A Study to Evaluate the Functional Outcome Following Open Reduction and Internal Fixation in Displaced Intra Articular Calcaneal Fractures

Vivian R D' Almeida, Tils P. Mathew, K. Raghuveer Adiga, John E. Benny, Ashwin Kamath

Department of Orthopaedics, Fr. Muller Medical College, Mangalore, Karnataka, INDIA.

*Corresponding Address:

v.dal1981@gmail.com

Research Article

Abstract: **Purpose:** To compare the final functional outcome following open reduction and internal fixation of displaced intraarticular calcaneal fractures to that given in standard literature. **Methods**: All patients with displaced intraarticular calcaneal fractures reaching the casualty of Father Muller Medical College who underwent definitive surgery with open reduction internal fixation with Recon or Y plate. Total 44 calcaneum were included in the present study from 33 patients. Clinical and roentgenographic evaluation and Functional outcome with AOFAS Clinical Rating System for Ankle-Hindfoot Scale was done. **Results:** When we consider the clinical evaluation under the AOFAS criterion, our sample showed average value of 77.89 points .Patients demonstrated a diminished outcome with a lower Böhler's angle. When evaluated for different fracture type a progressive deterioration in results were noticed from type II through IV. A bad outcome occurred in no patient among type II injuries. Among type III fractures, three patients had a bad outcome(25%). Nine cases with type IV injury had bad outcome (60%), but there were no excellent results, five had fair results, one had good result. **Conclusion:** Upon evaluation of the cases during final follow up, excellent results were achieved in 31.8%, good results in 21.5%, fair result in 11.04% and poor result in 27.3% .Since we had only 27% of bad results in this study, open reduction and internal fixation can be recommended as very good alternative to conservative treatment in calcaneal fractures.

Keywords: open reduction and internal fixation, Intra Articular Calcaneal Fractures.

Introduction

Epidemiology of Calcaneal fractures account for 2-3% of all fractures of the body, and 60% of all tarsal fractures. 75% of all calcaneal fractures are intra-articular and involve one or more of the three subtalar articulating facets[1]. Intra-articular fractures have a poorer prognosis than extraarticular fractures. Calcaneal fractures are most often seen in young adult men. Compression fractures of the lumbar vertebrae occur in 10-15% of cases presenting with a calcaneal fracture. **Clinical evaluation** Patients with calcaneal fractures present with significant swelling of the hindfoot and midfoot. A history of a fall from a height or a forced loading injury may be obtained. The amounts of displacement and soft-tissue disruption associated with an intra-articular fracture of the calcaneus are proportional to the force generated to produce the injury .Gross deformity may be present, depending on the displacement of the fracture. Gross oedema is usual and ecchymosis may be noticed in fair skinned individuals. Pain is usually severe and is related to the amount of bleeding into a tightly enveloped fascia of the heel. If the patient is seen more than six hours after the injury, the lateral skin is usually so swollen that the skin creases have disappeared. Careful evaluation by palpation of the fibular malleolus should be performed to discern whether the peroneal tendons have dislocated. Open fractures may present with a slight puncture wound medially, where a spike of the medial wall of the calcaneus protrudes, or they may be substantial, with extensive softtissue disruption, usually laterally.

Conventional Radiography Plain radiographs consist of a lateral radiograph ofthe hindfoot, an anteroposterior radiograph of the foot, and a Harris axial radiograph of the heel[2]. The lateral radiograph should confirm the diagnosis of a calcaneal fracture. Radiographs of intra-articular fractures usuallyshow a loss in the height of the posterior facet, with a decrease in the angle of Böhler and an increase in that of Gissane, but only if the entire facet is separated from the sustentaculum and depressed. If only the lateral half of the posterior facet is fractured and displaced, a split in the articular surface will be seen as a double density and Böhler's angle will be normal. The articular surface can be found within the body of the calcaneus; usually, it is rotated 90 degrees in relation to the remainder of the subtalar joint. The lateral radiograph also indicates whether the fracture is of the joint-depression or tongue type according to the classification of Essex-Lopresti[3]. Harris axial radiograph of the heel allows visualization of the joint surface as well as loss of height, increase in width, and angulation of the tuberosity fragment. Unfortunately, this radiograph is very difficult to make in the acute setting because of pain.

