

The surgical treatment of intra-articular calcaneus fractures: our long-term experience

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SUMMARY

Objective. We report on the clinical and radiographic results obtained using surgical treatment with plates and screws in displaced intra-articular calcaneal fractures (DIACFs).

Methods. 41 patients were included for a total of 43 DIACFs treated at our unit between 2008-2019. Fractures were classified by Sanders classification and radiographically we considered Böhler's angle. The American Orthopedic Foot and Ankle Score (AOFAS) was used for clinical evaluation.

Results. Of 43 fractures, 3 were classified type I, 13 type II, 20 type III and 7 type IV. The mean follow-up was 87.51 months (min. 9, max. 136). The average AOFAS score was 82.88 and the post-operative mean Böhler angle was 22.65°. We observed the following complications: one infection requiring hardware removal and hyperbaric oxygen therapy and 3 instances of delay in wound healing treated with antibiotic and medications. Hardware removal was needed in 10 cases.

Conclusions: the good functional and clinical results seen in our study encourage us to propose surgery as the first choice of treatment of DIACFs.

Key words: calcaneal fractures, open reduction and internal fixation (ORIF), plate

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Conflict of interest

The Authors declare no conflict of interest

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Introduction

Calcaneal fractures are the most frequent of the tarsal bones (60%), even if they represent only 2% of all fractures ¹. Despite improvements in surgery with new techniques and new materials, these fractures are often invalidating, leading to negative socio-economic impact as 1 in 5 patients will not be able to return to work within a year ^{2,3}. Historically, these fractures were treated conservatively through packaging of plaster casts associated or not with synthesis "a minima" (Kirschner, Steinmann wires, etc.), because surgical procedures with internal fixation were not yet available ⁴. Surgical treatment began to take place with improvements in fracture management ⁵ (1937, Böhler's Method). Although the optimal treatment of displaced intra-articular calcaneal fractures (DIACFs) still remains a debated topic, many studies in the literature have shown that surgery leads to better results in the long term ⁵. The aim of our study was to evaluate the clinical and radiographic results obtained in patients with DIACFs undergoing surgery with open reduction and internal fixation (ORIF; plates and screws).

Materials and methods

We retrospectively analyzed a group of patients affected by thalamic fractures of the calcaneus treated surgically with plates and screws between 2008 and 2019. Forty-one patients were included in the study for a total of 43 DIACFs (2 patients had bilateral fracture), and 26 were male; mean age at surgery was 51 years (min 19-max 84). All patients were treated with osteosynthesis with plates and screws using a lateral approach with an “L-no touch” incision after an immobilization period of 10-14 days to allow soft tissue healing from blisters and edema (Fig. 1). Fractures were classified according to Sanders classification as: type I (n = 3), type II (n = 13), type III (n = 20) and type IV (n = 7).

The analysis of the results was based on the data from medical records as age at surgery, sex, side involved, type of fracture, measurement of the pre- and postoperative Böhler angle, and any patient comorbidities were registered and analysed. CT scans were acquired for better visualisation of fractures (Figs. 2-4). The AOFAS score was used for clinical evaluation at follow-up ⁶⁻⁸ (although others are available such as Maryland Foot Score ⁹ or Creighton-Nebraska Health Foundation Assessment Score ¹⁰) (Figs. 5-9).

All patients accepted the proposed treatment and follow-up after being adequately informed and gave written consent. The study and follow-up, respecting the criteria of the Declaration of Helsinki, were approved by the Institutional Review Board of Azienda USL-Toscana, Department of Surgery and Translational Medicine. The study was approved by the Institutional



Figure 1. Soft tissue condition after calcaneus fracture (medial region of the right foot: edema, swelling and blisters).

