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Orthopaedics

MANAGEMENT OF INTRA-ARTICULAR CALCANEAL FRACTURES WITH ILIZAROV RING FIXATION Senior Resident, Department of Orthopaedics, Dr S.N. Medical College &

Nirottam Singn	Attached Hospitals, Jodhpur. *Corresponding Author	
Jagdish	Resident, Department of Orthopaedics, Dr S.N. Medical College & Attached Hospitals, Jodhpur.	
Hemant Jain	Associate Professor, Department of Orthopaedics, Dr S.N. Medical College & Attached Hospitals, Jodhpur.	
Kishore Raichandani	Professor, Department of Orthopaedics, Dr S.N. Medical College & Attached Hospitals, Jodhpur.	
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ABSTRACT Objective: Calcaneal fractures are caused by a high velocity force to the heel, mostly in road traffic accidents or fall from height. Debate continues regarding the best management of calcaneal fractures. We aim at evaluating the radiological and functional outcomes of displaced intra-articular calcaneal fractures treated with lizarov ring fixation.

Methods: Eighteen consecutive patients with intra-articular calcaneal fractures [Sanders type II (10), Sanders type III(6), and Sanders type IV (2)] were treated with the Ilizarov ring fixator from Sep 2017 to June 2020. Patients were evaluated in terms of associated injuries and x-rays of anteroposterior, lateral and axial views of the calcaneus. CT scan was done to assess the amount of comminution and articular depression. Patients were followed up clinically and radiologically at least for 1 year. Functional outcome was assessed using the American Orthopaedics Foot and Ankle Society (AOFAS) scale. Radiological assessment was done by Bohler's angle and Gissane's angle along with measurement of calcaneal height and width.

Results: At average follow-up of 18.5 months, average AOFAS score was 80.5 (range 71 to 90), with 6.25% having excellent, 75% having good, 12.5% having fair and 6.25% having poor results. All patients had stable ankle joint with all having dorsiflexion and plantar flexion more than 30°. All patients are able to wear their previous size shoes. The mean Bohler's angle, mean Gissane's angle, calcaneal height and width were 21.5°, 126.3°, 4.36 cm and 3.80cm respectively at final follow-up. Four patients had superficial pin tract infection. One patient had collapse of posterior facet after removal of fixator with peroneal tendinitis. All fractures united and none needed secondary bone grafting. Patients returned to work on an average of 5.5 months.

Conclusion: Ilizarov external ring fixation gives good functional outcomes, manifested by restoring near normal anatomic reconstruction of morphology and alignment of the calcaneus. The added advantages of these procedures are the considerably shortened operating time and hospital stay, no need of highly equipped operation theatres and the reduced risk of complications related to surgical exposure.

KEYWORDS : Calcaneus, Fractures, Ilizarov, Fracture fixation, External

INTRODUCTION

Calcaneal fractures are the commonest fracture of the tarsal bones^[1] and account for up to 75% of all foot fractures. Calcaneal fractures are caused by a high velocity force to the heel, mostly in road traffic accidents or fall from height.^[2] The anatomy and biomechanics of the hindfoot account for the difficulties in treating this type of fracture because the calcaneus is a wholly cancellous bone with a thin cancellous shell surrounding it. Calcaneus is constantly subjected to compression forces, provides a lever-arm in the Achilles-calcaneal-plantar system, and has articular surfaces which form two complex joints, the mid tarsal (Chopart) and the subtalar. Subtalar joint is a very unforgiving joint, and even minimal loss in the absolute joint congruency causes rapid wear on weight bearing and often necessitates secondary procedures like arthrodesis.

There are still controversies about the optimal kind of treatment of the calcaned fractures, especially for displaced intra-articular fractures.^[3,4,3] The goal of the treatment of intraarticular displaced fractures is to restore the articular surface and morphology of the calcaneus to optimize the functional outcome. Treatment options for calcaneal fractures include non-operative, application of plaster cast with early range of movement, closed manipulation and pin reduction, and open reduction internal fixation. Although open reduction and internal fixation is currently considered the treatment of choice for fractures type II, III and IV, according to Sander's classification^[6,7] uncertainty remains about the comparative final results of surgical and conservative treatment. neither provides good results without the risk of considerable early and delayed complications.

