Research Article

Outcome of Calcaneal Platting after fracture: two-year follow-up

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Abstract

The present study is aimed to analyse the results of surgical outcome of the intra articular reduction of Calcaneal fractures fixed using better implants. The treatment of Calcaneal fractures have evolved from conservative to operative management during the last few years thanks to better understanding of fracture pattern and availability of better implants. **Methods:** Thirty intra-articular fractures were prospectively evaluated followed up for mean 18 months. Calcaneum plates and locking reconstruction plates and were used using the lateral approach. McMaster technique was used to measure the final inversion and eversion of the foot. **Results:** Height and width of the Calcaneum were restored within 0.5-1 cm as compared to the normal side. The results were extrapolated as excellent in 13 patients (43%), good result in 11(37%) patients and fair in 4 (14%) and poor in 02 patients (7%) using Maryland foot and AOFAS scoring system. **Conclusion:** Surgical management is the treatment of choice for the majority of Calcaneal fractures. Amount of initial injury is the primary determinant of future outcome especially comminution, soft tissue compromise and joint surface destruction. The value of Bohler angle >20 degrees after reduction is good outcome factor. 86% patients have excellent and good results as per AOFAS and Marlyland foot score. The gait and joint range of motion are known to improve gradually with time and exercise.

Key words: Calcaneum fractures, Calcaneal Platting, McMaster technique, AOFAS score, Maryland score

Introduction

Calcaneum is the most commonly fractured tarsal bone. Majority of calcaneal fractures are intraarticular and 30% are extra-articular [1]. Fractures of the calcaneal bone account for about 2% of all fractures. They are sustained mostly in young active males, and are often associated with other injuries and poor functional outcome, resulting in a serious socioeconomic impact [2]. Calcaneus fractures continue to be a challenge for the treating physician.

Cotton and Wilson recommended closed treatment with use of a medially placed sandbag, a laterally placed felt pad, and a hammer to reduce the lateral wall and "re-impact" the fracture [3]. Despite the fact that Böhler advocated open reduction in 1931, the principal reasons for the predominance of nonoperative treatment were the technical problems associated with operative treatment. Anaesthesia was not always effective, radiography and fluoroscopy were not well developed, antibiotics did not exist, and a sound understanding of the principles of internal fixation was lacking. The resulting complications of infection, malunion, and non-union, and the possible need for amputation, made most surgeons believe that treatment should be non operative [4]. The treatment of intra-articular fractures of the calcaneum still remains controversial. Previous cohort studies have suggested that operative and non-operative treatment provide comparable results [5].

A better understanding of the debilitating nature of these injuries using 3D CT Scan imaging, in combination with improvements in implants and the routine use of intraoperative imaging, has renewed interest in operative fixation over the past decade. Internal fixation is now routinely recommended for displaced intra-articular calcaneal fractures and may decrease the socioeconomic burden of these injuries [6].

Calcaneus fractures often result in a varus deformity with heel widening, loss of calcaneal height, and subtalar articular incongruency. Open reduction and internal fixation (ORIF) can be used to address these deformities, restoring the anatomic morphology of the calcaneus and thereby the biomechanics and function of the hind foot. Restoring heel

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width prevents chronic peroneal tendinitis secondary to impingement from lateral wall blowout of the calcaneus, allowing easy shoe-wear, restoring the length and alignment of the Achilles tendon maintains plantar flexion strength. ORIF also provides the opportunity for anatomic reduction and rigid internal fixation of the subtalar joint along with restoration of the Bohler's tuber joint angle.

This angle seen in the lateral x-ray projection is the complement of the angle formed by the two lines drawn between the highest part of the anterior process and the highest part of the posterior articular surface and a line drawn between the same point on the posterior articular surface and the most superior point of the tuberosity. The tuber angle normally measures between 25^0 and 40^0 [4].

Normal subtalar motion is integral to the foot's ability to adapt to uneven surfaces with inversion and eversion [7]. We studied 30 calcaneal fractures for outcome with open reduction and internal fixation by measuring the American Orthopaedic Foot and Ankle society score (AOFAS) [8] and Maryland scoring [9].