Brodén's view, however, is a reproducible means of demonstrating the articular surface of the posterior facet on plain radiographs. This view, known as Brodén Projection I, is obtained with the patient supine and the x-ray cassette under the leg and the ankle. The foot is in neutral flexion, and the leg is internally rotated 30 to 40 degrees The x-ray beam then is centered over the lateral malleolus, and four radiographs are made with the tube angled 40, 30, 20, and 10 degrees towards the head of the patient.

Computed Tomographic Scanning Computed tomographic scanning has improved our understanding of these fractures substantially and has allowed for consistent analysis of the results of treatment. CT will demonstrates intra-articular extension of fracture, degree of comminution of posterior facet, calcaneocuboid joint, impingement of lateral border of calcaneus on lateral malleolus and entrapment of tendons or nerves can be demonstrated;- latter is best seen with the soft-tissue window examination

Materials and Methods

It is a hospital-based study in our college. All patients with closed, displaced intraarticular calcaneal fractures admitted in Dept. Of Orthopaedics is the study group. The study was be carried out for a period of 2 years, i.e. June 2011 to June 2013

Inclusion Criteria

Patients with displaced intraarticular calcaneal fractures who have been treated by open reduction and internal fixation unless patient's general medical condition will not permit a surgical intervention or he/she is not willing for the procedure

Exclusion Criteria

Patients with undisplaced fractures are treated conservatively by plaster immobilization in our department. Hence Sander's type I fractures were not included in this study

1. Open fractures
2. Age< 12yrs
3. Pathological fractures

Study Methodology

All patients with displaced intraarticular calcaneal fractures reaching the casualty were treated by initial resuscitation and temporary stabilization of fracture by below knee slab and immediate elevation later treated by definitive surgery performed as soon as the wrinkle test is positive. All patients were given preoperative antibiotics. Surgery is performed within the first three weeks of injury to prevent difficulties with reduction secondary to early consolidation of the fracture. Lateral extensile exposure technique by Benirschke and Sangeorzan[4] was employed. The peroneal tendons were left in their sheath. The sheath was stripped off the lateral wall of the calcaneus subperioseally and held subluxed anterior to the fibula by the use of twoK-wires, one in the fibula and one in the talus. This no-touch" technique not only retracted the peroneal tendons, but also obviated the need for manual retraction of the anterior skin flap. The calcaneofibular ligament was identified, sharply cut off the calcaneus. and retracted anteriorly. The lateral wall was gently retracted laterally to expose the fracture fragments. After clot removal, the depressed posterior facet fragment was rotated out from within the body of the calcaneus. This immediately decompressed the lateral wall. After identification of all remaining articular fracture fragments. Preliminary reduction was obtained using K-wires. If acceptable, 3.5-mm lag screws were employed to maintain joint reduction. The body was reduced and a malleable Y plate was used to maintain the body reduction and buttress the lateral wall. Closure was performed over a drain and final films taken. Patient were given a below knee plaster slab after surgery which is maintained until wound healing and suture removal. Following this all patients are given below knee plaster cast for 6 weeks. By the sixth postoperative week, active range of motion of the ankle and subtalar joint is instituted. No weight bearing was allowed till union is documented with radiographs

Outcome Assessment

Clinical and roentgenographic follow-up (AP and Lateral) examination was performed at follow up. CT scan was not performed due to financial reasons.Functional outcome was assessed in this study by employing AOFAS Clinical Rating System for Ankle-Hindfoot Scale. This scale is a modification of a clinical scale published previously[5]. A score of 100 points is possible in a patient with no pain, full range of sagittal and hindfoot motion, no ankle or hindfoot instability, good alignment, ability to walk more than six blocks, ability to ambulate on any walking surface, no discernible limp, no limitation of daily or recreational activities, and no assistive devices needed for ambulation. 50 points were assigned to function, 40 to pain, and 10 to alignment.It is not possible to determine isolated ankle joint range of motion clinically; therefore, dorsiflexion motion and plantarflexion motion are measured with a goni-ometer and described as sagittal motion. Hindfoot motion is expressed as a percentage of normal, A joint that can be passively dislocated or severely subluxated is graded as definitely unstable in these systems. Final outcome is computed by adding up the points received in each category and. A score of 90-100 is deemed as an excellent outcome, 80-89 as good, 70-79 as fair and a score less than or equal to 69 is considered a poor outcome.

