

OPEN REDUCTION & INTERNAL FIXATION OF INTRA-ARTICULAR TYPE OF FRACTURE CALCANEUM WITH LOCKING CALCANEUM PLATE- A PROSPECTIVE STUDY

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ABSTRACT

Introduction: Displaced intra articular calcaneal fracture are associated with severe disability and it is recommended that open reduction and fixation should be done to restore anatomy of subtalar joint. The intent of our study is to evaluate outcome of open reduction and fixation with locking plates in terms of foot and ankle function and complications

Materials and Methods: 25 patients with 30 fracture calcaneum (less than 3 weeks old) aged less than 50 years were included and classified according to sanders classification. Radiographs were taken to evaluate the Bohlers angle and Gissanes angle. Open reduction and internal fixation was done with locking calcaneum plate using a lateral approach. Outcome was evaluated using Maryland foot Score.

Results : Mean age in this study was 34.2 years (22-48 years). Sanders type III was commonest in our study (46.6%). Mean preoperative Bohlers angle was $15.16^{\circ} \pm 5.58^{\circ}$. Postoperative Bohlers angle was $29.5^{\circ} \pm 4.07$. Mean Pre operative Gissanes angle was $16^{\circ} \pm 7.95$. Mean Post operative Gissanes angle was $123^{\circ} \pm 11.75$. Average Maryland foot score was 79.7 (Good). Complications were seen in 6 patients

Conclusion: Open reduction and internal fixation of displaced intraarticular fractures of calcaneum is an excellent method with minimal complications and good to excellent results

INTRODUCTION

Calcaneal fracture or Os calcis fracture is a complex injury that presents 1-2 % of all fractures. 10% of these are bilateral and another 10% are associated with fracture of spine. 70% of all calcaneal fractures are intra-articular.¹ Most of these fractures involve young working males, subsequently the economic impact of these fractures is significant.² It may seem like one of the densest bones in our body but the bone is actually hard on the outside and soft from inside because of sparse trabeculae. This makes it prone to impaction of articular surface, fragmentation and collapse on a high-velocity impact to the heel mostly during fall

from height.

Despite extensive attempts during past century to improve functional out-come of a displaced intra-articular calcaneal fractures, the choice of method for treatment remain debatable. While some authors suggest that the best results are obtained by surgical methods (open reduction and internal fixation, subtalar arthrodesis or percutaneous screw fixation), others advocate a conservative treatment method.^{3,4-8}

In recent years open reduction and rigid fixation is increasing in popularity as there is better understanding of fracture patterns with computed tomography (CT) scans, availability of good quality

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implants and refinement of surgical techniques that have led to fewer complication rates there by allowing early movement and weight bearing.

The purpose of our study was to assess the result of open reduction and internal fixation of fracture calcaneum of intra articular variety with locking plates, in terms of foot and ankle function and complications.

MATERIALS AND METHODS

This was a prospective interventional study.

25 fresh cases of closed fracture calcaneum (less than 3 weeks old) aged 18-50 years attending to Orthopaedics Emergency and the Out Patient Department of our institute during june 2011 and august 2014 were included in this study. Only intra-articular variety of Type 2, 3 & 4 (Sander's classification) were included.

After admission initially the injured limbs were placed in a posterior slab and elevated to reduce the swelling with NSAID. Pre-operative evaluation was done clinically and radiologically. X-ray calcaneum antero posterior, lateral view and Harris-heel axial view were done along with a CT-scan calcaneum in sagittal and axial plane to assess and classify the fracture according to Sander's classification.

