

Clinico-Radiological Profile and Patient-Reported Outcomes of Patients with Intraarticular Calcaneal Fractures Treated SurgicallyGaurav Prakash¹, Vishal Kumar², Rishabh Kumar Singh³¹Assistant Professor, Department of Orthopedics, Sree Narayan Medical Institute and Hospital, Saharsa, Bihar, India²Senior Resident, Department of Orthopedics, Jakir Hossain Medical College and Research Institute, Raghunathganj, Murshidabad, West Bengal, India,³Senior Resident, Department of Orthopedics, Sree Narayan Medical Institute and Hospital, Saharsa, Bihar, India

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Conflict of interest: Nil

Abstract**Aim:** The aim of the present study was to evaluate the radiological, clinical and patient-reported outcomes of patients with intraarticular calcaneal fractures treated surgically.**Methods:** The Present study was single-center, prospective and observational study, conducted in patients of calcaneal fracture at Department of Orthopedics, Sree Narayan Medical Institute and Hospital, Saharsa, Bihar, India. Study duration was of 1 year. In present study 44 patients (50 calcaneal fracture) were operated and follow up was taken till 12 months postoperatively.**Results:** Mean age in present study was 44.6 ± 14.46 years. Male cases (72.72%) were more than female cases (27.28%). Most of fractures were Sander's type 2 (84%). Most fractures were unilateral (81.81%) as compared to bilateral 10 (22.79%). Associated injuries were noted in 36.6% cases. Mean time till surgery was 5.5 ± 1.3 days and average duration of hospital stay 8.2 ± 3.7 days. In present study 10% cases had pre-operative Bohler's angle $\geq 20^\circ$ and 90% cases had pre-operative Bohler's angle $< 20^\circ$. Excellent AOFAS (American Orthopedic Foot and Ankle Society) score was noted at 18 months post-op in majority of patients. No statistically significant difference was noted in AOFAS score among two groups. All mager grade 0 and 1 was noted in majority of patients from both groups. No statistically significant difference was noted among two groups. We compared pre-operative and post-operative Bohler's angle, at 18 months post-op follow up. In cases with Pre-operative Bohler's angle $\geq 20^\circ$, Post-operative Bohler's angle 25–29° was noted in 80% cases. While in cases with Pre-operative Bohler's angle $< 20^\circ$, post-operative Bohler's angle 25–29° was noted in 84.44% cases and statistically significant difference was noted among two groups.**Conclusion:** Surgical management of calcaneal fracture by open reduction with internal fixation is the ideal treatment for joint depression type and Sanders Type II/III fractures and had a good outcome in short-term follow-up.**Keywords:** Calcaneal Fracture, Operative Management, Displaced Intra-Articular Calcaneal Fractures (DIACFs), ORIF.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Calcaneal fractures involving the heel bone represent a complex orthopaedic challenge due to the intricate anatomy and the pivotal role of the calcaneus in weight-bearing. Typically resulting from high-energy trauma such as falls from height or motor vehicle accidents, these fractures can significantly impact a patient's quality of life. The calcaneus is a critical component of the foot's arch and is crucial in maintaining stability during ambulation. Understanding the nuances of calcaneal fractures is paramount for clinicians involved in their management. [1]

The annual incidence of calcaneal fractures is approximately 11.5 per 100,000 individuals, with a significantly higher occurrence in males (16.5 per 100,000) than females. Falls from a height are the most common cause of calcaneal fractures, accounting for approximately 47.5% of cases. Calcaneal fractures are relatively uncommon, comprising 1 to 2% of all fractures. [2] Effective management of calcaneal fractures is imperative to mitigate complications and ensure optimal functional outcomes. The intricate interplay of subtalar joint function, soft tissue integrity, and the complex anatomy of the

calcaneus necessitates a comprehensive approach. Neglected or improperly managed calcaneal fractures can lead to persistent pain, altered gait, and long-term disability. Hence, a nuanced understanding of surgical and non-surgical interventions is crucial for healthcare professionals treating calcaneal fractures. [2]

