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FUNCTIONAL ASSESSMENT FOLLOWING OPEN FIXATION OF CALCANEAL FRACTURES

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ABSTRACT: PURPOSE: Assessment of functional outcome following open reduction and internal fixation of displaced intra articular calcaneal fractures. **METHODS:** A total of 44 patients with intra articular calcaneal fractures which were managed by open reduction and internal fixation with Recon or Y plate were included in the study. Clinical and radiographic findings and functional outcome assessed with AOFAS Clinical Rating System for Ankle-Hind foot Scale was done. **RESULTS:** AOFAS criterion endowed our sample size with an average value of 77.89 points. The results progressively deteriorated through fracture patterns II to IV. Types II and III demonstrated zero and three (25%) bad outcome cases, respectively; type IV injury had nine cases with a bad outcome (60%), five had fair results, one had a good result and none with excellent results. Patients with a lower Böhler's angle on presentation had a poorer final outcome. **CONCLUSION:** At final follow up, excellent results were achieved in 31.8%, good results in 11.4%, fair result in 29.5% and poor result in 27.3%. As only 27% patients had poor outcomes, open reduction and internal fixation can be recommended as a very good alternative to conservative treatment in intra articular calcaneal fractures.

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

INTRODUCTION:

Epidemiology: 60% of all tarsal fractures are of the calcaneum. Of which 75% are intra-articular and can involve one or more of the three subtalar articulating facets¹. Extra-articular fractures are generally known to have a better prognosis when compared to intraarticular fractures. Axial compression of the calcaneum as sustained during a fall from height is the most common cause of calcaneal fractures. Compression fractures of the lumbar vertebrae are seen along with 10-15% of calcaneal fractures.

Clinical Evaluation: Patient usually presents with marked swelling of the hind foot, following a fall from height or a forced loading injury. The fracture pattern and displacement of fracture fragments and the soft-tissue contusion associated with an intra-articular calcaneal fracture are directly related to the force generated to produce the injury.

Bleeding into the tight enclosed fascia of the heel causes excruciating tenderness. Within six hours of injury, swelling would increase drastically obliterating the lateral skin creases and causing the peronei tendons to subluxate at the lateral malleoli.

Conventional Radiography: Regular radiographs include lateral view of the hind foot and a Harris axial view of the heel.² Intra articular fractures are usually diagnosed with a loss in the height of the posterior facet, a decrease in the angle of Böhler and an increase in the angle of Gissane.

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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 appear normal. The lateral radiograph helps to classify the fracture into joint depression or tongue type according to 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.

Brodén's view helps to demonstrate the articular surface of the posterior facet on plain radiographs. It is obtained with the patient supine and the cassette placed under the leg and the ankle.

The foot is kept in neutral flexion, and the leg is internally rotated 30 to 40 degrees. The x-ray beam is centered over the lateral malleolus, and four radiographs are made with the tube angled at 40, 30, 20, and 10 degrees towards the head of the patient.

Computed Tomographic Scanning: Computed tomographic scanning helps to demonstrate intra-articular extension of the fracture line, comminution of posterior facet, calcaneocuboid joint and impingement of lateral border of calcaneus on lateral malleolus. It also helps to assess consistent analysis of the results of treatment.

MATERIALS AND METHODS: All patients that presented with closed, displaced intra articular calcaneal fractures to the Department of Orthopaedics at our hospital were included in the study. The study period was from June 2011 to June 2013.

Inclusion Criteria: Patients with displaced intra articular calcaneal fractures who have been treated by open reduction and internal fixation by Recon or Y plates.

Exclusion Criteria:

1. Patients treated conservatively by cast immobilization. (Sander's type I fractures were excluded).
2. Open fractures.
3. Age < 12yrs.
4. Pathological fractures.

Study Methodology: Patients with displaced intra-articular calcaneal fractures were initially treated by immobilization of the fracture by below knee slab and limb elevation. Definitive surgery was later performed as soon as the wrinkle test is positive and within the first three weeks of injury to prevent difficulties with reduction secondary to early consolidation of the fracture.

Exposure technique described by Benirschke and Sangeorzan⁴ was used for the surgery. The peroneal tendons were left in their sheath and the sheath was stripped off the lateral wall of the calcaneus subperiosteally and held subluxed anterior to the fibula using two K wires, one in the fibula and one in the talus. This "no-touch" technique retracted the peroneal tendons, as well as obviated the need for manual retraction of the anterior skin flap.

The calcaneo-fibular ligament was identified, dissected off the calcaneum and retracted anteriorly. Fracture fragments were exposed, clots were removed and the depressed posterior facet fragment was rotated out from within the body of the calcaneus to decompress the lateral wall.