The AOFAS Ankle-Hind foot scale consists of total 100 points with parameters pain (40 points), function (50 points) and alignment (10 points). In Maryland foot score 100 marks are possible with pain, function and movements each carrying 45, 50 and 5 marks respectively. Less than 50 marks suggest failure, 50-74 fair, 75-89 good and 90-100 excellent results.

Methods

The study was conducted at N. H. L. Medical College and V. S. Hospital, Ahmedabad after getting clearance from the ethics committee. The study was conducted on the patients who were admitted from the emergency and outpatient departments of the hospital from March 2011 to December 2013. We evaluated 30 fractures in 29 patients (25 males and 4 females) who met the inclusion and exclusion criteria of the study. Informed consent was taken from all patients.

The inclusion criteria were (1) patients of either sex (2) isolated Calcaneum fractures (3) Displacement of posterior articular facet fragments more than 2 mm, significant shortening, loss of height, and widening of Calcaneum, varus deviation >5 degree, valgus deviation >10 degree. (4) Patients who have not received any other treatment for the fracture.

Exclusion criteria for study: (1) Injury >2 weeks old. (2) Open fractures and Soft tissue compromise for open reduction and internal fixation. (3) Patient's inability to adhere to weight bearing restrictions after surgery. (4) Patients with associated injuries to the spine or pelvis. (5) Skeletally immature patients.

Radiological evaluation

Radiological evaluation was done with lateral and axial (Harris view) and the Broden's views [10] were taken for all patients. The Bohler's and Gissane angle was measured. **(Figure 1)**

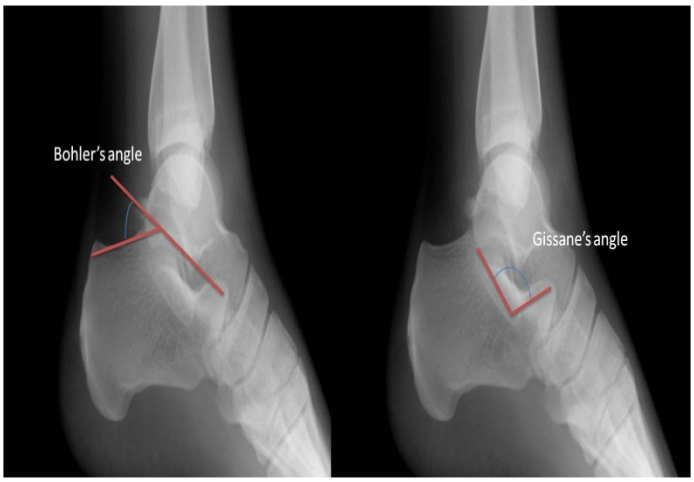

Figure 1: Bohler's and Gissane's angle

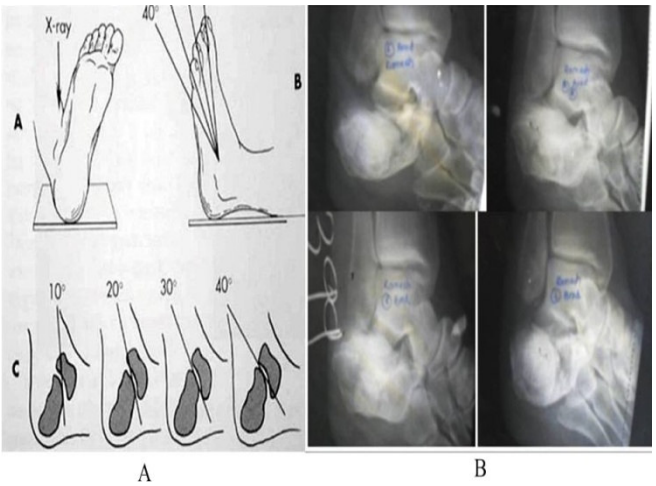

Fig 2 A: Broden's projection taken in 10^0, 20^0, 30^0 and 40^0 internal rotations
Fig 2 B: X-rays taken in Broden's view in 10^0- 40^0 showing posterior articular facet.

