

## FUNCTIONAL AND RADIOLOGICAL EVALUATION OF THE MANAGEMENT OF DISPLACED INTRAARTICULAR CALCANEAL FRACTURES

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### ABSTRACT

**Objective:** Displaced intra-articular calcaneus fractures (DIACFs) represent a source of potential disability to the patient, an economic burden to society, and a treatment challenge to the average orthopedic surgeon. Despite a lack of evidence of whether operative management is superior to non-operative management, there is a trend favoring the former.

**Methods:** Based on clinical and radiological examination patients were admitted in the hospital from April 2021 to September 2022 and were divided into 2 groups A and B. Group A (33) patients were managed conservatively and Group B (33) patients were managed by operative procedure. Each patient was followed up at 3 mo, 9 mo, and 1 y from injury. Appropriate lateral and axial view x-rays done at 3 mo and 1 y follow-ups and a radiological assessment was done. The ROWES score was assessed and recorded at each of these follow-ups.

**Results:** The duration of stay, Bohlers angle, ROM at 3 mo, and ROWE's score at 3 mo, 9 mo, and 12 mo show statistically significant differences among the groups with more duration of stay in the ORIF group, greater Bohlers angle in ORIF and more ROM at 3 mo, ROWE's score at 3, 9 and 12 mo in ORIF as compared to the conservative group.

**Conclusion:** We came to the conclusion that displaced intra-articular calcaneum fractures can be treated better and more effectively with open reduction and internal fixation with a pre-contoured calcaneum locking plate as compared to conservative treatment.

**Keywords:** Calcaneum fractures, ROWE'S score, Bohlers angle, Sanders classification, Range of motion

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### INTRODUCTION

Calcaneum fracture remains among the most challenging for an orthopaedic surgeon. They account for approximately 2% of all fractures, with displaced intra-articular fractures comprising 60% to 75% of these injuries [1].

The pattern of fracture and extent of comminution is determined by the position of the foot, the porosity of the bone the amount of force at the time of impact [2]. An axial load causes a displaced intra-articular calcaneal fracture (DIACF) and leads to crushing and sheering injury of the bone. Primary and secondary fracture lines develop. The primary fracture lines run through the posterior facet of the subtalar joint creating a superolateral fragment and a superomedial or "constant fragment" which includes the sustentaculum tali. If this force continues even further, a secondary fracture line is created. Depending on the direction of the force, it may form a tongue-type fracture or joint depression-type fracture [3]. The clinical examination focuses on pain, swelling, hematoma, and deformity at the hindfoot. Radiological evaluation of calcaneal fractures is essentially to classify the fracture as intraarticular or extra-articular, but other angles and parameters such as Bohler's angle, the critical angle of Gissane, Talar and tibial alignment, calcaneal height, width, length, and varus angle also constitute in assessing fracture and help in planning treatment. Assessment of fracture fragments, displacement, intra-articular extension, lateral wall blow-out, bone quality, and comminution are part of reading a calcaneal fracture radiograph [4].

CT scanning has improved the understanding of calcaneal fractures and subsequently allowed for the analysis of treatment results. The classification system of Sanders *et al.* is based on images in the coronal plane. TYPE I is Non-displaced articular fractures (less than 2 mm), regardless of the number of fracture lines. TYPE II is a two-part fracture of the posterior facet. TYPE III is a three-part fracture that usually features a centrally depressed fragment. Types included IIIAB, IIIAC, and IIIBC, and again were based on the location of the primary fracture line. TYPE IV is highly comminuted and often has

more than four articular fragments. Management of calcaneal fractures can either be operative or non-operative [5].

Indications for nonoperative treatment are Nondisplaced or minimally displaced extra-articular fractures, Nondisplaced intra-articular fractures, Anterior process fractures with less than 25% involvement of the calcaneocuboid articulation, Fractures in patients with peripheral vascular disease or insulin-dependent diabetes, Fractures in patients with medical co-morbidities prohibiting surgery. Non-operative treatment means the use of a supportive splint to allow dissipation of the initial fracture hematoma, followed by conversion to a prefabricated fracture boot with the ankle locked in neutral flexion, and an elastic compression stocking-to-minimize dependent edema. Early subtalar and ankle joint exercises are initiated, and non-weight-bearing restrictions are maintained for approximately 10 to 12 w until radiographic union is confirmed.