Non-operative treatment can be associated with malunion, peroneal tendon dysfunction, post-traumatic arthrosis, ankle and heel pain, and exostoses. Operative treatment carries the risk of similar complications with the addition of pain due to retained hardware and infection, both superficial and deep.^[11] Post-operative complications, specifically infection, decrease patient satisfaction and potentially functional outcome.^[12]

Ilizarov ring fixation with closed or percutaneous reduction, following a pre-operative CT scan, is a minimally-invasive technique that can obtain reduction and stable fixation of most displaced articular fractures while greatly reducing the risks of open surgery. The Ilizarov fixator overcomes nearly all the complications of open surgery, by virtue of its use of percutaneous small diameter wires does not violate the soft tissues, preserves blood supply, respects biology and the use of olive wires helps to reduce the major fractures by helping to achieve arthro-diastasis. We under- took a prospective study on Management of intra-articular calcaneal fractures with Ilizarov ring fixation and analysed the short-term clinical and radiological outcome and the complications encountered.

MATERIAL AND METHODS

Eighteen consecutive patients with intra-articular calcaneal fractures [Sanders type II (10), Sanders type III (6), and Sanders type IV (2)] were treated with percutaneous

reduction/mini open incision and fixation with the Ilizarov Ring fixator from Sep 2017 to June 2020. Patients with extraarticular fracture, nondisplaced intra-articular fracture and calcaneal fracture more then 3 weeks duration were excluded from the study. Ethical clearance was obtained from the ethical committee. Fourteen patients were male and four was female. The average age was 33.5 years (range 19-52 years). Six patients had sustained leg trauma in road traffic accidents, while the remaining twelve had fallen from a height. Two of the patients had open fractures (type I). In cases of open fractures, the wound was debrided at the time of definitive surgery. Two of the patients had associated musculoskeletal injuries; one patient had spinal fractures, of which one was operated and recovered in 3 months to achieve independent ambulatory status. One patient had medial malleolus fracture, was operated and fixed with malleolar screw at the time of definitive surgery (Fig. 1A&B).



Fig. 1A- Intra-articular calcaneal fracture with associated medial malleolus fracture, Fig. 1B- Fixed with malleolar screw.

Preoperative Evaluation

The patients were evaluated for associated injuries and anteroposterior, lateral, and axial radiographic views of the calcaneus were obtained (Fig. 2A & 2B) CT and 3-dimensional (3D) reconstruction were also performed to assess the details of articular depression (Fig. 2C) and to classify according Sanders classification. After injury, the limb was elevated and measures were taken to avoid edema.^[13]



Fig. 2A-Lateral radiograph showing joint depression type fracture, Fig. 2B-Axial radiograph showing varus collapse and Fig. 2C-CT and 3-dimensional (3D) reconstruction.

Operative technique

The patient is positioned supine on a radiolucent operating table. Closed reduction of the fracture by traction and manipulation was attempted in all the patients. If limited internal reduction was needed, the limb was elevated and the tourniquet inflated before a small incision necessary to elevate the depressed fragments was made and reduction is achieved using 10 mm curved osteotome or curved artery forceps by sinus tarsi approach. Reduction is held & retained using multiple k-wires under fluoroscopy guidance. Two parallel Ilizarov wires, 1.8 mm in diameter, were placed through the talar neck just proximal to navicular tuberosity and mounted on half/full rings of either 160 mm or 180 mm diameter, depending on the circumference of the foot and tensioned up to 90kg (Fig.3A&B). Schanz pin was applied to the calcaneal tuberosity to hold posterolateral fragment. This allowed manipulation and distraction to correct deformity. A calcaneal wire with olive was then placed from medial to lateral side to correct varus deformity and to apply side-toside compression through large medial and lateral wall fragments to reduce heel widening. Care was taken to prevent tethering of muscles or tendons by extension or flexion of the foot as indicated. Distraction between talar and calcaneal

ring correct the height and maintain the medial arch of foot .The subtalar joint was distracted, allowing for better observation of the articular surface and easier reduction and elevation of the articular surface and also helpful to prevent equinus contracture of the ankle. Additional calcaneal wires are used for stability of construct.

