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Original Research Article

A study on surgical management of calcaneal fracture

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ABSTRACT

Background: The treatment of Calcaneal fracture has been controversial. Thirty cases, of calcaneal fractures were treated and evaluated with the objective of assessing the results of percutaneous pin manipulation / primary subtalar arthrodesis/ ORIF & comparing treatment modalities and finding management strategies, depending on type of fractures.

Materials and Methods: Patients with calcaneal fractures presenting at OPD during the study period were admitted, treated and evaluated. Extra-articular fractures were managed mostly by conservative method with a below knee POP cast. Intra-articular fractures were managed by conservative, semi open Essex-Lopresti technique, ORIF with cancellous screws and primary subtalar arthrodesis. Patients were followed-up at 6 weeks, 12 weeks and 15 weeks. Paley and Hall criteria were used for evaluation of results.

Results: Functional and radiological review done at last follow-up was used to evaluate the result based on Paley and Hall criteria. Extra-articular fractures had 75% excellent results and 25% good results. Most of the poor results were due to communited type of intra-articular fractures. The overall results were 26.7% excellent, 33.3% good, 16.7% fair and 23.3% poor.

Conclusion: Calcaneal fractures are more common in younger age group and in males than females. Fall from height is the usual mode of injury. Extra-articular fractures constituted 26.7% of all fractures; they had good prognosis and hardly any complications. Intra-articular fractures constitute majority of fractures and are associated with poor functional outcome. Tongue-type can be treated best by Essex-Lopresti technique and Joint depression type deserves an aggressive well planned surgical management.

1. Introduction

Calcaneus is the most common fractured tarsal bone, accounting for 75% of intra-articular fractures involving the subtalar joint.[1] Conservative management is associated with broadening of the hind foot, decreased subtalar motion, muscle imbalance, peroneal tendon impingement and secondary osteoarthritis.[2] Operative management of calcaneal fractures also poses a significant fixation and reconstruction challenge to the surgeon. This challenge has its roots in the fact that there are three functionally interrelated joints that need to be reconstructed. Open reduction and internal fixation of the calcaneal fractures is most commonly done through the extensile lateral approach.[3] However this approach is often has increased risk of problems like soft tissue trauma, disturbed wound healing and necrosis.[4] The rate of skin necrosis is reported to be 2-11%, infection rate ranges from 1.3-7% and extended approaches have been reported to give a complication rate of 25%.[5–7] These reports highlight the necessity for a far better and optimal approach to calcaneal fixation. This has led to the development of varied approaches to the calcaneus. Some of these approaches are lateral, obtuse angled, medial and a combination of the medial and lateral approaches.[8] Not only are these approaches inherently beset with complications, but they can be disastrous in patients with diabetes, smokers, patients with vascular impairment. They are also problematic in

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patients with fracture blisters or compounding.[9] These reasons make the minimally invasive techniques attractive. There are four types of minimally invasive methods.[10]

1. Percutaneous methods.
2. Distraction by external fixators.
3. Ligamentotaxis with percutaneous screw fixation.
4. Sinus tarsi approach.

Closed reduction and percutaneous screw fixation is a widely reported minimally invasive surgical treatment in the literature to date, which can effectively avoid wound complications due to small incision. However, this method seems to be more suitable for these cases with more complete calcaneal fracture fragment and moderately displaced fracture because of the limited screw fixation strength. Thus combined plate fixation is advocated.

2. Material and Methods

This is a study of 30 cases of calcaneal fractures treated by percutaneous to surgical methods. Clearance was obtained from the Ethical Committee. Had the diagnosis established by clinical examination and X-ray evaluation in standard AP, lateral and axial views, the fractures were classified using the Essex-Lopresti classification. Sanders classification is based on the number of articular fragments seen on the coronal CT image at the widest point of the posterior facet.

2.1. Inclusion criteria

1. All patients with roentgenographic evidence of fracture os calcis.
2. Age more than 20 years.

2.2. Exclusion criteria

1. Age less than 20 years.
2. Pathological fractures.
3. Open fractures.

A detailed case history much of the injury was taken. The type and mechanism of injury was enquired in detail. Both active and passive movements available at injured and normal subtalar and ankle joints recorded. A careful clinical assessment of associated skeletal and soft tissue injuries and general condition of patient was done. Pain was alleviated by analgesics and the injured foot immobilized in a well-padded below knee posterior plaster of Paris slab. Patients were treated by one of the following modes of treatment.