Operative treatment is primarily indicated for Displaced intra-articular fractures involving the posterior facet, Anterior process of the calcaneus fractures with more than 25% involvement of the calcaneocuboid articulation, Displaced fractures of the calcaneal tuberosity, Fracture-dislocations of the calcaneus, and Selected open fractures of the calcaneus. Basic fracture patterns can be understood with plain radiographs. Surgery should be performed within the initial 3 w of injury before early consolidation of the fracture [6]. For internal fixation most surgeons use a single lateral plate that displays the anatomical features of the calcaneus, providing support to the tuberosity, the thalamic portion with the posterior joint facet and the anterior process. Generally, a minimum of two screws should be directed into the sustentaculum-tali, the tuberosity, and the anterior process [7]. Wound complications (10-25%) with increased risk in smokers, diabetics, and open injuries are common in fractures treated operatively. Subtalar arthritis requiring subtalar arthrodesis later, compartment syndrome (10%), and malunion also lead to poor results of calcaneal fracture treatment [8]. Recent advances in fixation devices and antibiotics have improved outcomes with operative management. Some studies have confirmed

better results with operative treatment but still associated with considerable morbidity [9-12]. However many subsequent and recent meta-analysis studies have shown that there is no significant improvement in overall outcomes between operative and non-operative management. This study aims to observe the radiological and functional outcomes of displaced intra-articular calcaneal fractures managed non-operatively vs managed operatively.

#### MATERIALS AND METHODS

This prospective randomized study was conducted on patients with displaced calcaneal fractures, admitted in the Department of Orthopaedics, Rajindra hospital, attached to Government Medical College, Patiala.

Based on clinical and radiological examination patients admitted to the hospital from April 2021 to September 2022 were divided into 2 groups A and B. Group A (33) patients were managed conservatively and Group B (33) patients were managed by operative procedure.

#### Criteria for selection of patients will be as follows

##### Inclusion criteria

- All patients above 15 y of age with displaced intra-articular calcaneum fractures
- Patients should be walking before the fracture
- Sanders type 1 type 2 and type 3 fractures

##### Exclusion criteria

- Fracture in children below 15 y of age.

- Open fractures or Gustilo Anderson Type II and III fractures
- Pathological fractures.
- Calcaneal fractures with associated spinal injuries
- Age >70 y old.
- Patients with Peripheral vasculopathies.
- Sanders Type I and IV.
- AO TYPE 83-A1 and 83-C2.

After obtaining consent, appropriate x-rays of the foot in lateral and axial views were obtained. Group a patients were managed conservatively, initially closed reduction was attempted by plantarly displacing both forefoot and hindfoot to reverse the mechanism of injury which allows elevation of the posterior facet.

If patient presented with the swelling over foot we temporarily splinted the foot with short leg POP back slab and advice limb elevation under cover of anti-inflammatory medication and analgesics. After reduction in significant swelling we applied short leg cast for 6 w followed by range-of-motion exercises. We began progressive weight bearing at 8 w with full weight bearing by 12 w.

Group 2 was managed operatively, surgical intervention was proceeded within 2 w of injury, although surgery may be safely performed up to 3 w from injury.

We used the lateral extensile approach for open reduction and internal fixation of calcaneal fractures.

**Table 1: Demonstrating demographic data of both groups**

Demographic date	Mode of treatment		p-value
	Conservative	ORIF	
Gender	Female	5	0.150
	Male	28	
Side	Left	17	0.213
	Right	16	
Mode of injury	Fall	14	0.460
	RSA	19	
Time interval between date of injury and presentation	Within 24 h	20	1.000
	Within 48 h	13	
Sanders classification	Type II	13	0.324
	Type III	20	

**Table 2: Distribution of partial weight bearing, full weight bearing and radiological union based on the mode of treatment**

Time duration for weight bearing and radiological union	Mode of treatment		p-value
	Conservative	ORIF	
Partial WEIGHT BEARING (IN WEEKS)	10 w	11	0.624
	11	3	
	12	14	
	13	1	
	14	4	
Full Weight Bearing (In weeks)	12	4	0.022*
	13	2	
	14	12	
	15	7	
	16	8	
Radiological union (in weeks)	12	13	0.586
	13	2	
	14	11	
	15	4	
	16	3	

No statistically significant difference was seen between the mode of treatment based on the partial weight bearing and radiological union ( $p > 0.05$ ). For the full weight bearing statistically significant difference was seen among the two groups based on mode of treatment with ORIF bearing full weight earlier as compared to the conservative treatment ( $p < 0.05$ ).

