



Research Article

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Surgical management of intra-articular fractures of the calcaneum

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Abstract

Objective: To study the results of internal fixation of intra-articular fractures of calcaneum, specifically Type II and TypeIII fractures, as classified by Sanders et al. **Methods:** Thirty patients with displaced intra-articular fractures of calcaneum were treated with open reduction and internal fixation from September 2004 to July 2008. We used CT classification as proposed by Sanders et al to classify these fractures. Surgery was performed using the standard extended lateral approach. Fractures were reduced and fixed with y-plate and screws without bone grafting. All patients were started on early motion and maintained on non weight bearing for 10 months. Average follow up was 18 months (8 to 30months). The Creighton – Nebraska Heath Foundation Assessment Scale for fractures of the calcaneum was used to evaluate the results. **Results:** There were 12 excellent, 12 good, 6 fair results. All TypeII fractures had excellent results. The average value of restoration of Böhler's angle was 5.2 degree. No significant complications noted. **Conclusion:** We recommend TypeII and TypeIII fractures of calcaneum to be treated with open reduction and internal fixation. Minimal complications were associated with this procedure.

Keywords: Calcaneal plate, Intra-articular calcaneal fracture, Lateral extensile approach.

Introduction

The calcaneum, the largest of the tarsals, is also the most frequently fractured tarsal bone with nearly seventy five percent of fractures being intra – articular. Despite the relative prevalence of this injury, the management of intra-articular calcaneal fractures remains controversial. Historically, closed treatment of these fractures has been unsatisfactory leading Bankart to remark “The results of crush fractures of the os calcis are rotten”. Initial reports of open reduction were however poor and outcomes were frequently worse than closed fractures. The irregular anatomy of the calcaneum, the complicated coupling with the talus via three facet joints and the highly specialized and delicate soft tissue envelope have made operative treatment a challenging task for the fracture surgeon.

Computerized Tomography (CT) scanning has revolutionized the understanding of these fractures and has allowed a scientific approach towards treatment. The CT scan classification by Sanders et al provided a better understanding of the fracture anatomy and also helped surgeons to plan the treatment. Except for Sanders type I fractures, closed treatment always leaves a malunited calcaneum. For better outcome of displaced intra-articular fractures of the calcaneum restoration of anatomy is important.

Materials and Methods

Thirty patients with closed displaced intra-articular fractures of the calcaneum presenting to the casualty or Out Patients Department at JIPMER during the period September 2004 to July 2008 were included in study. Assessment of fractures was done by taking X-ray (Fig 2). They were given a supportive below knee splint and the fractured limb was kept elevated in

order to reduce the pain and edema.

All patients on an elective basis underwent CT scans and the fractures were classified according to Sanders Classification: Type I undisplaced; Type II two part; Type III three part and type IV comminuted fractures. Patients with undisplaced, highly comminuted or open fractures were excluded from the study. Patients with evidence of peripheral vascular disease were also excluded from the study. All patients underwent routine pre-operative investigation and after getting fitness was posted for surgery only after local swelling had subsided (indicated by reappearance of skin wrinkles).

An extensile lateral L-shaped incision used for all patients. Tourniquet was used. A “no touch” method of retraction was used, once reduction was confirmed under fluoroscopy, fracture was fixed by using 3.5 mm cortical screws and contoured 3.5 mm Y-plate. No bone graft was used. Patient was put on a removable posterior below knee splint and started on early non weight bearing mobilization by the 4th post-operative day. Sutures were removed on the 14th post-operative day or when the wound healed.

The patients were initially reviewed after 4 wks. Patients were kept on strict non-weight bearing for about 10 wks and then gradual weight bearing was started and by 12 wks patient was allowed to bear full weight. Following this patient was reviewed regularly once in every 6 weeks for the next 6 months and there after every 3 months. Post – operatively outcome was evaluated clinically and radiologically at the end of 6 and 12 months. Radiologically, fracture union and fracture reduction (Bohler’s angle, Gissane’s angle, and calcaneal width) was assessed. Clinical outcome was assessed by using Modified Creighton – Nebraska Health Foundation Assessment Scale for fractures of the calcaneum. Assessment criteria included pain (30 points), activity (20 points), range of motion (20 points), return to work (20 points), swelling (5 points) and heel width (5 points) summing up to a total of 100 points.

Results

Thirty patients with displaced intra-articular calcaneal fractures (DIACFs) who had undergone open reduction and internal fixation formed the study group. Majority of them were male with average age 28.2 ± 6.5 years (range 16 – 35 years).