2.3. Closed treatment

2.3.1. Technique

A compression bandage is applied with a B/K POP slab and limb is kept elevated over BB splint or over a pillow. Active toe movements were encouraged to promote better circulation and reduce edema. Once the swelling subsided a BK POP cast (Figure 1) was applied with ankle in neutral position and taking the longitudinal and transverse arches of foot. Patient was discharged and re-examined after 6 weeks. POP cast removed and X-ray taken and tested for clinical and radiological union. If tenderness persists, a new cast applied for another 2 weeks. If clinical and radiological union occurred without tenderness, compression with elastocrepe bandage applied and non-weight bearing active ankle and subtalar range of movements permitted. Partial weight bearing is allowed after 10-12 weeks. Once pain subsided gradual full weight bearing was allowed then subjective and objective assessment of results was done.

Fig. 1: B/K POP cast

2.4. Essex-Lopresti technique

2.4.1. Indications

All tongue type of fractures (Figure 2) were treated by Essex-Lopresti method of closed reduction with percutaneous pin manipulation.

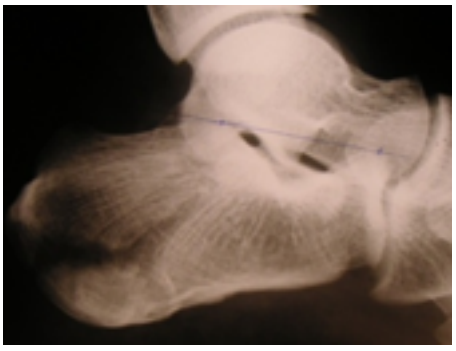

Fig. 2: Tongue-type of fracture

2.5. Operative technique

With the patient under spinal anesthesia and in prone position, the foot and lower third leg were prepared with iodine and draped. A stab incision is made just lateral to Achilles tendon insertion and a Steinman pin is passed into tongue fragment (Figure 3) directed towards calcaneocuboid joint and up to the subchondral bone of posterior facet. Intra operative image intensifier is used to determine the direction and position of the pin. Foot is plantar flexed and pin is then lifted to disimpact the tongue fragment from the body of calcaneum. The pin is then driven across the calcaneocuboid joint. The pin is incorporated in a BK POP cast.

2.6. Post operative

The limb is kept elevated to prevent edema. Antibiotics were given over a period of one week. After 4 weeks Steinman pin removed and an elastic crepe bandage applied. Active and passive ankle and subtalar movements encouraged. Partial weight bearing was allowed after 8-10 weeks when there is radiological evidence of good union. Full weight bearing was allowed after 12 weeks. Subjective and objective assessment of results was done.