Classification and Radiological Assessment

Based on X-ray pictures, Essex- Lopresti classification [11] was used, which still holds good for all practical purposes. This classification divides intra-articular Calcaneal injuries into 1) joint-depression type, in which the primary fracture line exited the bone close to the subtalar joint and 2) tongue-type, in which the primary fracture line exited the bone posteriorly. The lateral view allows assessment of posterior facet position and loss of calcaneal height (Bohler's angle) and gives general impression of overall comminution. The axial view shows the primary fracture line, widening of heel due to lateral wall displacement, varus angulation and fibular abutment. The oblique view also called Broden's view [10] **(Figure 2)** is taken by placing the cassette behind heel and distal tibia. The foot is placed in neutral ankle position and internal rotation of 40 degrees, while X-ray tube is angled 10-40 degrees, former shows details of posterior articular facet and the latter the anterior portion of subtalar joint. The broadening of the heel is due to the lateral displacement of the body fragment and lateral rotation of lateral joint fragment.

Implants design used: (1) Locking Reconstruction plate (2) Calcaneal plates with cortical and cancellous screws (3.5mm and 4mm)

Operative technique

We have used the lateral approach [12-14] which allows direct examination and elevation of posterior and middle facets and calcaneo-cuboid joints. Patient is placed in lateral decubitus position on a radiolucent operating table, an incision starting 4 cm. proximal to the tip of lateral malleolus is given, curving 1 cm. behind the fibula along the lateral border of the foot to the calcaneo-cuboid joint at the junctional line between the skin and the sole. The superior skin flap is retracted upwards along with the sural nerve. The inferior flap is dissected subperiosteally off the lateral wall of Calcaneum.

The superior retinaculum is incised and peroneal tendons are dislocated anteriorly. The calcaneo- fibular ligament is incised to expose the posterior sub-talar joint. Kirscner-wires are inserted in the lateral malleolar tip, cuboid and talar neck, which are used to self-retract the flap. Lateral wall is lifted and hinged on one side to directly visualize the fragment. The depressed fragment is elevated to restore the Bohler's angle **(Figure 3).** The lateral wall is buttressed with plate and screws. The peroneal tendons are brought back to the original place and retinaculum is repaired. Retinaculum is repaired thoroughly to prevent anterior subluxation of peroneal tendons. The wound is loosely sutured to avoid skin necrosis over a negative suction drain. A Posterior splint was applied.

Post-operative management

Closed suction drainage was removed after 48 to 72 hours. Splint was continued till suture removal. No weight bearing is allowed for at least 6 to 8 weeks after which partial weight bearing was allowed along with Ankle and subtalar joint range of motion exercise, gait training and wobble board exercises. After 12 to 14 weeks, in presence of radiological signs of union, full weight bearing was started.

Follow up

The patients were followed up in the outpatient department of the hospital at 2 weeks post-op and then at monthly intervals for 3 months, then at 6 months and 1 year. Duration of follow up was 6 to 30 months (mean 18 months) in our study.

Radiographs, lateral and axial views were obtained for all patients at 1 month, 3 months and thereafter at 6 months interval.

Outcome assessment

Movements of the subtalar joint and ankle joint were measured at 3months, 6 months and at 1 year post-operative and compared to the opposite normal side if the fracture was unilateral. **McMaster's method** was used to measure range of movement (ROM) of the subtalar joint [15] **(Figure 5)**.The patient was placed supine with the foot and lower leg on a large drawing board. The foot and ankle are placed in neutral position with a specially constructed pointer fixed to the middle of the heel with adhesive strapping with the axis of the pointer in line with the longitudinal axis of the tibia. From this position, the movements of inversion and eversion were measured. At the extremes of both inversion and eversion, marks were made in the line of the pointer. After removing the foot from the drawing board, these marks were joined and projected back until the two lines crossed. The angle made between these two lines was the measurement of the subtalar joint motion.

