ACTA FACULTATIS
MEDICAE NAISSENSIS

UDC: 616.718.7-001.5-089
DOI: 10.5937/afmnai39-33264

Case report

Sanders type III Calcaneal Fracture Fixed with a Locking Angular Plate: A Case Report

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SUMMARY

Introduction. The calcaneus is a tarsal bone which plays a major role in transferring weight from the lower leg down through the ankle joint onto the forefoot and toes. It participates in the formation of the outer and inner longitudinal arch of the foot and has a significant role in walking and transferring body weight. Calcaneal fractures most often occur by jumping, falling from a height, or less often, in traffic accidents. Calcaneal fractures can be extra-articular and intra-articular. Intra-articular fractures can entirely damage joint surfaces, which results in deformity and immobility of the foot. They can be extra-articular and intra-articular, when disruption of the entire articular surfaces, deformity, and weakness of the foot occur.
Case report. This case report presents a 40-year-old male with an intra-articular calcaneal fracture. He was injured by falling from a height of 3 meters and sustained an intra-articular fracture type IIIAB where one fracture line went laterally and the other centrally over the posterior calcaneal facet. Surgery was performed on the sixth day after the injury. The prepared locking plate for calcaneus was adapted and fixed with spongy screws in relatively preserved joint fragments: sustentaculum tali, tuberositas lateralis calcanei and tuber calcanei. In this way, we ensured the position of the repaired fragments, and then we placed 4 more spongy screws inside the healthy bone tissue, which was enabled with the use of this plate. With this procedure, the calcaneal axis, i.e. the varus deformity, height, width, length and angles of the bone (Bohler's and Gissane's angle) were corrected. From day one, the patient started to move his toes, and on the third day the patient started to move the ankle and began to walk with the help of props with no support on the leg.
Conclusion. The preoperative value of Bohler's angle is a significant correlation between the severity of the injury and displacement of fragments in intra-articular calcaneal fractures. The goal of the surgery was to restore the posterior calcaneal articular facet, avoid soft tissue infection and form a normal shape and position of a foot.

Keywords: **calcaneus, weight transfer, fracture, osteosynthesis**

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INTRODUCTION

The calcaneus is the largest of the tarsal bones. It is a spongy, oval shape bone consisting of six sides. The anterior side of the calcaneus with its cuboid bone forms a calcaneocuboid joint. The posterior part of the calcaneus (tuber calcanei) is massive, the back side of which is rough and covered with adipose tissue and calcaneal bursa, which protect the Achilles tendon. The two side parts are parallel, the lateral side is smooth and flat and has the advantages and suitability for internal fixation with a plate (1, 2). The medial side is rough and covered with a neurovascular bundle, which makes the surgical approach even more challenging. The superior side in its middle posterior part has a facet joint for articulating with the talus – and the two form the subtalar joint. In front of it is the second articular surface (facies articularis), which corresponds to the second articular surface of the talus. The groove divides it into the middle and the front facet. The calcaneal sulcus is wide and with a corresponding groove of the talus it forms the tarsal canal. This canal is occupied by the interosseous talocalcaneal ligament, which firmly connects the ankle with the heel bone and the vascular network that feeds 2/3 of the talus body (3).

About 1 - 2% of all body fractures are calcaneal fractures, while about 60 - 70% of these are tarsal bone fractures (4, 5). In over 60% of cases, calcaneal fractures occur by falling from a height, and in 10% of cases they can be bilateral (6, 7). Another reason for the calcaneal fractures are road traffic accidents, or car-tire injuries, when the wheel of the vehicle runs over the foot that rests on the ground (8).

There are two types of calcaneal fractures:

1. Intra-articular fractures are more common, up to 75% and involve the posterior talar articular facet of the calcaneus. The Sanders classification groups divides these fractures into four types (9). The primary fracture line passes through the posterior calcaneal articular facet and is directed medially or laterally. If the force of the trauma is excessive, another fracture line appears and fractures the surface of the ankle, forming a tongue-like depressed bone fragment, having different directions of extension (A, B, C), different localizations and dislocations of fragments (Figure 1).