The impact force generated upon landing can exert substantial pressure on the calcaneus, resulting in fractures. Individuals involved in occupations or activities that require working at heights face an increased risk, making fall prevention measures and safety protocols crucial in mitigating such incidents. [3] In the context of motor vehicle accidents, collisions can have severe implications for the calcaneus, especially when the foot experiences direct impact or crushing forces. High-speed accidents amplify the trauma, leading to fractures. Understanding the dynamics of these accidents and implementing preventive measures, such as proper vehicle safety features and awareness campaigns, becomes essential in reducing the incidence of calcaneal fractures in these scenarios. [4]

Treatment is based on the characteristics of the fracture and associated injuries, as well as on the local soft tissue conditions. [5,6] Re-establishment of the normal anatomy is correlated with the good functional outcome. [6,7] Conservative treatment is usually indicated for extra-articular injuries or in those with small intra-articular involvement, with little or no deviation. The presence of severe joint involvement, significant deviation, and compound lesions are indications for surgery. The UK heel fracture trial was a large pragmatic randomized controlled trial in the National Health Service conducted in an attempt to find an answer to the above question. [8] It was concluded that operative treatment did not provide symptomatic or functional advantage over nonoperative treatment after two years and the risk of complications was higher after surgery.

The aim of the present study was to evaluate the radiological, clinical and patient-reported outcomes of patients with intra-articular calcaneal fractures treated surgically.

Materials and Methods

The Present study was single-center, prospective and observational study, conducted in patients of calcaneal fracture at Department of Orthopedics, Sree Narayan Medical Institute and Hospital, Saharsa, Bihar, India. Study duration was of 1 year. In present study 44 patients (50 calcaneal fracture) were operated and follow up was taken till 12 months postoperatively.

Inclusion Criteria

Patients of age >20 years, of either sex, with displaced intra-articular fractures with minimal or

no soft tissue compromise/swelling at the time of surgery, underwent surgical treatment with minimum follow-up of 12 months.

Exclusion Criteria

- Calcaneal fractures which were open, extra-articular,
- Calcaneal fractures associated with other significant injuries
- Calcaneal fractures older than 10 days, pathological fractures
- Lost to follow up
- Not willing to participate

Written informed consent was taken from each of the patients after explaining the surgical procedure and other treatment modalities for similar fracture patterns. Patients underwent detailed history taking and examination. Initially conservative treatment was provided for average 7 days to allow soft-tissue swelling to resolve enough for the skin to wrinkle. Till then appropriate preoperative investigations, assessment of Bohler's angle and width of calcaneum were done, and patients were put up for operation after proper anaesthetic check-up and counselling. All patients underwent open reduction and internal fixation with screws, operated in lateral decubitus/prone position under spinal/general anaesthesia. Indirect reduction achieved by closed method using bilateral JESS distractors, often with an elevation of depressed fragment by small lateral window. Internal fixation with 3 or more cannulated hip screws given percutaneously in posterior to anterior direction and occasional mediolaterally. Distractors were removed after the procedure.

Limb kept elevated in POP below knee back slab till subsidence of pain and edema, usually 10–12 days. Vigorous ankle mobilization exercise was started. Non-weight bearing crutch walking or protected weight bearing in a synthetic cast was started after 3 weeks post-operative and continued for the next 6 weeks. Cast removed and partial weight bearing crutch walking upto radiological or clinical evidence of fracture healing- then gradually full weight bearing along with physiotherapy. Patients were evaluated by a unified scoring system, the American Orthopedic Foot and Ankle Society (AOFAS) clinical rating system, the ankle hindfoot scale for the calcaneal area, and all macter grading for subtalar arthrosis.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Difference of proportions between qualitative variables was tested using chi-square test or Fisher exact test as applicable. P-value less than 0.5 were considered as statistically significant.