All the fractures were operated on a radiolucent table in the lateral decubitus position so that the fractured extremity faced upwards. Spinal anaesthesia was used. All fractures were treated

with a lateral approach, advocated by Sander 3 using Benirsche and Sangeorzan⁹ (L shaped) incision. Surgery was delayed by an average of 7.1 ± 4.5 days (range, 3-20 days) to resolve the soft tissue swelling and after appearance of wrinkle. Wrinkle test (Figure 1) according to Sander, is a good indication that swelling has subsided. This is performed by maximally planter flexing the ankle. Skin wrinkles are present when ankle is brought back to neutral position indicates edema has subsided

A large L shaped surgical incision was made deep down to the bone in order to make a subcutaneous flap. The flap was developed anteriorly to expose the posterior subtalar joint. The flap was elevated, along with the sural nerve and peroneal tendons. K wires were then inserted in to the lateral malleolus, neck of talus and cuboid, and then bent to hold the flap. The fractured lateral wall (whenever present) of the calcaneum was gently opened, leaving the fracture fragments within their periosteal envelope. The depressed facet was elevated. The articular surface was reduced, lateral wall repositioned, and fixation was made using temporary Kirschner wires (Figure 2). Then an appropriate Calcaneal plate was contoured and positioned at the appropriate location on the lateral calcaneal wall. (Figure 3) K wires for soft tissue retraction and temporary fixation was removed . After putting drain, flap was closed meticulously with monofilament suture using Allgower-Donati technique.



Figure 1 :



Figure 2 :



Figure 3 :

Postoperatively all patients received antibiotic prophylaxis for one week. Drain removal was done at 48 hours. All patients irrespective of fracture pattern were immobilized in below knee slab. Suture and slab removal was done at 3 weeks. Active range of motion exercises of ankle and subtalar joint were started. Partial weight bearing was started at 8-10 weeks post operatively depending on radiological progress of union and gradually increased to full weight bearing.

Patients were followed up in orthopedic OPD at 6 weeks, 12 weeks, monthly till 6 months and once in a 3 month till 1 year. Each patient was evaluated on each visit radiologically and clinically using Maryland foot score.

RESULTS

25 patients with 30 closed fractures of

calcaneum were studied. Majority of the patients were between the ages of 21-40 years group (80%) with the mean age being 34.2 years. The ratio of male: female in this series was 11.5:1.22 patients (88%) sustained injury due to fall from height. Right calcaneus was involved in 12 cases (48%) with 5 patients having bilateral fracture (20%). Mean delay in the surgery was 7.1 days. Sanders type 3 was commonest in our study (46.6%-14 cases) followed by type II (33.3%-10 cases) and type IV (20%-6 cases). Mean follow up duration was found to be 13.4±1.35 months. Maximum period of follow up was 16 months while minimum was 12 months.

The change in Bohler's angle, Gissane's angle, Height and Width of calcaneum pre and post operatively along with the Maryland foot score is shown in Table 1 according to fracture type.

**Table 1
Results**

Fracture type	Samples	Bohlers angle		Gissanes angle		Height of calcaneum		Width of calcaneum		Maryland foot score			
		Pre operative	Post operative	Pre operative	Post operative	Pre operative	Post operative	Pre operative	Post operative	Grade	Number	Overall Score	Overall Grade
Type 2	10	18± 2.58	31± 3.8	154± 4.47	110± 6.67	3.8± 0.06	4.4± 0.1	4.1± 0.05	3.5± 0.08	E G F P	6 3 1 0	87.9 ±9	Good
Type 3	14	17± 3.58	30± 4	162± 6.18	126± 4.72	3.5± 0.11	4.1± 0.09	4.3± 0.08	3.8± 0.05	E G F P	0 10 3 1	79.5± 10.6	Good
Type 4	6	6± 2.89	26± 2.89	170± 5.76	138± 5.54	3.1± 0.14	3.7± 0.15	4.5± 0.05	4± 0.06	E G F P	0 1 4 1	66.5± 11.3	Fair
Overall		15.16± 5.58	29.5± 4.07	160.9± 7.95	123± 11.75	3.58± 0.3	4.17± 0.27	4.3± 0.17	3.7± 0.18			79.7± 12.5	Good

E - Excellent, G - Good, F - Fair, P - Poor

In the patients treated by open reduction & internal fixation, pre and post-operative comparative values for Bohler's angle, Gissane's angle, height and width shows the change is significant as p-value in each case is < 0.0001 .

Average Maryland foot score was 79.7 ± 12.5 (Good). Excellent results are seen in 20% cases (six) all of them being type 2 fractures.

