



## Stabilization of calcaneus fractures in a closed manner with a distraction screw

Kalkaneus kırıklarının kapalı yöntem ve distraksiyon vidasıyla stabilizasyonu

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Calcaneus fractures with joint crunches need surgical treatment. This treatment can be closed reposition and overstitching, or open reposition with osteosynthesis using an H plate. There is also a minimal invasive technique, whereby the fracture is reduced with a distraction device in a closed manner and stabilized with three supporting screws. This method became widespread with Zdravec's endeavors and has become the most popular and most frequent way of stabilization for calcaneus fractures in our institute. To further improve the Zdravec's technique, we developed a new headless distraction screw. There are threads on both ends of the screw, which turn in the same direction. The size of the threads on the side of the screw head is greater in diameter and pitch compared to those on the other end, exerting and maintaining a distancing effect. The repositioning tool has undergone changes, as well. A desirable ligamentotaxis is achieved by a newly designed distraction-reposition apparatus. We currently use two half-arcs, on which three Kirschner wires can be used. For accurate repositioning, we rely upon the ligamentotaxis effect of the reposition tool, and the inner synergetic effect of the distraction screw. The technique described here was used in 56 patients (mean age 46 years; range 28 to 67 years) with calcaneus fractures. The patients were followed-up for a mean of 18.3 months (range 10 to 36 months) and were evaluated by the American Orthopaedic Foot and Ankle Society (AOFAS) score for the ankle and hindfoot. The mean AOFAS score was 76.5 (range 54 to 98), and the mean pain score was 22 (range 22 to 32). The authors believe that this minimally invasive technique will arouse even more interest among orthopedic surgeons.

**Key words:** Bone screws; calcaneus/injuries; fracture fixation, internal/methods; manipulation, orthopedic/methods.

Eklem ezilmelerine yol açan kalkaneus kırıkları cerrahi tedavi gerektirir. Bu kırıklar, kapalı pozisyon ve dikişleme veya açık pozisyon ve H plakla osteosentez ile tedavi edilebilir. Ayrıca, minimal invaziv teknik de kullanılabilir. Bu teknikte kırık redüksiyonu, kapalı olarak, bir distraksiyon aletiyle yapılmakta ve üç adet destekleyici vida ile tespit edilmektedir. Bu yöntem, ülkemizde Zdravec'in girişimleriyle yaygınlaşmış ve kuruluşumuzda kalkaneus kırıklarının stabilizasyonunda en yaygın kullanılan yöntem haline gelmiştir. Zdravec'in tekniğini daha da ilerletmek amacıyla, biz de başsız bir distraksiyon vidası geliştirdik. Vidanın her iki ucunda, aynı yöne dönen yivler bulunmaktadır. Vidanın baş kısmındaki yivlerin hem çap hem de aralığı diğer uca göre daha fazla olduğundan, bu durum itici etkiyi artırmaktadır. Repozisyon aletinde de birtakım değişikliklere gidildi ve yeni geliştirilen distraksiyon-repozisyon aletiyle istenen ligamentotaksis etki sağlanmış oldu. Bu alette, yarım daire şeklinde ve üzerine üç adet K-teli yerleştirilebilen iki adet repozisyon yayı bulunmaktadır. Hassas repozisyon için, ligamentotaksis etki repozisyon aleti tarafından, içteki sinerjistik etki ise distraksiyon vidası tarafından sağlanmaktadır. Burada tanımlanan teknik, kalkaneus kırıklı 56 hastanın (ort. yaş 46; dağılım 28-67) tedavisinde kullanıldı. Hastalar ortalama 18.3 ay (dağılım 10-36 ay) süreyle izlendi. Değerlendirme, AOFAS'nin (American Orthopaedic Foot and Ankle Society) ayak bileği ve arka ayak skoru ile yapıldı. Ortalama AOFAS skoru 76.5 (dağılım 54-98), ağrı skoru 22 (dağılım 22-32) bulundu. Bu alandaki araştırmacılar, bu yeni tekniğin ortopedi cerrahları arasında ilgi uyandıracaklarını düşünmektedirler.

**Anahtar sözcükler:** Kemik çivisi; kalkaneus/yaralanma; kırık tespiti, internal/yöntem; manipülasyon, ortopedik/yöntem.