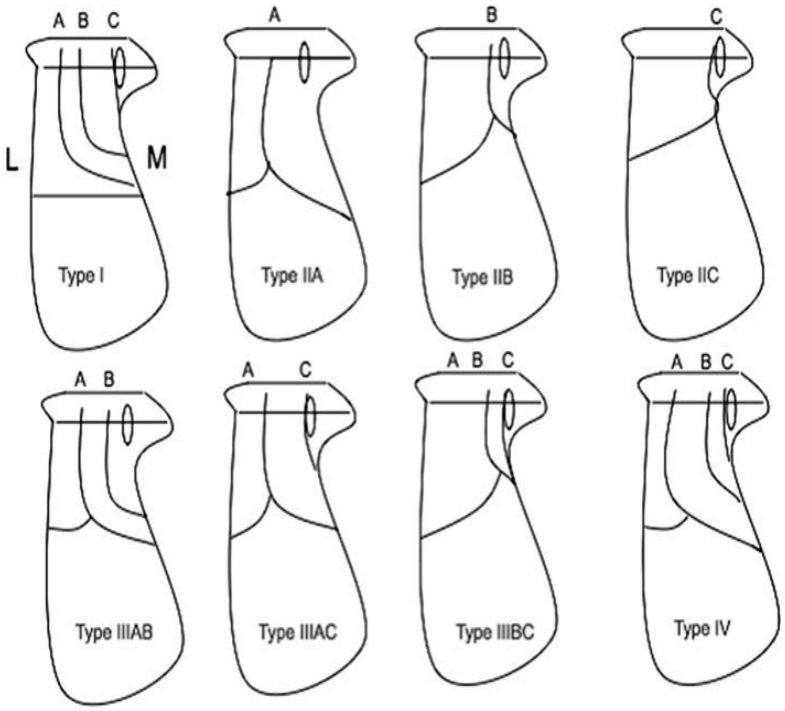

Figure 1. *Sanders classification. Line drawing of a semi-coronal image of the calcaneus showing all three fracture lines (A, B, C)*

2. Extra-articular fractures do not involve the posterior facet of the subtalar joint. They are less common, up to 25% (6).

At the time of patient admission, it is necessary to determine an accurate diagnosis and get the insight into the severity and shape of the fracture. A golden rule is to perform lateral radiography of the foot and multi-slice computed tomography (MSCT) which shows the fracture reconstruction.

Intra-articular fractures, Sanders type I and type II are treated conventionally, if there is no heavy dislocation of fragments, and the same applies to extra-articular fractures. Other fractures, Sanders type II with dislocation, Sanders type III and IV are treated surgically in order to reposition fragments and restore anatomical appearance of the posterior calcaneal facet.

The aim of this study was to present a severe form of a calcaneal fracture (Sanders type III) and the surgical procedure which involves the use of a locking plate and screws fixed inside the healthy fragments, all along ensuring the stability of the fracture.

CASE REPORT

Herein we present a case of a 40-year-old man with an intra-articular calcaneal fracture. He was injured by falling from a height of 3 meters.

In our methodology, we used the Sanders classification for intra-articular calcaneal fractures (Figure 1). It is based on the number of fracture lines, the number of fragments and the classified four types of fractures. In our case, there is an intra-articular fracture type IIIAB where one fracture line goes laterally and the other centrally over the posterior calcaneal facet.

To monitor the morphology of the calcaneus, we applied the parameters which show the reliability and the degree of trauma:

1. Length of the calcaneus - the distance from the end point of the tuber calcaneus to the calcaneocuboid joint; the average values in men are 75 mm, and in women 69 mm (10).

2. Height of the calcaneus - the distance from the inferior cortex to the highest point on the posterior facet.

3. Width of the calcaneus - the distance between the lateral and medial cortex.

4. Bohler's angle - this is an angle formed by the intersection of two lines, one starting from the highest point on the posterior facet and going over the upper edge of the tuber calcanei, and the other from the highest point on the posterior facet to the upper edge of the calcaneocuboid joint. The normal values for Bohler's angle is 25 - 400 (11).