Results

Table 1: Demographic data

Parameters	No. of cases (Percentage) / Mean \pm SD
Age (in years)	44.6 \pm 14.46
Gender (N=44)	
Male	32 (72.72)
Female	12 (27.28)
Sander's type (N=50)	
Type 2	42 (84)
Type 3	8 (16)
Fracture site (N=44)	
Unilateral	36 (81.81)
Bilateral	10 (22.79)
Other factors	
Associated injuries	16 (36.36)
Time till surgery (in days)	5.5 \pm 1.3
Duration of hospital stay (in days)	8.2 \pm 3.7

Mean age in present study was 44.6 \pm 14.46 years. Male cases (72.72%) were more than female cases (27.28%). Most of fractures were Sander's type 2 (84%). Most fractures were unilateral (81.81%) as

compared to bilateral 10 (22.79%). Associated injuries were noted in 36.6% cases. Mean time till surgery was 5.5 \pm 1.3 days and average duration of hospital stay 8.2 \pm 3.7 days.

Table 2: Distribution according to pre-operative Bohler's angle and AOFAS score

Pre-operative Bohler's angle	AOFAS (American Orthopedic Foot and Ankle Society) score (at 12 months post-op)			
	Excellent	Good	Fair	Poor
Pre-operative Bohler's angle $\geq 20^\circ$ (n=5)	4	1	0	0
Pre-operative Bohler's angle $< 20^\circ$ (n=45)	35	10	0	0

In present study 10% cases had pre-operative Bohler's angle $\geq 20^\circ$ and 90% cases had pre-operative Bohler's angle $< 20^\circ$. Excellent AOFAS (American Orthopedic Foot and Ankle Society)

score was noted at 12 months post-op in majority of patients. No statistically significant difference was noted in AOFAS score among two groups.

Table 3: All macher grade in respect of pre-operative Bohler's angle

Pre-operative Bohler's angle	All macher grade				
	0	1	2	3	4
Pre-operative Bohler's angle $\geq 20^\circ$ (n=5)	4	1	0	0	0
Pre-operative Bohler's angle $< 20^\circ$ (n=45)	30	7	6	2	0

All macher grade 0 and 1 was noted in majority of patients from both groups. No statistically significant difference was noted among two groups.

Table 4: According to pre-operative and post-operative Bohler's angle

Pre-operative Bohler's angle	Post-operative Bohler's angle 20–24°	Post-operative Bohler's angle 25–29°
Pre-operative Bohler's angle $\geq 20^\circ$ (n=5)	1	4
Pre-operative Bohler's angle $< 20^\circ$ (n=45)	7	38

We compared pre-operative and post-operative Bohler's angle, at 12 months post-op follow up. In cases with Pre-operative Bohler's angle $\geq 20^\circ$, Post-operative Bohler's angle 25–29° was noted in 80%

cases. While in cases with Pre-operative Bohler's angle $< 20^\circ$, post-operative Bohler's angle 25–29° was noted in 84.44% cases and statistically significant difference was noted among two groups.

Table 5: Postoperative Complications

Postoperative Complications	N%
Heel pain	16 (32)
Stiffness	5 (10)
Wound infection	4 (8)
Gait abnormality	3 (6)
Plaster sores	1 (2)

In present study post-op complications noted were heel pain (32%), stiffness (10%), Wound infection (8%), Gait abnormality (6%) and Plaster sores (2%). All complications were managed conservatively.

