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Original Research Article

Radiographic and functional outcome of operated closed intra-articular fractures of calcaneum: a retrospective analysis

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ABSTRACT

Background: The present study aims to analyse the results of surgical outcome of the operated calcaneal fractures using either plates or cannulated cancellous screws. Recently there has been considerable shift of treatment of calcaneal fractures from conservative to operative owing to better understanding of fracture pattern. However, reduction of long-term functional outcome of such patients is always questionable and remains unanswered.
Methods: A 25 fractures were operated with locking plates or cannulated screws after proper assessment. Functional assessment was done using AOFAS scoring system. Radiological outcome was assessed using restoration of Bohler and Gissane angle.
Results: The results were extrapolated as excellent in 20 patients, good in 3 patient's and poor result in 2 patients. Statistical analysis revealed better outcomes in percutaneous cannulated screw fixation as compared to open plate fixation. 6 patients had to undergo implant exit of which 5 were cannulated screw backout, prominence irritating the soft tissue and 1 plate removal had to be done because of infection. None of the patients had subtalar arthritis, heel pad problems, peroneal tendinitis or implant failure.
Conclusions: Surgical management in the treatment of choice for intra articular calcaneal fractures after thorough evaluation. The choice of implant depends upon the communition of fracture, soft tissue compromise, joint surface incongruity and surgical expertise. Radiological maintenance of Bohler and Gissane angle intraoperatively and at follow up is a good indicator for predicting functional outcomes score.

Keywords: Calcaneum fracture, Intra-articular fracture, Screw vs plate, Communited fracture

INTRODUCTION

Calcaneal fractures account for 2% of all skeletal injuries. Accounting for 60%, it is the most common tarsal bone fracture.[1-5] It often occurs following high energy trauma including fall from altitude or high velocity automobile accident.[2-4] 75% of the fracture of calcaneum are intra-articular.[1,2,4] The vertical violence following axial loading leads to displaced intra-articular calcaneal fracture (DIACF) along with fractures of spine in 10% and other fractures seen 25% of cases.[2] These are more common in middle aged male as they are mainly involved in heavy works.[1-3,6] There has been an increasing incidence of calcaneal fractures, owing to technological advancements leading to the occupational and road traffic accidents.[1] They also impose significantly economic burden as nearly 20% patients are incapacitated for 3-5 years.

Treatment modalities include conservative and operative (percutaneous, mini open and open) procedure with an aim to achieve congruity of subtalar and calcaneocuboid joints and restore calcaneal height, heel width, and avoid varus.

Undisplaced fractures are treated conservatively with immobilisation and non-weight bearing. This can lead to a painful, stiff foot due to delayed reconstruction of

malunited fracture and might require secondary arthrodesis.[6-8]

Literature has evidence that operative management of calcaneum fracture gives better functional outcome scores and a less painful feet, yet at a cost of increased chances of surgical site infection (SSI) and delayed wound healing.[6,8] The results of percutaneous versus open reduction and internal fixation remains controversial.[3,6] The aim of current study was to observe the outcome of operatively managed calcaneal fractures at our institution, a tertiary care centre and add our experience to the existing database.

METHODS

The current study was performed at Tata Main hospital, Jamshedpur, a tertiary care centre of a tier 2 city involving 25 patients of calcaneum fracture operated during June 2016 to March 2020. This retrospective observational study acquired and analysed data from the hospital management system (HMS) after taking clearance from the institutional ethics committee. The data was analysed for age and sex of the patient, fracture geometry on CT scan, date of surgery, laterality, classification of fracture, surgical procedure performed, telephone number and follow up in outpatient department. The X-rays were recorded for implants used, any migration or loosening during follow ups and union achieved. The patients who were admitted with calcaneum intraarticular fractures but managed conservatively or who did not opt for surgery were excluded from the study. The other exclusion criteria were bilateral calcaneal fractures, open fractures and extraarticular fractures of calcaneum. The patients who didn't follow up regularly were reached out telephonically to assess the functional score and if any implant removal was done. The patients who could not be followed up were also excluded from the study.

The data acquired was entered in statistical package for social science (SPSS) version 23 (IBM Corp Armonk NY USA). A p< or equal 0.05 was considered significant.

Figure 1: Lateral view with fracture.

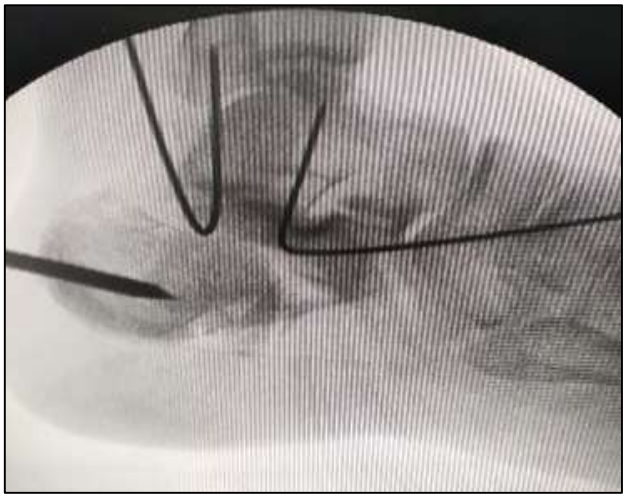

Figure 2: Plating intraoperative steps.

