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Limited sinus tarsi approach for treatment of intraarticular fractures of the calcaneus

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Abstract

Purpose: Is limited sinus tarsi approach sufficient to reduce and fix intraarticular fracture calcaneus? What type of fracture can be treated through this approach and added techniques to facilitate reduction and fixation?

Methods: Thirty feet in 28 patients with intraarticular fracture calcaneus were treated using limited sinus tarsi approach with added percutaneous reduction and fixation. Plain X-Ray films included anteroposterior (AP) view; lateral view, axial heel view, and Broden's oblique view of the foot were done for all patients. Preoperative computed tomographic (CT) examination was done for all patients. The classification of fractures according to Sander's *et al* was type II in 10 feet, type III in 20 feet.

Results: Eight patients (28.5%) had no pain; sixteen patients (57%) had mild tolerable pain with activity, and four (14.5%) patients had moderate pain needing anti-inflammatory and analgesics. According to the American Orthopedic Foot and Ankle Society (AOFAS) score, eight patients had excellent score (28.6%), good in ten (35.7%), fair in six (21.4%) and poor in four (14.3%).

Conclusion: The limited lateral sinus tarsi approach gives good reduction aided by percutaneous reduction and screw fixation. The technique is more effective in patients with type II & III Sander's classification especially in risky patients. The timing of operation can be as soon as possible with reduced rate of soft tissue morbidity and good range of motion compared with the extensile formal procedures.

Keywords: Sinus tarsi, calcaneus, intraarticular, fixation

Introduction

Due to the proper shape, length, and height of the calcaneus; the motion of the hind foot complex depends upon the smoothness of the articular surfaces of the calcaneus and the three-dimensional (3D) relationships between the talus, calcaneus, and cuboid. Fractures of the calcaneus can be caused by sudden axial loading [1, 2]. Sanders [3] classified these fractures according to the comminution of the posterior facet fragments (Figure 1). Clinically, the foot is usually swollen and bruised, and fracture blisters may occur in the first 24–48 h. The heel may be widened and shortened. Neurapraxia of the medial or lateral plantar nerves can be present. Compartment syndrome may occur in the plantar spaces of the foot, producing painful limited motion of the toes [4].

The treatment of calcaneal fractures continues to evolve. Smaller incisions and the use of titanium locking plates designed for the limited incisions to accomplish open reduction and internal fixation (ORIF) of calcaneal fractures represent such an advance [5]. The idea of minimal invasive surgery have been developed, and what was done through a large exposure can be done with smaller incisions and less tissue disruption without diminishing the end result. The dual-incision approach to the heel fracture and sinus tarsi approach are examples of these techniques [6, 7]. This prospective study evaluate the results of limited sinus tarsi lateral approach aided by percutaneous reduction and fixation of thirty intraarticular fracture calcaneus in twenty eight patients.

Patients and Methods

Thirty feet in 28 patients 20 males and 8 females with intraarticular fracture calcaneus were treated in the period from May 2009 to November 2013. The age of the patients ranged from (28 to 52) average 38 years. The mechanism of injury was fall from height in 16 patients, car accident in 8 patients, and sport injury in 4 patients. Left foot was affected in eighteen patients, right foot in eight, and two patients had bilateral calcaneal fracture.

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The fractures were simple in 28 feet, and open in 2 feet. Associated fractures ipsilateral or contralateral as post-concussion, internal hemorrhage, hemothorax or axial injuries were recorded in 12 patients.

All patients were clinically evaluated for the vascular and neurological status of the foot, any signs of compartment syndrome, skin condition and blisters. Plain X-Ray films included anteroposterior (AP) view; lateral view, axial heel view, and Broden's oblique view of the foot [8] were done for all patients. A lateral view of the uninjured foot was done for comparison and measuring Bohler's angle in all cases [9]. Bohler's angle was documented for all patients preoperative and postoperative for the injured side.

Preoperative computed tomographic (CT) examination was done for all patients. The classification of fractures according to Sander's *et al* was type II in 10 feet, type III in 20 feet (Figure 2). The average time before surgery was 4 days (range 2- 10 days). All operations were done in supine position on radiolucent operating table with the foot close to the end of the table and under image intensifier.

Surgical technique: The position of the patients was semi-lateral with a sandbag under the buttock and the affected foot is uppermost. Under high tourniquet, a small lateral approach extended from below lateral malleolus for 5 to 6 cm long up to sinus tarsi was done in twenty fractures. In ten fractures closed reduction and percutaneous fixation were done through multiple stab wounds in different directions according to screw entry. The incision was carried down to the peroneal tendon sheath with protection of the sural nerve and the short saphenous vein. Opening the peroneal sheath, and releasing fibers of extensor digitorum previs for good exposure, followed by dissection of the sinus tarsi view the anterior aspect of the posterior calcaneal facet.

