

To study A minimally invasive surgical approach for Sanders type 2 & 3 calcaneal fractures

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Abstract

Introduction: Calcaneus fractures are most common fracture of the tarsal bones, yet the treatment approach has always been the challenge in clinical research of orthopedics.

It is hard to obtain excellent anatomical reduction, especially for displaced fractures. 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.

Objectives of the study: To study A minimally invasive surgical approach for Sanders type 2 & 3 calcaneal fractures.

Materials: 45 intraarticular calcaneal fractures in 40 patients were treated from September 2016 to June 2018. The classification of fractures according to Sander’s et al (10) was type II in 26 feet, type III in 19 feet. All operations were done in lateral position on radiolucent

operating table with the foot close to the end of the table and under image intensifier.

Results: Radiological results (before and after operation) and functional outcome score in 45 feets of 40 patients were done (table 3 and 4). The overall mean MFS was 88.1 ± 8.8 , in which excellent outcomes were achieved in 36 patients, good in 6, and fair in 3 {Excellent and good rate= 93.3% (42 of 45)}

Conclusion: Minimally invasive sinus tarsi approach with percutaneous screw and/or plate fixation technique for the treatment of intra-articular calcaneal fractures sanders type 2 and 3, can not only obtain the satisfactory Functional and Radiological outcomes, but also can effectively prevent surgical complications.

Keywords: calcaneal fracture, sanders type 2,3, minimal invasive approach.

Introduction

Calcaneus fractures are most common fracture of the tarsal bones, yet the treatment approach has always been

the challenge in clinical research of orthopedics. It is hard to obtain excellent anatomical reduction, especially for displaced fractures.

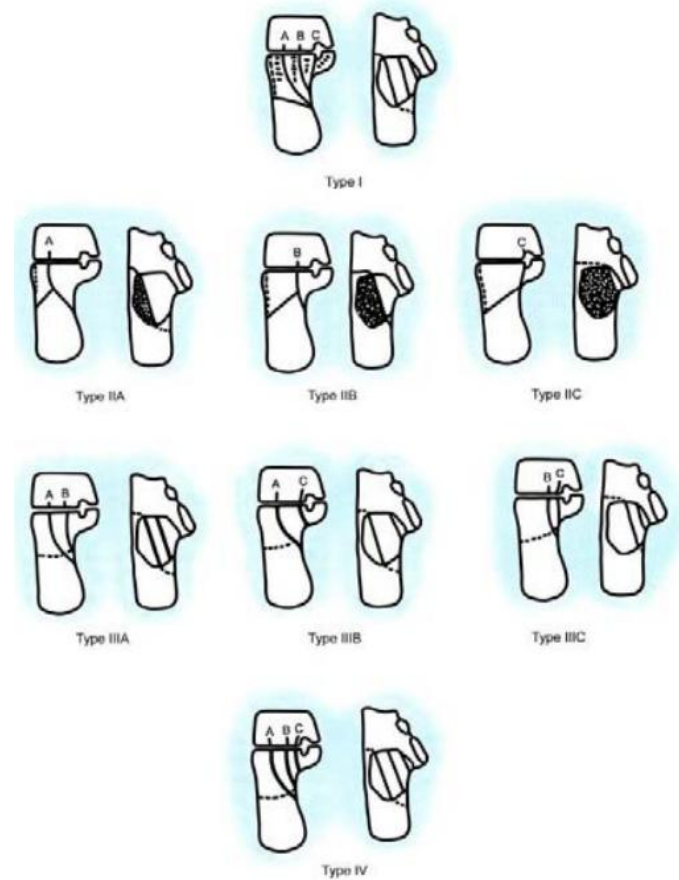
Due to the proper shape, length, and height of the calcaneus; the motion of the hind foot complex depends upon the smoothness of the articular surfaces of the calcaneus and the (3D) relationships between the talus, calcaneus, and cuboid.

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 (Table 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. Neuropraxia 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 evaluates the results of limited sinus tarsi lateral approach aided by percutaneous reduction and fixation of forty-five intraarticular fracture calcaneus in forty patients.

Table 1:



Material and method

45 intraarticular calcaneal fractures in 40 patients were treated from September 2016 to June 2018.

Inclusion criteria

1. Sanders type 2 & 3 calcaneal fractures.
2. Both sexes.
3. Skeletally mature patient.
4. Patient ambulatory prior to fracture, though they may have used an aid.