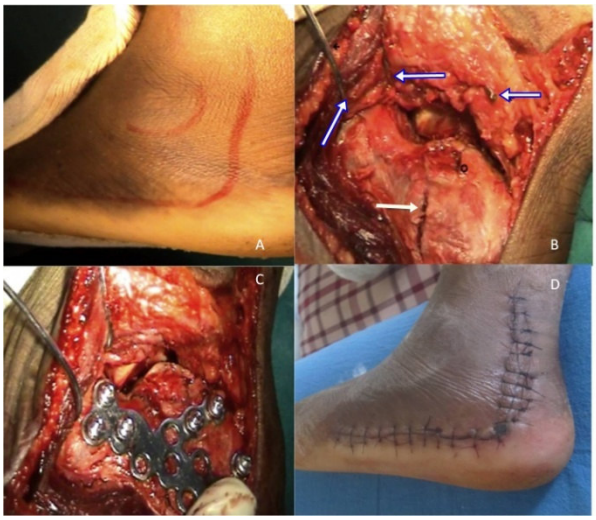

Fig 3: Incisional line, K wire, Plate & Healed wound

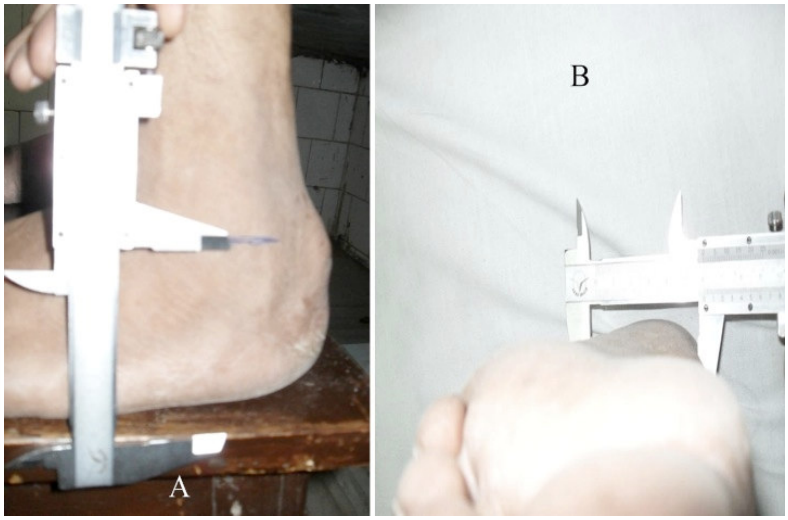

Fig 5: Vernier calliper used to measure height and width of the heel respectively

