Functional and radiological outcomes in displaced heel fractures: Open reduction and internal fixation versus external fixation

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Abstract

Management of intra-articular heel fractures is controversial. The main goals of surgical treatment are restoring subarticular articular congruence and width, height, form and alignment of the heel. The gold standard is considered Open Reduction and Internal Fixation (ORIF), a complex technique with a high rate of complications. External Fixation (EF) could be a good alternative. In this study were identified 37 fractures in 35 patients (24 patients underwent ORIF and EF was performed in 13 cases) and the outcomes of the two techniques were compared. The mean surgical time for ORIF was 107.8 minutes, while for EF was 88.61 minutes and the ORIF group presented a higher rate of complications, despite of similar results in the mean post-operative AOFAS Ankle and Hindfoot Scale scores (73.31/100 points in the ORIF group and 75.40/100 points in the EF group). Fast learning curve, short surgery time and low complications rate make EF an alternative to ORIF in treating intra-articular heel fractures.

Introduction

Heel fractures represent 1-2% of all fractures; about 60% to 75% are intra-articular fractures.1,2 They are caused by high energy trauma, such as fall from heights or car accidents. These fractures occur mostly in younger patients, who can be unable to work, representing a high demanding economic issue.3,4 Despite their frequency, the management of this kind of lesion is still controversial. Conservative treatment of displaced fractures is usually associated to negative outcomes.5 The main goals of surgical treatment are restoring subarticular articular congruence and width, height, form and alignment of the heel, avoiding medial and lateral impingement and enabling the patient to return to a normal way of life.6,7 The gold standard for treating intra-articular displaced heel fractures is considered nowadays Open Reduction and Internal Fixation (ORIF), that can be obtained by several approaches: extensive lateral, medial, plantar, posterior or a combination of these. The extensive lateral approach is the most commonly used, allowing a good visualization of the fragments and of the subtalar and calcaneocuboid joints.8-10 ORIF of intra-articular heel fracture is often a complex surgical procedure even for skilled surgeons, with a high rate of complications (16%-33%): it can be a dangerous procedure in case of damaged soft tissue, leading to delayed wound closure and deep infections; the need for a medial approach to obtain reduction increase the risk of complications in wound healing; an inadequate reduction can lead to unstable fixation and hardware failure; particular attention must be paid to avoid injury to the sural nerve.11-13 Problems in wound healing are reported in 43% of patients, skin necrosis from 2% to 11%, superficial infections in 19.7%, deep infections in 5.6% and osteomyelitis in about 1%.14,15 Many minimally invasive techniques, such as arthroscopically assisted reduction, calcaneoplasty or percutaneous/closed reduction and External Fixation (EF), were proposed in order to decrease the rate of post-operative problems.16-20 Among these, EF can be a good option in case of multifragmentary fractures and extensive impairment of soft tissue. It permits a minimal dissection and a lower tissue stretching than the ORIF technique and it seems to be effective in restoring height, width and length of the heel bone.21,22 Literature about EF for treating intra-articular displaced heel fractures is not univocal, but it shows good results in most cases, probably due to an early mobilization of the peritalar joints and an early post-operative load.23 The aim of the study was to compare middle/long-term outcomes of the two techniques (ORIF vs EF) and to highlight the surgical criteria and the different surgical skills needed by both.

Materials and Methods

We performed a retrospective study on patients of both sexes who underwent surgery (ORIF or EF) in the Traumatology Department of our Institution for closed displaced heel fractures during the period from 1st January 2010 to 31st August 2018. Exclusion criteria were: inability to walk and deformity/osteoarthritis of ankle, hindfoot, midfoot and forefoot before surgery, and peripheral vasculopathy or neuropathy. Preoperative imaging was conducted for all patients with AP+LL x-ray of the foot + Broden view + mortise view of the ankle and 2D and 3D CT scan reconstruction and fractures were divided in groups according to the CT Sanders classification; Bohler’s and Gissane angles were calculated before and after surgery. Post-operative imaging was conducted for all patients with AP+LL x-ray of the foot + mortise view of the ankle and any post-operative arthritic alteration was classified according to the Kellgren Lawrence scale; the post-operative functional evaluation was made by using AOFAS Ankle and Hindfoot Scale, SF-36 and VAS. The mean follow-up time was 50.1 months (range 113-12 months). Of every patient we recorded sex, age, school level, Body Mass Index (BMI) and post-operative complications. We calculated the average surgical time of both ORIF and EF and the average time from injury to surgery. The patients were divided in groups, according to the type of surgery (ORIF