Observations and Results

A total of 33 patients were available for follow up at the end of the study. And total 44 fractures was assessed in the final follow up 30 patients were males and 3 females were present in the study group. Age distribution ranged from 14 to 52years, with mean age being 32.5.There were 11 bilateral cases and 22 unilateral cases for analysis.Out of the total of 22 unilateral cases 12 had sustained fracture of right calcaneum and 10 of the left side. All the patients' sustained injury following fall from height.

Fracture type (Table1)upon classifying fractures using Sander's classification, there were 14 type II fractures, 15type III and 15 type IV fractures

Table 1: Distribution of fractures by Sander's classification

Fracture Type Sander's classification	No. of patients (Total 19)	% of cases
Type II	14	31.8
Type III	15	34.1
Type IV	15	34.1

Final outcome of fractures according to sanders classification(Figure 1)

Upon evaluation of the cases during final follow up, excellent results were achieved in 31.8%, good results in 21.5%, fair result in 11.04% and poor result in 27.3%

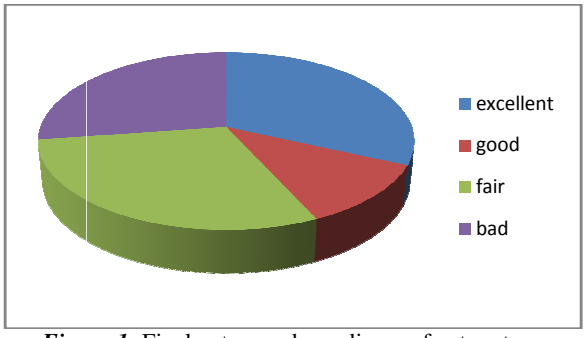

Figure 1: Final outcome depending on fracture type

When evaluated for different fracture type a progressive deterioration in results were noticed from type II through IV. A bad outcome occurred in no patient among type II injuries. Among type III fractures, 3 patients had a bad outcome (25%). 9 cases with type IV injury had bad outcome (60%), but no excellent results, five had fair results, one had good result (Table 2).

Table 2: Final outcome depending on fracture type

Results	excellent	%	good	%	fair	%	bad	%	total
Type 2	8.0	57.1	4.0	28.6	2.0	14.3	0.0	0.0	14.0
Type 3	6.0	40.0	0.0	0.0	6.0	40.0	3.0	20.0	15.0
Type 4	0.0	0.0	1.0	6.7	5.0	33.3	9.0	60.0	15.0
Combined	14.0	31.8	5.0	11.4	13.0	29.5	12.0	27.3	44.0

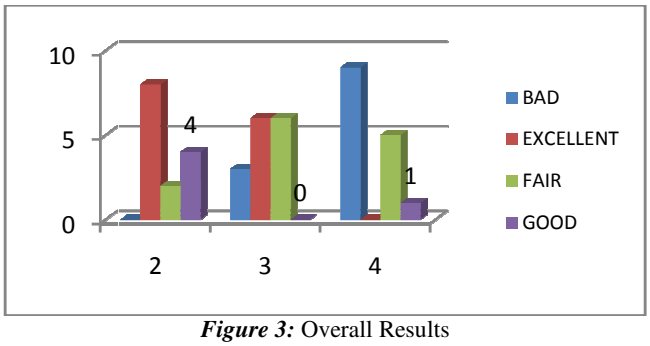

Figure 3: Overall Results

Duration of immobilization

The mean duration was 6.6 wks and range was 4 to 12 week

AOFAS Score

The mean aofas score was 77.89 (Range45to97).