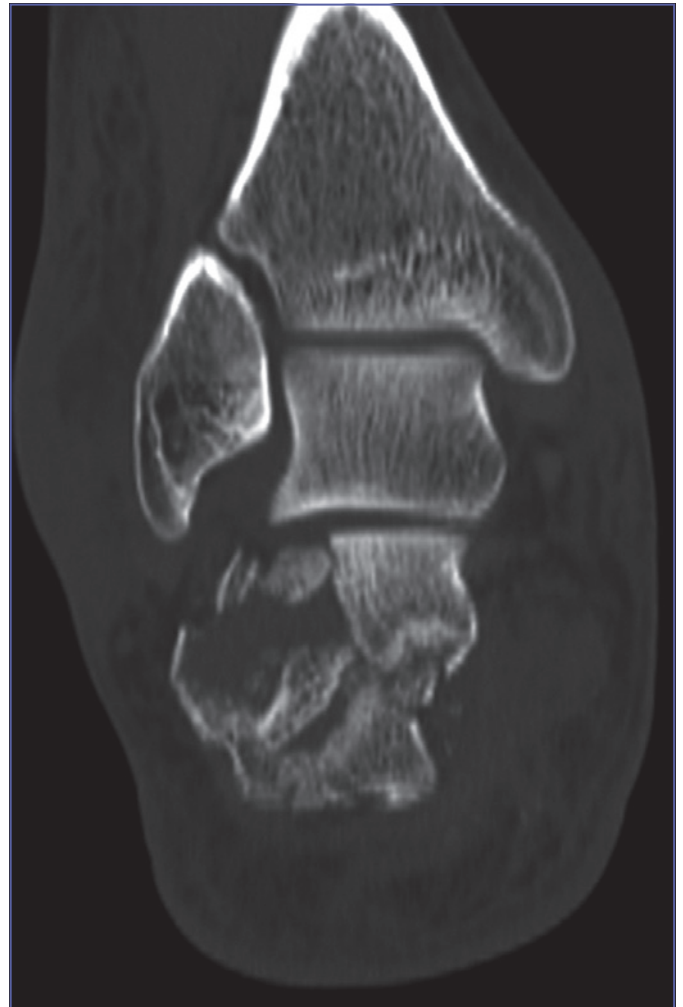


Figure 2. CT scan (coronal view).

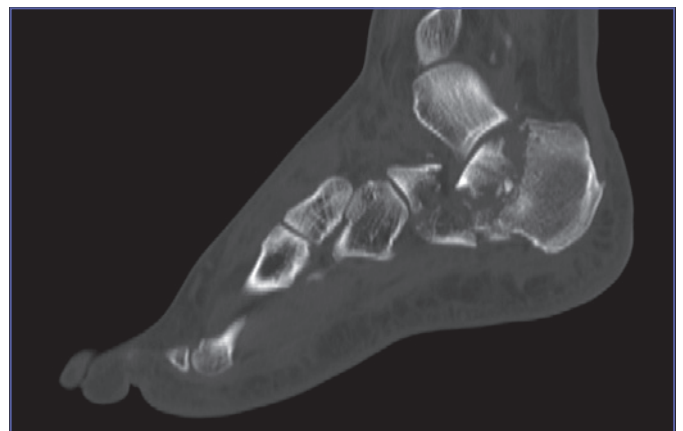


Figure 3. CT scan (sagittal view).

Review Board and proper informed consent was obtained from all patients.



Figure 4. CT scan (axial view).



Figure 5. Clinical case (dorsal flexion).



Figure 6. Clinical case (plantar flexion).

We used an “L-no touch” lateral access with full-thickness incision, with the patient in lateral decubitus with perioperative ampliscopic control and tourniquette at the thigh. The peroneal tendons were spread superiorly and fixed by three 1.4 mm diameter Kirschner wires (one in the peroneal malleolus, one in the talus and one at the base of the 5th metatarsal) to better expose the fracture (Fig. 10). A traction wire with a diameter of 3 mm was placed in the posterior apophysis of the calcaneus to allow postero-inferior traction in order to restore the Böhler angle, reducing the frequent calcaneal varus often present after talus reduction, and correct reduction of the medial face of the calcaneus (Fig. 11). This purpose could also be obtained by performing the Atkins method, which associates the traction of the apophysis with a lever on the medial wall frequently overlapped. With a periosteal elevator we then lifted the talus which was temporarily fixed with 1.4 mm diameter Kirschner wires.