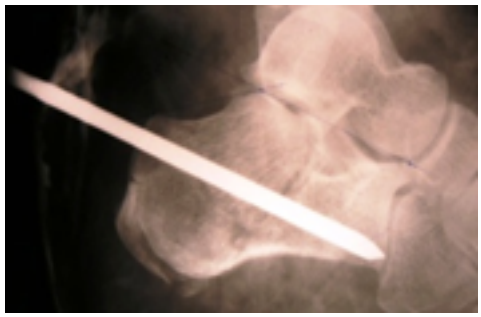

Fig. 3: Percutaneous pin elevation

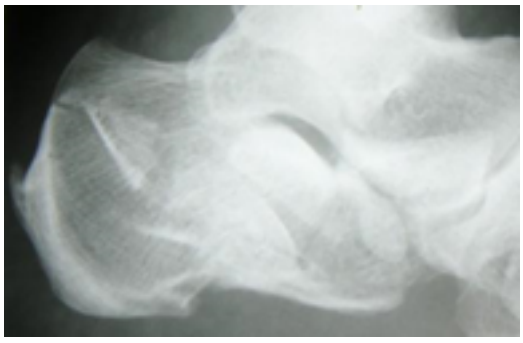

Fig. 4: Comminuted fractures

2.7. Open surgical procedures

For patients with displaced intra-articular fractures with little comminution (Figure 4), open reduction and internal fixation was done using a lateral extensile exposure (Figure 5). The skin flaps were retracted using no touch technique, the fracture fragments were disimpacted and reduced exercises was allowed. For patients with severe comminution, primary subtalar arthrodesis was done using a large Steinman pin passed from inferior surface of calcaneum into the talus across the subtalar joint and a POP cast applied. At 6 weeks cast was removed and ankle mobilized. Weight bearing was started early at 6-8 weeks as tolerated by the patient.

Fig. 5: ORIF with plating

Fig. 6: Sanders classification[11]

3. Results

The results of the study were evaluated as per Paley and Hall criteria (Table 1)

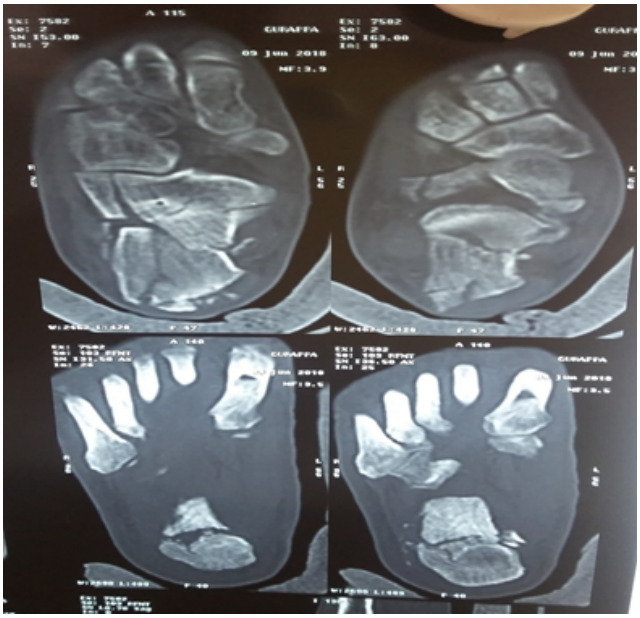

Fig. 7: Axial view

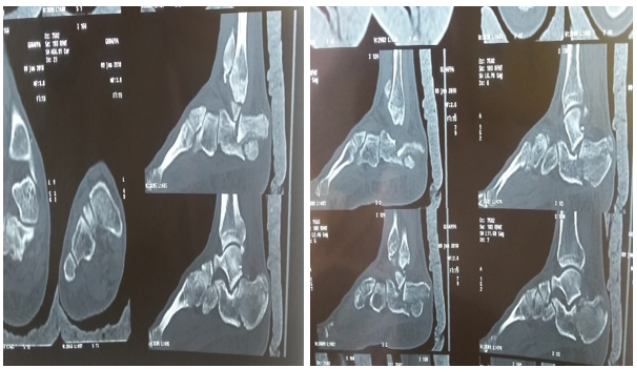

Fig. 8: Sagittal view

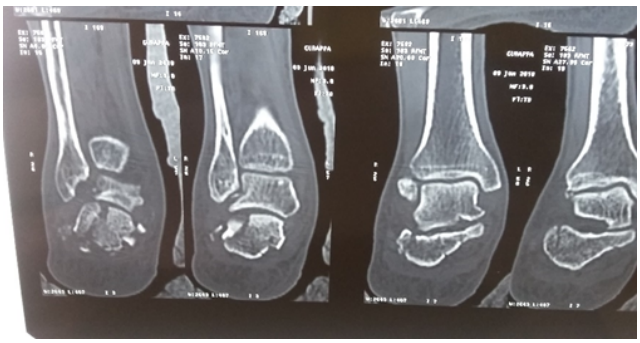

Fig. 9: Coronal view

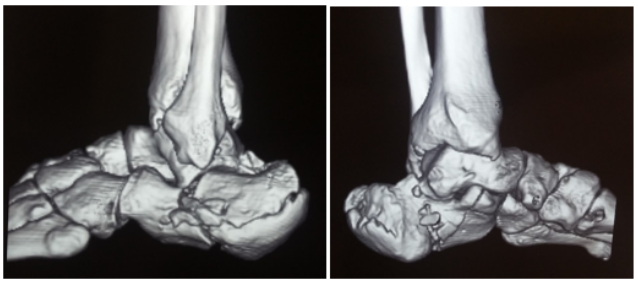

Fig. 10: CT 3D virtual reconstruction of bone

Table 1: Paley and hall criteria [12]