Calcaneus fractures with articular surface involvement require operative treatment.<sup>[1-4]</sup> Open operative technique and plating are well-known. Closed pinning is also a part of our arsenal. There is also a minimal invasive technique, whereby the fracture is reduced with a distraction device in a closed manner and stabilized with three supporting screws. The method became widespread with Zadavec's endeavors and has been used more frequently at the National Institute of Traumatology and Emergency Medicine since 1991.<sup>[5,6]</sup> It has become the most popular and most frequently used way of stabilization for calcaneus fractures in our institute. In this technique, an external fixator is only necessary during the operative intervention.

The main disadvantage of the Zadavec's method is that closed repositioning is achieved by distraction, then a screw is inserted with compressing effect.

Our aim is to resolve this inconsistency by using a newly designed distraction screw. There are threads on both ends of the screw with self-cutting edges, which turn in the same direction. The size of the threads on the side of the screw head is greater in diameter and pitch compared to those on the other end, exerting and maintaining a distancing effect (Fig. 1).

The repositioning tool has also changed. A desirable ligamentotaxis is achieved by a newly designed distraction-reposition apparatus. We currently use two half-arcs, on which three Kirschner wires can be used.

By the peaks of a symmetric triangle, the needed distance can be reached by changing the direction of pulling. Under stereotactic guidance, special distraction screws are introduced, allowing to induce an appropriate osteotaxis effect. For accurate repositioning, we rely upon the ligamentotaxis effect of the reposition tool, and the inner synergetic effect of the distraction screw.

#### X-ray studies

The following X-ray investigations are indispensable for the assessment of the fracture type and



**Fig. 1.** Distraction screw.

displacement, evaluation of intraoperative findings and the healing process.

1. Lateral projection with the X-ray beam in the mediolateral direction for determination of the Böhler's angle and for the assessment of the position of the thalamus of Destot.

2. Böhler's axial projection: We still deem it necessary for the measurement of varus displacement and assessment of "widening".

3. Broden's oblique projections (with 30° and 45° X-ray beam alignment) feature mainly the subtalar joint, provide information about the articular step-off, displacement of the thalamic fragment, the position of other fragments and the space between them, and the lateral shift of the tuber.

Another option is computed tomography scan, which facilitates the three-dimensional orientation.

#### Fracture types

According to Zadavec, based on roentgenograms, there are three main fracture types, each of which is divided into three subgroups depending on the extent of displacement (Fig. 2).

Type I: Extra-articular fractures, with ventromedial fragment affecting the subtalar joint, and the dorsal fragment being displaced upwards and towards the external malleolus.

Type II: Intra-articular fractures with transthalamic direction of the fracture gap. The lateral, thalamic fragment rotates forward and tilts inwards, ripped out by the calcaneofibular ligament.

Type III: In contrast to type II fractures, the thalamic fragment remains in one block with the upper part of the tuber. The sustentaculum tali is broken, multiple intra-articular fractures may be seen. One medial fragment of the plantar surface of the tuber may be broken (Fig. 3).

#### Therapy

*Indications:* Immediate operation is necessary in case of severe deformity due to considerable displacement, which endangers blood circulation of the skin and in case of imminent compartment syndrome.<sup>[7-10]</sup> Apart from these cases, delayed operation is performed; the ideal point of time for surgery is within a week, but beyond this time, exact reduction is less feasible with this closed