On suture removal almost all patients of open reduction and internal fixation had healthy skin condition, except for 4 cases (86.67%) that showed edge necrosis although, wound healed after serial dressings.

2 patients suffered loss of reduction during follow up. We had 2 incidence of subtalar arthritis both being type 4 fractures that required subtalar arthritis.

DISCUSSION

In our study the calcaneal fractures were found most common in active young men more than 80% in the age group 21-40 years. This incidence is supported by other authors,^{8,9,10} however it was contrary to some authors,^{3,12} and may be explained by the fact that in our country the males are more indulged in outdoor activities, working on heights and thus more exposed to trauma.

In this present series the calcaneal fracture were found to be most common in laborers (24%), next common were mechanics (16%), followed by servicemen and farmers (12%). This shows considerable economic importance of calcaneal fractures in industrial workers, as observed by

other authors also.^{3,9}

In our study, mean delay in the surgery was 7.1 days. In the series of Christoph W. Geel and Flemister¹³ surgery was delayed by an average of 12 days (range, 1-20 days) to allow for resolution of soft tissue swelling.

We used an L-shaped, sharp angulated extensile lateral approach as mentioned by many authors.^{3,9,12,14} Proposed benefits of this modified lateral approach included better visualization of fracture fragments, protection of sural nerve, and less irritation to the peroneal tendons.^{13,14}

There were 4 cases with edge necrosis which healed after few dressing immobilization and elevation.

Bohler's angle and Gissane angle as measured on plain radiographs have been used by most surgeons as the indication that satisfactory results have been obtained by either open or closed methods. Paul M, Peter R and Hoffmeyer P¹⁵ reviewed 70 patients with a calcaneal fracture and suggested the prognostic relevance of Bohler's angle. Brudeaux B.D. (1983)¹⁶ stressed to restore the heel width a deformity equal in significance to the loss of Bohler's angle, which produces morbidity.

In our series we emphasized on restoration of not only subtalar joint but realignment of overall shape of the calcaneum in terms of Bohler's angle, Gissane angle, height and width of calcaneum. We were able to achieve a mean Bohler's angle of $29.5^\circ (\pm 4.07)$ from $15.16^\circ (\pm 5.58)$, mean Gissane's angle of $123^\circ (\pm 11.75)$ from $160.9^\circ (\pm 7.95)$, mean height of $4.17 (\pm 0.27)$ cms from $3.58 (\pm 0.3)$ cms &

Table 2
Post-operative movements (in degrees)

Fracture type (Sander's classification)	No. of fractures	Plantar flexion (Mean)	Dorsiflexion (Mean)	Inversion (Mean)	Eversion (Mean)
Type 2	10	40.6 ± 6.93	17.6 ± 5	30 ± 7.5	14.8 ± 3.4
Type 3	14	31.86 ± 5.5	11.57 ± 3.29	21.85 ± 5.6	11.28 ± 2.7
Type 4	6	23.75 ± 5.9	7.16 ± 3	15.33 ± 5.7	6.66 ± 2.58
Overall	30	33.27 ± 8.4	12.7 ± 5.4	23.26 ± 8.19	11.53 ± 4

CASE 1

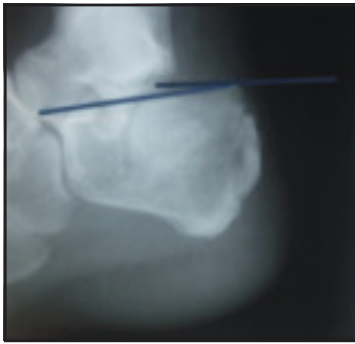


Figure 4 : Pre-operative radiograph



Figure 5 : Post-operative radiograph (Lateral view)



