



ISSN: 2395-1958
IJOS 2018; 4(1): 27-33
© 2018 IJOS
www.orthopaper.com
Received: 10-11-2017
Accepted: 11-12-2017

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Open reduction and internal fixation by extensile lateral approach in displaced intra-articular fracture Calcaneum: A study of 44 cases

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DOI: <https://doi.org/10.22271/ortho.2018.v4.i1a.07>

Abstract

Introduction: Intra-articular fractures of calcaneum pose a challenge for all orthopaedic surgeons due to different treatment options and their varied eventual functional outcome. The aim of this study is to evaluate the medium term outcome of open reduction and internal fixation by extensile lateral approach using low profile anatomical locking calcaneal plate.

Method: 44 cases of intra-articular fracture calcaneum in 40 patients were included in this study. These were classified based on Sanders classification system. Open reduction and internal fixation was done using extensile lateral approach and anatomical locking calcaneal plate. Functional outcome was assessed using the Creighton-Nebraska scoring system at the end of six months.

Results: Excellent result was seen in 69% cases, Good result in 13% cases, Fair and Poor results were seen in 9% cases each. Bilateral fractures showed poorer results compared to unilateral fractures. Associated injuries had a direct bearing on the eventual functional rehabilitation. Average union time was 12 weeks. Most of the patients could return to pre-injury work status by the end of six months.

Conclusion: Immediate, appropriate post-traumatic soft tissue care can probably decrease the incidence of potential wound problems. Extensile lateral approach provides excellent visualization and reduction of displaced intra-articular fragments. Anatomical calcaneal plate provides stable fixation. Role of bone grafting needs further evaluation in a larger population study.

Keywords: calcaneum fracture, anatomical plate, mal-union

1. Introduction

Calcaneum fractures account for 2% of all body fractures. They represent 60% of all tarsal fractures. Upto 70% of all calcaneal fractures are displaced intra-articular and associated with heel widening, varus deformity, decrease in calcaneal height and incongruity of sub-talar joint. In upto 10% cases the injury is bilateral. Fall from height is the most common mechanism of injury [1-5]. Extra-articular fractures of calcaneum have traditionally been treated conservatively and consistently given satisfactory results [6]. It is the intra-articular fractures that have generated lot of interest and controversies and discussions keep cropping up regarding their management [7-9]. Since early 1980's ORIF has evolved as a treatment Of choice for displaced intra-articular fractures, however soft tissue complications such as surgical dehiscence and infections can occur In upto 30% of patients [10-12, 13]. Main aim of ORIF is to restore height, length and width of calcaneum allowing reconstruction of sub-talar and calcaneo-cuboid joint surface with stable internal fixation to allow early rehabilitation [14]. ORIF is associated with potential complications of flap necrosis, neuro-vascular injury, post-traumatic arthritis and potential non-union leading to considerable morbidity in some patients [15-17]. In order to circumvent the potential complications of ORIF newer minimally invasive approaches have come up with different implants but all are under close scrutiny and a matter of ongoing debate and research with each having marginal advantages and disadvantages over one another [18-20]. The extensile lateral approach has been considered the gold standard approach for treatment of displaced intra-articular fractures. It provides excellent exposure of the fracture, the subtalar and calcaeo-cuboid joint thereby allowing anatomical reduction and restoration of the anatomy of calcaneum. However wide dissection of soft tissue can lead to potential problems of wound gaping, marginal skin necrosis and non-union [21-28].

The aim of the study was to evaluate the outcome of open reduction and internal fixation by lateral extensile approach and fixation by anatomical locking calcaneal plate, identify the potential complications associated and assess the long term final functional outcome.

Materials and methods

Forty patients with intra-articular fracture calcaneum (Sanders type II, III and IV), treated by ORIF by lateral extensile approach from Jan 2012 to April 2017 were evaluated for complications, functional outcome and long term effects. Most common mode of injury was fall from height followed by direct injury and vehicular accident. All the patients were initially evaluated on outdoor basis and associated injuries were noted down. Any primary major injuries were dealt with first. Radiological screening of both ankle antero-posterior view, lateral view and calcaneal views were taken. Additional x-rays of affected body parts were taken. Primary care in form of well padded dressing plus splintage and elevation was done. Round the clock analgesics were started. Patients were further evaluated by 3-D computed tomography and then injury was classified based on Sanders classification. Further pre-operative evaluation and assessment was done for fitness for surgery. Local soft tissue condition was monitored regularly till complete subsidence of edema and appearance of wrinkle sign. Once soft tissue edema subsided fully patient was posted for surgery.