The lateral extensile incision starts approximately 2 cm above the tip of the lateral malleolus, just lateral to the Achilles tendon. This

line was continued vertically toward the plantar surface of the heel. It was connected to a line drawn at the junction of the lateral foot

and the heel pad—typically when compressing the heel, a crease appeared in this region. Posteriorly, this line connects to the vertical limb; anteriorly, it was curved up to follow the skin creases, ideally centering over the middle of the calcaneocuboid joint articulation [13]. Definitive fixation was achieved by using Calcaneal locking plate and screws. The patients were managed in the hospital ward with analgesics and antibiotics and placed in a short-leg non-weight-bearing POP back-slab. Aseptic dressings were done regularly at 3<sup>rd</sup>, 7<sup>th</sup> and 11<sup>th</sup> d in ward. Alternate sutures were removed at 13<sup>th</sup> post-operative day and complete suture removal was done at 15<sup>th</sup> post-operative day depending on the condition of the wound. Partial and full weight bearing were started depending upon the radiological union. Once weight bearing was initiated, the patient was gradually

transitioned into regular shoes as tolerated. Regular follow up was done by clinical and radiological examination monthly for 12 mo. Functional outcome were assessed using Modified Rowe score after following the cases over mean period of 3, 9 and 12 mo.

## RESULTS

The mean age of the patients was 36 with a standard deviation of 9.47 in conservative group and mean 41.85 with a standard deviation of 11.93 in ORIF group. Based on the gender, side of injury, mode of injury, time interval between date of injury and presentation and Sanders classification the patients were equally distributed among the two groups for mode of treatment, which was also statistically non-significant ( $p > 0.05$ ).

**Table 3: Distribution of pain, activities, work at 3 mo follow up based on the mode of treatment**

Distribution of pain and activities		Mode of treatment		P-value
		Conservative	Orif	
Pain at 3 mo	Mild on daily activity	0	2	0.223
	Pain at Rest	23	18	
	Pain on bearing weight	10	13	
Activities at 3 mo follow-up	Able to walk Short distances only	12	19	0.049*
	Moderate daily restrictions	0	2	
	Unable to walk	21	12	
Work at 3 mo follow-up	Substantial restrictions	21	26	0.174
	Unable to work	12	7	
Gait at 3 mo	Moderate Limp	9	20	0.006*
	Severe Limp	24	13	

No significant difference was seen among the two modes of treatment for pain at 3 mo and work at 3 mo follow-up ( $p > 0.05$ ). Activities and gait at 3 mo follow-up shows significant differences among the two groups with more patients able to walk short distances in ORIF group as compared to the conservative group and more severe limp in the conservative group as compared to ORIF group. ( $p < 0.05$ )

**Table 4: Distribution of grading at 3, 9 and 12 mo follow up based on the mode of treatment, \*statistically significant ( $p < 0.05$ )**

Grading based on mode of treatment		Mode of treatment		p-value
		Conservative	ORIF	
Grading at 3 mo	Poor	33	33	-
Grading at 9 mo	Excellent	3	9	0.048*
	Good	11	15	
Grading at 12 mo	Poor	5	1	0.036*
	Satisfactory	14	8	
	Excellent	13	24	
	Good	14	8	
	Poor	1	0	
	Satisfactory	5	1	

The grading at 9 and 12 mo shows more excellent results in ORIF as compared to conservative group with statistically significant difference among the groups ( $p < 0.05$ ). Mean distribution of duration of intervention, duration of hospital stay, Bohers angle, ROM at 3 mo, ROWE's score at 3, 9 and 12 mo follow up based on the mode of treatment

**Table 5: Demonstrating duration of stay, Bohlers angle and ROWE score**

Mean±SD	Mode of treatment		p-value
	Conservative	ORIF	
Duration of intervention (Days)	NA	7.57±1.03	-
Duration of hospital stay (days)	3.12±0.99	18.94 ±1.74	0.000*
Bohlers angle	19.39±3.99	26.55±5.13	0.000*
ROM at 3 mo	20.30±6.84	31.82±17.96	0.001*
ROWE's score at 3 mo	11.06±11.57	20.00±15.71	0.011*
ROWE's score at 9 mo	71.06±13.44	77.88±11.99	0.033*
ROWE's score at 12 mo	82.58±11.25	88.33±6.80	0.014*

\*Statistically significant ( $p < 0.05$ ), The duration of stay, bohlers angle, ROM at 3 mo, ROWE's score at 3 mo, 9 mo and 12 mo shows statistically significant difference among the groups ( $p < 0.05$ ) with more duration of stay in ORIF group, greater Bohlers angle in ORIF and more ROM at 3 mo, ROWE's score at 3, 9 and 12 mo in ORIF as compared to the conservative group

## DISCUSSION

Displaced intra-articular calcaneus fractures (DIACFs) represent a source of potential disability to patients, an economic burden to society, and a treatment challenge to the average orthopedic

surgeon. While some recent research has demonstrated that there is no benefit to operational treatment, numerous other investigations have demonstrated that operative treatment produces better results. Because of the complicated bone and fracture architecture, the tenacious soft tissue envelope, and the challenges of anatomic

reduction and stiff fixation, the application of these principles to intra-articular calcaneal fracture has been gradual. Many surgeons are becoming more active in the treatment of these fractures as a result of advancements in surgical methods and complication rates [14].