Figure 6 : X ray axial view at the end of 1 year



Figure 7 : X ray (Lateral view) at the end of 1 year

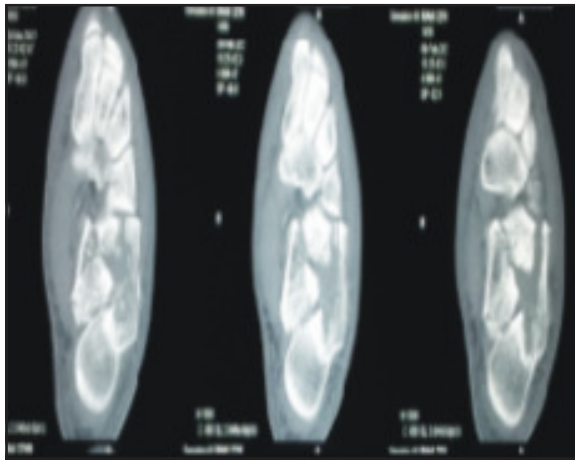


Figure 8 : Pre-operative CT Scan



Figure 9 : Post-operative radiograph (Axial view)



Figure 10 : Dorsiflexion at the end of 1 year



Figure 11 : Plantar flexion at the end of 1 year

mean width of 3.7 (± 0.18) cms from 4.3 (± 0.17) cms by open reduction and internal fixation method. Soeur and Remy using lateral approach reported an average postoperative Bohler's angle of 24°.

Although we had some restriction of movement but most patients of type 2 and 3 had returned to their pre injury activities having Maryland score of good to excellent.

Movement restriction in type 4 fracture was significant. 2 of our patients one each of type 3 and 4 fractures had persistent pain due to subtalar arthritis and required subtalar arthrodesis. The mean Maryland foot score in type 4 fracture was fair (66.5) with one patient having poor outcome. So we conclude that it is difficult to obtain a good outcome in patients having type 4 calcaneal fractures even with open reduction and internal fractures.

The open reduction with internal fixation group showed considerably lower complication rate (80% i.e. 24 cases had no complications). 4 cases (6.6%) had skin complications which healed after few dressings and immobilization and of these 1 developed subtalar arthritis later requiring subtalar arthritis. 2 other patients had loss of reduction during follow up also requiring subtalar arthritis. It was contrary to previous report that showed higher complication rate following surgery. The rate of wound complications in our study after open reduction and internal fixation was 13% which was lesser than that in many studies in the literature. Stephenson¹⁶ reported a 27% rate of wound edge necrosis while Sanders et al³ in a series of 120 surgically managed patients reported eight wound dehiscence, three below knee amputations, and five mayocutaneous free flaps to cover wounds. This reduction in such complications in our series was possibly attributed to our method in which thick flap of skin, subcutaneous tissue and fat was raised from the bone and minimum damage was produced by keeping the flap retracted with the help of 3 k-wires.

The use of bone graft is still controversial. Palmer and Leung et al¹⁷ believed that bone

grafting was necessary to prevent subtalar joint collapse. On the other hand, Stephenson¹⁸ and Sanders et al³ did not use bone graft in their cases and found only one case of late collapse, and suggested bone graft unnecessary. In our series we did not used any bone graft, the bone healed well and there were 2 cases of subtalar joint late collapse noted. One was a 30 year old male patient with type 3 fracture who was non-compliant and started weight bearing at 5 weeks. Other was a 48 year old female with type 4 fracture. Late collapse in her even with non-weight bearing for 8 weeks could possibly be attributed to osteoporosis and type of fracture. We agreed with Stephenson¹⁸ and Sanders et al³ that bone grafting is not necessary in open reduction for calcaneal fractures. We must emphasize here that it is critical to keep the patients in strict non weight bearing for at least 8 weeks and in case of osteoporotic patients for a longer duration if necessary to prevent any possible loss of joint reduction, as also suggested by others.¹⁹

We observed that the realignment of Bohler's angle, Gissane's angle, height and width of calcaneum results in pain free and mobile heel especially in type 2 and 3 fractures.

CONCLUSION

Considering the complex anatomy of calcaneum and the way calcaneal fractures are being treated at various centers, our conclusion is that intra-articular fractures of calcaneum should be approached in more practical and scientific manner so that normal anatomy of the subtalar joint and overall shape of the calcaneum can be restored with early range of motion. So in our experience, Open reduction and internal fixation of displaced intra articular fractures of calcaneum using a lateral approach, with meticulous dissection of soft tissue and careful positioning of a plate, even without the need of bone graft by experienced hands, is an excellent method with minimal complications and maximum excellent to good results in type 2 and 3 fractures but fair to poor results in type 4 intraarticular fractures.

