



# Early Stage Results in the Treatment of Intra-Articular Calcaneus Fractures and the Factors Affecting Complication Rates

## Kalkaneus Kırıklarının Tedavisinin Erken Dönem Sonuçları ve Komplikasyonları Etkileyen Faktörler

Treatment of Intra-Articular Calcaneus Fractures

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### Özet

**Amaç:** Eklem içi kalkaneus kırıklarının plak ile osteosentez sonuçlarını değerlendirmek ve komplikasyon oranlarını azaltmaya yönelik izlenecek yöntemleri belirlemek. **Gereç ve Yöntem:** Merkezimizde 2010-2013 yılları arasında tedavi edilmiş 43 kalkaneus kırıklı hastanın 45 ayağı çalışmaya alındı. Hastaların 36 tanesi erkek, 7 tanesi kadın idi. Hastaların ortalama yaşı 40,6 idi. Tüm hastalara genişletilmiş lateral insizyonla plak osteosentezi uygulandı. **Bulgular:** Hastalar klinik olarak Maryland ayak skorlamasına göre değerlendirildi. Radyolojik değerlendirme Böhler ve Gissane açılarındaki değişikliklere göre yapıldı. Hastalar ortalama 25 ay (dağılım, 12-38 ay) takip edildi. Beş hasta dışında diğer hastalarda iyi ve çok iyi sonuç elde edildi. **Tartışma:** Literatürdeki çalışmalarla karşılaştırıldığında erken ve orta dönemde başarılı sonuçların benzerliği ve plak ile osteosentezde daha yüksek komplikasyon oranlarının bildirilmesi ilk etapta özellikle yüksek komplikasyon riski taşıyan hastalarda minimal invazif yöntemlerin daha kabul edilebilir olduğunu düşündürmektedir.

### Anahtar Kelimeler

Kalkaneus; Komplikasyon; Kırık

### Abstract

**Aim:** To evaluate the results of plate osteosynthesis in intra-articular calcaneus fractures and to define methods to be followed to reduce complication rates. **Material and Method:** The study included 45 calcaneus fractures of 43 patients treated at our centre between 2010-2013. The patients were 36 males and 7 females with a mean age of 40.6 years. Plate osteosynthesis was applied to all the patients with an extended lateral incision. **Results:** Clinical evaluation of the patients was made using the Maryland Foot Score. Radiological evaluation was made according to change in the Böhler and Gissane angles. The follow-up period was mean 25 months (range, 12-38 months). With the exception of 5 patients, good and excellent results were obtained. **Discussion:** Results of this study were similar to previous studies in the literature in the success of early and mid-term successful plate osteosynthesis. The use of less invasive methods could be a treatment alternative in patients at risk of complications, such as those who are smokers or have Type II diabetes.

### Keywords

Calcaneus; Fracture; Complication

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## Introduction

Calcaneus fractures are the most frequently seen of all tarsal fractures at a rate of 60% [1]. Because 75% of calcaneal fracture related to the subtalar joint surface, they are accepted as problematic fractures in orthopedic surgery[2]. To obtain good results from calcaneus fracture surgery, primary factors include good knowledge of the calcaneus anatomy, appropriate patient selection, and correct timing of the treatment. These types of fractures generally occur from high-energy trauma so it is necessary to be alert for related compartment syndrome, as there may be severe injury to the soft tissue around the bone. Until recently, there was a tendency for conservative treatment of calcaneus fractures because of high rates of infection and other complications and because some centres did not have sufficient imaging and fixation facilities. But there is now a trend for surgical treatment because of positive results reported in the literature worldwide.

Patients with diabetes, who smoke cigarettes, have open fractures, or any substance addiction form a high-risk group in respect of infection or wound site problems [3].

In this study, although the successful results of the open reduction internal fixation applied to 45 calcaneus fractures were consistent with the literature, we aimed to identify cases in which complications developed and to discuss alternative forms of treatment.