Pain component 3 patients were pain free(6.8%) ,24 patients(54.5%) had occasional mild pain and 17patients (38.6%)had moderate daily pain.

Activity limitations 25 patients(56.8%) had no limitations,18 patients(40.9%)suffered limitation of daily activities, limitation of recreational activities, but no support was needed.1 patient (2.3%) had limited daily and recreational activities, cane use. None had incapacitating limitation activities

Gait abnormality Abnormal gait was obvious in 8 patients and 36(81.8%) had no gait abnormality clinically. Walking surfaces21 patients (47.7%)had no difficulty on walking in any surface Some difficulty on uneven terrain, stairs,ladders was noticed in 22(50%) One had severe difficulty on uneven terrain,inclines and ladders.

Sagittal motion (flexion plus extension) .Normal or mild restriction (30° or more)was seen in 22 (50%). Moderate restriction (15°-29°)was present in net 50%.

Hind foot motion (inversion plus eversion). Marked restriction (less than 25% normal) of hind foot motion was seen in 22 patients (50%).Moderate restriction (25%-74% normal) seen in 20 patient's (45.5%) and 1 patient had mild restriction.

AOFAS Score and Sander's Fracture Type

One way ANOVA test is utilized to find out any significant relation exists between sanders classes and AOFAS score. The study showed a significance difference between the outcome of sanders types.

Associated injuries

Anterior wedge compression fracture of spine with out any neurological deficit occurred in 3 patients,lower end radial fracture occurred in 3 patients ,and 2 closed shaft of femur fracture also

Complications

Table 3: Complications

Complication	No.	% of cases
Ankle swelling	31	70.5
Osteomylitis	1	0.02
Nonunion	0	0
Peroneal tenosynovitis	10	22.7
Peroneal tendon dislocation	4	10
Heel pain	18	40.9
Heel exostosis	5	11.36
Sural nerve injury	9	20.5
Sympathetic osteodystrophy	1	0.02
Subtalar arthritis	9	20.5
Heel widening	44	100
Skin dehiscence	6	13.6

The complications encountered have been listed in the table3 above. In our study the incidence of wound complication is more when the patient is operated before 10 days.Six patients (13.6%) developed skin dehiscence which resolved when treated with wound care and antibiotics. No cases developed flap necrosis..we have observed that most of the patients are non-complaint in limb elevation ,this may be the cause of long duration observed in this study to decrease the edema . Certainly, we think that patients who are noncompliant in the initial management of soft-tissue swelling are not good surgical candidates. Soft-tissue management is extremely important, and early surgery (in the first few days) is not recommended.

Discussion

The calcaneum is more likely bone to be fractured between the tarsus bone; however there is no consensus yet about the best type of treatment .The treatment of calcaneal fractures has, in recent years, been systematized by the use of careful classification systems and treatment algorithms. The role of conservative treatment in undisplaced fractures is supported by Sanders[6]. Likewise, open reduction may offer little in severely comminuted fractures with fragments deemed too small to fix. It is in the displaced intraarticular fractures with relatively large displaced fragments that surgery seems to have more of a role and the decision of whether to operate becomes less controversial. There were 44 calcaneum were included in the present study from 33 patients. Of which 11 cases were bilateral 22 were unilateral. Concerning the age, sex, mechanism of trauma, our cause is comparable to the one in the literature [7], we had 10% female patients. Analysis of the age distribution shows that the fracture affects the most productive age group. 90 % of the fracture affect the age group 20 to 60 which has a major socioeconomic impact, in terms of loss of productivity. Side distribution compared to other studies was in accordance with other studies (table 4).