Discussion

The Calcaneus, also called the heel bone, is a large bone that forms the foundation of the rear part of the foot. Calcaneal fractures are rare and account for about 1 – 2% of all fractures occurring in the human body and 60% of all tarsal bones' injuries. [9] Particularly, intra-articular fractures account for approximately 75% of calcaneal fractures and historically have been associated with poor functional outcome. [10] These fractures are uniformly caused by an axial load mechanism, such as a fall or a motor vehicle accident, and may be associated with other axial load injuries, such as lumbar, pelvic, and tibial plateau fractures. [15] Subtalar joint stiffness and arthritis, heel widening, peroneal impingement, implant-related problems and heel pad pain are the potential complications. [11] No treatment, conservative treatment, open reduction and internal fixation, primary subtalar arthrodesis, delayed primary arthrodesis and calcaneotomy are treatment options in the literature. [12]

Mean age in present study was 44.6 ± 14.46 years. Male cases (72.72%) were more than female cases (27.28%). Most fractures occurred in young male patients (84.6%), with a mean age of 36.8 years, similar to that observed in the literature. [6,13] Most of fractures were Sander's type 2 (84%). Most fractures were unilateral (81.81%) as compared to bilateral 10 (22.79%). As the studies suggest, bilateral calcaneal fractures tend to present greater Böhler angle decrease and higher rates of complications, associated injuries, and worse outcomes when compared with unilateral lesions. [14,15] Associated injuries were noted in 36.6% cases. Data on associated injuries are divergent among the studies; some show high prevalence, [16] while others show figures with little significance. [17] Mean time till surgery was 5.5 ± 1.3 days and average duration of hospital stay 8.2 ± 3.7 days.

In present study 10% cases had pre-operative Bohler's angle $\geq 20^\circ$ and 90% cases had pre-operative Bohler's angle $< 20^\circ$. Excellent AOFAS (American Orthopedic Foot and Ankle Society) score was noted at 12 months post-op in majority of patients. No statistically significant

difference was noted in AOFAS score among two groups. In study by Mukherjee D et al [18] 80% achieved excellent results, whereas 20% achieved good results functionally according to the AOFAS scale. Allmacher grade 0 and 1 was noted in majority of patients from both groups. No statistically significant difference was noted among two groups. We compared pre-operative and post-operative Bohler's angle, at 12 months post-op follow up. In cases with Pre-operative Bohler's angle $\geq 20^\circ$, Post-operative Bohler's angle $25-29^\circ$ was noted in 80% cases. While in cases with Pre-operative Bohler's angle $< 20^\circ$, post-operative Bohler's angle $25-29^\circ$ was noted in 84.44% cases and statistically significant difference was noted among two groups.

Superficial wound infection was seen in two patients, but no patients required a revision surgery. [19] It is also well established that pre existing comorbidities such as peripheral vascular disease, diabetes and smoking adversely affect wound healing following operative management. [20] In present study post-op complications noted were heel pain (32%), stiffness (10%), Wound infection (8%), Gait abnormality (6%) and Plaster sores (2%). All complications were managed conservatively. The treatment of calcaneal fractures must be planned according to different factors such as type of trauma, classification of the fracture, skin condition and injury mechanism. Good evaluation, preoperative planning and appropriate treatment bring out better results. [21]

Conclusion

Surgical management of calcaneal fracture by open reduction with internal fixation is the ideal treatment for joint depression type and Sanders Type II/III fractures and had a good outcome in short-term follow-up.

References

1. Davis D, Seaman TJ, Newton EJ. Calcaneus Fractures. 2023 Jul 31. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–.
2. Guerado E, Bertrand ML, Cano JR. Management of calcaneal fractures: what have we learnt over the years? *Injury*. 2012 Oct;43 (10) :1640-50.
3. Galluzzo M, Greco F, Pietragalla M, De Renzis A, Carbone M, Zappia M, Maggialetti N, D'andrea A, Caracchini G, Miele V. Calcaneal