During sharp dissection of the lateral wall, the lateral wall fragments were kept attached to the overlying soft tissue, and opening it carefully to view depressed fragments. Disimpaction of fragments was the next step in the technique, and was done through periosteal elevator from sinus tarsi to subtalar joint or stiemen pin in the tuberosity and rocking it with applying traction on the pin for freeing of the fragments. After manipulations, two Kirschner wires 1.5 to 2 mm were used to help reduction and give temporary fixation. One of the two wires was used as joystick to keep the fragment reduced, and the second were driven across the fracture for temporary fixation. In the type III fractures, two fragments were held in reduced position using reduction forceps, and two K-wires passed to fix the two fragments to the third. After reduction and temporary fixation, it was important to check the posterior subtalar joint congruity using intraoperative radiology multiple views (Figure 2A & B & C).

The following step was final fixation of the fracture. The direction of screws differed according to the direction of the fracture, with the main entry from posterior to anterior or from anteromedial to posterolateral (Figure 3D&E&F). Cancellous screws over washers were used in 26 fractures, plate fixation was added to screws in 4 fractures (Figure 4), and K-wires were left in place with screws in 4 fractures (to support small fragments to avoid further comminution). Hemostasis was obtained after releasing the tourniquet, then wound closed by interrupted sutures and plaster splint or cast was done in all patients and bivalve in the second day to be removed with stitches after two weeks.

A new cast was done for 4 weeks. Active movements of ankle and subtalar joints were begun after removal of cast. Partial

weight-bearing was allowed 8–10 weeks after radiographic healing and extraction of K-wires. The mean duration of follow-up was 22 months (range 12–40 months). The clinical rating system of the American Orthopedic Foot and Ankle Society (AOFAS) was used for the clinical evaluation pre and post-operative [10]. The swelling of the heel was compared with the normal side and graded as mild, moderate, or severe.

Results

Clinically, eight patients (28.5%) had no pain; sixteen patients (57%) had mild tolerable pain with activity, and four (14.5%) patients had moderate pain needing anti-inflammatory and analgesics. The cause of pain was due to subtalar joint arthrosis in twelve patients, and peroneal tendinitis in eight patients. The average range of motion compared to other side was 90% in ten patients (35.7%), and 70% in eighteen patients (64.3%). The distance of walking improved at final follow up to free walking distance in twenty patients (71.5%); in eight patients walking interrupted for 500-1000 meters. While 13 patients (46.5%) returned to their work before trauma, ten patients (35.7%) modified their job, and five patients (17.8%) changed their manual work to sedentary one.

The heel swelling was soft tissue in origin and took a long time to resolve increasing with effort and long standing. The swelling was moderate and interfered with shoe wear in eight patients, and mild in twenty two patients. Four patients complained wound problems, three of them were superficial infection and treated by repeated dressing and parenteral antibiotics, one patient had deep infection and needed extraction of screws and debridement at 11 weeks postoperative (Figure 5).

According to the American Orthopedic Foot and Ankle Society (AOFAS) score [10], eight patients had excellent score (28.6%), good in ten (35.7%), fair in six (21.4%) and poor in four (14.3%).

Radiologically, the Bohler's angle [9] ranged from -22 degrees to 15degrees preoperative with a mean of 4.6 degrees. At the final follow up the mean Bohler angle was 32.5 degrees (range 19-42 degrees). Comparing the Bohler angle to the normal side it was restored by 89% of normal side (range 70-98%). The improvement of calcaneal height ranged from 80–95% (average 92%). The residual widening of calcaneus was found in all patients and ranged from 5 to 25% (average 12%) of normal side, but clinically only eight patients were complaining from this problem. The subtalar congruity was documented in all patients and C-T postoperative was done in fifteen patients for follow up to evaluate reduction and joint congruity. Congruent joint was found in 22 (73.35%) feet (20 patients -2 bilateral), step 1- 2 mm in five feet (16.65%), and step of 3mm in three feet (10%).

When correlating clinical results to radiological findings, there was increased patient satisfaction (64.3% of patients with excellent to good AOFAS) in those with near normal correction of Bohler angle (87% to 98% of normal site) [$p = 0,001$]. According to fracture classification, patients with Sander's type II were excellent or good (AOFAS), and increased satisfaction. The patients with good reduction and joint congruity were the patients who had good walking distance and mild pain ($p= 0.005$), and joint movement more than 65% of normal ($p= 0.001$). The patients (71.4%) with calcaneal height above 90% of normal had good clinical results compared to the patients (28.6%) with less than 90% correction ($P = 0.005$). There was no significant difference in results between male and female patients, younger and older patients.