Table 4: Side distribution compared to other studies

	Present study	Richard Buckley [9]	Crosby and Fitzgibbons [8]
Right	54.5%	51%	40%
Left	45.5%	49%	60%
Bilateral	33.3%	47%	10%

Final outcome of fractures

Since most of the previous studies used a different scoring system or a different classification system it is difficult to get a direct comparison. But general comparison of results is possible as most of the studies use similar criteria to classify the results to excellent to bad.(Table -5)

Table 5: Comparison Final outcome of fractures

	Present study	Kitaoka *et al*. 1994[10]	Hall 1993[11]	Crosby and Fitzgibbons[8]
Excellent	31.8	18.5	36.5	27
Good	29.5	18.5	25.0	20
Fair	11.4	26	23.1	17
Bad	27.3	37	15.4	37

AOFAS score

Table 6: Comparison AOFAS of various studies

	Present study	Thordarson and Krieger[12]	Ibrahim T[13]	Howard *et al*[14]
The mean aofas score	77.89 (Range45to97)	86.7	conservative = 78.5 operative = 70	66 (42 to 92).

The result of operative treatments varies between different studies .Since we had only 27% of bad results this study, open reduction and internal fixation can be recommended as very good alternative to conservative treatment in calcaneal fractures. When we consider the clinical evaluation under the AOFAS criterion, our sample showed average value of 77.89 points. Our sample shows AOFAS value criterion, also similar to the ones found for Sanders *et al*[15], Zwipp *et al* [16] , Bezes *et al* [17.] According to the studies the index shows there were good functional results; make it possible the patient come back to their activities. The most common classification used, the Sanders classification, received a vote of confidence from this study as patients with less comminution likely to score above the mean on the AOFAS scoring scale when treated operatively (Table7) This finding provides evidence that the fracture was not only the result of lower-energy trauma but was also easier to reduce to fix and more reliably reduced.

Table 7: Correlation of Sanders and AOFAS outcome

Sanders type	**Mean AOFAS Score**
Type 2	89.57
Type 3	78.33
Type 4	66.53

Bohler's tuber joint angleand Prognosis

Bohler's tuber joint angle is commonly assessed when evaluating calcaneal fractures. A severe heel fracture will result in a significant decrease or loss of this angle .In 1992, Janzen *et al*[18]. reported that a loss of Bohler's angle was associated with a poor clinical outcome ;Fernandes studied 33 patients and 38 intra-articular calcaneal fractures , II and III by Sanders, with at least 24 months followed up, he found correlation with the angle of Böhler and AOFAS criteria; however, more recently Hutchinson and Huebner[19] have indicated that Bohler's angle at follow-up did not correlate with the final clinical result. In our study we found that clinical AOFAS score has got an important correlation with Bohler's angle at presentation. Patients demonstrated a diminished outcome with a lower Böhler's angle.We believe that higher energy injuries produce flatter Bohler's angles, with more bone and soft tissue injury. This results in a poorer long-term outcome in severely displaced intra-articular calcaneal fractures.

Table 8: Comparison of various complications in different studies.

Complication	**%**	**Crosby and Fitzsimmons 1993[8]**	**Kitaoka *et al*1994[10]**	**Letournel, 1993[20]**
Ankle swelling	70.5		51.8%)	
Sural.nerve injury	20.5		3.7%	
Subtalar arthritis	20.5	36.67%		
Heel widening	100			
Skin dehiscence	13.6		3.7%	
Pain	13.6	36.67%		44.44%

The treatment of intraarticular calcaneal fractures remains a controversy in Orthopaedics because of the associated complications .The reluctance to treat displaced calcaneal fracture is mainly based on the fear of the surgeon regarding the complication associated with ORIF.advances in antibiotic treatment,surgical technique,better understanding of vascularity of the lateral flaps has decreased complications of ORIF as proved by many studies.Increased awareness of these complications and their prevention will aid the practitioner in decision-making and result in better treatment outcomes for this fracture. The most common complication reported from our study is heel widening followed by ankle swelling and heel pain. Problems encountered in comparing complication rates include a lack of common terminology for complications and use of

less specific terms. The rate of wound dehiscence in this study was 13.6%, which is similar to that in many studies in the literature. Soft-tissue management is extremely important, and early surgery (in the first few days) is not recommended