Figure 3: Plating intraoperative steps.

Figure 4: Plating intraoperative steps.

Figure 5: Plating intraoperative steps.

Figure 6: Case 2 pre operative X ray.

Figure 7: Case 2 pre operative X ray.

Figure 8: CT scan.

Figure 9: Immediate post op X ray.

Figure 10: Six month follow up X ray.

RESULTS

This retrospective observational study included 25 patients of which 18 (72%) males which was significant (p=0.046) with slight propensity of left (56%) sided involvement. There was no significant difference in age groups of below and above 40 years of age (p=0.761). 11 patients had a history of fall from stairs, 3 had a h/o direct blow while other 11 patient fell from stairs. No statistical significance regarding mechanism of injury. Sander's type 2A (24%) and 2C (24%) fractures were most common fractures but had no statistical significance (p=0.078). Mean Bohler and Gissane angle 29.08±3.95 and 125.76±5.30 degrees resp. There no statistical significance regarding these angles.

Mean follow up period 44.40±15.25 months ranging from 18-72 months. Overall mean AOFAS score 94±5.51 (95% CI, 79-100), with 20 "excellent" (80%), 3 "good" (12%), and 2 "poor" (8%) results. There was no significant difference in functional outcome of patients treated with CC screw/plates (p=0.658). Implant removal was needed in 6 out of 25 patients. Mean duration of these implant removal surgery from index procedure 19.44±15.07 months (range 5-52 months). There was no significant difference in this duration between 2 surgical modalities (p=0.387).

Table 1: Demographical analysis: continuous variables.

Name of variables, (n=25)	Mean (SD)	Range (Min, Max)
Age (In years)	48.92 (13.83)	53 (26, 79)
Follow up duration in months	44.40 (15.25)	54 (18, 72)
AOFAS	94.00 (5.51)	21 (79, 100)
Implant removed duration in months	19.44 (15.07)	47 (5, 52)
Bohler angle	29.08 (3.95)	16 (20, 36)
Gissane angle	125.76 (5.30)	20 (116, 136)

Table 2: Comparison of continuous variables with implant.

Name of variables, (n=25)	Implant, (n=25), mean (SD)				P value
	CC left, (n=06)	CC right, (n=09)	Plate left, (n=08)	Plate right, (n=02)	
Age (In years)	49.17 (14.66)	47.00 (14.82)	52.63 (14.72)	42.00 (0.00)	0.783
Follow up (Months)	35.50 (12.99)	49.44 (16.56)	47.13 (15.52)	37.50 (0.71)	0.410
AOFAS	95.00 (5.48)	92.89 (4.17)	93.50 (7.45)	98.00 (0.00)	0.658
Implant removed duration (Months)	26.00 (16.96)	13.00 (8.54)	6.00 (0.00)	(0.00, 0.00)	0.387
Bohler angle	28.67 (2.42)	27.67 (2.83)	30.13 (5.56)	32.50 (3.54)	0.082
Gissane angle	126.67 (5.88)	123.78 (3.80)	126.00 (6.23)	131.00 (4.24)	0.485

Table 3: Demographical analysis: categorical variables.

Name of variables, (n=25)	Name of grouping variables	N (%)
Age (In years)	≤40	8 (32.0)
	>40	17 (68.0)
Sex	Female	7 (28.0)
	Male	18 (72.0)
Implant	CC left	6 (24.0)
	CC right	9 (36.0)
	Plate left	8 (32.0)
	Plate right	2 (8.0)
Implant removed	Yes	10 (40.0)
	No	15 (60.0)
Associated fractures	Calcaneum	18 (72.0)
	DER+ calcaneum	2 (8.0)
	Ileum+ calcaneum	1 (4.0)
	L2+ calcaneum	1 (4.0)
	L3+ calcaneum	1 (4.0)
	Lateral mal+ calcaneum	1 (4.0)
	Olec+ calcaneum	1 (4.0)
MOI	DB	3 (12.0)
	FFH	11 (44.0)
	FFS	11 (44.0)

Continued.

Name of variables, (n=25)	Name of grouping variables	N (%)
Sanders	2A	6 (24.0)
	2B	4 (16.0)
	2C	6 (24.0)
	3AB	4 (16.0)
	3AC	5 (20.0)

Table 4: Comparison of continuous variables with implant.

