



Functional and radiological outcome of depressed intra-articular fractures of calcaneus managed with operative methods

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Abstract

Calcaneal fractures are the most common fracture of the tarsal bones, controversy still exists on the best treatment option for these fractures. However as a better understanding of fracture patterns with computed tomography scans and modern surgical techniques and hardware has improved outcome and lowered morbidity. Hence we aim at evaluating the radiological and functional outcomes of displaced intra-articular calcaneal fractures treated with operative methods with calcaneal plate or by percutaneous/mini-open Ilizarov fixation. In our study we included 30 patients, 23 were male and rest 7 were female. The mechanism of injury involved fall from height in 20 cases and road traffic accident in the remaining cases. These patients were followed average 14.6 months and the functional outcome was assessed in all the patients using Creighton-Nebraska health foundation assessment scale (CNHFAS). According to this scale, 8(26.66%) patients had excellent results, 14 (46.66%) patients had good results, 4(13.33%) patients had fair results and 4(13.33%) patients had poor results. The results were promising, revealing that the operative treatment of intra-articular calcaneal fractures should be done as anatomical reduction and rigid internal fixation to allow early movement and weight bearing. The technique of contoured plate fixation with a lateral approach and ilizarov external fixator are good with regards to fracture union and functional outcome.

Keywords: calcaneus fracture, intra-articular, Ilizarov, fixator

Introduction

Calcaneus is most commonly fractured tarsal bone and 60-75 of injuries are intra-articular fractures due to traumatic axial loading in fall from height and motor-vehicle accidents, yet controversy still exists on the best treatment for these disabling injuries [1-4]. However, as a better understanding of fracture patterns with computed tomography scans and modern surgical techniques and hardware has improved outcome and lowered morbidity, trend has developed toward open reduction and internal fixation (ORIF) for displaced, intra-articular calcaneal fractures [5-7]. Calcaneal fractures often results in a varus deformity with heel widening, loss of calcaneal height, and subtalar joint incongruency. Open reduction and close reduction can be used to address deformities, restoring the anatomic morphology of the calcaneus, and thereby the biomechanics and function of the hind foot. Restoring heel width prevents chronic peroneal tendonitis secondary to impingement from lateral wall blow out of the calcaneus, and restoring the length and alignment of the Achilles tendon maintains plantar flexion strength [3, 4, 7]. Open reduction and fixation also provides the opportunity for anatomic reduction and rigid internal fixation of the subtalar joint. The distraction technique with Ilizarov ring apparatus for indirect reduction by ligamentotaxis and fracture fixation with percutaneous /minimal skin incisions has been suggested for patients with intra-articular fractures associated with high risk skin problems [9-12].

These problems include comminuted intra-articular fractures of the distal tibia (pilon fracture) and tibial plateau fractures. The same method can be used for calcaneal fractures in patients with poor skin condition [13]. Treatment by Ilizarov apparatus could offer an outcome near similar to open reduction with a decreased risk of complications.

Material and Method

The present study was conducted in Department of Orthopaedics at Dr. SN Medical College and Associated group of Hospital, Jodhpur from January 2018 to November 2020. Ethical clearance was obtained from the ethical committee. The patients were evaluated for associated injuries and anteroposterior, lateral, and axial radiographic views (Fig. 1A & 2A) of the calcaneus were obtained, 3D CT reconstruction were also performed to assess the details of articular depression and to classify according Sanders classification. After injury, the limb was elevated and measures were taken to avoid oedema. All patients above 18 years of age with fresh intra-articular calcaneus fractures and patients with sanders type II, III and IV who were walking prior to the fracture were included in the study. Patients with pathological fractures, severe osteoporosis and those not willing for surgery were excluded from the study.

Operative procedure

All the patients were operated under regional anaesthesia in

supine position on a standard operative table with tourniquet. The patient is positioned in lateral decubitus position for calcaneum plating and supine for Ilizarov ring fixator. For calcaneal plating: We used extensile lateral approach using L-shaped surgical incision. This lateral incision allows direct access and easier reduction of the displaced lateral fragment. K-wires (Fig.1B) were then inserted and bent to hold the flap and the soft tissues in place. The subtalar joint is opened and the fractures of the lateral calcaneal wall are dissected, in order to expose the fracture and depressed articular fragments. The reduction manoeuvre usually begins at the posterior articular surface and proceeds to the Gissane’s angle and to the body of the calcaneus. The plate was fixed with the help of 3.5mm cortical screws/ 4mm fully threaded cancellous screws. After fixation of plate tourniquet was removed and haemostasis was maintained, closure done in layers. Compression bandage & limb elevation in immediate post op period to reduce the edema. Below knee slab applied for two weeks. For ilizarov external fixator: The Ilizarov external fixation frame (Fig. 2B) was applied in the form of one half/ full static ring attached to the talus by two 1.8 mm parallel wires. One 5/8 or half ring was attached to calcaneum by crossing wires or olive wires (for compression of the fracture fragments). Distraction was done by connecting these two half rings with connecting rods. Reduction was achieved indirectly by traction and manipulation and maintained with olive wires. In some