Table 1: Type of fracture (Sanders classification)

Type	No. of patients (n=30)	Percentage
Type II	9	30%
Type III	21	70%

Table 2: Associated injuries

S. No.	Associated injury	No. of patients
1.	Ipsilateral chip fracture of the body of talus	1
2.	Contralateral comminuted fracture of talus	1
3.	Undisplaced fracture of lateral malleolus	2
4.	Chip fracture body of L ₂ [lumbar] vertebra	1
5.	Undisplaced ipsilateral fracture superior public rami	1
6.	Closed contralateral metatarsal fracture	1

Table: 3 Complications following ORIF of calcaneal fractures

S. No.	Complications	No. of patients
1.	Ipsilateral chip fracture of the body of talus	0
2.	Contralateral comminuted fracture of talus	1
3.	Undisplaced fracture of lateral malleolus	1
4.	Chip fracture body of L ₂ [lumbar] vertebra	0
5.	Undisplaced ipsilateral fracture superior public rami	0
6.	Closed contralateral metatarsal fracture	0
7.	Peroneal tendon syndrome	0
8.	Calcaneofibular abutment	0
9.	Reflex sympathetic dystrophy	0
10.	Peroneal tendon injury	1

All fractures healed without displacement. There were no instances of hardware loosening or failure. Mean follow up in our patients was 14.2 ± 3.5 months (range 6 – 18 months). Final outcome was assessed at the end of 6 & 12 months by clinicoradiological examination and the Modified Creighton – Nebraska Health Foundation Assessment Scale for fractures of calcaneum. The fractures united in all patients by an average of 8 months (7 – 9 months). Fracture reduction was assessed by using Bohler’s angle, Gissane’s angle and calcaneal width.

Table 4: Radiological outcome analysis (Mean \pm SD)

	Pre-operative patients (n = 30)	Post-operative patients (n = 30)	Postoperative correction achieved
Bohler’s angle (degree)	13.4 ± 12.7	19.0 ± 9.0	5.6 ± 7.2
Gissane’s angle (degree)	122.6 ± 14.0	114.8 ± 11.2	7.8 ± 7.8
Calcaneal width (centimeter)	3.7 ± 0.6	3.4 ± 0.4	0.32 ± 0.34

N = Number of patients

SD = Standard deviation

Since most of our patients were barefoot walkers, we modified the Creighton-Nebraska Health Foundation Assessment Scale for

fractures of calcaneum. We used heel width difference between normal limb and operated limb instead of shoe size. Score is given as follows.

No difference	-	5
< 1cm	-	3
1 to 2cm	-	2
> 2cm	-	0

Table 5: Final outcome analysis*:

	No. of patient (n=30)	% of patients (out of 30)
Excellent	12	40%
Good	12	40%
Fair	6	20%
Poor	0	0

* = Creighton – Nebraska Health Foundation Assessment Score for Fractures of Calcaneum

Discussion

The calcaneal fracture has been described since the time of Hippocrates and has always had a poor reputation with regards to functional outcome. Fractures of calcaneum have traditionally been treated by non-operative methods. Anatomic reduction and internal fixation has been advocated as a treatment of choice for virtually all displaced fractures.

Recently, the pendulum has started to showing again towards operative intervention due to advances in surgical approach, soft tissue management, pre-operative planning and early aggressive mobilization. Our study involved 30 displaced intra-articular calcaneal fractures with mean age of 28.2 ± 6.5 years (range 16 – 35 years). Majority of them were male with fall from height is most common mode of injury. Our findings comparable to study done by Stromosoe K *et al*¹ and Kankare J².

Calcaneal fractures are mainly caused by axial load mechanism, so associated with other axial loading injuries such as lumbar, pelvic and tibial plateau fractures. In our study we had five patients with associated injuries (Table 2). Other studies showing associated injuries are given on Table 6.

Table 6: Comparison of studies (associated injuries)

S. No.	Author	Associated injuries
1.	Stromosoe K <i>et al</i> ¹	Vertebral, long bone fractures
2.	Raymakers <i>et al</i> ³	Malleolar, tibial, Supracondylar humerus fractures
3.	Tornetta P 3 rd <i>et al</i> ⁴	Ankle, tibial, pelvic, spine, femur fractures

Our study included Sanders type II and type III fractures. Huang PJ *et al* used Sanders CT scan classification (Fig.1) it allowed accurate assessment of fracture patterns and pre-operative

planning in their series.⁵ Early surgery prior to resolution of the local edema has been associated with increased incidence of wound complications. In our study mean injury-operative interval was 13 days (range 11-19 days). We found that in patients operated 2wks after injury accurate fracture reduction was difficult. In Tornetta P 3rd study the average time of surgery was 11days (range 0-24days) post injury.⁵



Figure 1: CT-Scan of calcaneal fracture



Figure 2: X-ray of calcaneal fracture

We used the extensile L-shaped lateral approach in all patients due to excellent visualization it provided, and minimal soft tissue complications encountered after surgery. In addition the peroneal tendon and sural nerve were protected within the flap, which minimized the risk of injury to the sural nerve. Internal fixation of calcaneum is completed with the use of an anatomically shaped plate fixed (Fig 3 and 4) to the restored lateral wall of the calcaneum.