Inclusion Criteria: Close fractures, Sanders type II, III and IV. Age group 18 to 65 years.

Exclusion Criteria: Open injuries, medically unfit patient, patient who refused consent for surgery.

Surgical Procedure: All patients were operated under regional spinal anaesthesia under tourniquet control in lateral decubitus position under fluoroscopic guidance. Extensile lateral incision approach was taken with due care to prevent sural nerve injury. Sharp dissection was carried out deep down to bone and soft tissue and periosteum was elevated off the lateral wall. This flap alongwith peroneal tendons in their sheath was reflected proximally to expose the sub-talar joint. Varus deformity of calcaneum was corrected by using 4 mm Steinmann pin and held temporarily. The fracture at medial wall was then reduced under vision and provisionally fixed with k-wires. Next step involved reduction of displaced intra-articular fragment of sub-talar joint. Once height and length of calcaneum was restored, k-wires were inserted to fix the medial column temporarily along the medial wall to sustentaculum tali. Provisional reduction was confirmed under fluoroscopy. Depending upon the extent of void created in calcaneum, decision to do bone grafting was taken from anterior superior iliac spine. Finally anatomical locking calcaneal plate was placed over lateral wall and fixed with locking screws. Final fixation was assessed under fluoroscopy. Wound was closed in layers and sterile well padded dressing was applied. Post-operative radiographs were taken to assess improvement in Bohler's angle and Gissane's angle. Limb was elevated for next 72 hours and later on gentle ankle and foot exercises were started. Stitch removal was planned at an average duration of 14 to 21 days. Strict non-weight bearing was advised for first six weeks and then based on subsequent progress partial weight bearing was permitted. Full weight bearing was permitted only after 3 months. Regular follow-up was advised at 6 weeks, 10 weeks, 14

weeks and six months. At each visit clinical and radiological assessment was done and functional outcome was assessed using the Creighton - Nebraska score.

Creighton-nebraska functional score

	Min	max
Pain on activity	0	15
pain at rest	0	15
activity	0	20
range of motion	0	20
return to work	0	20
change in shoe	0	5
swelling	0	5

Total score: out of 100.

Excellent	90 to 100
good	80 to 89
fair	65 to 79
poor	< 64

Results

Total 40 patients were enrolled for study. 34 had unilateral fractures and 6 had bilateral fractures. Out of 6 bilateral fractures only 4 calcaneal fractures underwent bilateral ORIF. Hence total calcaneal fractures operated were 44 in 40 patients. Out of them 9 were type II, 22 were type III and 13 were type IV. Mode of injury was fall from height in 31 patients and vehicular injury in 9 patients. Associated other injuries were as per table no 1. 35 were males and 5 were females. Age distribution range was from 19 years to 65 years with average age of 36.45 yrs. 19 were right sided and 25 were left sided. Average admission - operation interval was 6 days with range of 1 to 15 days. Average duration of hospital stay was 14.4 days with range of 6 to 30 days. Stitch removal ranged from 14 days to 22 days with average of 16 days. Bone grafting was done in 4 patients (Incidence of 9%). Marginal skin necrosis was seen in 4 patients. (Incidence of 9%). Superficial wound dehiscence occurred in 3 patients which eventually healed by secondary intention. Deep delayed infection with sinus was seen in 2 patients which necessitated eventual implant removal at the end of 6 months. There was no case of post-operative compartment syndrome. Peri-incisional numbness was seen in 5 patients. Most of the patients could return to pre-injury work status by 24 weeks. No patient required change in foot wear or use of orthotics after 6 months. Hardware prominence issue was seen in 8 patients out of which 4 patients underwent voluntary removal at the end of 12 months. Bohler's angle and Gissane's angle could be restored to near normal range in most of the cases and there was no statistically significant difference at the final follow-up. Sub-talar arthritis and stiffness was seen in 4 patients but none was so serious to warrant an arthrodesis. There was no case of non-union in our series. Based on creighton-nebraska score the results were as per table no 2.