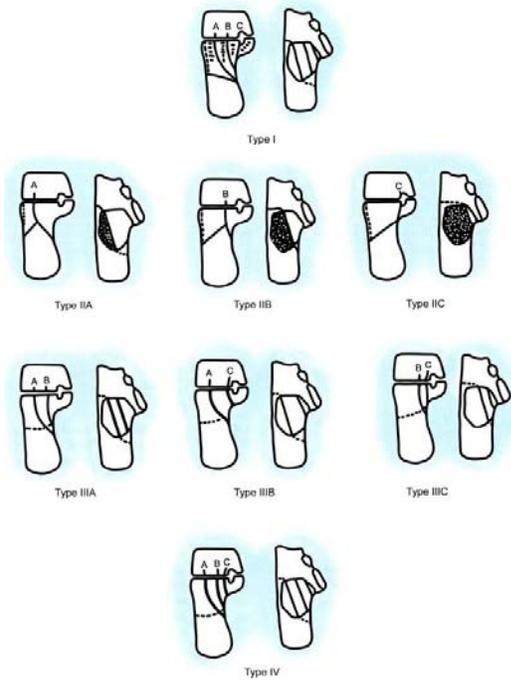


Fig 1: Sander's classification of calcaneal fractures [3].



Fig 2: Case no (4) Preoperative diagnosis and preparation: A & B) plain x-ray lateral and axial view; C & D & E) different C T cuts for classification of the fracture.

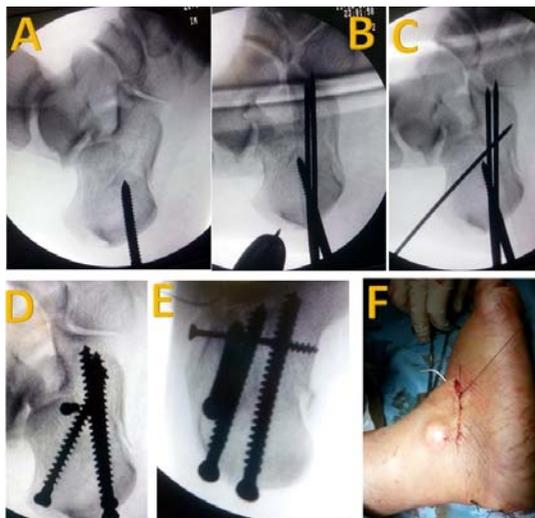


Fig 3: Operative technique A & B) Trials for reduction of the fracture; C) temporary K- wires fixation; D&E) Final screw fixation; F) intraoperative photo showing wound closure.

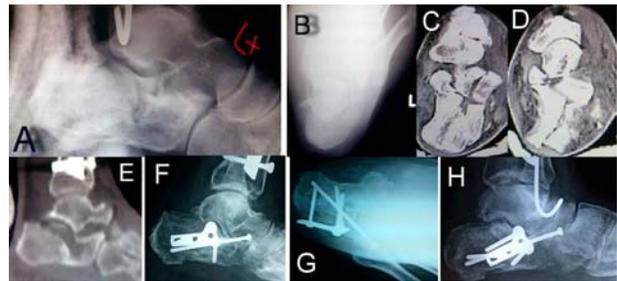


Fig 4: Case no (7): male patient 48 years old with fracture calcaneus and ipsilateral fracture both bone leg fixed by interlocking nail tibia and k wire for fibula; A&B) Preoperative x-ray; C&D&E) different C T cuts with type III Sander's classification; F&G) postoperative x-ray with fixation by screws and mini plate low profile; H) one year postoperative x-ray.

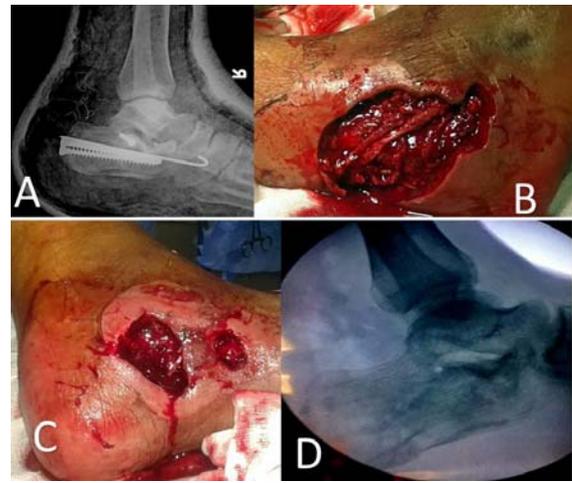


Fig 5: Case no (5): male patient 35years old with fracture calcaneus type II Sander's classification fixed by screws A) x-ray lateral view in cast 5 weeks postoperative B&C) intraoperative photos showing wound for debridement and screw extraction; D) intraoperative radiograph after removal of screws.