5. Gissane's angle - this is the angle formed between the tangent drawn from the posterior articular facet and the line drawn from the upper side of the calcaneus to the calcaneocuboid joint. The average

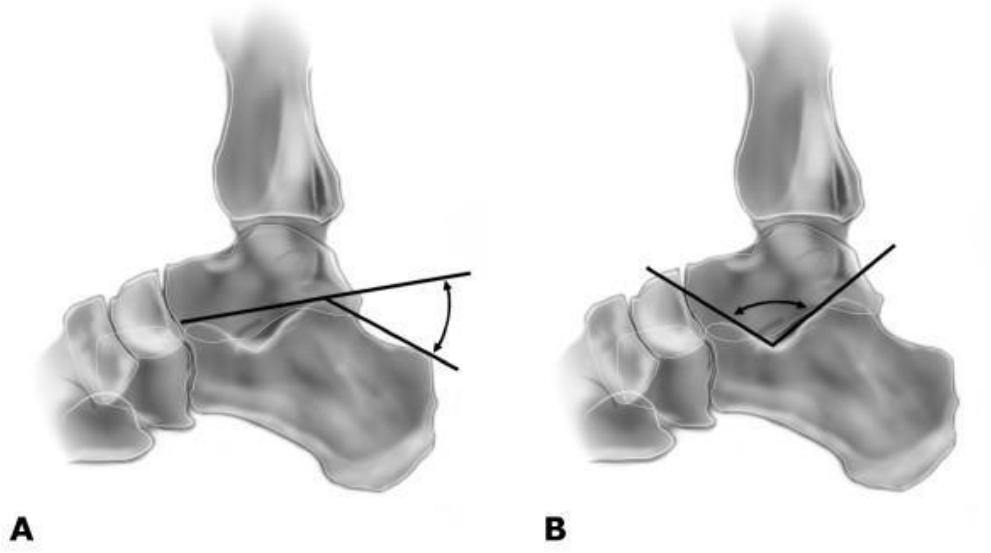

Figure 2. *Measurement techniques - Bohler's angle (A); Gissane's angle (B)*

value of this angle is 120 - 1450 (12), (Figure 2A, B).

In order to restore the length of the calcaneus, it is necessary to perform anatomical reposition of the calcaneus and in this way regulate its height and width. To control the length of the calcaneus in intra-articular fractures, we use the method of comparing the length of the talus with the length of the calcaneus. Preoperatively, radiologically, we determine the length of the calcaneus in order to determine the length of the adequate plate, which is equal to the length of the talus, increased by 1/3, i.e. the ratio of the talus length to the calcaneus length is 1:1.3 (13).

As an indication for surgical treatment of intra-articular calcaneal fracture, we applied the following parameters: 1) Sanders type II - IV, 2) roughness of joint surfaces, displacement > 1 cm, 3) loss of calcaneal height > 1.5 cm, increase in width > 1 cm and leg shortening > 2 cm, 4) Bohler's angle < 200, Gissane's angle < 1000 or > 1350, 5) calcaneal varus > 500 and eversion > 100 (14).

On admission, an X-ray and MSCT of the right foot were performed. Upon inspection we confirmed that this was an intra-articular calcaneal fracture, Sanders type IIIAB. The foot was swollen, painful, with ecchymosis and tense skin, and movements in the ankle were painful and limited. An analgesic was given, the plaster splint was not placed due to the large swelling, and the leg was elevated and cooled, while the local skin status was monitored. After five days, the swelling subsided, the skin in the heel area was wrinkled, without bullous changes.