We verified the reduction obtained with the C-harm with lateral and Broden views. In some complex cases, we also used cannulated cancellous bone screws of 3.5 mm to synthesise the thalamic fragment attached to the medial one when intact, performing “de visu” a more correct reduction of the posterior articular surface. In fact, we believe that this wider surgical exposure, allowing meticulous reduction of the joint surfaces, can offer better functional results, especially in the long term. We applied the plate without modeling it to guarantee the restoration of the side wall and fixed it with angular stability screws. In the absence of important bone defects, as in the case of marked osteoporosis, we did not use bone grafts. When we used grafts, both bank and synthetic, we did it to ensure a better primary mechanical seal than to promote osteoinduction which, in a cancellous bone like the calcaneus, we did not consider necessary.

We did not normally apply drainage, without obvious acute or later complications, either at the flap level or for subcutaneous haematoma. Although there are reports in the literature that recommend Allgöwer-Donati skin suture, we always used loose stitches with braided thread for the subcutis and metal clips (Fig. 12) for the skin, with results comparable to the studies in the literature in consideration of post-operative skin complications¹¹ (Fig. 13).

Regarding the postoperative protocol, all patients were forbidden to load on the operated limb for about 8 weeks, the first 4 weeks using a plaster splint to immobilize the limb, reducing postoperative pain, and to promote better healing of the surgical wound. At the end of this period, again with the prohibition of loading on the operated limb, the patient was allowed to start rehabilitation processes with active and passive movements to increase the ROM; the load, after radiographic control, was granted with gradual resumption at 8 weeks after surgery, in accordance with the data in various studies¹⁴⁻¹⁶. Although there are numerous rehabilitation protocols for this type of fracture¹⁷ (showing that there is no general consensus about the topic and that each patient is different), the use of this standardised reha-



Figure 7. Clinical case (preoperative XR: notice the reduction of Böhler's angle).



Figures 8-9. Clinical case (postoperative XR).

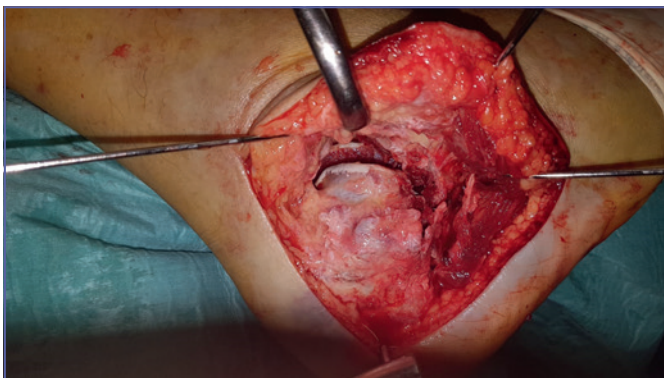


Figure 10. Osseocartilaginous damage of the posterior articular surface of the calcaneus: on x-rays it is possible to recognise a double profile.



Figure 11. A 3mm-diameter wire placed in the posterior apophysis of the calcaneus used for a postero-inferior traction.



Figure 12. Metal clips used for skin suture.



Figure 13. Ischaemic suffering at the edges of a surgical wound.

bilitation protocol has allowed us to obtain clinically and radiographically satisfactory results in most patients.

Results

The mean follow-up was 87.51 months (min 9-max 136). The mean Bohler angle shifted from 9.15° (min -2° , max 32°) in the pre-operative to 22.65° (min 19° , max 40°) post-operative. The average AOFAS score was 82.88 points. Although technically a positive correlation, the relationship between post-operative Bohler angle and AOFAS is weak, $r(43) = 0.2019$, $p = 0.194166$. We observed the following complications: one infection requiring hardware removal and hyperbaric oxygen therapy and 3 events of delayed wound healing treated with

antibiotics and medications. Hardware removal was needed in 10 cases.