Conclusion

In conclusion calcaneal fractures often present as complex injuries. Relatively common in clinical practice they assume significance because of a higher likelihood of long term morbidity following this injury. Distinct advances have been made in the understanding and treatment of displaced intra-articular calcaneal fractures. Computed tomographic scanning has allowed an understanding of the pathological anatomy of these fractures, and two-dimensional computed tomographic scans in both the coronal and the transverse plane are recommended. Classifications based on computed tomographic scanning are prognostic with respect to outcome, Open reduction and internal fixation must be attempted in all displaced calcaneal fractures, as fractures reduced to regain posterior facet congruity and bohlers angle has got better prognosis

References

1. Cave, E.F., Fracture of the os calcis--the problem in general. Clin Orthop Relat Res, 1963. 30: p. 64-6.
2. Stephenson, J.R., Treatment of displaced intra-articular fractures of the calcaneus using medial and lateral approaches, internal fixation, and early motion. J Bone Joint Surg Am, 1987. 69(1): p. 115-30.
3. Essex-Lopresti, P.: The mechanism, reduction, technique, and results in fractures of the os calcis. British J. Surg., 39: 395-419, 1952.
4. Benirschke, S.K. and B.J. Sangeorzan, Extensive intraarticular fractures of the foot. Surgical management of calcaneal fractures. Clin Orthop Relat Res, 1993(292): p. 128-34.
5. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, mid-foot, hallux and lesser toes. Foot Ankle Int. 1994; 15:135-49.
6. Sanders, R., et al., Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. Clin Orthop Relat Res, 1993(290): p. 87-95.
7. Kundel, K., et al., Calcaneal fractures: operative versus nonoperative treatment. J Trauma, 1996. 41(5): p. 839-45.
8. Crosby LA, Fitzgibbons TC. Open reduction and internal fixation of type II intra-articular calcaneus fractures. Foot Ankle 1996;17:253—258
9. Buckley, R., Calcaneal fractures: to fix or not to fix: Opinion: nonoperative approach. J Orthop Trauma, 2005. 19(5): p. 357-9.
10. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, mid-foot, hallux and lesser toes. Foot Ankle Int. 1994; 15:135-49.
11. Hall, R.L. and M.J. Shereff, Anatomy of the calcaneus. Clin Orthop Relat Res, 1993(290): p. 27-35.
12. Thordarson, D. B., and Krieger, L. E.: Operative vs. nonoperative treatment of intra-articular fractures of the calcaneus: a prospective randomizedtrial. Foot and Ankle Internat., 17: 2-9, 1996.
13. Ibrahim, T., Rowsell, M., Rennie, W., Brown, A. R., Taylor, G. J. S., & Gregg, P. J. (2007). Displaced intra-articular calcaneal fractures: 15-year follow-up of a randomised controlled trial of conservative versus operative treatment. Injury,38(7), 848-855.
14. Howard, J. L., Buckley, R., McCormack, R., Pate, G., Leighton, R., Petrie, D., &Galpin, R. (2003). Complications following management of displaced intra-articular calcaneal fractures: a prospective randomized trial comparing open reduction internal fixation with nonoperative management. Journal of orthopaedic trauma, 17(4), 241-249.
15. Sanders, R., Displaced intra-articular fractures of the calcaneus. J Bone Joint Surg Am, 2000. 82(2): p. 225-50.
16. Zwipp, H., S. Rammelt, and S. Barthel, Calcaneal fractures--open reduction and internal fixation (ORIF). Injury, 2004. 35 Suppl 2: p. SB46-54.
17. Bezes, H., et al., The operative treatment of intraarticular calcaneal fractures. Indications, technique, and results in 257 cases. Clin Orthop Relat Res, 1993(290): p. 55-9.
18. Janzen, D.L., et al., Intraarticular fractures of the calcaneus: value of CT findings in determining prognosis. AJR Am J Roentgenol, 1992. 158(6): p. 1271-4.
19. Hutchinson F 3rd, Huebner MK. Treatment of os calcis fractures by open reduction and internal fixation. Foot Ankle Int 1994;15:225-232
20. Letournel, E.: Open treatment of acute calcaneal fractures. Clin. Orthop., 290: 60-67, 1993.