The surgery was performed on the sixth day after the injury. Thirty minutes before surgery the patient was given Longaceph 2 g, preventively. The patient was positioned on a healthy hip, intravenous conduction anesthesia was performed and a Tourniquet (pressure 45 KPa) was placed to reduce blood loss and ensure good visibility of the operative field. With a lateral L incision, we dissected the skin and subcutaneous tissue to the periosteum, made a cut of the peroneal retinacula and pulled the tendons of the long and short peroneal muscle with the accompanying nerve. We placed a 3 mm Steinmann pin in the caput tali and tuber calcanei - this is how we exposed the subtalar joint, calcaneocuboid joint and the outer calcaneal wall. In the outer-middle part of the posterior calcaneal articular facet, we noticed fragments denivelation, so we performed an elevation of fragments with a 2 mm Kurchner needle and obtained the anatomical reposition and smooth surface of the posterior facet. We managed to fix Bohler's and Gissane's angle with these maneuvers. The prepared locking plate for calcaneus was adapted and fixed with spongy screws in relatively preserved joint fragments: sustentaculum tali, tuberositas lateralis calcanei and tuber calcanei. In this way, the position of the repaired fragments was ensured, and then four more spongy screws were placed inside the healthy bone tissue, which is possible with the use of this plate (Figure 3 A, B, C). The task of the placed plate is to fix at least three points within the calcaneal body and to ensure stability which would not allow secondary displacement of fragments and skin tension. With this procedure, we corrected the calcaneal axis, i.e. we corrected the varus deformity, height, width, length and angles of the bone (Bohler's

Figure 3. *Fracturae calcaneus, Sanders tip III (A)*

Figure 3. *Fracturae calcaneus, osteosintesis of the angulare plate B*

Figure 3. *Fracturae calcaneus, osteosintesis of the angulare plate C*

and Gissane's angle). We radiologically checked all the parameters. The wound was sutured and suction drainage was placed in for 24 hours, after which the drainage was < 30 ml.

Postoperative treatment consisted of cooling and elevation of the leg, without orthopedic cast, and for 4 days the patient was given an antibiotic and analgesic (Longaceph 2 g, Novalgetol). From day one, the patient started to move his toes, and on the third day the patient started to move the ankle and began walking with the help of props with no support on the leg. After 6 weeks, we allowed a load of 25% of body weight, with a gradual increase, and after 12 weeks we allowed full body support. We monitored the healing process radiologically, after the first, third and sixth month.

One year after the injury, we performed a clinical evaluation according to the American Orthopaedic Foot and Ankle Society (AOFAS), Ankle – Hindfoot score – excellent result (90 - 100 points), good result (75 - 89 points), average result (50 - 74 points) and poor result (< 50 points) (15). The total score in our patient was 92 points with the following parameters: the values of the height, length and width of the calcaneus are the same as the ones on calcaneus of a healthy leg; Bohler's angle was 310, and had been 200, Gissane's angle was 1250, and had been 1000. The patient had no pain or swelling in the foot, the movements of the ankle joint were within the full range. We assessed the degree of post-traumatic arthritis by the means of classification according to Tonnis (16), and the subtalar joint was without signs of arthritic changes.

DISCUSSION

Calcaneus fractures are very common fractures of tarsal bones, and occurr in about 60 - 70%. About 75% of calcaneus fractures are intra-articular, with significant dislocation of the posterior calcaneal articular facet of varying degrees (3).

Bohler's angle quantifies displacement and is a prognostic indicator of calcaneus fracture repair. It is a crucial angle and is related to the degree of dislocation and the type of injury according to Sanders classification (17). The decrease in the Bohler's angle is an indicator of the severity of the trauma and the displacement of bone fragments. Technically, it is very difficult to restore this angle to the normal position. Therefore, the first goal of surgery is to restore the Bohler's angle. If the restoration of the angle is greater than 100, a good outcome is expected (18, 19), and bad restoration results in a bad outcome. The postoperative Bohler's angle can predict the clinical outcome and there is a significant positive correlation between the size of the angle and the final result measured according to the AOFAS system (20 - 22). Sanders et al. (9) present the relationship between the type of a fracture and the possibility of repositioning the Bohler's angle: type II (66% anatomical reposition), type III (60% anatomical reposition), type IV (no anatomical reposition) – subtalar arthrodesis is recommended.

In our case, the restoration of the joint surface was achieved, i.e. we achieved the anatomical reposition of the posterior facet of the calcaneus and Bohler's angle was corrected by 120, and therefore a good result was expected.