## Material and Method

The study included 45 calcaneus fractures of 43 patients treated at our centre between 2010-2013. The patients were 36 males and 7 females with a mean age of  $40.6 \pm 10.6$  years. 2 fractures were bilateral. With an extended, traditional, L-shaped, lateral incision, an anatomic locking titanium plate and screw combination (Wright-Darco) was applied to all patients with open reduction and internal fixation. All the patients were examined in respect of age, gender, follow-up time, severity of trauma, whether the fracture was open or closed, additional injuries, additional diseases, radiological classification of the fracture, and treatment methods. Preoperatively, anteroposterior (AP) and lateral (L) radiographs and computed tomography (CT) images of the ankle were taken. In the early postoperative period, AP and L ankle radiographs were taken. AP and L ankle radiographs were also taken at 45 days and at 3 months postoperatively. At the final follow-up examination, direct radiographs and CT of the ankle were taken. All the fractures were classified according to the Sanders classification.

Radiological evaluation was made by measuring the Böhler angle and the Gissane angle (Figures 1 and 2) on the lateral radiographs before and after reduction. The mean follow-up period was 25 months (range, 12-38 months). At the final follow-up examination, clinical evaluation was made using the Maryland Foot Score, in which pain, walking functions, the cosmetic appearance of the foot, and functional activities are scored between 0-100 [4-5].

## Surgical Technique

All the surgical interventions were applied by one of two surgeons. Extensile, lateral incisions were used in all cases, starting in the proximal from between the Achilles tendon and the



Figure 1. Measurement of Böhler angle



Figure 2. Measurement of Gissane angle

sural nerve, continuing to the plantar and dorsal skin joint, and then extending as far as the calcaneocuboid joint. The sural nerve or branches were located in the proximal and distal. A full layer flap going as deep as the bone was raised from the incision corner. By raising the flap, within which are located the peroneal tendons and sural nerve, from the calcaneus lateral wall towards the anterior, it could then be retracted with 2-3 K-wires placed in the talus neck and fibula. A pin was placed in a manner so as not to pass the medial cortex from the lateral of the posterior of the fracture line. The fracture fragments were first identified with axial traction and a varus manoeuvre. By raising the posterior facet from the cancellous bone with a periosteum elevator, the joint was reduced and restoration was achieved. Then the Böhler and Gissane angles were corrected with pin manipulation. Under fluoroscopy guidance, calcaneus fixation was achieved with an anatomic plate.

## Statistical Analysis

The Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois) version 11.5 was used for statistical analysis. The patients were divided into two groups according to the baseline Böhler angle: Group 1 (Böhler angle  $\leq 0^\circ$ ;  $n=14$ ) and Group 2 (Böhler angle  $>0^\circ$ ;  $n=31$ ). Continuous variables were expressed as mean  $\pm$  standard deviation (SD) and categorical variables were expressed as number (n) and percentage (%). The difference between continuous variables was evaluated with the Mann Whitney U test. The difference between categorical variables was evaluated with the Chi-square ( $\chi^2$ ) or Fisher Exact test as appropriate. The Spearman correlation test was applied for correlation analysis. A two-sided p value  $<0.05$  was considered to indicate statistical significance.

## Results

The fractures were 39 closed and 6 open. Of the total patients, 6 had Type 2 diabetes and were receiving regular treatment,

20 were cigarette smokers (>10/day), and 5 had an additional injury. The fractures occurred as a result of a fall from 3 metres or higher in 34 patients and from a fall of 2 metres or lower in 9 patients. According to the Sanders classification using CT, the fractures were 10 Type II, 18 Type III, and 17 Type IV.

The mean age of the patients was 40.6±10.6 years. Statistical analysis was made of the clinical and radiological results of the patients separated into groups of those with Böhler angle <0° and >0°, those with and without diabetes, and those who smoked or did not smoke cigarettes.

Taking the preoperative Böhler angle into consideration, Group 1 comprised 14 patients with Böhler angle <0° and Group 2 was 31 patients with Böhler angle >0°. In Group 1, the mean Böhler angle was measured as -2.4° preoperatively and 21.2° postoperatively. In Group 2, the mean Böhler angle was measured as 4.2° preoperatively and 25.8° postoperatively.

