RESEARCH PAPER

Prospective Study of Functional Outcome of Intraarticular Fracture of Calcaneum Treated Surgically by Plating in a Tertiary Care Hospital in Chengalpattu District

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ABSTRACT

Intra-articular fractures of the calcaneum are complex hindfoot injuries that significantly affect function and quality of life. This prospective study aims to evaluate the functional outcome of displaced intra-articular calcaneal fractures treated surgically by open reduction and internal fixation with plating in a tertiary care hospital in Chengalpattu District. Adult patients meeting inclusion criteria will undergo standardized surgical management and postoperative rehabilitation. Functional outcomes will be assessed using validated scoring systems at regular follow-up intervals. Radiological parameters and complications will also be documented. The study intends to determine the effectiveness of plating in restoring anatomy and improving functional recovery in this population

Aim: To Assess Functional outcome of intraarticular fracture of calcaneum treated by plating

Objectives

Primary objective: To evaluate the functional outcome of intraarticular fracture of calcaneum treated surgically by plating

Secondary Objective: To correlate between the functional outcome with different grades of fractures according to sanders classification

Result: Thirty patients with displaced intra-articular calcaneal fractures were evaluated. The mean age was 38.5 years, with male predominance (80%). Fall from height was the commonest mechanism (60%). Sanders Grade II fractures were most frequent (46.7%). Significant radiological improvement was observed postoperatively, with mean Böhler angle improving from 9.8° to 26.2° and posterior facet step-off reducing from 4.2 mm to 1.4 mm ($p < 0.001$). Mean AOFAS scores improved from 56.3 at 6 weeks to 87.3 at 24 weeks ($p < 0.001$). Excellent to good outcomes were achieved in 76.7% of patients. Higher Sanders grade was associated with poorer functional outcome.

Conclusion: This prospective study demonstrates that open reduction and internal fixation with plating for displaced intra-articular calcaneal fractures provides significant radiological restoration and progressive functional improvement over a 24-week follow-up period. There was a statistically significant correction of Böhler angle and posterior facet step-off, which translated into satisfactory functional outcomes in the majority of patients, with 76.7% achieving excellent to good results.

Fracture severity, particularly higher Sanders grade, was associated with comparatively lower functional scores, indicating that initial fracture pattern influences prognosis. Although complications such as wound problems and subtalar stiffness were observed, they did not significantly affect overall functional outcomes.

Overall, surgical plating in a tertiary care setting proved to be an effective modality for restoring anatomy, improving function, and facilitating return to activity in patients with displaced intra-articular calcaneal fractures.

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INTRODUCTION

Fractures of the calcaneum represent a complex spectrum of hindfoot injuries that pose significant challenges in orthopaedic trauma care due to their intricate anatomy, weight-bearing role, and close association with the subtalar joint. The calcaneus is central to load transmission from the tibia to the forefoot and is essential for normal gait mechanics, balance, and shock absorption. Disruption of its articular congruity, particularly in intra-articular fractures, often leads to altered biomechanics, chronic pain, stiffness, and long-term functional impairment if not adequately addressed. These injuries are most commonly sustained following high-energy axial loading mechanisms such as falls from height or road traffic accidents and predominantly affect adults in their economically productive years, thereby amplifying their socioeconomic impact [1].

Historically, the management of intra-articular calcaneal fractures has been controversial, with debates surrounding operative versus non-operative treatment and the optimal surgical technique. Advances in imaging, surgical exposure, and implant design have progressively shifted treatment paradigms toward anatomical reduction and stable fixation using plates, aiming to restore calcaneal morphology and subtalar joint congruity [2]. Contemporary clinical studies have demonstrated that open reduction and internal fixation with plating can yield satisfactory functional outcomes when appropriate patient selection and surgical principles are followed [3]. However, variability in reported outcomes across institutions highlights the influence of fracture pattern, surgical timing, technique, and postoperative rehabilitation on recovery [4].

MATERIALS & METHODS

Study design – Prospective analytical study

Study area – Tertiary care hospital in Chengalpattu district

Study Population – This was a prospective study conducted at the Department of Orthopaedic Surgery, with patients selected from the In-Patients Department admitted to a tertiary care hospital in Chengalpattu district.

Duration – 18 months

Sample Size Calculation

Sample size calculation was based on a previous study [70]. The proportion of exposed and non-exposed groups of calcaneal fracture was 4% and 50%, respectively, with a 5% level of significance and 80% power. The total sample size was 30, including a 10% non-response rate.