Exclusion criteria

1. Medically unfit patients.
2. Any infection around the fracture.
3. Skeletally immature patients.
4. Sanders type IV.

Forty five feet in 40 patients (33 males and 12 females) with intraarticular fracture calcaneus were treated in the period from September 2016 to June 2018. The age of the patients ranged from (24 to 54) average 39 years. The mechanism of injury was fall from height in 22 patients, RTA in 18 patients. Left foot was affected in 20 patients, right foot in 15, and 05 patients had bilateral calcaneal fracture.

All fractures were closed. Associated fractures ipsilateral or contralateral as post-concussion, internal hemorrhage, hemothorax or axial injuries were recorded in 08 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 (8) of the foot 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 (10) was type II in 26 feet, type III in 19 feet. All operations were done in lateral position on radiolucent operating table with the foot close to the end of the table and under image intensifier.

Surgical procedure

Pre-operative antibiotics were administered, all patients were operated under spinal anesthesia. All procedures were performed under thigh tourniquet. A 3 to 4 cm incision was made over the sinus tarsi following a line from the tip of the fibula to the base of the fourth metatarsal (fig 1). Dissection was carefully carried down to the posterior facet as the extensor digitorum brevis

was retracted (fig 2). A C-arm was brought in from the ipsilateral side to facilitate acquisition of multiple lateral and axial heel radiographs. Hintermans retractor (fig 3) is placed over k wire inserted in talus and calcaneum for proper visualization of posterior facet. The depressed posterior facet was visualized to expose borders of the fracture fragment. A periosteal elevator was then placed (fig 4,5) under the posterior facet fragment to elevate it up into an anatomic position. The Steinman pin and lamina spreader (fig 6,7) were used together to position the posterior fragment into place. Once the posterior fragment was anatomically reduced, a 1.4mm K-wire was inserted into the fragment, across the subtalar joint into the talus to hold the fragment in a reduced position. The screw position was confirmed under C Arm. A 6.5 mm or 4.0mm cannulated screw was inserted from lateral to medial just beneath the Gissane's angle to support the posterior facet. To restore axial height and length and correct any varus of the heel, a percutaneous Schanz pin was placed in the calcaneal tuberosity. The Steinman pin was then removed and a guide pin for a 6.5-mm partially threaded cannulated screw (fig 8,9) was inserted posteriorly directed into the anterior aspect of the calcaneus. This guide pin helped to maintain calcaneal height and alignment, supported the posterior facet. Finally lateral, axial and Broden's heel radiographs were taken, and the subcutaneous tissues and skin sutures were applied. Similar procedure done for plating also(fig10,11). closure is done in layers(fig12). Patients were placed in a posterior splint in non-weight bearing position with strict elevation. Range of motion exercises were started at 2 weeks; slab was removed after 4 weeks. Progressive weight-bearing and physical therapy was started 10 weeks to 12 weeks after surgery and full weight-bearing was allowed 12

weeks to 16 weeks after surgery. Patients were released for full activity 8-12 months after surgery.

Figure legends



Figure 1



Figure 2



Figure 3



Figure 4



Figure 5



Figure 6

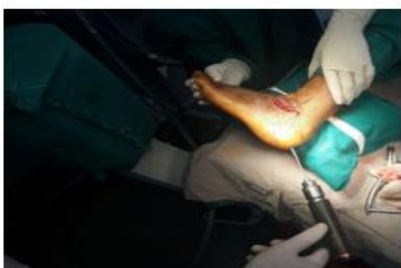


Figure 7



Figure 8



Figure 9



Figure 10



Figure 11

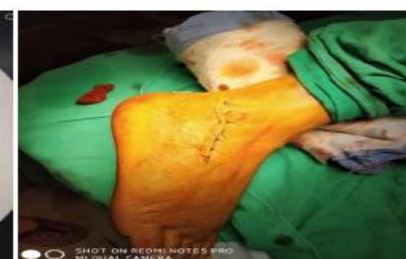


Figure 12

Results

Radiological results (before and after operation) and functional outcome score in 45 feet of 40 patients were done (table 3 and 4). All patients had been followed up

for an average of 12 months ranged from 3 months to 24 months. Pre and post operative evaluation of Bohlers angle, Gissanes angle, Calcaneal length (mm), Calcaneal width(mm), Calcaneal height(mm), were measured as

shown in table 3. Satisfactory restoration of the calcaneal height, width, length, Bohlers angle And Gissanes angle were done. There was no statistical difference between the 3- month postoperative group and the last follow-up group. Mery land functional outcome score were Table 2:

recorded (shown in table 4). The overall mean MFS was 88.1 ± 8.8 , in which excellent outcomes were achieved in 36 patients, good in 6, and fair in 3 {Excellent and good rate= 93.3% (42 of 45)}.