Discussion

Due to the unsatisfactory functional results of conservative treatment of the displaced intra-articular calcaneal fractures, the surgical treatment of these fractures evolved and still updating [11, 12]. Many authors believe that there is a relationship between poor clinical outcome and bad reduction with heel deformity. The most widely used approach was lateral extensile approach as the lateral calcaneal surface is more applicable for plates and rigid fixation. Infection and wound dehiscence were the most common complications associated with this approach. To avoid these complications those authors recommended 14-21 days after fracture until skin condition is ready for surgery [12, 16].

To avoid the serious soft-tissue complications of extensile approaches, Burdeaux [16] used medial approach for direct reduction and fixation and indirect reduction of articular surface. Paley and Hall [17] used only the medial approach for all his cases and reported that this approach was not adequate to address the lateral extrusion of bone fragment.

The combined medial and lateral approach was performed by Stephenson [18]. He found it possible to reduce the posterior facet accurately through the lateral small approach, and the tuberosity fragment was reduced with medial approach.

With increased advance in methods of diagnosis and intraoperative radiology the concept of mini invasive techniques for open reduction and internal fixation of these

fractures has been developed. In this work, the sinus tarsi lateral approach was used primarily for open reduction and low profile plate fixation in twenty fractures, and percutaneous reduction and screw fixation in ten fractures. The mean time elapsed from injury to surgical interference was 4 days (range 2- 10 days) in this study, with the percutaneous technique more early excluding only potentially infected skin blisters related to the fracture site. Infection rate in this series was three superficial treated conservatively, and one case of deep infection treated by surgical debridement and screw extraction. Wound healing was 100% in maximum three weeks.

These results were comparable with the results of Stulik *J et al* [4] using minimally-invasive technique, the reduction of the calcaneal fractures restoring the length, height, and width of the heel was accepted. Assessment of the articular surface reduction was good using image intensification intraoperative and on the CT scans postoperative. They reported favorable results compared to those of patients treated by open reduction with 7% superficial and 1.7% deep infection which were significantly lower than those in most series using extensile approaches.

In this study the radiological results were good regarding the Bohler angle which improved from a mean of 4.6 degrees preoperative to 32.5 degrees postoperative. The calcaneal height was average 92% of normal side, and 12% average widening of calcaneus.

Percutaneous reduction and fixation technique was the method of treatment in 10 Sander's type II fractures and was helpful for screw fixation from medial and posterior portals added to sinus tarsi approach in 16 fractures, and mini plate fixation after open reduction through lateral sinus tarsi approach in 4 fractures.

Tornetta [17] treated 46 patients with percutaneous fixation, and reported that the most suitable cases for this method is type II Sander's fractures where the intact posterior facet is in continuity with the tuberosity fragment. Eighty five per cent of his patients had excellent to good results. Many authors believe that the minimal dissection decreases the post-operative swelling, peri-articular scarring. Those authors observed good subtalar movements in spite of nearly anatomical joint reduction compared to reduced range of movements after open reduction of joints and internal fixation [5, 14, 18, 19].

In this series, all fractures were treated using minimal lateral sinus tarsi approach for reduction and percutaneous reduction and screw fixation to restore reduction and stability of the fractures with less soft tissue handling. The fracture anatomy and joint congruity were assessed intraoperatively using image intensifier and C T was done in query patients postoperative. The joint congruity was reached in 22 feet (73.35%). In eight feet (26.65%) step of less than 3mm was found but not affected clinical results significantly ($p= 0.001$). Clinically there were eighteen patients (64.3%) with excellent to good (AOFAS) score and fair to poor score in ten (35.7%).

Conclusion

The limited lateral sinus tarsi approach gives good reduction aided by percutaneous reduction and screw fixation. The technique is more effective in patients with type II & III Sander's classification especially in risky patients. The timing of operation can be as soon as possible. Reduced rate of soft tissue morbidity and good range of motion are possible with these techniques compared with the extensile formal procedures. The limitation of this study is low number of cases and that no Sander's type IV fractures included giving

complete image about all intraarticular fracture types.

All patients included in this study have given informed written consent for participating in the research before operation.

This prospective study was conducted at Zagazig University Hospitals, after approval of our ethical committee for research in accordance with the ethical standards laid down in the 1964 declaration of Helsinki and its later amendments.

Conflict of interest: No: The author state that there has been no conflict of interest and there were no potential benefits in any form from a commercial party related directly or indirectly to the subject of this manuscript. No funds, grants, or personnel to be acknowledged have been hidden.

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