As per inclusion-exclusion criteria, 66 patients were included in the study. The mean age of the patients was 36±9.47 in the conservative group and 41.85 ±11.93 in the ORIF group with 16 females and 50 males. The average patient age in our study was 36 in the conservative group and 41.85 in the ORIF group. This is consistent with the Kharat AA *et al.* [15] study, in which the patient's mean ages, which ranged from 20 to 52 y, were 35.1 y. The majority of fractures occurred in patients between the ages of 21 and 50, which can be linked to their busy lifestyles. Silva *et al.* [16] reported a mean age of 41.41 y with a range of 20-60, while Pillai *et al.* [17] recorded a mean age of 39.1 y.

No statistically significant difference between the treatment modalities based on partial weight bearing and radiological union was observed in our investigation ( $p>0.05$ ). Based on the form of therapy, there was a statistically significant difference between the two groups for full weight bearing, with ORIF bearing full weight earlier than the conservative treatment ( $p < 0.05$ ). This is consistent with research done by Tank *et al.* [18] which found that complete weight bearing began earlier in the surgical group-on average, at 13.4 w-and later in the conservative group-by 1 w. Similar findings were obtained in research by Sanders, R. *et al.* [19], where early full weight bearing was accomplished in the surgical group with a mean time of 13.3 was compared to the control group. In our investigation, there was no discernible difference between the two treatment modalities for pain at 3 mo or for work at 3 mo of follow-up ( $p>0.05$ ). At three months, 23 patients experienced discomfort when bearing weight, 41 patients experienced pain when at rest, and 2 patients' experienced mild pain during everyday activity. This is in contrast to a study by Manikandarajan *et al.* [20]. In which 5 patients had subtalar arthritis. This contradicts Tank *et al.*'s [18] study, in which the majority of patients in the conservative group had some restrictions on working at their customary vocation while the operated group had no restrictions.

At the three-month checkup, there are clear differences between the two groups' activities and gait, with more patients in the ORIF group being able to walk short distances than in the conservative group and a more severe limp in the conservative group than in the ORIF group. ( $p<0.05$ ) This is consistent with a research by Tank *et al.* [18], in which the majority of patients in the surgical group had normal gaits while 7 patients exhibited slight limps mean distribution of duration of intervention, duration of hospital stay, Bohers angle, ROM at 3 mo, ROWE's score at 3, 9 and 12 mo follow up based on the mode of treatment. The duration of stay, bohlers angle, ROM at 3 mo, ROWE's score at 3 mo, 9 mo, and 12 mo shows statistically significant differences among the groups with more duration of stay in the ORIF group, greater Bohlers angle in ORIF and more ROM at 3 mo, ROWE's score at 3, 9 and 12 mo in ORIF as compared to the conservative group.

According to Modified Rowe's score used in this study, only 6.66% of cases had satisfactory results after a year of follow-up, and the observed mean Modified Rowe's score was 87. Of the operative group, 40% had excellent scores, 53.33% of patients had good scores, and 40% had average scores. These outcomes were comparable to those of the study by S. Rammelt *et al.* [21], in which 60 to 85 percent of patients with open reduction and lateral plate fixation experienced satisfactory to excellent outcomes. At a year's follow-up, 54% of conservative group cases had satisfactory to bad outcomes, compared to 46% of good outcomes.

According to Modified Rowe's score in the Tank *et al.* [18] study, only 6.66% of cases had satisfactory outcomes at a year's follow-up, and the observed mean Modified Rowe's score was 87. Of the operative group, 40% had excellent scores, 53.33% of patients had good scores, and 40% had average scores.

## CONCLUSION

We came to the conclusion that displaced intra-articular calcaneum fractures can be treated better and more effectively with open

reduction and internal fixation with a pre-contoured calcaneum locking plate as compared to conservative treatment because calcaneum fractures are one of the common fractures affecting the current generation. As a result of adhering to the fundamental principle of anatomical reduction in intra-articular fractures, which also applies to intra-articular calcaneum fractures, early rehabilitation, fewer comorbidities, early weight bearing, and improved functional recovery are the outcomes.

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Nil

## AUTHORS CONTRIBUTIONS

All the authors have contributed equally

## CONFLICTS OF INTERESTS

Declared none

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