Table 1

Associated injury	No.
clavicle fracture	3
distal radius fracture	5
lumbar spine fracture	2
hip dislocation	2
pubic rami fracture	2
trochanter fracture	2
shaft femur fracture	3
tibia fracture	3
Total:	22

Table 2

	Score	No of PTS	Percent
Excellent	> 90	30	69%
Good	80 to 89	6	13%
Fair	65 to 79	4	9%
Poor	<64	4	9%



Pre-op. x-ray lateral view.



Pre-op x-ray axial view.



3-D C.T Scan view.



C.T Scan view.



Post-operative lateral view.



3 months post -op x-ray.

Discussion

The complex anatomy of calcaneum, its spongy bony structure with thin cortical component, vital articulation and high energy trauma with little soft tissue coverage contribute to the difficulty in treating these fractures optimally [29-31]. Despite modern surgical techniques and the considerable number of studies in literature, calcaneum fracture and its best

treatment method remains an enigma for all orthopaedic surgeons [18, 7-9]. Axial loading is by far the most common mechanism of injury causing vast majority of intra-articular fracture calcaneum. Second most common mechanism being crushing injury as a result of vehicular accidents. Incidence of bilateral calcaneum fracture occurs in 5% to 10% cases [32]. In our series there were 6 cases of bilateral fractures with incidence of 15%. According to CAVE *et al* 10% of these injuries are associated with dorso-lumbar spine injuries and upto 26% cases have other systemic injuries. Lance and associates had observed incidence of 60% associated injuries (91 cases out of 152) [33]. SLATIS and colleagues had observed this incidence to be upto 70% in their series [34]. The incidence of associated injuries in our series was 55% (22 out of 40 cases). Sanders classification has been found to be the most universally accepted classification and easily reproducible, for planning the treatment method of these fractures [35]. Various treatment options for calcaneal fractures include, close reduction and casting, close reduction and percutaneous fixation, mini-open reduction and fixation and the classical open reduction and internal fixation technique.

Before 1990's the earlier trend was to treat most of these fractures by conservative means. Essex-Lopresti was the first one to stress the need for close reduction and axial percutaneous pin insertion technique for "tongue- type" and open reduction and internal fixation for "joint depression" type. In the past the pendulum has swung between operative and non-operative management of calcaneal fractures, however recent literature suggests that operative treatment results in better pain scores, good functional outcome and lower incidence of subtalar arthritis in long term follow-up [36-38]. We in our study of 40 patients have analysed the clinical and functional outcome of open reduction and internal fixation by extensile lateral approach and anatomical locking compression plate.

Most of the problems associated with ORIF in these fractures have centered around the discussion on when to operate. The timing of surgery seems to be one of the most important factor in the outcome of treatment. The general consensus is to wait for soft tissue swelling to subside and appearance of "wrinkle sign". This can range from 5 to 10 days. Delaying the surgery by three weeks or more can cause difficulty in reduction due to early consolidation of fracture. The average admission – operation interval in our study was 6 days ranging from 1 to 15 days.

We have used extensile lateral approach, in which the sural nerve is very well identified and can be protected, there is adequate visualization of both the calcaneo-cuboid joint and the sub-talar joint, the peroneal tendons are also well visualized and retracted and the medial wall can be reduced under vision, and the intra-articular reduction can also be achieved properly. At the same time the medial neuro-vascular structures are well protected. We have used low-profile locking anatomical plate which has adequate strength and stiffness to prevent collapse thereby maintaining height and length of calcaneum without the fear of loss of reduction. Although calcaneum is a pure cancellous bone ideally there should not be any need for bone grafting, however role of doing bone grafting remains a topic of discussion and debate. It may probably impart more mechanical strength and possibly stimulate early fracture healing. We have used bone grafting only in 4 cases where there was a large void after ORIF with an aim to prevent potential collapse and achieve osteo-inductive potential.