Postoperative Plan

Patients started ankle joint ROM exercises as soon as possible and non-weight bearing walking on the second postoperative day. Regular pin tract dressing with normal saline and cleaning of rings with spirit solution was done. The aim was to keep all pins dry and clean with removal of any discharge (Fig. 4A). Progressive weight bearing began after 3 weeks, and full weight bearing was allowed after 8 weeks (Fig. 4B). The Ilizarov frame was removed once the fracture had consolidated well clinically (no pain, swelling, or tenderness at the fracture site) and radiologically. Patients were followed up clinically and radiologically at least for 1 year. Radiological assessment was done by Bohler's angle^[14] and Gissane's angle^[15] along with measurement of calcaneal height and width. Functional outcome was assessed using the American Orthopaedics Foot and Ankle Society (AOFAS) scale.^[16,17] The AOFAS scales are disease-specific outcome questionnaires consisting of 3 individual items (pain, function, and alignment) and range from a minimum score of 0 (worst outcome) to a maximum score of 100 (excellent outcome) points.



Fig. 3A- Intra-op lateral view showing congruent posterior articular facet, Fig. 3B- Post-op lateral radiograph with maintained calcaneal height and pitch.



Fig. 4A- Clinical picture showing well maintained medial arch of foot, Fig. 4B- Clinical picture showing a comfortable full weight bearing with Ilizarov ring fixator.



Fig. 5A-One yr follow-up radiograph showing acceptable alignment in axial view, Fig. 5B-One yr follow-up radiograph with good calcaneal morphology and near normal Bohler's Angle.

RESULTS

Eighteen patients (fourteen unilateral and four bilateral) with displaced intra-articular calcaneal fractures treated by closed/mini-open reduction and fixed with Ilizarov ring fixator were enrolled in the study. Finally sixteen patients (fourteen

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unilateral and two bilateral, Fig. 7A, 7B and 7C) consisting of four female and twelve male were included in the study as two patients lost in follow-up. The mean delay in surgery was 5.4 days (range 2-13 days). The average duration of surgery was 72 minutes (range 60 to 84 minutes). The average follow-up was 18.5 months (range 12 to 36 months). More than 82% of the patients had no or only mild occasional pain with no limitation of daily activity and no gait abnormality and were able to walk without difficulty on uneven surface. All patients had stable ankle joint with all having dorsiflexion and plantar flexion more than 30° (Fig 6A and 6B). All patients are able to wear their previous size shoes. Average Hind foot AOFAS score at final follow-up was 80.5 (range 71 to 90). The mean Bohler's angle improved from preoperative 5.15° (range -15° to10°) to 21.5° (range 16° to 28°) at final follow-up. It was maintained in near normal range (20° to 40°) (Fig. 5B) in all the patients except two with Sanders type IV fractures. The mean Gissane's angle improved from preoperative 160° (range 134° to 172°) to 126.3° (range 118° to 150°) at final follow-up. The mean calcaneal height improved from preoperative 3.2 cm (range 3.0 to 4.2 cm) to mean 4.36 cm at final follow-up. The mean calcaneal width improved from preoperative 4.18 cm (range 4.1 to 4.6 cm) to mean 3.80 cm (range 3.7 to 4.0 cm) at final follow-up (Fig. 5A). Four cases had superficial pin tract infections (25%). These were treated with local dressing and oral antibiotics for one week without requiring surgical intervention. One patient had collapse of posterior facet after removal of fixator with peroneal tendinitis (Fig. 6C) None of the patients had compartment syndrome, heel pad problems or implant failure. All fractures united and none needed secondary bone grafting. Patients returned to work on an average of 5.5 months.



Fig.6A-1 yr clinical photograph showing normal heal width & medial arch comparable to unaffected side, Fig. 6B- Clinical photograph showing near normal range of motion at ankle joint in sagittal plane, Fig. 6C- Radiograph showing collapse of posterior facet after removal of fixator.



Fig. 7A- Another case example with bilateral calcaneal intra articular fracture with varus collapse, Fig. 7B- Post operative radiograph with well aligned morphology.



Fig. 7C- Bilateral calcaneal fracture Patient walking comfortably with full weight bearing.