Various types of plates are available for fixation. In our study we used mainly 3.5 mm Y-plate. We found it adequate for calcaneal fracture fixation. The use of bone graft is still controversial. Leung KS *et al* believed that bone grafting was necessary to prevent subtalar joint collapse.⁶ On other hand Stephenson JR and Sanders R *et al* did not use bone graft in their cases and found only one case of late collapse.^{7,8} Therefore they suggested that bone grafting was unnecessary. In our series, we did not use bone graft and there was no subtalar joint collapse post-operatively.

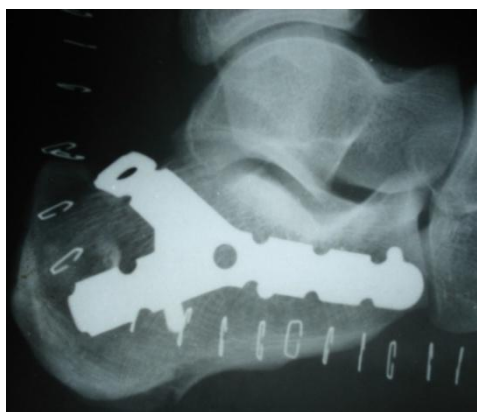


Figure 3: Post-op X-ray of calcaneal fracture

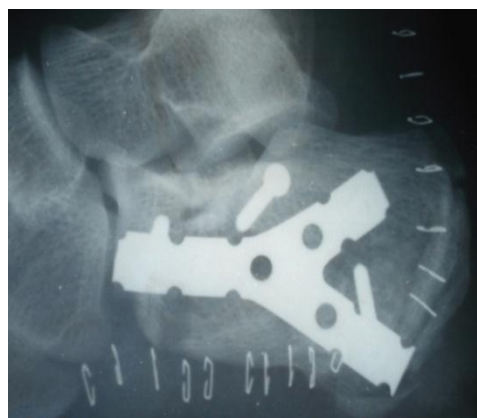


Figure 4: Post-op X-ray of calcaneal fracture

We had one patient with a partial cut to the peroneal tendon which was repaired intra-operatively. One patient had decreased sensation along the dermatomal distribution of the sural nerve. Folk JW et al in their study showed that smoking, diabetes, and open fractures increases the risk of wound complications after surgical stabilization.⁹

In our study three patients had maceration of skin. In 2 of these patients the tourniquet was released after closure of wound. We subsequently abandoned the procedure and in remaining patients wound closure was performed only after tourniquet removal and adequate hemostasis were achieved. One deep infection occurred but this did not require implant removal.

Janzen et al reported that a loss of Bohler's angle was associated with a poor clinical outcome.¹⁰ However, Hutchinson and Huebner found that Bohler's angle at follow up did not correlate with the final clinical result.¹¹ In our study even though we achieved a mean correction of Bohler's angle of 5 degrees only, post-operatively clinical outcome was good.

Therefore we believe restoration of Bohler's angle does not correlate with clinical outcome. Recently many studies are using the Creighton-Nebraska Health Foundation Assessment Scale (CNHFAS) for fractures of the calcaneum.^{2, 3, 6} which is mainly based on pain, activity, return to work, range of motion, change in shoe size and swelling.

Table 7: Comparison of studies

S. No.	Author	No. of patients	Average follow up (months)	Assessment score	Operative group results
1.	Kankare J ²	25 patients 25 fracture	24	CNHFAS	32% Excellent 20% Good 20% Fair 28% Poor
2.	Leung KS <i>et al</i> ⁶	44 patients 44 fracture	35	CNHFAS	90% Good/Excellent 10% Fair
3.	Tornetta P ⁴	33 patients 35 fracture	25	MFS	26% Excellent 51% Good 20% Fair 3% Poor
4.	Raymakers JT <i>et al</i> ³	31 patients 33 fractures	24	CNHFAS	73% Good/Excellent 21% Fair 6% Poor
5.	Stromsoe K <i>et al</i> ¹	40 patients 46 fractures	21	Scoring system developed by author	21.7% Excellent 43.5% Good 19.5% Satisfactory 15.2% Unsatisfactory
6.	Our study	30 patients 30 fractures	18	CNHFAS	40% Excellent 40% Good 20% Fair No Poor results

Conclusion

The following conclusions can be drawn regarding the management of closed displaced intra-articular fractures of the calcaneum.

- Restoration of subtalar congruency is necessary for optimal outcome.
- Extensile L-shaped lateral approach is associated with minimal post-operative wound complications, better visualization of subtalar joint and wide space for lateral plate fixation.
- Delaying operative intervention for more than 2wks following injury can be associated with difficulties in intraoperative fracture reduction and consequently may adversely affect the clinical outcome.
- Bone grafting is not necessary.
- To decrease post-operative wound complication it is advisable to release the tourniquet first, achieve hemostasis and then close the wound
- “No-touch” technique of retraction is associated with decreased incidence of wound edge necrosis.
- Hence, it can be concluded that open reduction and internal fixation can be considered for closed displaced intra-articular fractures of the calcaneum.

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