Higher incidence of post-operative wound dehiscence and

superficial and deep infection is a major concern in management of this fracture. Risk factors for wound problems include smoking, diabetes, obesity, open fractures and other associated injuries. Most common complication is related to wound healing [39-41]. Tennent *et al.* and Geel and Flemister *et al* reported infection rates from 0.3% to 22% respectively. [42, 43]. Xiao YU *et al* reported incidence of 13.6% skin and superficial infection [44]. M.Haddad *et al.* had incidence of skin necrosis in one patient (incidence 2%) and superficial infection in 4 patients (incidence 8%) [45]. Study by Ying LI *et al* had incidence of skin necrosis in 6.8%, wound infection incidence of 3.9%, deep infection of 1.7% and superficial infection of 2.273% [15]. Study by Deniz Gulabi *et al.* had 2 patients of skin necrosis (8%), 4 patients of superficial infection (16%) and none had deep infection [46]. In our study we had 4 cases of marginal skin necrosis, 3 cases of superficial wound infection which resolved with oral antibiotics according to culture and sensitivity report. There were 2 cases of deep wound infection which eventually needed implant removal at the end of six months. Delaying the timing of surgery till skin creases reappear, avoiding pressure during retraction of soft tissues and raising of entire soft tissue flap from bone surface can minimize the chances of skin necrosis and superficial infection.

The most common neurological complication is the iatrogenic nerve injury. Sural nerve is at risk of stretching during ORIF. Xiao Yu *et al* reviewed 21 papers and concluded the incidence rate to be 2.8% [44]. Deniz gulabi had one case of temporary sural nerve hypoesthesia (incidence 4%) [46]. M Haddad *et al* had minor local sensory neurological deficit incidence in 7 patients (incidence 17%) [45]. We had 5 cases of persistent hypoesthesia at final follow-up.

The occurrence of mal-union has very low incidence in this fracture. Improper positioning of foot during surgery, or sub-optimal positioning of fluoroscopy can falsely result in accepting the sub-optimal in-accurate reduction of intra-articular fragments and later on result in sub-talar arthritis and chronic pain and stiffness. Infection, mal-alignment, severely comminuted fractures and early weight bearing all can lead to mal-union. XIAO Yu *et al* had hardly 0.8% incidence in their review [44]. We had no case of mal-union in our series. Calcaneum being richly supplied by blood vessels and being purely cancellous in nature the incidence of non-union is very rare. Different studies have quoted the incidence from 0% to as low as 0.5%. There was no case of non-union in our series. Use of low profile, locking anatomical plates have largely reduced the incidence of hardware irritation and prominence in treatment of this fracture. However there were 8 cases of hardware prominence in our series and out of which 4 underwent voluntary removal at the end of 12 months.

The incidence of sub-talar arthritis and joint stiffness occurred in 4 patients in our series. Out of them 2 were advised sub-talar fusion for same but refused any further surgical intervention as pain and discomfort was well within manageable limits by analgesics and physiotherapy.

No patient required change in foot wear. Almost all the patients could return to pre-injury work status at the end of 6 months. None required change in their job-profile.

Functional outcome at the end of six months was assessed using the Creighton-Nebraska scoring system. We had excellent result in 69% cases, good result in 13% cases and fair and poor results in 9% cases each.

Conclusion

Immediate post-traumatic care of soft tissue injury by rest, ice

application, compressive well padded dressing and elevation and analgesics has an important role in prognosis. Complete subsidence of oedema and appearance of wrinkle sign is a must to avoid wound problems. Extensile lateral approach provides optimum visualization for near normal anatomical reduction. Accurate anatomical reduction of intra-articular fragments is a must for optimum results. Intra-operative soft-tissue handling is essential to avoid potential wound complications. Use of low profile anatomical locking plates is highly recommended. Non-weight bearing is advocated till three months in post-operative phase. Role of bone grafting needs to be further evaluated in a larger population study group before coming to the conclusion of its potential beneficial effects. Better clinical, radiological and functional results can be obtained by ORIF by lateral extensile approach in displaced intra-articular fracture calcaneum.

Conflict of interest: The authors have no conflict of interest to declare.

Funding: The authors have not received any funding or government grant or institutional funding for the above mentioned study.

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