Inclusion Criteria

1. Age group between 20–60 years
2. Non-diabetic patients or patients under strict glycaemic control
3. Sanders type II–IV fractures
4. Closed fractures and compound fracture grade I
5. Dislocated calcaneal fractures (posterior articular facet step-off >2 mm, significant shortening, loss of height, widening of calcaneum with decreased Böhler's angle and increased Gissane angle, valgus deviation >10 degrees, varus deviation >5 degrees)
6. Patients presenting within 3 weeks of injury
7. Patients with associated fractures

Exclusion Criteria

1. Age <20 years or >60 years
2. Severe uncontrolled diabetes mellitus / severe medical problems / severe soft-tissue injury
3. Sanders type I fractures
4. Grade II and III compound fractures
5. Associated vertebral fracture with neurological deficit
6. Non-reducible dislocation of the calcaneum requiring subtalar arthrodesis
7. Injury duration >21 days

Radiological investigations – X-ray, CT scan

Study Variables

1. Fracture pattern
2. Reducibility of fracture
3. Quality of bone
4. Age of the patient
5. Co-morbidity

Ethical Considerations

1. Institutional Ethical Committee approval was obtained prior to commencement of the study.
2. Patients gave consent for participation in the study.
3. Informed and printed consent was signed by the patients.
4. Patients were given the choice of whether to participate or not in the study.
5. Privacy and confidentiality of the patients were maintained throughout the study.

Procedure Involved
Patients with clinical suspicion of intra-articular fracture of the calcaneum presenting to the ER/OPD of the Department of Orthopaedics were evaluated.

Radiologically confirmed cases of intra-articular fracture of the calcaneum were included.

Informed consent was obtained.

Open reduction and internal fixation with plating was performed.

Patients were followed up for a minimum of 6 months post-operatively.

Statistical analysis

Data Collection
Radiologically confirmed cases of calcaneum fracture were admitted.

All cases were operated in our hospital. Patients were given the choice to become subjects in the study.

A minimum of 6 months of post-operative follow-up was ensured.

A specified post-operative protocol was followed for all patients.

Outcome was measured using the AOFAS score at intervals of 6, 12, and 24 weeks.

Radiological assessment was done at intervals of 6, 12, and 24 weeks.

Data Analysis
Data were entered systematically in MS Excel.

Continuous variables were assessed for normality of distribution using the Shapiro–Wilk test and were presented as mean ± standard deviation and range, as appropriate.

Student's *t*-test was used for comparisons of continuous variables.

Correlations between continuous variables were assessed using either the Pearson or Spearman correlation coefficient, as appropriate.

Statistical analysis was performed using SPSS software.

In all the above tests, a *p*-value of less than 0.05 was accepted as indicating statistical significance.

RESULTS

Table 1: Baseline sociodemographic profile (n=30)

Variable	Category / Summary	n (%) / Value
Age (years)	Mean ± SD	38.5 ± 9.0
	Range	20.0–53.0
Age Group	20–29	6 (20.0)
	30–39	10 (33.3)
	40–49	10 (33.3)
	50–59	4 (13.3)
Sex	M	24 (80.0)
	F	6 (20.0)
Education	Secondary/HigherSec	15 (50.0)
	Primary	11 (36.7)
	Graduate+	4 (13.3)
Occupation	ManualLabour	12 (40.0)
	Homemaker	7 (23.3)
	Service	4 (13.3)
	Student	3 (10.0)
	SkilledWorker	3 (10.0)
	Shop	1 (3.3)
Kuppuswamy SES	UpperLower	13 (43.3)
	LowerMiddle	8 (26.7)
	UpperMiddle	7 (23.3)
	Lower	2 (6.7)

Table 2. Injury characteristics at presentation (n=30)

Variable	Category	n (%)
Mode of Injury	FallHeight	18 (60.0)
	RTA	10 (33.3)
	Other	2 (6.7)
Injury Type	Closed	27 (90.0)
	Compound I	3 (10.0)
Side	Right	19 (63.3)

	Left	11 (36.7)
Associated Fractures	No	19 (63.3)
	Yes	11 (36.7)
Presentation Category	<1 week	19 (63.3)
	1–2 weeks	8 (26.7)
	2–3 weeks	3 (10.0)
Prior Injury or Surgery	No	28 (93.3)
	Yes	2 (6.7)

Table 3: Presenting symptoms / soft-tissue status (n=30)