Name of variables, (n=25)	Name of grouping variables	Implant, (n=25)				P value
		CC left, (n=06) (%)	CC right, (n=09) (%)	Plate left, (n=08) (%)	Plate right, (n=02) (%)	
Age (In years)	≤40	2 (33.3)	4 (44.4)	2 (25.0)	0 (0.0)	0.761
	>40	4 (66.7)	5 (55.6)	6 (75.0)	2 (100.0)	
Sex	Female	2 (33.3)	5 (55.6)	0 (0.0)	0 (0.0)	0.046
	Male	4 (66.7)	4 (44.4)	8 (100.0)	2 (100.0)	
Implant removed	Yes	5 (83.3)	3 (33.3)	2 (25.0)	0 (0.0)	0.093
	No	1 (16.7)	6 (66.7)	6 (75.0)	2 (100.0)	
Associated fractures	calcaneum	4 (66.7)	5 (55.6)	7 (87.5)	2 (100.0)	0.854
	DER+ calcaneum	1 (16.7)	0 (0.00)	1 (12.5)	0 (0.00)	
	Ileum+ calcaneum	0 (0.00)	1 (11.1)	0 (0.00)	0 (0.00)	
	L2+ calcaneum	0 (0.00)	1 (11.1)	0 (0.00)	0 (0.00)	
	L3+ calcaneum	0 (0.00)	1 (11.1)	0 (0.00)	0 (0.00)	
	Lateral mal+ calcaneum	0 (0.00)	1 (11.1)	0 (0.00)	0 (0.00)	
	Olec+ calcaneum	1 (16.7)	0 (0.00)	0 (0.00)	0 (0.00)	
MOI	DB	2 (33.3)	1 (11.1)	0 (0.00)	0 (0.00)	0.289
	FFH	1 (16.7)	5 (55.6)	3 (37.5)	2 (100.0)	
	FFS	3 (50.0)	3 (33.3)	5 (62.5)	0 (0.00)	
Sanders classification	2A	1 (16.7)	2 (22.2)	3 (37.5)	0 (0.0)	0.078
	2B	1 (16.7)	0 (0.0)	3 (37.5)	0 (0.0)	
	2C	2 (33.3)	2 (22.2)	2 (25.0)	0 (0.0)	
	3AB	2 (33.3)	2 (22.2)	0 (0.0)	0 (0.0)	
	3AC	0 (0.0)	3 (33.3)	0 (0.0)	2 (100.0)	

DISCUSSION

Calcaneum has a unique anatomy of having a cortical shell with varied cortical thickenings and having both compressive and tensile areas.[17] The "neutral triangle" found in the anterolateral region remains the weakest zone of the bone, predisposing to injury. Satisfactory fixation of these fractures is widely based on recreating a congruous joint surface and bony alignment. Ideal fixation technique remains a hot cake for the anticipated spectrum of complications.

The newly designed variable angle locking plates are superior to the previous non-locking plates.[20] These plates are contoured according to the lateral wall of the calcaneum. The reduction needs to be perfect anatomically, for the plate to be contoured on the calcaneum surface. Locking plate fixation aims at providing raft support to the condensed areas, mainly, just inferior to the calcaneocuboid joint.[18] Locking plate provides a rigid construct and good pull-out strength. These plates can even negate the use of bone graft, even in osteoporotic bone.[19] With the locking screw placed at the bony condensations, holding the reduction in place, the need for fluoroscopy is significantly reduced. There however is high risk of soft tissue complications compared to percutaneous or minimally invasive techniques.

CC screws provide minimal soft tissue handling and similar functional outcome if done with precision and expertise. Screw placement is a challenge owing to the peculiar anatomy of the bone. CT scan becomes detrimental in deciding the entry, direction, length, and the area of purchase of these screws. They are used both as compressive and as a strut screw to achieve compression and maintaining reduction respectively. Screws however should be counter sunk in the bone and screw placement should be avoided from the heel, caudo-cephalic, to minimise irritation and difficulty while mobilisation. Biomechanical studies have confirmed safe bony corridors for these screw placements.[13,14] This procedure is technically demanding and has a learning curve but has definite advantages of lesser blood loss, decreased hospital stay, better soft tissue handling and lesser complication rates.

These are usually associated with compromised functional outcome and impose a financial burden due to longer

return to work duration. Apart from the usual complications of any fracture fixation calcaneum is notorious for high incidence of skin complications and sab talar arthritis.[11] Studies have revealed a 70-100% incidence of subtalar arthritis in the long term follow up.[9-11] Some authors resort to subtalar fusion due to counter this dreaded complication.[12] Our study concluded no significant difference between the two techniques. There were more implant removals with CC screws but statistically insignificant.

However, the study was conducted at a single centre and retrospective analysis was done. Over a period of 5 years, only 25 patients met the required inclusion criteria which also confirms the rarity of these fractures. A longer period of study with a larger population or a multicentric study is suggested.

CONCLUSION

There seems to be no functional difference between the functional outcome of both the procedures and choice of fixation should rely with the surgeon depending on the soft tissue condition, the fracture geometry, and the expertise of the surgeon. Various studies have been reported and confirmed on cadaveric studies, that there is no biomechanical advantage of one procedure over another. Our study was not less of limitations. Reconstruction of Bohler angle was only taken as an indicator of fracture reduction and post operative CT scan was not done, also the sample size was small.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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