Many authors state that the end result of treatment depends on the primary loss of cartilage from the posterior facet, which is more distinct in severe forms of fractures (Sanders, type III and IV). The result of the treatment also depends on the residual dislocation of the cartilage, which appears in a stairs-like shape, and if this dislocation is > 2 mm, the functional result will be poor (5, 7, 9)

Calcaneal fractures can be treated conventionally (23) (extra-articular fractures and Sanders type I and II fractures without dislocation) and surgically: by means of solo screws, Essex – Lopresti method (12) and a plate with screws. A modelled polygonal plate is most often used because of its advantages: 1) it can be placed over a minimal surgical incision and the screws can be fixed in healthy parts of the calcaneus, 2) it maximally covers the outer side of the calcaneus and provides the possibility of choosing a place for setting screws inside the healthy fragments, 3) spongy screws perfectly restore the width of the calcaneus, 4) the plate solidly maintains the height, length and posterior calcaneal articular facet after adequate repositioning (24). We performed osteosynthesis with such plate and placed sufficient number of screws to ensure repositioning and its preservation until the complete fracture repair.

The goals of the surgery are: short time of the procedure - in our case it was 65 minutes; shorter period of recovery between the injury and surgery; care and nursing of the skin in order to manage the swelling and restore skin's natural rugosity without bullous changes; placing the plate without stretching the dermal layer. Singh et al. (25) state an average time period from injury to surgery of 7 days (2 to 21), and in our case, we performed the surgery 6 days after the injury.

CONCLUSION

The preoperative value of the Bohler's angle is a significant correlation between the severity of the injury and the displacement of fragments in intra-articular calcaneal fractures. The postoperative Bohler's angle plays a crucial role in predicting the functional recovery. Restoration of the Bohler's angle has a big role in performing surgical treatment, and its increase by > 100 has an essential impact on the functional outcome. The goal of the surgery is to restore the posterior calcaneal articular facet, avoid soft tissue infection and to establish a normal shape and position of a foot.

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Prelom petne kosti – Sanders tip III fiksiran angularnom pločom: prikaz slučaja

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S A Ž E T A K

Uvod: Kalkaneus je tarzalna kost koja ima ulogu prenošenja telesne težine sa potkolenice, preko skočnog zgloba, na prednji deo stopala do prstiju. Učestvuje u formiranju spoljašnjeg i unutrašnjeg uzdužnog svoda stopala koji ima veliku ulogu u hodu i transferu težine. Prelomi kalkaneusa najčešće nastaju skokom – padom sa visine ili ređe u saobraćaju. Mogu biti ekstraartikularni i intraartikularni, kada nastaje narušavanje celine zglobnih površina, nastaje deformitet i nemoć stopala.
Prikaz slučaja: U našem slučaju prikazujemo pacijenta starog 40 godina sa intraartikularnim prelomom kalkaneusa. Povređen je padom sa visine od 3 metra i postoji intraartikularni prelom tipa III AB, gde jedna frakturna linija ide lateralno, a druga centralno preko zadnje fasete kalkaneusa. Šestog dana od povrede urađena je operacija. Pripremljenu angularnu pločicu za kalkaneus adaptirali smo i fiksirali spongioznim šrafovima u relativno očuvanim zglobnim fragmentima: u *sustentakulum tali*, *tuberositas lateralis calcanei* i *tuber calcanei*. Na ovaj način smo osigurali poziciju reponiranih fragmenata, a potom smo postavili još četiri spongiozna šrafa u zdravo koštano tkivo – to nam ovakva ploča omogućava. Ovim postupkom smo ispravili osovinu kalkaneusa, tj. korigovali smo varus kosti, popravili visinu, širinu, dužinu i uglove kosti (Bohlerov i Gisanov ugao). Od prvog dana su započeti pokreti prstiju, a pokreti skočnog zgloba i hod uz pomoć štaka bez oslonca na nogu od trećeg dana.
Zaključak: Preoperativna vrednost Bohlerovog ugla je signifikantna korelacija između težine povrede i deplasmana fragmenata kod intraartikularnih preloma kalkaneusa. Cilj operacije je restauracija artikularne zadnje fasete, bez infekcije mekog tkiva i formiranje normalnog oblika i položaja stopala.

Ključne reči: **kalkaneus, prenos težine, prelom, osteosinteza**