Symptom/Sign	Category	n (%)
HeelPain	Yes	30 (100.0)
Swelling	Yes	29 (96.7)
	No	1 (3.3)
Non Weight Bearing	Yes	28 (93.3)
	No	2 (6.7)
Visible Deformity	No	15 (50.0)
	Yes	15 (50.0)
Blisters	No	24 (80.0)
	Yes	6 (20.0)

Table 4. Comorbidities / risk factors & host factors (n=30)

Variable	Category / Summary	n (%) / Value
BMI (kg/m²)	Mean ± SD	25.0 ± 2.9
	Range	20.5–31.7
Diabetes Controlled	No	27 (90.0)
	Yes	3 (10.0)
Tobacco Use	No	19 (63.3)
	Yes	11 (36.7)
Alcohol Use	No	22 (73.3)
	Yes	8 (26.7)
Bone Quality	Normal	22 (73.3)
	Osteopenic	8 (26.7)

Table 5: Baseline imaging & fracture severity profile (n=30)

Variable	Category / Summary	n (%) / Value
Sanders grade	II	14 (46.7)
	III	11 (36.7)
	IV	5 (16.7)
Fracture pattern	JointDepression	19 (63.3)
	TongueType	11 (36.7)
Lateral wall bulge	Yes	22 (73.3)
	No	8 (26.7)
Subtalar subluxation/dislocation at admission	No	20 (66.7)
	Yes	10 (33.3)
Posterior facet step-off (mm)	Mean ± SD	4.2 ± 1.4
	Range	2.3–7.3
Böhler angle (pre-op, °)	Mean ± SD	9.8 ± 5.1
	Range	1.3–22.8
Gissane angle (pre-op, °)	Mean ± SD	135.9 ± 10.6
	Range	115.4–156.8

Table 6. Sanders grade distribution (n=30)

Sanders grade	n	%
II	14	46.67
III	11	36.67
IV	5	16.67

Table 7. Peri-operative and surgical details of ORIF plating (n=30)

Variable	Category / Summary	n (%) / Value
Time injury to surgery (days)	Mean ± SD	6.2 ± 2.7
	Range	2.0–10.0
Operative time (min)	Mean ± SD	97.2 ± 17.5
	Range	60.0–139.0
Blood loss (mL)	Mean ± SD	141.3 ± 55.8
	Range	51.0–285.0
Hospital stay (days)	Mean ± SD	8.0 ± 2.5
	Range	3.0–14.0
Surgical approach	ExtensileLateral	22 (73.3)
	Limited/Other	8 (26.7)
Bone graft used	No	21 (70.0)
	Yes	9 (30.0)
Reducibility	Good	24 (80.0)
	Difficult	6 (20.0)

Table 8. Pre-op vs post-op radiological correction (paired analysis)

Parameter	Pre-op (mean ± SD)	Post-op (mean ± SD)	Change (mean ± SD)	Test	p-value
Böhler angle (°)	9.8 ± 5.1	26.2 ± 5.9	16.5 ± 7.1	Paired t-test	<0.001
Posterior facet step-off (mm)	4.2 ± 1.4	1.4 ± 0.8	2.8 ± 1.6	Paired t-test	<0.001

Table 9. AOFAS scores over follow-up (6w, 12w, 24w)

Time point	Mean ± SD	Median (IQR)	Range
AOFAS (6 weeks)	56.3 ± 8.4	57.5 (51.0–62.0)	37.0–72.0
AOFAS (12 weeks)	74.7 ± 8.6	76.0 (69.0–80.0)	55.0–91.0
AOFAS (24 weeks)	87.3 ± 8.6	89.0 (82.0–93.0)	66.0–100.0

Overall change across timepoints: Friedman test p-value <0.001.

Table 10. Functional outcome categories at 24 weeks (AOFAS)

Category	n	%
Excellent	12	40.0
Good	11	36.7
Fair	6	20.0
Poor	1	3.3

Table 11. Patient-centred recovery at 24 weeks

Variable	Category / Summary	n (%) / Value
Returned to pre-injury job (24w)	Yes	16 (53.3)
	No	14 (46.7)
Satisfaction score (0–10)	Mean ± SD	7.3 ± 1.3
	Range	4.0–10.0

Table 12. AOFAS 24 weeks by Sanders grade (Objective-2)

Sanders grade	n	Mean ± SD (AOFAS 24w)	Median (IQR)
II	14	91.1 ± 6.7	92.0 (88.0–96.0)
III	11	86.5 ± 7.8	87.0 (83.0–92.0)
IV	5	78.0 ± 8.2	79.0 (74.0–84.0)

Between-grade comparison: Kruskal–Wallis p-value 0.014.