cases depressed posterior articular fragment was elevated by curved artery or osteotome using mini-incision sinus tarsi approach.

Postoperative care

Immobilization using a below knee slab for a duration of 2 weeks and subsequently after 2 weeks ankle and subtalar joint mobilisation were started. Suture removal was done at 3 weeks postoperatively. Patients with Ilizarov external fixator range of motion exercises of ankle joint was started on second postoperative day. Regular pin tract dressing with normal saline and cleaning of rings with spirit solution was done. Progressive weight bearing began after 3 weeks, and full weight bearing was allowed after 8 weeks. The Ilizarov frame was removed once the fracture had consolidated well radiologically. The patients were followed up clinically and radiologically at 6weeks, 12 weeks,6 months and 1 year for assessing patients according to Creighton-Nebraska health foundation assessment scale and fracture reduction was assessed by using Bohler’s angle, Gissane’s angle and calcaneal width (Fig. 1C), (Fig. 2C).

Observation and results

In this study a total of 30 patients were included, amongst them 23 were male and 7 were female (table 1). The mode of injury was noted to be fall from height in 20 patients and road traffic accident in the rest.

Table 1: “Distribution of patients according to age and sex.”

Age (yrs)	Gender				Total	
	Male		Female			
	N	%	N	%	N	%
16-25	3	13.04	0	0.00	3	10.00
26-35	10	43.48	5	71.43	15	50.00
36-45	3	13.04	2	28.57	5	16.67
46-60	7	30.43	0	0.00	7	23.33
Total	23	100.00	7	100.00	30	100.00

The fractures were classified according to sanders classification after the required semi-coronal plane CT scans were done and most cases were of type 2B, 2C and 3C (Table 2).

Table 2: “Distribution of patients according to sander’s classification.”

Sander’s classification	No. of patients	Percentage
2B	5	16.66
2C	5	16.66
3A	3	10.00
3AB	3	10.00
3AC	3	10.00
3B	3	10.00
3BC	3	10.00
3C	5	16.66
Total	30	100.00

The surgery was done after swelling subsided and wrinkle sign appeared in cases with ORIF and whereas Ilizarov external fixation surgery was done relatively early compared to ORIF (Table 3).

Table 3: “Distribution of patients according to operated day from the date of injury.”

Waiting time (days)	No. of patients	Percentage
≤5	2	6.67
6-10	6	20.00
11-15	16	53.33
16-20	6	20.00
Total	30	100.00

Amongst 30 patients in our study, 20 patients were operated with plating and 10 of them operated with Ilizarov external fixator. These patients were followed up clinically and radiologically at least for 1 year and the functional outcome was assessed in all the patients using Creighton-Nebraska health foundation assessment scale(CNHFAS) which includes Pain on activity, Pain at rest, Activity level, Range of inversion/eversion, Returning back to work, Change of shoe size, Swelling. According to this scale, 8 (26.66%) patients had excellent results, 14 (46.66%) patients had good results, 4 (13.33%) patients had fair results and 4(13.33%) patients had poor results (Table 4).

Table 4: “Functional outcome according to Creighton-Nebraska health foundation assessment (CNHFAS) scale at 12 months followup.”

Results at 12 months	No. of patients	Percentage
Excellent	8	26.66
Good	14	46.66
Fair	4	13.33
Poor	4	13.33
Total	30	100.00

Among 30 patients, patients who were operated with plating had pre-op Gissane’s angle, Bohler’s angle and Calcaneal

width improved from 161.15± 5.00 to 138.42± 6.71, from 13.78± 4.09 to 32.42± 5.48 and 3.8 ± 0.5 to 3.3 ± 0.6 respectively whereas in Ilizarov ring fixator pre- op Gissane’s angle, Bohler’s angle and Calcaneal width improved 157.63± 6.86 to 140.54± 7.85, 17.09± 2.58 to 29.81± 4.68 and 3.6 ± 0.6 to 3.4 ± 0.2 respectively. In our study patients operated with plating had mean weight bearing after 12 weeks and mean radiological union after 16.4 weeks, whereas in ilizarov external fixator had mean weight bearing after 8 weeks and mean radiological union after 14weeks (Table 5). (Fig. 1C), (Fig. 2C).