DISCUSSION

There is a lack of consensus on classification, treatment, operative technique and postoperative management in calcaneal fractures.[12] CT scanning and 3D reconstruction have provided more details of calcaneal fractures in recent years.^[18] A recent systematic review showed that patients with calcaneal fractures may have better outcomes with surgical fixation but might also experience higher complications by surgery. [19-20] The principal aims of surgical treatment of calcaneal fractures are restoration of the length, width, height, and axis of the calcaneus; restoration of function by primary stable osteosynthesis; and anatomic reconstruction of all joint surfaces.^[30] ORIF is the best surgical treatment for achieving anatomical joint reduction of a displaced intra-articular calcaneus and restoration of the morphology^[21]. Soft tissue complications might be the main reason ORIF has not always been accepted by all surgeons.^[22-23] Majority of the patients were in third and fourth decade with male predominance with fall from height as most common mode of injury. These fractures affect mostly young active patients who work on heights and causing major economic impact.^[9,10]. We observed that quality of reduction is better in early surgery compared to delayed of more than one week because manipulation of fracture fragments by capsule-ligamentotaxis and with thin olive wires is easy, when operated early. The study by Court-Brown et al^[24] showed that delaying surgery was not associated with a lower infection rate. We chose the close reduction by manipulation and traction and in few cases minimally invasive lateral sinus tarsi approach to lift the depressed thalamic fragment. In our study, the mean Bohler's angle, mean Gissane's angle, calcaneal height and width were to 21.5°,126.3° ,4.36 and 3.80 cm respectively at final follow-up. Bohler's angle is the measure of compression and deformity after calcaneal fracture and is the most important prognostic radiological parameter. Hence restoration of Bohler's angle is associated with a better outcome. Bohler's angle was maintained in near normal range (20° to 40°) in all the patients except two patients who had highly comminuted Sanders type IV fractures. At the last follow-up visit, Bohler's angle and Gissane's angle were maintained in the near normal range (20 to 40 and 120 to 145, respectively) (Fig. 5B). Similarly the functional result was good or fair in all our patients as per the AOFAS questionnaire. At final follow-up, average AOFAS score was 80.5 with 6.25% having excellent, 75% having good results, 12.5% having fair results, where as 6.25% had poor results[Table 1]. In our study the average pain AOFAS score was 29 and more than 82% of the patients had no or only mild occasional pain with no limitation of daily activity and no obvious gait abnormality. Two Patients had some difficulty on uneven surface. All patients had stable ankle joint with dorsiflexion and plantar flexion at ankle joint more than 30°. The good functional outcome assessment as seen in our study is considered due to respecting biology of fracture, preserved blood supply, no retained hardware, free ankle range of motion and unloading of subtalar joint by arthrodiastasis to enhance cartilage healing which is responsible for early consolidation of fracture and better rehabilitation as compared to conventional plate fixation. In our study we did not use bone grafts and graft substitutes to fill defects to prevent collapse. Initially some of our cases showed collapse then we start using full ring for talus and 5/8 ring and additional wires for calcaneus fixation and delayed weight bearing and problem was solved. Controversies still exit with regards to primary bone grafting to prevent collapse. A series of cases have been reported with no significant collapse, even without using bone graft for calcaneal fixation, showing no specific benefit with use of the bone graft to prevent collapse. ^[25-27] However, Leung, Thordarson and Schildhauer et al recommended use of bone graft or cement to increase stability and compressive strength of fixation and rapid rehabilitation^[28-30]. Hence we recommended more rigid construct with more wires and delayed weight bearing in such

highly comminuted fractures. The primary limitation of the present study was that the investigation period was short, the sample size was small, and some patients had lost follow- up visits. It is unclear whether collapse will occur with a longer follow-up period. Wang and Wei⁽³¹⁾, found that Bohler's and Gissane's angle had decreased at a mean follow-up period of 40.4 months compared with immediately postoperatively.

Table 1. Clinical results of the 16 fractures (%) according to the American Orthopaedics Foot and Ankle Society (AOFAS) scale at the time of final follow-up.

AOFAS Score		
Excellent	(01) 6.25	
Good	(12)75	
Fair	(02)12.5	
Poor	(01) 6.25	

Conclusion

We found that Ilizarov external ring fixation provides good functional outcomes, manifested by restoring near normal anatomic reconstruction of Bohler's angle, Gissiane's angle, and the height, width and pitch of the calcaneus. The added advantages of these procedures are the considerably shortened operating time and hospital stay, no need of highly equipped operation theaters and the reduced risk of complications related to surgical exposure. We therefore consider that Ilizarov external ring fixation of displaced intraarticular calcaneal fractures is a valid alternative treatment compared with open reduction and internal fixation. This technique provides radiographic and functional results almost similar to results obtained with ORIF, can be used in patients with peripheral vascular disease, smokers and poor skin conditions without risk of wound problems, deep infection and peroneal tendon irritation by the hardware.

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