The improvement in mean Böhler angle was 23.6° in Group 1 and 21.6° in Group 2. The difference of 2° between the groups was not found to be statistically significant. The postoperative angle was >20° in 11 (78%) feet in Group 1 and in 24 (77%) feet in Group 2. In Group 1, the mean Gissane angle was measured as 150.5° preoperatively and 123.9° postoperatively. In Group 2, the mean Gissane angle was measured as 145.6° preoperatively and 126.3° postoperatively. The mean postoperative Maryland score was 78.4 in Group 1 and 85.1 in Group 2, and this difference was determined to be statistically significant (p<0.001). Complications developed in 4 feet in each group; this was not statistically significant (p=0.231) (Table 1).

No statistically significant difference was determined between the groups with and without diabetes in respect of the preoperative and postoperative Böhler and Gissane angles. Although the Maryland scores of the diabetes group were lower, the difference was not statistically significant. Complications developed in 50% of the patients with diabetes and 12.8% of the patients without diabetes. The difference in these rates was determined to be statistically significant (p<0.05) (Table 2).

The clinical scores were found to be higher in the non-smoking group compared to the smoking group but the difference was not statistically significant. Complications developed in 7 of the 20 smoking patients and in 1 of the 25 non-smoking patients. This difference was found to be statistically significant (p<0.005). (Table 3)

When the statistical data were evaluated, two significant results could be concluded:

A positive interaction was determined between the preoperative Böhler angle and the postoperative clinical results of the patients in both Groups 1 and 2. As the preoperative Böhler angle advanced towards a negative value, even if a normal angle was obtained as a result of the operation, the postoperative clinical results deteriorated. However, this did not affect the rate of complications seen. In other words, a preoperative negative Böhler angle did not increase the incidence of postoperative complications.

The second outcome was that in patients with a smoking or Type II diabetes history, a statistically significant increase was determined in the rate of postoperative complications (p<0.005).

Table 1. Baseline demographic, clinical, and post-procedural properties

	All cases (n=45)	Group 1 (n=14)	Group 2 (n=31)	P
Age, (years)	40.6 ± 10.6	44.6 ± 12.0	38.8 ± 9.6	0.111
Female gender	7 (15.6)	2 (14.3)	5 (16.1)	0.874
Current smoker	20 (44.4)	7 (50.0)	13 (41.9)	0.614
Diabetes mellitus	6 (13.3)	2 (14.3)	4 (12.9)	0.899
SandersType				
1	0 (0.0)	0 (0.0)	0 (0.0)	
2	10 (22.2)	0 (0.0)	10 (32.3)	0.019
3	18 (40.0)	2 (14.3)	16 (51.6)	0.023
4	17 (37.8)	12 (85.7)	5 (16.1)	<0.001
Open Fracture, type				
1	5 (11.1)	3 (21.4)	2 (6.5)	0.166
2	1 (2.2)	0 (0.0)	1 (3.2)	1
Böhler angle, °				
Preoperative	2.2 ± 3.8	-2.4 ± 2.3	4.2 ± 2.2	<0.001
Postoperative	20.4 ± 4.4	21.2 ± 4.1	25.8 ± 3.6	0.005
Change of Böhler	18.2 ± 3.7	23.6 ± 3.5	21.6 ± 3.7	0.140
Gissane angle, °				
Preoperative	143.7 ± 8.5	150.5 ± 5.5	141.6 ± 7.5	<0.001
Postoperative	128.6 ± 6.4	123.9 ± 3.9	126.3 ± 5.8	<0.001
Change of Gissane angle	-15.1 ± 5.9	-26.6 ± 3.9	-15.3 ± 6.6	0.238
Maryland score	83.1 ± 6.6	78.4 ± 3.7	85.1 ± 6.5	0.002
Maryland score≥85	22(48.8)	4(28.5)	18 (58)	0.008
Complications	8 (17.8)	4 (28.6)	4 (12.9)	0.231
Infection	4 (8.9)	2 (14.3)	2 (6.5)	0.578
Wound complications	3 (6.7)	1 (7.1)	2 (6.5)	1
Neuropraxia	1 (2.2)	1 (7.1)	0 (0.0)	0.311