Table 5: “Radiological outcome analysis (Mean ± SD), N = Number of patients SD = Standard deviation”

	Pre- operative patients (n = 20) ORIF	Post- operative patients (n = 20) ORIF	Pre- operative patients (n = 10) Ilizarov ring fixator	Post- operative patients (n = 10) Ilizarov ring fixator
Gissane’s angle(degree)	161.15±□ 5.00	138.42±□ 6.71	157.63±□ 6.86	140.54±□ 7.85
Bohler’s angle(degree)	13.78±□ 4.09	to 32.42±□ 5.48	17.09±□ 2.58	29.81±□ 4.68
Calcaneal width (centimeter)	3.8 ±□0.5	3.3 ±□0.6	3.6 ±□0.6	3.4 ±□0.2

The complications after performing plating and ilizarov fixator were (a)- arthritis which was seen among 2 patients (b)- flap necrosis seen among 2 patients (c)- infection and wound dehiscence seen among 4 patients (Table 6).

showing well maintained posterior articular facet, no lateral wall bulging and good alignment of heal.

Table 6: “Distribution of patients according to operative procedure and complications.”

Complications	Plating		Ilizarov		Total	
	N	%	N	%	N	%
Arthritis	1	5.00	1	10.00	2	6.66
Flap necrosis	2	10.00	0	0.00	2	6.66
Infection/ wound dehiscence	2	10.00	2	20.00	4	13.33
No complications	15	75.00	7	70.00	22	73.33
Total	20	100.00	10	100.00	30	100.00



Fig 3: Complication of ORIF – Flap necrosis.

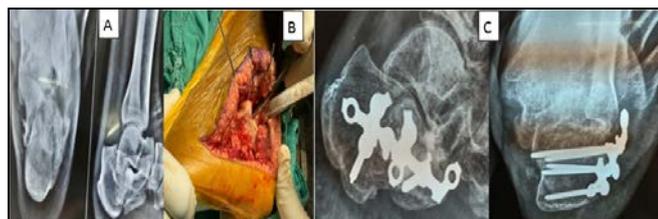


Fig 1A: -Axial view of calcaneus showing varus collapse & Lateral radiograph showing joint depression type fracture, Fig.1B – Intra-op photograph showing full thickness periosteal-cutaneous flap retracted with help of K- wires and elevation of depressed posterior articular fragment with help of curved osteotome, Fig.1C- Follow-up Lateral radiograph showing well maintained posterior articular facet and axial radiograph showing good alignment.



Fig 2A: -Axial view of calcaneus showing varus collapse & Lateral radiograph showing joint depression type fracture, Fig. 2B –Clinical photographs showing patient with Ilizarov external fixator, Fig. 2C- Follow-up Lateral, AP and Axial radiographs

Discussion

Calcaneal fractures are one of the most disabling fractures with frequent occurrence during the wage earning period of life. This study was initiated to access clinical and radiological outcome of calcaneal fractures treated by surgical treatment. The management of intra-articular calcaneal fractures is still controversial. There are many systems for classifying displaced intra-articular fractures, but there is no consensus amongst surgeons as to which is the most practical one. Some studies have demonstrated good results after open reduction and internal fixation of intra-articular calcaneal fractures [14, 30, 31]. The best choice of treatment remains controversial because prospective randomized studies have not shown convincingly better results after surgery [7]. However, in the largest prospective randomized trial described to date, Buckley *et al.* found better results in some subgroups of patients after surgery [32]. It is difficult to compare outcome between studies since different measures of outcome are often used and there is no consensus among surgeons as to which is the most scientific and practical system. Essex-lopresti, Rowe and Sanders are the commonly used classification systems for calcaneal fractures. Classifying a fracture is of utmost importance, one to ensure the uniformity in description of various

components and grades of severity of injury and secondly to make the comparison of various studies scientifically correct and to draw conclusions which would be valid. The obscurity in the treatment protocol of calcaneal fractures is evident from the fact that there are more than forty five different classification systems discussed in literature. There is varying degrees of agreement among users of these classification systems. Although, classifications show positive correlation with outcome, there is no correlation with choice of treatment [33, 35]. In our study we have used the Sander's classification system. In our study, out of 30 patients 23 were male and 7 were

female and commonly affected in between 26-35 years of age group, whereas most common mode of injury was fall from height followed by road traffic accidents, and 4 patients had bilateral involvement and 2 patients had spine injury with no neurological deficit.