- fractures: radiological and CT evaluation and classification systems. *Acta Biomed.* 2018 Jan 19;89(1-S):138-150.
4. Benson E, Conroy C, Hoyt DB, Eastman AB, Pacyna S, Smith J, Kennedy F, Velky T, Sise M. Calcaneal fractures in occupants involved in severe frontal motor vehicle crashes. *Accid Anal Prev.* 2007 Jul;39(4):794-9.
 5. Worsham JR, Elliott MR, Harris AM. Open calcaneus fractures and associated injuries. *J Foot Ankle Surg.* 2016;55(1):68-71.
 6. Sharr PJ, Mangupli MM, Winson IG, Buckley RE. Current management options for displaced intra-articular calcaneal fractures: non-operative. ORIF, minimally invasive reduction and fixation or primary ORIF and subtalar arthrodesis. A contemporary review. *Foot Ankle Surg.* 2016;22(1):1-8.
 7. Zhang W, Chen E, Xue D, Yin H, Pan Z. Risk factors for wound complications of closed calcaneal fractures after surgery: a systematic review and meta-analysis. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine.* 2015 Dec;23(1):1-1.
 8. Griffin D, Parsons N, Shaw E, Kulikov Y, Hutchinson C, Thorogood M, Lamb SE. Operative versus non-operative treatment for closed, displaced, intra-articular fractures of the calcaneus: randomised controlled trial. *Bmj.* 2014 Jul 24;349.
 9. Meng Q, Wang Q, Wu X, Peng A, Yan J. Clinical application of the sinus tarsi approach in the treatment of intra-articular calcaneal fracture. *Medicine.* 2018 Mar;97(13).
 10. Zwipp H, Rammelt S, Barthel S. Fracture of the calcaneus. *Der Unfallchirurg.* 2005 Sep;108:737-48.
 11. Lim EA, Leung JP. Complications of intra-articular calcaneal fracture. *Clin Orthop Rel Res* 2001; 391:7-16.
 12. Dhillon MS, Bali K, Prabhakar S. Controversies in calcaneus fracture management: a systematic review of the literature. *Musculoskelet Surg* 2011, 95: 171-181.
 13. Jain S, Jain AK, Kumar I (2013) Outcome of open reduction and internal fixation of intra-articular calcaneal fracture fixed with locking calcaneal plate. *Chin J Traumatol* 16: 355-360.
 14. Mitchell MJ, McKinley JC, Robinson CM. The epidemiology of calcaneal fractures. *Foot.* 2009;19(4):197-200.
 15. Dooley P, Buckley R, Tough S, McCormack B, Pate G, Leighton R, Petrie D, Galpin B. Bilateral calcaneal fractures: operative versus non-operative treatment. *Foot & ankle international.* 2004 Feb;25(2):47-52.
 16. Zeman J, Matějka J, Matějka T, Salásek M, Zeman P, Nepraš P. Open reduction and plate fixation (ORIF LCP) for treatment of bilateral calcaneal fractures. *Acta chirurgiae orthopaedicae et traumatologiae Cechoslovaca.* 2013 Jan 1;80(2):142-7.
 17. Bohl DD, Ondeck NT, Samuel AM, Diaz-Colgado PJ, Nelson SJ, Basques BA, Leslie MP, Grauer JN. Demographics, mechanisms of injury, and concurrent injuries associated with calcaneus fractures: a study of 14 516 patients in the American College of Surgeons National Trauma Data Bank. *Foot & Ankle Specialist.* 2017 Oct;10(5):402-10.
 18. Mukherjee D, Roy S, Rakshit D, Chakraborty K. Clinical Experience of Close Reduction and Internal Fixation of Displaced Intra-articular Fractures of Calcaneum. *Int J Sci Stud* 2019;6 (12):21-27.
 19. Rachakonda KR, Nugur A, Shekar NA, Kidiyur B, Kilaru P, Gannamani S, Joseph VM. Minimally invasive fixation for displaced intra-articular fractures of calcaneum: a short-term prospective study on functional and radiological outcome. *Musculoskelet Surg.* 2019 Aug;103(2):181-189.
 20. Razik A, Harris M, Trompeter A. Calcaneal fractures: Where are we now? *Strateg Trauma Limb Reconstr.* 2018; 13:1-11.
 21. Türkmen F, Korucu IH, Sever C, Göncü G, Kaçira BK, Toker S. Calcaneal fractures, treatments and problems. *Clin Res Foot Ankle.* 2014;2(138):2.