Radiological results before and after operation

(n=45 feet, 40 patients)

| Group | Bohler angle (°) | Gissane angle (°) | Calcaneal length (mm) | Calcaneal width (mm) | Calcaneal height (mm) |
|----------------------------|------------------|-------------------|-----------------------|----------------------|-----------------------|
| Preoperative | 19.2 ± 6.1 | 104.1 ± 16.5 | 60.1 ± 5.0 | 37.0 ± 3.0 | 31.6 ± 2.5 |
| Three months postoperative | 30.7 ± 6.7* | 119.8 ± 6.5* | 64.8 ± 8.0 | 33.1 ± 3.0* | 36.9 ± 1.7* |
| Last follow-up | 30.7 ± 6.6* | 119.7 ± 6.5* | 66.6 ± 10.3* | 33.0 ± 3.0* | 37.1 ± 1.8* |

Satisfactory restoration of the calcaneal height, width, length, Bohlers angle And Gissanes angle

There was no statistical difference between the 3-month postoperative group and the last follow-up group.

*p < 0.01, compared with the preoperative group

Table 3:

Function outcome scores

| Maryland score | Mean ± SD | Excellent (%) (90–100) | Good (%) (75–89) | Fair (%) (50–74) | Poor (<50) |
|----------------|-------------|------------------------|------------------|------------------|------------|
| Total | 88.1 ± 8.8 | 36 (80) | 6 (13.3) | 3 (6.66) | 0 (0) |
| Sanders II | 88.1 ± 8.8 | 20 (76.9) | 4 (15.4) | 2 (7.6) | 0 (0) |
| Sanders III | 87.8 ± 10.1 | 16 (84.2) | 2 (10.5) | 1 (5.2) | 0 (0) |

The overall mean MFS was 88.1 ± 8.8 , in which excellent outcomes were achieved in 36 patients, good in 6, and fair in 3 {Excellent and good rate= 93.3% (42 of 45)}

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 fixation with various methods like screw, plate, screw and plate combination. The mean time elapsed from injury to surgical interference was 3 days (range 2- 7days) in this study, with the percutaneous technique more early excluding only potentially infected

skin blisters related to the fracture site. Superficial infection in 2cases. No Deep infection. Screw prominence in 3 cases. Complex regional pain syndrome in 1 patient. Wound healing was 100% in maximum three weeks. These results were comparable with the results of Stulik J et al (4) using minimallyinvasive 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 postoperative.

In this study the radio logical results were good regarding the Bohler angle which improved from a mean of 19.2 ± 6.1 degrees preoperatively to $30.7 \pm 6.6^*$ degrees postoperatively. Gissans angle was 104.1 ± 16.5 preoperatively and $119.7 \pm 6.5^*$ postoperatively.

The calcaneal height (mm) was 31.6 ± 2.5 preoperatively and $37.1 \pm 1.8^*$ postoperatively. The calcaneal length (mm) was 60.1 ± 5.0 preoperatively and $66.6 \pm 10.3^*$ postoperatively. The calcaneal width (mm) was 37.0 ± 3.0 preoperatively and $33.0 \pm 3.0^*$ postoperatively. *p

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 postoperative 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 or plate fixation or combination of both screw and plate 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 overall mean Maryland Functional outcome Score was 88.1 ± 8.8 , in which excellent outcomes were achieved in 36 patients, good in 6, and fair in 3 {Excellent and good rate= 93.3% (42 of 45)}.

Conclusion

Our results suggest that minimally invasive sinus tarsi approach with percutaneous screw and/or plate fixation technique for the treatment of intraarticular calcaneal fractures sanders type 2 and 3, can not only obtain the satisfactory Functional and Radiological outcomes, but also can effectively prevent surgical complications. 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.

Our study has some limitations

- Patients were not randomized to receive our surgery.
- we did not have a control group, which made our comparison inconclusive
- Follow-up was short, which may have led to the underestimation of the complication rate and long-term reduction effect.

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