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Preliminary reduction was obtained using K-wires and if acceptable, 3.5-mm lag screws were employed to hold the reduction. The calcaneal body was reduced and a malleable Y plate or recon plate was used to maintain the reduction and buttress the lateral wall.

Closure was performed over a drain and put on below knee slab. After suture removal, below knee cast was maintained for 6 weeks. By the sixth postoperative week, active range of motion of the ankle and subtalar joint is initiated. Absolute non-weight bearing was enforced till union was documented with radiographs.

Outcome Assessment: Clinical and radiographic examinations were performed at follow up and CT scan was avoided due to financial constraints of the patients. Functional outcome was assessed using AOFAS Clinical Rating System for Ankle-Hind foot Scale.⁵

Factors considered were: pain, range of sagittal and hind foot motion, ankle stability, alignment of fracture fragments on radiographs, ability to ambulate on any walking surface, presence of a limp, any limitation of daily activities, and requirement of assistive ambulatory devices. 50 points were assigned to function, 40 to pain, and 10 to alignment. Dorsiflexion and plantar flexion motion were measured with a goniometer and described as sagittal motion.

A joint that can be passively dislocated or severely sub luxated is graded as definitely unstable. 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: 44 calcaneal fractures in 33 patients which met the inclusion and exclusion criteria were taken into the study and were carefully followed up. There were 11 bilateral cases and 22 unilateral cases. 30 patients were males and 3 females between 14 to 52 years, with mean age being 32.5 years.

Fracture Type (Table1):

Sander's classification	Number of patients	Percentage of cases
Type II	14	31.8
Type III	15	34.1
Type IV	15	34.1

Table 1: Distribution of fracture type by Sander's classification

Final outcome of fractures according to Sander's Classification: At final follow up, excellent results were achieved in 31.8%, good results in 11.4%, fair result in 29.5% and poor result in 27.3%.

Although types II and III demonstrated zero and three (25%) cases of bad outcomes, respectively; type IV injury had nine cases with bad outcome (60%), five had fair results, and one had good result and none with excellent results.

Results	Excellent	%	Good	%	Fair	%	Poor	%	Total
Type 2	8.0	57.1	4.0	28.6	2.0	14.3	0.0	0.0	14
Type 3	6.0	40.0	0.0	0.0	6.0	40.0	3.0	20.0	15
Type 4	0.0	0.0	0.1	6.7	5.0	33.3	9.0	60.0	15
Combined	14.0	31.8	5.0	11.4	13.0	29.5	12.0	27.3	44

Table 2: Final outcome depending on fracture type

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Duration of Immobilization: The mean duration was 6.6 weeks. (Range 4 to 12 weeks).

AOFAS Score: The mean AOFAS score was 77.89 (Range 45-97).

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

Limitation of Activity: 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. One patient (2.3%) had limited daily and recreational activities, and required the assistance of a cane. None had incapacitating limitation of activities.

Gait Abnormality: Abnormal gait was obvious in 8 patients and 36 (81.8%) had no gait abnormality clinically. 21 patients (47.7%) had no difficulty on walking on any surface. 22(50%) had some difficulty on walking on uneven terrains, stairs and ladders. One had severe difficulty on uneven terrain, inclines and ladders.

Sagittal Motion: (dorsiflexion and plantar flexion) Normal or mild restriction (30° or more) was seen in 22 (50%) patients. Moderate restriction (15°-29°) was present in the remaining 50% of patients.

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

AOFAS Score and Sander's Fracture Type: One way ANOVA test was used to find out if any significant relation exists between Sander's classes and AOFAS score. The study showed a significant difference between the outcomes among the Sanders types.

Associated Injuries: Anterior wedge compression fracture of spine without any neurological deficits occurred in 3 patients; distal radius fracture occurred in 3 patients and closed femoral shaft fracture in 2 patients.

COMPLICATIONS:

Complication	Number	Percentage
Heel widening	44	100
Ankle swelling	31	70.5
Heel pain	18	40.9
Peroneal tenosynovitis	10	22.7
Sural nerve injury	9	20.5
Subtalar arthritis	9	20.5
Skin dehiscence	6	13.6
Heel exostosis	5	11.36
Peroneal tendon dislocation	4	10
Sympathetic osteodystrophy	1	0.02
Osteomyelitis	1	0.02
Nonunion	0	0

Table 3: Complications

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Heel widening is said to be the dictum after calcaneal fractures; as it heals by collapse, being a cancellous bone. The incidence of wound complications is found to be more when the patient was operated before 10 days. Skin dehiscence was seen in six patients (13.6%) which resolved with wound care and antibiotics.

