ORIGINAL RESEARCH

International Journal of Surgery 12 (2014) 475–480

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Open reduction and internal fixation with conventional plate via L-shaped lateral approach versus internal fixation with percutaneous plate via a sinus tarsi approach for calcaneal fractures – A randomized controlled trial

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ARTICLE INFO

Article history:
Received 16 August 2013
Received in revised form
17 September 2013
Accepted 1 March 2014
Available online 5 March 2014

Keywords:
Calcaneus
Intra-articular fractures
Percutaneous plate fixation
Sinus tarsi approach
Open reduction and internal fixation

ABSTRACT

Objective: We aimed to compare the clinical outcomes of intra-articular calcaneus fractures treated with open reduction and internal fixation with conventional plate via L-shaped lateral approach (routine treatment) versus those with percutaneous plate via a sinus tarsi approach (minimally invasive treatment).

Methods: One hundred and seventeen displaced intra-articular calcaneal fractures in 108 patients from January 2007 and September 2010 were randomly allocated to receive routine treatment (49 patients) or minimally invasive treatment (59 patients). Operative time, preoperative and postoperative calcaneal height, width, length, Böhlers angle, Gissanes angle, and incision healing were recorded. Maryland foot score system was used to evaluate clinical functional outcomes.

Results: The operative time of minimally invasive group was significantly shorter than that of the routine group [46–80 min (mean, 62 min) vs 65–110 min (mean, 93 min), $p < 0.01$]. Postoperative X-ray showed the calcaneal height, width, length, Böhlers angle and Gissanes angle were significantly improved in both two groups, and no significant difference was observed between two groups postoperatively. No feet developed wound complications in minimally invasive group, but incision complications occurred in 8 feet in routine group. The excellent and good rate according to the Maryland foot score was significantly higher in minimally invasive group than that in the routine group (93.8% vs 86.8%).

Conclusion: Compared with L-shaped lateral approach treatment of displaced intra-articular calcaneal fractures, sinus tarsi approach for the reduction and internal fixation with percutaneous plate seems to be more safe and effective, with satisfactory clinical therapeutic effects and without postoperative complications.

1. Introduction

Calcaneus fractures are the most common fracture in the tarsal bones, accounting for 60% of all tarsal fractures, with 75% of those being displaced intra-articular fracture [1]. The management of displaced intra-articular calcaneal fractures remains challenging and often controversial. Open reduction and internal fixation with conventional plate via an extensible lateral L-shaped approach has been considered to be a standard treatment for displaced intra-articular calcaneal fractures because it provides excellent exposure of the fracture and allows direct reduction of the depressed posterior facet fragment [2]. However, several studies report that the postoperative wound complication rate of this technique, including wound edge necrosis, dehiscence, hematoma, or deep infection, is high [3–5].

To lower the wound complications, numerous minimally invasive procedures have recently been introduced, including percutaneous reduction internal fixation, arthroscopically assisted fixation, and minimal incision techniques via medial, modified lateral (such as the sinus tarsi approach), posterior, or combined approaches [6]. These techniques minimize soft tissue trauma, thereby reducing the risk of operative complications, while still allowing good fracture reduction [7–9].

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http://dx.doi.org/10.1016/j.ijsu.2014.03.001
1743-9191/

Our team developed a new minimally invasive percutaneous insert plate according to the characteristics of anatomical structure of calcaneus and sinus tarsi approach to treat displaced intra-articular calcaneal fractures, which has yielded favorable outcomes in our clinical series. The purpose of this study is to compare the therapeutic effects and complications between open reduction and internal fixation with conventional plate via L-shaped lateral approach and internal fixation with our percutaneous plate using a sinus tarsi approach for treatment of calcaneal fractures.

2. Materials and methods

2.1. Patients

From January 2007 to September 2010, 136 displaced intra-articular calcaneus fractures in 127 patients were surgically treated in our hospital because a decrease in the height and an increase in the width of the calcaneus, and reduced Böhler and Gissane angle (Figs. 1A, B and 2A, B). Injury mechanisms were a fall or jump from a height in 98 cases and traffic accident in 10 cases. All patients were closed fracture, without long-term smoking and severe diabetes. All the patients were randomized by coin tossing by the sixth author (Ziping Wang) blind until the end of the study: if it comes head, the patient will go to receive internal fixation with percutaneous plate using a sinus tarsi approach (minimally invasive treatment group, $n = 70$), and if it comes tail, he will go to receive open reduction and internal fixation with conventional plate via L-shaped lateral approach (routine treatment group, $n = 57$) (Fig. 3). All patients agreed to participate in this clinical trial by signing an informed consent form. The trials were approved by ethics committee of our institution (approval code: ZPYYLL-2007015) and performed in accordance with the ethical standards.