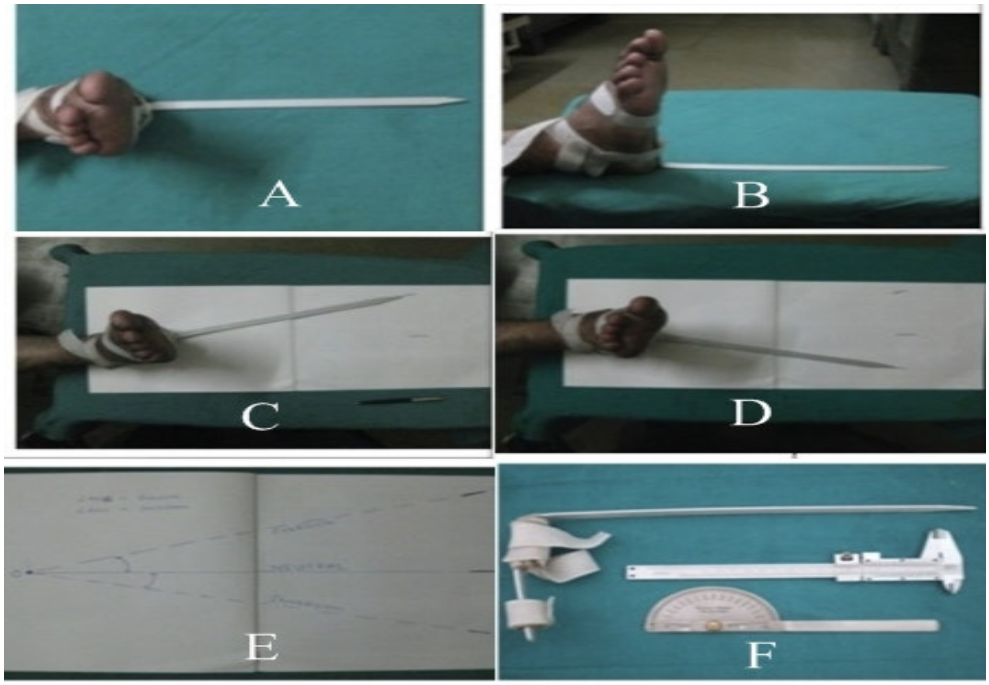

Fig 4: McMaster technique. A & B: Pointer strapped to the foot top and side view. C & D: Pointer position in inversion and eversion respectively. E: Measurement of sbutalar movement. F: Pointer, Vernier callipers and goniometer used for measurements.

The widening of the heel was measured with help of Vernier callipers at the point of maximum width of the heel. The height was measured from the tip of lateral malleolus to the edge of the sole of the foot with help of Vernier callipers **(Figure 4).**

The AOFAS score [8] was excellent if the score was between 90 and 100, good between 80 and 89, fair between 70 and 79, bad result if the score was <69.

The functional outcome was assessed using the Maryland foot score [9] and graded as excellent if the score was between 90 TO 100, good for a score of 75 TO 89, fair result for a score of 50 TO 74 and poor if the score was < 50.

Results

In 30 fractures studied in 29 patients, the mean age was 33.5 years (range 18-58years). Most of the patients were between 20-30 years. (Table1).

Table 1: Age distribution in the study

Age Group	Number of Subjects
16-25	4
26-35	18
36-45	4
46-55	3
56-65	1

Fall from height was the common mode of Injury, n=27 (93%) patients. Road traffic accidents were the cause in two cases. Soft tissues were compromised in 6(20%) of patients. 3 subjects had associated injuries. 25 (83%) subjects were Males and 4(17%) patients were Females. Manual Labourers were most commonly affected group in our study n=26(87%). N=19(63%) were Joint depressing and n=11(37%) were tongue type fractures. Majority of the patient were operated within 3days of admission and hospitalized for mean 8 days (range 5-11days). The mean duration of follow up were 18 months (range 6 to 30 months). McMaster technique showed range of motion of subtalar joint <3 degree variation in majority of patients in affected joint.

Table 2: Showing difference between the width and height of heel between the fractured and normal side in unilateral cases

Widening of heel as	Number of subjects	Height of heel as	Number of subjects
<0.5 cm	21	<0.5 cm	21
0.6 to 1 cm	5	0.6 to 1 cm	4
>1 cm	3	>1 cm	4

Height and width were restored within 0.5-1cm (table 2) as compared to the normal side in unilateral cases. 1 patient had bilateral fracture.

The Bohler Angle $<20^0$ was present in 7 fractures while Bohler angle $>20^0$ was present in 23 fractures. The scores were better in the subjects with pre-operative Bohler angle $>20^0$ as all 7 subjects had excellent results.

3 (10%) subjects had superficial infection which were managed conservatively. one patient had deep infection after 3 months, In this case the implant was removed and the result was poor.

Implant removal was done in n=2(7%) subjects due to lateral impingement out of which 1 subject required lateral wall decompression and osteotomy along with plate removal. 6(20%) subjects had residual pain. 4(13%) had persistent pain at 6 months on performing more than routine activity while 2(7%)subjects continued to have pain at 2 years follow-up. 4(13%) subjects had slight limp at the end of follow up. 6(20%) patients had swelling out of which 3 had persistent swelling and 3 had intermittent swelling relived with rest. 2 (7%) subjects had loss of reduction which developed subtalar joint arthritis at 18 months follow-up. 1 patient had radiological non-union at the end of 9 months. 2 patients had flat-foot and 2 had varus deformity of the heel at the end of follow-up. 2 patients had difficulty in squatting and walking on uneven surface.

The results were extrapolated as excellent in 13 patients (43%), good result in 11(38%) patients and fair in n=4 (14%) and poor in 02 patients (7%) using Maryland foot and AOFAS scoring system. 20 patients (69%) were able pursue their routine work and around 7(24%) patients had to change their job and around 2 patients (7%) were yet to resume their jobs. 24 patients were able wear shoes without discomfort.