Result	Pain	Subtalar ROM*	Bohler's angle
Excellent	Nil	>60%	$>25^0$
Good	Occasional	>30%	$>20^0$
Fair	Moderate	≥5%	$\geq 10^0$
Poor	Severe	<5%	$<10^0$

*The percentages refer to the percentage of normal or of standard value.

3.1. Post op range of movement

Most of the patients with fixation showed good range of movements post operatively (Figures 11, 12, 13, 14, 15 and 16)

Fig. 11: Inversion

30 cases of calcaneal fractures in adults aged more than 20 years and of both sexes were treated by conservative to surgical methods. Closed reduction and POP cast application, percutaneous pin elevation technique, Open reduction internal fixation with cancellous screws and primary subtalar arthrodesis were the different modes of treatment.

The most common type of fracture was intra-articular type (73.3%) and extra-articular type constituted 26.7% of cases. Among intra-articular fractures, comminuted type were more common (33.3%), followed by tongue type

Fig. 12: Eversion

Fig. 13: Dorsiflexion

Fig. 14: Plantar flexion

Fig. 15: Weight bearing in squatting

Fig. 16: Weight bearing in standing

(23.3%) and joint depression type (16.7%).

Table 2: Distribution of sample by age

Age(years)	Frequency	Percentage
20-30	12	40.0%
30-40	8	26.7%
40-50	3	10.0%
>50	7	23.3%
Total	30	100.0%

$\chi^2 = 5.467$; P<0.141 (NS)

The calcaneal fractures were most common in the age group of 20-30 years (3^{rd} decade) with a frequency of 40% followed by 4^{th} decade (26.7%) and then in >50 years

(23.3%). The distribution was statistically not significant.

Table 3: Distribution of sample by sex

Sex	Frequency	Percentage
Male	21	70.0%
Female	9	30.0%
Total	30	100.0%

$\chi^2 = 4.800$; P<0.028 (significant with 95% confidence level)

Most of the cases reported had a fall from a height (80%) as the mode of injury and only 20% had road traffic accident as the mode of injury. There was significant association of fall from height to the calcaneal fracture statistically.

Vertebral compression fractures were the most common injuries associated with calcaneal fractures and were seen in 20% of cases, 16.7% had lower limb fractures, 10% had open fractures and one case had a Colles' fracture (3.3%).

The commonest type of fracture was comminuted type which was seen in 10 patients and majority of them (8) were treated conservatively with a B/K POP cast and 2 were treated by primary subtalar arthrodesis. Among 8 extra-articular type of fractures, 7 were treated conservatively and 1 case of fracture calcaneal tuberosity with avulsion of Tendo Achilles was treated with ORIF with cancellous screw. All 7 patients with tongue type fracture were treated by semi open technique of Essex-Lopresti. 3 of the 5 joint depression type fractures were treated conservatively and 2 by ORIF with cancellous screws and bone grafting.

Most of the excellent results (75%) were in extra-articular type of fractures followed by tongue type (25%). Most of the poor results (71.4%) were in comminuted type of fracture followed by joint-depression type (28.6%). The association was statistically significant with CC = 0.638 and P<0.014.

3.2. Complications

Out of the 30 cases with calcaneal fractures, 9 had complications (30%). Subtalar arthritis was most common complication seen in 4 patients (13.4%) followed by heel widening (Figure 17 a) in 6.7% cases. There were one each case with infection, compartment syndrome and skin blisters (Figure 17 b).