Data are expressed as number (percentage) or as mean ± standard deviation

Table 2. Clinical and procedural properties—Patients with diabetes mellitus

	Diabetes mellitus (+) (n=6)	Diabetes mellitus (-) (n=39)	P
Age, yr	47.2 ± 7.1	39.6 ± 10.8	0.096
Böhler angle, °			
Preoperative	2.1 ± 3.5	2.3 ± 5.5	0.700
Postoperative	20.5 ± 3.9	20.0 ± 7.1	0.947
Change of Böhler	18.3 ± 3.5	17.7 ± 4.9	0.933
Gissane angle, °			
Preoperative	128.4 ± 7.8	137.7 ± 6.8	0.009
Postoperative	107.9 ± 6.3	113.0 ± 5.1	0.082
Change of Gissane angle	-20.5 ± 6.1	-24.7 ± 2.1	0.101
Maryland score	78.3 ± 2.9	83.7 ± 6.8	0.067
Maryland score≥85	0 (0.0)	22 (41.0)	0.049
Complications	3 (50.0)	5 (12.8)	0.047
Infection	1 (16.7)	3 (7.7)	0.448
Wound complications	2 (33.3)	1 (2.6)	0.043
Neuropraxia	0 (0.0)	1 (2.6)	1

Data are expressed as number (percentage) or as mean ± standard deviation

## Discussion

For many years in orthopaedic surgery, many surgeons steered clear of an open surgical approach for calcaneus fractures, as they considered that limited benefit could be provided in respect of preventing arthritis and deformity which can develop in the late period and because of the possibility of complica-

Table 3. Clinical and procedural properties according to smoking status

	Current smoker (n=20)	Non-smoker (n=25)	P
Age (years)	39.5 ± 10.8	41.6 ± 10.6	0.385
Böhler angle, °			
Preoperative	1.3 ± 4.7	2.9 ± 2.9	0.429
Postoperative	19.7 ± 4.6	21.0 ± 4.1	0.372
Change of Böhler	18.4 ± 2.9	18.1 ± 4.3	0.963
Gissane angle, °			
Preoperative	130.2 ± 9.6	129.2 ± 9.1	0.478
Postoperative	109.9 ± 6.4	107.6 ± 6.2	0.217
Change of Gissane angle	-20.3 ± 7.3	-21.7 ± 4.5	0.390
Maryland score	82.2 ± 9.3	86.1 ± 6.3	0.008
Maryland score ≥ 90	5 (25.0)	11 (44.0)	0.186
Complications	7 (35.0)	1 (4.0)	0.015
Infection	4 (20.0)	0 (0.0)	0.033
Wound complications	2 (10.0)	1 (4.0)	0.577
Neuropraxia	1 (5.0)	0 (0.0)	0.444

Data are expressed as number (percentage) or as mean ± standard deviation

tions [6]. The most frequently seen early-stage complications include infection, wound site problems, prolonged serous discharge, and damage to the peroneal tendon and sural nerve. However, developments in surgical techniques and infection control have brought surgical treatment into popular use again in recent years [7].

In studies by Parmar et al.[8] comparisons were made of calcaneus fractures treated with operative and non-operative methods and no significant difference was found in the results clinically or radiologically. Paul et al.[9] made a retrospective examination of 70 displaced and non-displaced calcaneus fractures and reported that the results of the non-displaced calcaneus fractures were better and the results of the non-operated displaced fractures were poor with weak restoration of the Böhler angle. In the current study, considering the importance of anatomic restoration of the Böhler and Gissane angles of the subtalar joint with open surgery, open reduction with plate-screw osteosynthesis was applied. The anatomic reduction and stable osteosynthesis obtained were seen to be related to the high clinical scores.