Table 13. AOFAS trajectory by Sanders grade

Sanders grade	AOFAS 6w (mean ± SD)	AOFAS 12w (mean ± SD)	AOFAS 24w (mean ± SD)
II	58.9 ± 7.6	77.9 ± 8.3	91.1 ± 6.7
III	54.7 ± 8.3	71.9 ± 8.5	86.5 ± 7.8
IV	48.6 ± 8.9	67.2 ± 5.8	78.0 ± 8.2

Between-grade p-values: 6w = 0.081, 12w = 0.032, 24w = 0.014.

Table 14. Correlation of severity / timing with outcomes (Spearman)

Predictor	Outcome	Spearman r	p-value	n
Posterior facet step-off (mm)	AOFAS 24w	-0.286	0.125	30
Posterior facet step-off (mm)	Satisfaction (0–10)	-0.233	0.216	30
Böhler angle pre-op (°)	AOFAS 24w	0.116	0.540	30
Böhler angle pre-op (°)	Satisfaction (0–10)	0.340	0.066	30
Gissane angle pre-op (°)	AOFAS 24w	-0.252	0.179	30
Gissane angle pre-op (°)	Satisfaction (0–10)	-0.241	0.200	30
Time injury→surgery (days)	AOFAS 24w	-0.226	0.230	30
Time injury→surgery (days)	Satisfaction (0–10)	-0.281	0.133	30

Table 15. Early and late complication profile

Complication	Yes n	Yes %	No n	No %
Wound Complication (6w)	3	10.0	27	90.0
Sural Paraesthesia (6w)	2	6.7	28	93.3
DVT PE (6w)	1	3.3	29	96.7
Hardware Irritation (24w)	3	10.0	27	90.0
Subtalar Stiffness Pain (24w)	7	23.3	23	76.7
Subtalar Arthrosis Early (24w)	5	16.7	25	83.3

Table 16. Functional impact of complications (any complication vs none)

Outcome	No complication (mean ± SD)	Any complication (mean ± SD)	Test	p-value
AOFAS 24w	88.4 ± 7.1	86.3 ± 9.7	Mann–Whitney U	0.573
Satisfaction (0–10)	7.5 ± 1.5	7.1 ± 1.3	Mann–Whitney U	0.416

Table 17. Univariable predictors of poor 24-week outcome (Fair/Poor AOFAS category)

Predictor	Unadjusted OR	95% CI	p-value	n
Sanders grade (per grade increase)	4.39	1.15–16.70	0.030	30
Posterior facet step-off (mm)	1.11	0.60–2.08	0.736	30
Blisters present	5.00	0.73–34.35	0.102	30
Diabetes (controlled)	8.80	0.66–117.24	0.100	30
Tobacco use	0.62	0.10–3.92	0.614	30
Osteopenic bone quality	1.13	0.17–7.47	0.896	30
Time injury→surgery (days)	1.43	0.95–2.13	0.084	30
Difficult reducibility	5.00	0.73–34.35	0.102	30
Bone graft used	2.13	0.36–12.39	0.402	30

Table 18. Multivariable model for poor outcome (parsimonious; n=30)

Predictor	Adjusted OR	95% CI (low)	95% CI (high)	p-value
Sanders_num	3.15	0.71	13.95	0.130
Time Injury To Surgery (days)	1.32	0.88	1.99	0.184
Blisters_yes	3.28	0.32	33.32	0.315

DISCUSSION

In this prospective study, surgical management of displaced intra-articular calcaneal fractures with open reduction and internal fixation using plating demonstrated significant radiological and functional improvement over a 24-week follow-up. The study population predominantly consisted of young to middle-aged males, reflecting the typical demographic affected by high-energy axial loading injuries such as falls from height and road traffic accidents. Restoration of calcaneal anatomy, particularly Böhler angle and posterior facet congruity, was achieved with statistical significance, indicating effective reduction and fixation.

Functional outcomes improved progressively across follow-up intervals, with the majority of patients achieving excellent to good AOFAS scores at 24 weeks. These findings support the principle that anatomical reduction of the subtalar joint correlates with better functional recovery. However, patients with higher Sanders grades demonstrated relatively lower functional scores, highlighting the influence of fracture severity on prognosis. Although early and late complications such as wound issues, hardware irritation, and subtalar stiffness were observed, they did not significantly impact overall functional outcomes.

The results emphasize that careful patient selection, meticulous soft tissue handling, and timely surgical

intervention are critical determinants of success. Overall, plating remains a reliable option for managing displaced intra-articular calcaneal fractures in tertiary care settings.

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