REFERENCES

1. Bridgman SA, Dunn KM, McBride DJ, Richards PJ (2006) Interventions for treating calcaneal fractures. *Cochrane Database Syst Rev*4:CD001161
2. Epstein N, Chandran S, Chou L. Current concepts review: intra-articular fractures of the calcaneus. *Foot Ankle Int.* 2012; 33(1):79-86.
3. Sanders R. Displaced intra-articular fractures of the calcaneus. *J Bone Joint Surg Am* 2000;82:225-50.
4. Giachino AA, Uthoff HK. Intra-articular fractures of the calcaneus. *J Bone Joint Surg [Am]* 1989;71:784-7.
5. Howard JL, Buckley R, McCormack R, Pate G, Leighton R, Petrie D, et al. Complications following management of displaced intra-articular calcaneal fractures: a prospective randomized trial comparing open reduction internal fixation with nonoperative management. *J Orthop Trauma* 2003;17:241-9.
6. Barnard L, Odegard JK. Conservative approach in the treatment of fractures of the calcaneus. *J Bone Joint Surg [Am]* 1955;37-A:1231-6.
7. Kitaoka HB, Schaap EJ, Chao EY, An KN. Displaced intraarticular fractures of the calcaneus treated non-operatively. Clinical results and analysis of motion and ground-reaction and temporal forces. *J Bone Joint Surg [Am]* 1994;76:1531-40.
8. Pozo JL, Kirwan EO, Jackson AM. The long-term results of conservative management of severely displaced fractures of the calcaneus. *J Bone Joint Surg [Br]* 1984;66:386-90.
9. Benirschke SK, Sangeorzan BJ. 1993. Extensive intra-articular fractures of the foot. Surgical management of calcaneal fractures. *Clin Orthop* 292: 128-34.
10. Leung KS, Yuen KM, Chan WS. 1993. Operative treatment of displaced intra-articular fractures of the calcaneum. Medium-term results. *J Bone Joint Surg Br*75: 196-201.
11. Lindsay WRN, Dewar FP. Fracture of Calcis. *Am J Surg* 1958; 95:555- 576
12. Zwipp H, Tscherne H, Thermann H, Weber T. 1993. Osteosynthesis of displaced intra-articular fractures of the calcaneus. Results in 123 cases. *ClinOrthop*290: 76-86.
13. Geel CW, Flemister ASJ. 2001. Standardized treatment of intra-articular calcaneal fractures using an oblique lateral incision and no bone graft. *J Trauma* 50: 1083-89.
14. Eastwood D. M, Gregg P.J & Atkins R. M. 1993; Intra-articular fractures of calcaneum, Part-I &II: Open reduction and internal fixation by the extended lateral trans calcaneal approach. *J Bone Joint Surg Br* 75-B:183-95
15. Paul M, Peter R, Hoffmeyer P. 2004. Fractures of the calcaneum. A review of 70 patients. *J Bone Joint Surg Br*86: 1142-45.
16. Burdeaux B.D. July / August, 1983, Reduction of Calcaneal Fractures by the Mc Reynolds Medial Approach Technique, *Clin. Ortho.* No. 177, Pg. No. 87-103.
17. Leung KS, Yuen KM, Chan WS. 1993. Operative treatment of displaced intra-articular fractures of the calcaneum. Medium-term results. *J Bone Joint Surg Br*75: 196-201.
18. Stephenson JR., Nov. 1993. Surgical Treatment of Intra-articular Fractures of calcaneus Combined lateral and Medial Approach, *Clin. Ortho.* 290, pp. 68-75.
19. Peng-Ju Huang, Hsuan-Ti Huang, Tai-Bin Chen, Jian-Chih Chen, Yen-Ko Lin, Yuh-Min Cheng & Sen-Yuen Lin Nov. 2001, Open Reduction and Internal Fixation of Displaced Intra-articular Fractures of the Calcaneus, , *J. of Trauma*, No. 5, 946-950.