There were no cases of flap necrosis. It has been observed that most of the patients are non-complaint in limb elevation, and this may ascertain the long duration to curtail edema. This also implies that patients who are noncompliant in the initial management of soft-tissue swelling are not optimum surgical candidates. Soft-tissue management is extremely important and early surgery (in the first few days) is not recommended.

DISCUSSION: The calcaneum is the most common tarsal bone to be fractured; however there is no consensus yet regarding its best treatment option. The role of conservative treatment in un displaced fractures is supported by Sanders.⁵

Likewise, in severely comminuted fractures with small fragments, open fixation is not a feasible option. Whereas, displaced intra articular fractures with relatively large fragments require surgery. There were 44 calcaneum included in the present study, of which 11 cases were bilateral and 22 unilateral.

Studies have shown that calcaneum fractures affect the working force more than others.^{6,7}

90% of the fractures affect the age group 20 to 60 years which has a major socio-economic impact in terms of loss of productivity and lost working hours. Side distribution compared to other studies was in accordance with other studies (Table 4).

	Present study	Richard Buckley⁸	Crosby and Fitzgibbons⁹
Right	54.5%	51%	40%
Left	45.5%	49%	60%
Bilateral	33.3%	47%	10%

Table 4: Side distribution compared to other studies

Final outcome of Fractures: Comparison of results is possible as most of the studies use similar criteria to classify the results from excellent to bad. (Table -5)

	Present study	Hall 1993¹⁰	Crosby and Fitzgibbons⁹	Kitaoka et al. 1994¹¹
Excellent	31.8	36.5	27	18.5
Good	11.4	25.0	20	18.5
Fair	29.5	23.1	17	26
Bad	27.3	15.4	37	37

Table 5: Comparison of Final outcome of fractures

AOFAS score.

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	Present study	Ibrahim T ¹²	Howard et al ¹³	Thordarson and Krieger ¹⁴
The mean AOFAS score	77.89 (Range 45 to 97)	conservative = 78.5 operative = 70	66 (42 to 92)	86.7

Table 6: Comparison of AOFAS of various studies

As the present study depicted only 27% of bad outcomes, open reduction and internal fixation can be recommended as very good alternative to conservative treatment of intra articular displaced calcaneal fractures. The AOFAS score of this study is in accordance with the AOFAS score of multiple previous similar studies.^{15,16,17}

According to the studies, the index showed good functional results; making it possible for the patient to resume their previous occupation or to find a more sedentary work. Sanders classification⁵ being the most common classification used, showed in this study that patients with less comminution are likely to score higher when treated operatively (Table 7). This provides ample evidence that the fracture was not only the result of low energy trauma but was also more reliably reduced and easier to fix.

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

Table 7: Correlation of Sanders and AOFAS outcome

Bohler's tuber joint angle and Prognosis: Bohler's tuber joint angle is a very effective measure used in assessing calcaneal fractures. Janzen et al¹⁸ in 1992 stated that a marked loss of Bohler's angle was directly related with a poor clinical outcome.

Fernandes studied 38 intra articular calcaneal fractures of Sanders type II and III, with a minimum of 24 months follow up and found significant correlation of the angle of Böhler with AOFAS criteria; however, more recently Hutchinson and Huebner¹⁹ have indicated that Bohler's angle at follow-up did not correlate with the final clinical outcome in patients.

In our study we found that clinical AOFAS score has got an important correlation with Bohler's angle at presentation. Patients with a lower Böhler's angle in their initial radiographs demonstrated a poorer outcome. The present study demonstrates that higher energy injuries produce flatter Bohler's angles, with more bone and soft tissue injury.

The treatment of intra articular calcaneal fractures remains a controversy because of the indefinite outcome of any treatment option and the associated complications. Advances in antibiotic treatment, better understanding of vascularity of lateral flaps and improved surgical technique has proven to decrease complications of ORIF.

The most common complication reported from our study is heel widening followed by ankle swelling and heel pain. The rate of wound dehiscence in this study was 13.6%, which is similar to studies in the literature.

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CONCLUSION: Calcaneal fractures can often be a potential challenge to any surgeon. Long term morbidity and multiple associated complications make this fracture significant. Computed tomographic scanning both in coronal and transverse plane has allowed an understanding of the pathological anatomy of these fractures. Classifications based on computed tomographic scanning are of ample prognostic value with respect to outcome. As evidenced from our study, open reduction and internal fixation must be attempted in all displaced intra articular calcaneal fractures.

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