splint is applied immediately after the trauma, it may cause swelling in the foot and ankle. As the swelling decreases, the splint may lose its ability to hold the reduction.[23] In addition, one of the important problems encountered in splint applications is patient noncompliance.[9] After temporary stabilization with a splint, re-dislocation can be observed in 25%-50% of cases.[14,15] No study was found in the literature showing re-dislocation rates after temporary stabilization with CST. In the present study, the rate of re-dislocation during temporary stabilization was calculated as 33%. This result is compatible with the literature. When the temporary stabilization methods were evaluated separately, it was determined that the rate of reduction loss was significantly higher among patients who underwent CST than those who underwent SLS. Calcaneal skeletal traction is a method that can be easily affected by the movements of the patient. Patients undergoing this procedure should move their lower extremities as little as possible. However, patients have difficulty adapting to this situation. We think this is why recurrent dislocations were seen at a higher rate among patients who underwent CST in the period until definitive surgery.

The development of skin necrosis at the injury site is one of the important complications seen in ankle fracture-dislocations.[24] Wawrose et al[14] investigated the effect of splints and fixators on the development of skin necrosis, which is one of the preoperative complications of ankle fracture-dislocations, and did not find any significant difference between the 2 methods. Buyukkuscu et al[18] compared splinting and external fixation as temporary fixation methods in their study and skin necrosis was found to be significantly less prevalent before definitive treatment in the external fixator group. There are no previous studies comparing SLS with CST and examining the development

of preoperative skin necrosis. In this study, in which these 2 methods were compared, it was observed that the rate of skin necrosis development in the preoperative period was significantly higher in patients with CST than in patients with SLS. In patients who underwent CST, the rate of recurrent dislocations in the period until definitive surgery was higher than in those who underwent SLS. Each recurrent dislocation can prolong the recovery time of edema in the injury site. We may conclude that this situation causes skin necrosis as a result of the negative effects on the skin.

There is no study in the literature investigating the effect of temporary stabilization methods used for ankle fracture-dislocations on joint ROM in the postoperative period. According to the results of this study, the number of patients with postoperative ROM limitations was higher in the CST group than in the SLS group. Reduction loss was more common among patients with CST, and such reduction loss may cause damage to the ankle cartilage. It is thought that this affects the joint ROM in the postoperative period.

In the literature, there are many studies conducted to evaluate the functional results of ankle fracture-dislocations in postoperative follow-up.[1,25] However, only one study investigated the effects of different temporary stabilization methods on functional results. Buyukkuscu et al[18] compared splinting and external fixation as temporary stabilization methods and found no significant difference between the methods in terms of functional results. In the present study, it was determined that the effects of SLS and CST applications before definitive surgery on postoperative functional results were similar. Postoperative functional outcomes depend on several factors, including the type of fracture, the surgical method, and the morphological characteristics of the patient, as well as the preoperative temporary stabilization method. Therefore, it is necessary to consider these factors when evaluating the postoperative results. However, it should not be forgotten that proper extremity stabilization is also an important factor in the preoperative period.

Although this study has demonstrated that gradual surgery using a temporary stabilization method is safe and effective, it has also significant limitations. First, this study was retrospective. Second, the number of patients included in the study was small. The third and one of the most important limitations of this study is the patient selection for the temporary treatment methods applied. We believe that a valuable contribution to the literature could be made by conducting randomized prospective studies in which more cases are evaluated.

CONCLUSION

In conclusion, temporary stabilization with CST before definitive surgery in case of ankle fracture-dislocation is associated with the risk of developing skin necrosis and a high incidence of reduction loss in the preoperative period. In addition, CST is one of the important risk factors for the development of ROM limitations in the postoperative period. Surgeons should be aware that when patients are being followed after CST, they should be observed closely for possible complications.

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Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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