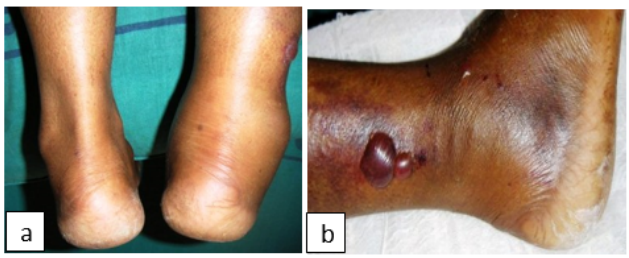

Fig. 17: a): Heel widening; **b):** Skin blistering

The overall results of this series of study were 26.7% excellent, 33.3% good, 16.7% fair and 23.3% poor.

4. Discussion

The mechanisms creating extra-articular calcaneal fractures are diverse low-energy injuries[13] ranging from – minor falls, twisting injuries, direct blow and forceful muscular contraction (Triceps Surae). In contrast to this, the intra-articular calcaneal fractures occur due to more significant high-energy injuries[14] such as – fall from height and motor vehicle accidents. The patient drops and lands heavily on his feet. The momentum of his body is carried along the tibia and is transmitted through the talus to the calcaneus. A combination of shear and compression forces is generated in the calcaneus.

4.1. Shear force

A primary shear fracture line parallel to the posterolateral edge of the talus is produced[2] which splits the calcaneus into two parts – a posterolateral (tuberosity) fragment and an anteromedial (sustentaculum or constant) fragment. The fracture line varies in location from calcaneal sulcus to the lateral portion of posterior facet but always is posterior to interosseous ligament.[15] The exact position of the fracture line depends in part on the position of the foot at impact. If the hind foot is in valgus, the fracture tends to occur more laterally.[1]

4.2. Compression force

The compressive force starts at the angle of Gissane, due to axial loading of the wedge-like anterolateral process of talus and splits the Calcaneum into anterior and posterior halves. This creates the thalamic fragment. The compression fracture continues on the lateral wall in a characteristic inverted Y – configuration. The result is a typical lateral wall "blow-out".

The exact orientation of the posterior limb of "Y" varies depending on the posterior exit point of the secondary fracture line and whether the loading is more horizontal or vertical. In horizontal loading it exits superiorly just behind the posterior facet and produces joint-depression type of fracture and in vertical loading it exits posteriorly through the tuberosity and produces tongue-type of fracture proposed by Essex-Lopresti.[1,2,11,14–16]

The structure and function of foot is one segment of the integrated activities of lower extremity responsible for gait. The most important articulation of foot is the subtalar joint complex formed by the posterior talocalcaneal joint and the acetabulum pedis lodging the talar head.[13,17,18] The calcaneocuboid joint is an inescapable component of subtalar joint complex.

The motion generated at the subtalar joint is that of flexion-supination-adduction and of extension-

pronation-abduction, best described as "inversion" and "eversion" respectively. The subtalar axis is oriented obliquely upwards, anteriorly and medially. It penetrates posterolateral corner of calcaneus, passes perpendicular to tarsal canal, pierces superomedial aspect of talar neck and then through dorsomedial part of the navicular. The mean angulation of the axis is 42^0 inclination in sagittal plane relative to the horizontal line and 23^0 of medial deviation in horizontal plane relative to the axis of foot passing through second interdigital space.[19] The total ROM is quite variable ranging from 10^0 to 65^0. 25^0-30^0 of inversion and 5^0-10^0 of eversion represents a practical average range of motion.[18]

5. Conclusion

Fractures of calcaneum are the commonest fractures among all tarsal bones due to its function of weight bearing which results in transmission of momentum of body to it during fall and road traffic accidents. Calcaneal fractures are more common in young age group (3^{rd} decade) and in males than females. Intra-articular type is more common (75%) than extra-articular type (25%).Comminuted type is the most common type of intra-articular fracture.Fall from a height is the most common mode of injury. Essex-Lopresti classification has a diagnostic and prognostic significance; tongue type fractures have better prognosis than joint depression type. Extra-articular fractures have better outcome with conservative treatment. Tongue-type fractures are better managed by semi open technique of Essex-Lopresti. Most of the complications are due to displaced intra-articular fractures which usually have poor functional outcome and deserve well planned surgical management.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare that there is no conflict of interest.

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