The effect of the preoperative Böhler angle on postoperative long-term functional results was investigated by Persson et al.[10]. It was reported that preoperative negative Böhler values had a negative effect on long-term functional results. In a study by Pozo et al.[11] it was suggested that the effect of the subtalar joint on results was exaggerated and that soft tissues were mainly responsible for residual symptoms. In the current study, a comparison was made of cases with a preoperative Böhler angle <0° and >0°, and although an angular improvement was obtained in the cases with preoperative Böhler angle <0°, the Maryland scores obtained for those cases were statistically significantly lower. This result was thought to be related to the soft tissue damage created as a result of high-energy trauma. In this context, it is therefore believed necessary for both surgeon and patient to be aware that there is a possibility of relatively lower functional and clinical results in patients with a preoperative Böhler angle of <0°. In addition to this finding, it

was also determined that a preoperative Böhler angle that had shifted to negative did not affect the incidence of postoperative complications.

The most common complications following calcaneus fractures have been reported to be wound site necrosis (13.8%) and neurovascular injury (2.8%) [12]. Sural nerve injury has been reported to be significantly high particularly in the direct lateral and extended lateral approaches [13]. The severe course of infection and wound site problems has been especially highlighted as these may be of lengthy duration, costly, and could result in amputation [12, 14]. Patients with diabetes, who smoke, have open fractures, or who have a substance addiction are at a significantly higher risk of infection [15, 16]. In a report of the surgical treatment results of 218 displaced calcaneus fractures, there were complications such as infection, wound site problems, and neuropraxia in 34 (16.5%) patients, and secondary procedures such as arthrodesis and osteotomy were applied to 17 (7.8%) patients in the long-term. However, the conclusion of that study emphasised that osteosynthesis with a lateral approach in calcaneus fractures was a safe and reliable method [17].

In another study, with extensile lateral approach with open reduction and internal fixation, it was reported that complication rates reached 20% [18]. In the current study, the mean Maryland score was found to be 83.1. Complications developed in 8 (17%) patients, which was close to the generally reported rates. Although these results are consistent with the literature, the rate of complications in patients with a lateral extensile L-shaped incision was considered relatively high. This indicates that there is a need for alternative techniques to reduce possible complications in some patients.

Of the 8 patients with complications, 4 had Type 2 diabetes and 7 smoked cigarettes which supported findings in the literature in respect of risk factors. Despite the successful clinical and radiological results of surgical treatment, the serious outcomes of complications that can develop, especially infection and wound site problems, have encouraged studies comparing less invasive fixation methods and conservative methods. In a study by Wang Q et al.[19] comparing conservative methods and surgical treatment methods, no statistically significant difference was found in the clinical results but fewer complications were reported in the group where less invasive fixation had been applied. In recent studies evaluating a minimally invasive approach and fixation, satisfactory results and low complication rates have been reported [20, 21, 22]. Even in Sanders Type 4 fractures, long-term successful results have been reported from conservative treatment [13]. Results of semi-invasive techniques with arthroscopic joint reduction and percutaneous fixation early-stage were successful with low complication rates[23]. In the current study, the complication rate of patients with a risk factor was significantly higher than that of those with no risk factor; these complications were observed to have a negative effect on functional results even if the surgical reconstruction was sufficient.

### Conclusion

In the surgical treatment of calcaneus fractures, although the negative shift of the Böhler angle related to high-energy trauma

ma had a negative effect on postoperative clinical results, it did not affect complication rates. Where as The patients with type II diabetes and cigarette smokers were associated with high complication rates. This suggests that in the surgical treatment of calcaneus fractures, the risk of complication depends more on the presence of risk factors such as a history of Type II diabetes and cigarette smoking than on the fracture type. Therefore, it can be considered that the use of less invasive methods could be a treatment alternative in patients at risk of complications.

Examples for references (Pay attention to punctuation marks): For international published articles: Çubuk EC, Karakurt T. Surgical management of chest wall tuberculosis. *J Cutan Med Surg* 2009;13(1):33-9.

### Competing interests

The authors declare that they have no competing interests.

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