In our study, patients were grade according to sanders classification and in which maximum patients were of type-2B, 2C and type-3C each had 5 patients.

In our analysis, we assessed functional outcome in patients by using Creighton-Nebraska score and we found excellent results in 8 patients, good results in 14 patients, 4 patients each in fair and poor category (Table - 4&6).

Table 7: "Comparison of studies according Creighton-Nebraska Health Foundation Assessment Scale (CNHFAS)."

S. No.	Author	No. of patients	Average follow up(months)	Assessment score	Operative group results
1.	Kankare J36	25 patients, 25 fracture	24	CNHFAS	32% Excellent 20% Good 20% Fair 28% Poor
2.	Raymakers JT <i>et al</i> 37	31 patients 33 fractures	24	CNHFAS	73% Good/Excellent 21% Fair 6% Poor
3.	Leung KS <i>et al</i> 21	44 patients, 44 fracture	35	CNHFAS	90% Good/Excellent 10% Fair
4.	Our study	30 patients,30 fractures	14.6	CNHFAS	26.66% Excellent,46.66% Good,13.33% Fair,13.33%Poor

Among 30 patients, patients who were operated with plating had pre-op Gissane's angle, Bohler's angle and Calcaneal width improved from 161.15 ± 5.00 to 138.42 ± 6.71 , from 13.78 ± 4.09 to 32.42 ± 5.48 and 3.8 ± 0.5 to 3.3 ± 0.6 respectively whereas in Ilizarov ring fixator pre- op Gissane's angle, Bohler's angle and Calcaneal width improved 157.63 ± 6.86 to 140.54 ± 7.85 , 17.09 ± 2.58 to 29.81 ± 4.68 and 3.6 ± 0.6 to 3.4 ± 0.2 respectively. In our study patients operated with plating had mean weight bearing after 12 weeks and mean radiological union after 16.4 weeks, whereas in ilizarov external fixator had mean weight bearing after 8 weeks and mean radiological union after 14weeks (Table 5), (Fig. 1C), (Fig. 2C).

Complications are a cause of significant morbidity for patients. The rate of wound complications (flap necrosis and infection) in our study was 20%, which is similar to that in many studies in the literature [30]. The timing of surgery is also an important factor. Buckley [32] believed soft-tissue management to be critical; they did not recommend early surgery. In addition, Abidi *et al* [38]. Concluded infection rate was substantially increased if surgery was done ≥ 5 days after the injury. We found No such co-relation between timing of surgery and infections. Cases treated with plating, 2 patients had flap necrosis (Fig. 3). Which were managed with debridement and reverse sural artery flap, and 2 patients had wound dehiscence and infection which were managed with regular dressing and i.v. antibiotics. Cases treated with Ilizarov fixator 2 patients had pin tract infections which were managed with regular pin tract dressing and oral antibiotics for 2 weeks. 2 patients treated with calcaneal plating and ilizarov fixator had arthritis which were given symptomatic treatment.

There were certain limitations to our study, Only 30 patients with calcaneal fractures were operated and their functional outcome score was measured at average follow-up 14.6 months. A study involving more patients followed up for a longer period of time can more accurately define the functional outcome of displaced intra articular calcaneal fractures treated by this method. Therefore this discussion is essentially a preliminary assessment.

Conclusion

Fractures of the calcaneum are one of the common fractures affecting young generation and treatment modality has to be decided carefully. We are of the opinion that the operative treatment of intra-articular calcaneal fractures should be done as anatomical reduction and rigid internal fixation is essential to allow early movement and weight bearing. The technique of contoured plate fixation with a lateral approach and Ilizarov external fixator are good with regards to fracture union and functional outcome. It also shows that anatomical reduction in terms of the correction in Bohler's and Gissane's angle plays an important role in determining the good functional outcome. The fallacies in our study are, the sample size is small and we have not taken other fracture patterns into consideration. From this study a good orientation of calcaneum is must along with soft tissue handling which helps us to achieve good functional outcomes.

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Conflict of interest

None.

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