Discussion

Calcaneal fractures usually affect economically active groups, which can impose a great social-economical loss. The most common cause of calcaneus fractures, as reported by literature, is the fall from height [3, 16] which accounted for 93% of the fractures in our series.

Joint depression-type fractures are the most prevalent, accounting for 61% of intra-joint fractures [17, 18]. In this study, we found 63% of joint depression-type fracture using the Essex-Lopresti classification.

Conservative treatment of the displaced intra-articular fracture is unlikely to result in normal function because of secondary arthritis and malunion of the Calcaneum [19- 21].Thordarson and Krieger using the American Orthopaedic Foot and Ankle Society Score (AOFAS) scoring system showed surgically-treated patients scoring 86.7, whereas patients treated non-operatively only managed a score of 55.[20]

For the open surgical treatment, there is a consensus of waiting some time, ranging from 3 to 7 days so that edema could be reduce, except in open fractures, which should receive immediate surgical care [21- 23]. In this study, the time interval between trauma and surgery for the 24 (88%) fractures was, in average, 2 to 3 days.

The lateral extensile approach is the most widely used. Surgeons employing this approach including Sanders and Zwipp et al [24] stress the importance of anatomical reduction of the posterior and middle facets.

Serious complications are associated with open approach, the most common being wound dehiscence, which may occur as much as four weeks after surgery. Folk et al [25] reported that in 190 fractures, there was a 25% wound complication rate, 22 patients required early removal of their implants and 11 needed flap cover. Abidi and Gruen [14] reported problems with wound healing in 32% of their cases. In our study 3 subjects had stitch line complications which healed conservatively. 1 subject required implant removal for deep infection after three months of surgery. 2 subjects underwent implant removal, due to lateral impingement.

Loucks and Buckley [26] stated that fractures with a Bohler's angle markedly reduced at the immediate post-trauma period provided bad outcomes, variations between 10 and 40 degree were found. Our study shows that all the 7 subjects with Bohler angle $>20^0$ had excellent results.

In the evaluation of the results by AOFAS and Maryland Foot Score scale, we found rates in literature ranging from 42.22% to 62% of excellent results [26, 27] for open approach. In our study, 80% had outcomes good and excellent results. Leung et al [28] obtained 90% excellent and good result. H Zwipp et al [24] obtained 72% excellent and good results. O'Farrel et al [29] reported that 66.66% of the patients submitted to open surgery returned to work and the non operated cases it was noticed only 12% returned to work, while in our study 67 % were managed to returned to their previous work after open reduction and fixation while 13% needed a change in job profile. Comparing with Zeman et al [30] series as shown in table 3 our series had 43 % excellent results and 38% good results as against 34.5% and 51.7% respectively.

Table 3: Comparison between our series with Zeman et al series

Series	Injury:Fall from height	Bilateral	Average operative interval	Post op complications	Results Excellent	Results Good	Results Poor
Zeman P et al	93.1%	20.7%	11.7 days	20.7%	34.5%	51.7	6.9%
Nadeem et al	93%	3.45%	8 days	10%	43%	38%	7%

Conclusion

Accurate evaluation of fracture morphology is an essential prerequisite. Surgical management is the treatment of choice for the majority of displaced, intraarticular calcaneal fractures and certain extraarticular fractures.

Good roentgenography which includes lateral, axial and Broden's oblique views of the Calcaneum is a must in understanding the displacement of major fragments. Some fractures despite an anatomically reduction may result in posttraumatic subtalar arthritis resulting from damage to the articular surface at the time of injury.

Amount of initial injury is the primary determinant of future outcome especially comminution, soft tissue compromise and joint surface destruction. Adherence to good soft handling and elevation of the osteo-periosteal flap is key to avoid skin healing issues.

The value of Bohler angle >20 degrees after reduction is good outcome factor. 86% have excellent and good results as per AOFAS and Marlyland foot score. The gait and joint range of motion are known to improve gradually with time and exercise.

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