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group and EF group), the surgeon who performed the procedure (F&A spec. group for the patients who underwent surgery performed by a surgeon skilled in foot and ankle pathology, and Trauma. group for the patients who underwent surgery performed by a trauma surgeon), and the BMI (BMI≥25 and BMI<25). We also analyzed if there was a difference in surgical experience between surgeons who performed ORIF and surgeons who performed EF. According to our criteria, we identified 37 fractures in 35 patients (21 males and 14 females; 2 patients reported bilateral heel fracture). 24 patients underwent ORIF; EF was performed in 13 cases. Average age was 54 years (range 25-77 years). Following the CT Sanders classification, the fractures were divided in 5 IIa, 4 IIb, 2 IIc, 8 IIIaB, 9 IIIaC, 9 IV. 21 surgical procedures were conducted by 3 orthopedic surgeons skilled in foot and ankle pathology (17 ORIF; 4 EF), while the other 16 were performed by the trauma surgeon on duty at the time of surgery (6 different trauma surgeons performed 7 ORIF and 9 EF). All fractures could have been treated by ORIF or EF: the decision about the surgical procedure was made according to the confidence of the surgeon with a specific technique (Table 1).

ORIF was performed in 81.82% of Sanders type II fractures, while EF in 18.18%; 57.7% of Sanders type III and IV have been subjected to open reduction and internal fixation, and the remnant 42.3% to percutaneous/closed reduction and external fixation (Table 2).

Two patients died for reasons not related to surgery (both underwent ORIF by 2 of the 3 foot and ankle surgeons). Five patients didn’t accept to be part of the study: 4 of them underwent surgery by the 3 orthopedic surgeons skilled in foot and ankle pathology (3 ORIF and 1 EF), while the other one underwent bilateral EF by one trauma surgeon. Post-operative program for patients treated with ORIF was leg brace for 60 days without loading, then leg brace removal and progressive loading with two canes until reaching of total loading. Post-operative program for patients treated with EF was 60 days without loading with early mobilization of the ankle, then progressive loading with two canes until reaching of total loading. External fixators were all removed at 90 days. Low molecular weight heparin (LMWH) was administered to every patient from the time of diagnosis until reaching of total loading. The differences between the average values obtained were compared using T test.

Table 1. Distribution of surgical procedures among the equipe.

| Surgeon | ORIF | EF |
|---------|------|----|
| Spec. 1 | 1    | —  |
| Spec. 2 | 6    | —  |
| Spec. 3 | 10   | 4  |
| Trauma s. 1 | 1 | —  |
| Trauma s. 2 | — | 1  |
| Trauma s. 3 | — | 1  |
| Trauma s. 4 | — | 2  |
| Trauma s. 5 | 5   | 5  |
| Trauma s. 6 | 1   | —  |

Table 2. Fracture pattern and type of surgery.

| Fracture pattern* | ORIF | EF |
|------------------|------|----|
| IIa              | 5    | —  |
| IIb              | 3    | 1  |
| IIc              | 1    | 1  |
| IIIaB            | 5    | 3  |
| IIIaC            | 5    | 4  |
| IV               | 5    | 4  |

Table 3. The comparison between the mean post-operative AOFAS Ankle and Hindfoot Scale scores didn’t show any statistically significant difference (P<0.05); however, it seems that a BMI≥25 leads to poorer clinical results (P=0.0823).

| Post-operative AOFAS Ankle and Hindfoot Scale score (mean values) | Δ | P value |
|---------------------------------------------------------------------|---|---------|
| ORIF (19 cases) 73.31/100 pts                                      | 2.09 | 0.7631 |
| F&A spec. (15 cases) 71.20/100 pts                                 | 5.87 | 0.3688 |
| ORIF F&A spec. (12 cases) 67.75/100 pts                            | 9.67 | 0.3373 |
| EF F&A spec. (3 cases) 77/100                                     | 2.29 | 0.7215 |
| BMI ≥ 25 (15 cases) 68.66/100 pts                                 | 11.12 | 0.0823 |

ORIF, open reduction and internal fixation; EF, external fixation; F&A spec., surgery performed by an orthopedic surgeon skilled in foot and ankle pathology; Trauma. surgery performed by the trauma surgeon on duty; BMI, body mass index.
patients who underwent ORIF was 2.94 points (2.61 s.d.), while for patients who underwent EF was 3.0 (1.69 s.d.); the difference between the two groups was not statistically relevant (P=0.9547 per P<0.05). One ORIF patient out of 28 assessed patients reported negative outcome at SF-36 questionnaire. We found a significant improvement in the pre and post-operative radiological features (Bohler’s and Gissane angles) of the heel in both ORIF and EF (Table 4).