Discussion

Although we are still distant far from identifying the ideal treatment for DIACFs, some studies have tried to compare surgical and conservative treatment. Basile et al.⁷, in a retrospective level I study based on 33 patients treated surgically and conservatively, identified in the first ones higher scores (AOFAS average 86 points) than in the second ones (average 70 points), as well as in VAS, reaching the same conclusions that were found in the level II study by Buckley et al.³. The study by Basile et al.⁷ also reported a complication rate of 87% in the 15 patients of the conservative treatment group (subtalar arthrodesis in 8 patients, shoe modifications in 5 patients), and a complication rate of 28% in the 18 patients in the surgical treatment group (subtalar arthrodesis in 2 patients, postoperative infection in 2 patients and shoe modifications in 1 patient). However, from another level II⁸ study there were no differences in the clinical and functional evaluation between the patients included in the two groups, finding a higher average AOFAS value in patients treated conservatively (78.5 versus 70) compared to patients who underwent ORIF. It is necessary to remember that the AOFAS does not consider important evaluation parameters, such as the incidence of postoperative infections and the need to undergo a secondary arthrodesis. These data are in line with our results.

Hardware removal was needed in 10 patients and was higher in our study (23.0%) than in the literature (11.4%)^{3,6,12-14}.

The measurement of Böhler angle postoperatively has to be considered in the evaluation of results after surgical treatment of DIACFs^{3,14}. Some studies have shown that the increase interval of the Böhler angle after an extended lateral approach was between 13.7° and 31.0° ¹⁸, in accordance with what we found in the periodic evaluations of the patients included in our study.

The choice of using an extended lateral approach with an "L-no touch" incision in the patients of our study was dictated by the small number of complications and healing delays observed, also supported by several studies in the literature^{6,19,21}. Some studies cite the use of different surgical approaches, such as a plantar²² approach for depression-like fractures of the Essex-Lopresti classification and an approach with incision parallel to the Achilles tendon²² in cases in which it was necessary to rotate the superior fragment in tongue-like fractures. Another study also suggested the use of the medial approach²³. Although bone grafts have not been used routinely in our practice, the data in the literature are conflicting on their correct use. In some studies it is mentioned that the bone graft can prevent, by filling the bone defect, the formation of post-surgical haematoma and reduce the infection rate²⁴, as well as being able to favour load in the initial phase and reduce the risk of a

subsequent collapse of the articular surface and the incidence of non-union^{25,26}. However, Rammelt et al.²⁷ and Longinus with Buckley²⁸ published data suggesting that it is not necessary to implant a bone graft for DIACFs.

In the literature there are numerous papers that mention how the anatomical position of the calcaneus and the “L” surgical access determine inadequate drainage of the wound, as well as local haematoma and infection, thus suggesting the use of an internal drain with negative pressure to prevent wound complications²⁹⁻³¹, due to easier discharging of congested blood and relief from edema; in addition, negative pressure can also favour the expansion of small arteries, mitosis and production of a new capillary bed, even reopening capillaries that are occluded around the wound caused by injuries and infections^{32,33}. However, in this study, we noticed that the percentage of post-surgical wound complications is in line with the studies cited, although internal drainage was not used in any case.

In our study we extended the surgical indication with plates and screws even in patients with Sanders IV fracture and in elderly patients with good autonomy, reserving arthrodesis as a possible second choice in case of failure. We reported satisfactory results in these cases, according to the literature^{7,20,34,35}. From our experience, we can also say that adherence to the rehabilitation process, starting at an early time from removal of the plaster cast and that continues for several months in the postoperative period, can lead to better results.

Conclusions

Although there are several studies in the literature both in favour of surgical and conservative treatment, the good functional and clinical results of our study encourage us to propose surgery as the first choice of treatment of DIACFs. Specifically, the introduction of angular stability screws allowed obtaining a stable synthesis with optimal results even in patients with poor bone quality when lesser results were expected. The main limitation of our study is the absence of a control group with patients treated conservatively.

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