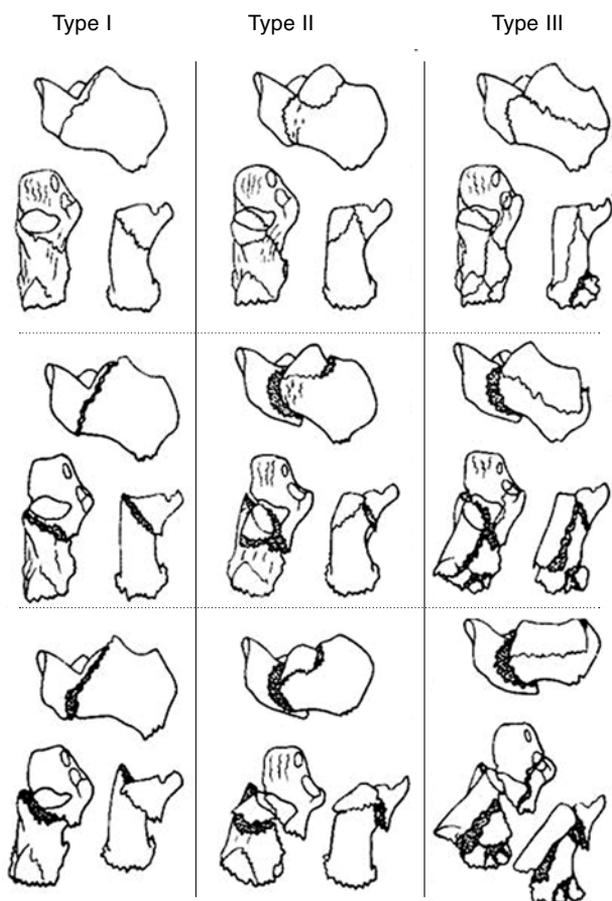


Fig. 2. Fracture types.

method. The limb is kept elevated, local chilling is applied, and edema reducing drugs are administered if necessary.

*Operation technique:* Contrary to the original description, we perform the operation in the prone position. Reduction and the position of the inserted screws can be checked by a 30°-45° horizontal shift of the image intensifier even in Broden's projection.



Fig. 4. Application of the external fixator.

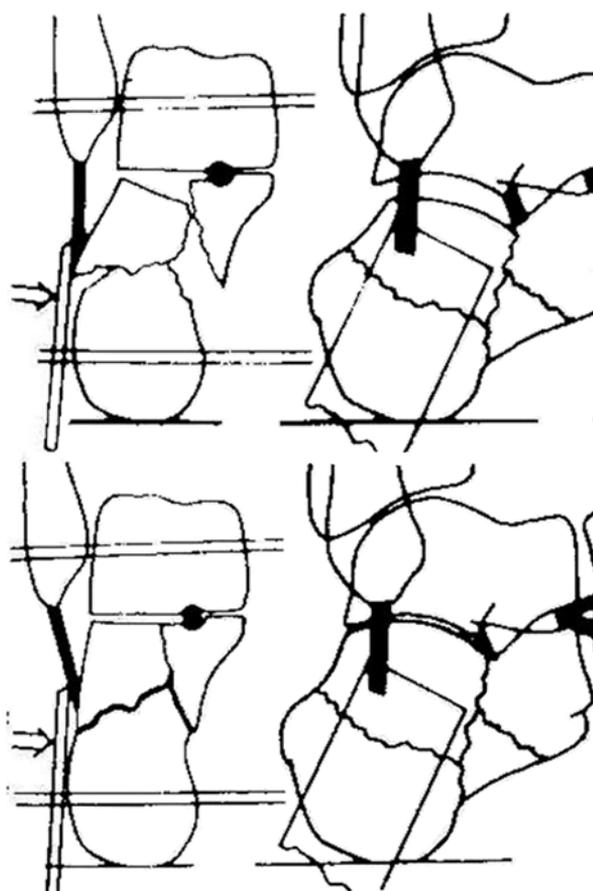


Fig. 3. Typical dislocation and reposition.

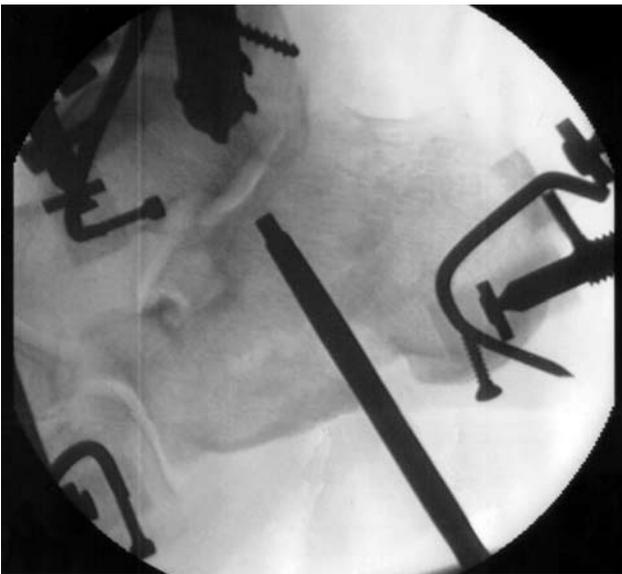
At the same time, we have good access to both sides of the tarsal region, facilitating the application of the reduction device. Three K-wires of 3 mm diameter are drilled transversely into the talus,



Fig. 5. Position of the three K-wires.