Five patients who underwent ORIF (26.3%) showed early complications (delay in wound healing), while 1 patient treated with EF reported superficial infection at the entry point of one of the fiches. 22.7% of ORIF patients and 53.8% of EF patients developed osteoarthritis (OA) after the surgery (Kellgren Lawrence grade 1-2). 42.85% of patients with BMI≥25 and 28.5% of patients with BMI<25 developed OA after the surgery. Two EF patients need orthopedic insole or footwear and 36.8% of ORIF patients and 40% of EF patients complain slight discomfort at the lateral side of the ankle. Four patients underwent surgery to remove the plate, due to pain at surgical access. Among those who accepted to be part of this study, 1 patient was a graduate, 16 have a high school degree and 11 have a lower education level; these results were not related to any negative outcome at AOFAS Ankle and Hindfoot Scale.

### Discussion

In our series, both ORIF and EF led to a significant improvement of Bohler’s and Gissane angles and have allowed to regain good articular congruence, indexes of good reduction and fracture stabilization. Comparing the results of AOFAS Ankle and Hindfoot Scale in the two groups, both techniques seemed to be efficient in restoring a good functionality of ankle and foot, without significant differences. Recent studies demonstrate satisfying results in ORIF, but there are fewer specific studies comparing it to EF. In our series the great majority of ORIF surgery (70.8%) was performed by the 3 senior orthopedic surgeons skilled in foot and ankle pathology, while EF was performed by 4 on duty trauma surgeons with a wide range of ability levels and 1 expert foot and ankle surgeon, highlighting a simpler procedure and a faster learning curve in EF than ORIF, despite of similar results. Five of 19 patients who underwent ORIF and accepted to be part of the study suffered a delay in wound healing (one of them underwent a debridement of surgical wound after 30 days), and in 4 cases was necessary to remove the plate due to pain at the surgical access; only 1 of 13 fractures treated with EF developed a complication directly related to surgery (superficial infection at the entry point of one of the fiches); according to literature, EF revealed to be a less invasive and safer procedure than ORIF in soft tissue sparing. No patients developed venous thromboembolism after administration of LMWH, that appeared to be more manageable than unfractionated heparin due to the low dose needed, less bleeding risk and greater efficacy in the prevention of venous thromboembolism. Though it was not statistically significant, probably due to the small number of cases, the mean surgery time to perform EF was shorter than the one needed to perform ORIF; furthermore the lower average time from injury to surgery in the EF group, in which the timing is less related to the local skin conditions, permitted to reduce costs and the duration of the hospitalization. Nor BMI or school level were statistically related to negative outcomes at AOFAS Ankle and Hindfoot scale, but it seems that a BMI≥25 led to poorer clinical results (P=0.0823 per P<0.05), and to a higher rate of OA. While BMI is considered relevant in analyzing the results of other surgical techniques, such as ORIF after ankle fracture or in joint arthroplasty, we didn’t find studies in literature that relate post-operative AOFAS Ankle and Hindfoot scores after heel fractures to BMI values. The development of post-operative OA in both groups (ORIF and EF) may be due to the fact that surgery has influenced the onset of the pathogenetic mechanisms implicated in the pathology and to the difficult to restore a perfect articular surface, in particular in the EF group. An evolving subtalar OA may lead to a surgical subtalar arthrodesis: VAS level in both groups (ORIF: 2.94 pts; EF: 3 pts) showed a good pain control and no patient in our series required this type of surgery.

### Conclusions

The ideal treatment for displaced intra-articular heel fractures is still under debate. The severity of the lesion is related to the degree of the posterior articular facet impaction of the subtalar joint, measured by the pathological alteration of Bohler’s and Gissane angles and by the CT Sanders classification of the fracture. Both techniques show good radiographic and functional results in the middle/long-term, allowing the patients returning to a normal way of life. However, comparing costs and benefits, the external fixation appears to be equally effective and less expensive than ORIF. An early mobilization of the ankle after EF can positively affect the clinical result, despite a higher rate of OA developed after the surgery. Obese and overweight patients may have worse functional outcomes compared with those with normal weight and also a BMI≥25 may lead to a higher rate of OA. In our experience, a fast learning curve, less specific skills needed, a short surgery time and a low complications rate make EF an effective alternative to ORIF in treating intra-articular displaced heel fractures.

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