2.2. Surgical procedure

Operation was performed usually from 5 to 12 days (average, 7.4 days) after injury by the senior author. After admission, the extremities of all patients were elevated and ice applied in an effort to minimize swelling and avoid blisters. All patients underwent spinal subarachnoid block analgesia or epidural anesthesia and were placed in a lateral decubitus position with the lateral malleolus of affected foot uppermost to treat unilateral fracture or in a supine position for bilateral fracture.

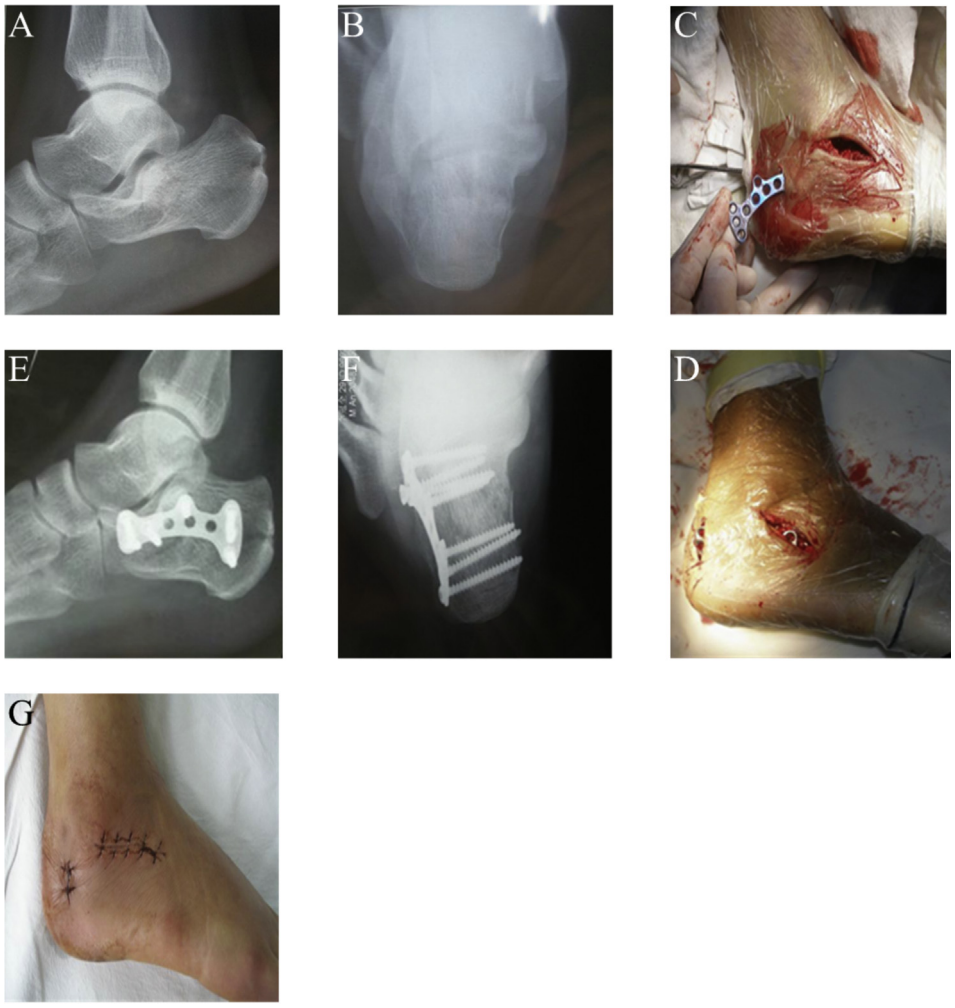

Fig. 1. Internal fixation with percutaneous plate using a sinus tarsi approach for treatment of calcaneal fractures. Preoperative lateral X-ray showed significantly reduced calcaneal height, Böhlers angle and Gissanes angle (A), and preoperative axial X-ray indicated significantly increased calcaneal width (B); After establishing the lateral calcaneal channel, the plate was inserted from the rear incision to the front along the right lateral wall of the calcaneus (C); The plate was placed in the lateral calcaneal channel (D); Postoperative lateral X-ray showed that the calcaneal height, Böhlers angle and Gissanes angle were significantly improved (E). Postoperative axial X-ray showed the calcaneal width recovered well (F); Surgical incision healed well on the 14th day after surgery, and sutures had been removed (G).