**Fig. 6.** The Cotton's hammer method.



**Fig. 7.** Insertion of an advancing rod to make reduction more accurate.

calcaneal tuber, and the cuboid bone, respectively. Then, we apply the modified distraction devices to both sides as an external fixator (Fig. 4). The main difference from the former devices is that important anatomical structures, essential for reduction and positioning of the screws are not covered under the image intensifier (Fig. 5).

During three-point distraction according to Harris, the dorsolateral fragment is advanced to the ventromedial one. In case of severe displacement, the tuber is advanced medially with the Cotton's hammer method, which restores the position of the thalamic fragment, as well (Fig. 6).<sup>[11,12]</sup> In case of visible residual double contours, tilting, or articular step off in Broden's projection, reduction may be made more accurate by introducing



**Fig. 8.** The thalamic fragment is fixed to the sustentaculum with a compression screw.



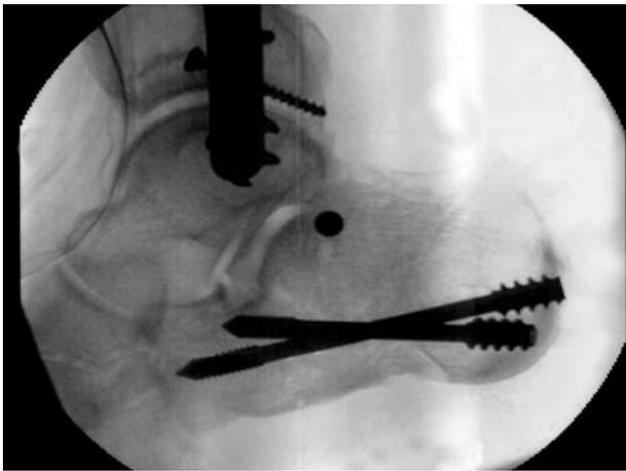
**Fig. 9.** Insertion of the oblique distraction screw.



**Fig. 10.** Insertion of the longitudinal distraction screw.

an advancing rod from the sole, from lateral, or, eventually, from dorsal (Fig. 7).

The tip of the targeting device is positioned on the sustentaculum, and after drilling through a protective sleeve, the thalamic fragment is fixed



**Fig. 11.** Postoperative x-ray.

to the sustentaculum with a compression screw (Fig. 8). The main fragments are fixed to each other with a distraction screw, starting from the distal-lateral part of the tuber and targeting at the same spot (Fig. 9).

The third screw is advanced without targeting device from the insertion point of the Achilles tendon along the longitudinal axis of the calcaneus (Fig. 10). After the removal of the external fixator (Fig. 11), wounds are closed with 1-1 stitches and an elastic compressive dressing is applied.

### Rehabilitation

Active physiotherapy of the tibiotalar and talocalcaneal joints starts on the first postoperative day. After the tumescence has decreased, careful partial weight bearing is allowed with crutches on the fourth or fifth days, which can be increased up to the limit of pain by patients with good compliance. Patients may switch over to a walking stick after one month. Some surgeons are considerably more careful concerning weight bearing and apply a plaster. Removal of the screws is only necessary if they cause local tenderness.

### Clinical applications

The described technique was used in 56 patients with calcaneus fractures. The mean age of the patients at the time of injury was 46 years (range 28 to 67 years). The patients were followed-up for a mean of 18.3 months (range 10 to 36 months) and were evaluated by a third, blinded orthopedic surgeon with a questionnaire based on the American Orthopaedic Foot and Ankle Society (AOFAS) score

for the ankle and hindfoot.<sup>[13]</sup> The mean AOFAS score was 76.5 (range 54 to 98), and the mean pain score was 22 (range 22 to 32).

### Conclusion

Over 20 years of usage, the Zdravec technique has become popular both nationwide and abroad. The authors believe that further improvements in this minimally invasive technique will arise even more interest among orthopedic surgeons.

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