



FUNCTIONAL OUTCOME AFTER OPEN REDUCTION INTERNAL FIXATION OF DISPLACED INTRA ARTICULAR CALCANEAL FRACTURES – A PROSPECTIVE STUDY

Orthopaedics

Dr Shekar M	Assistant professor, Department of orthopedics Sanjay Gandhi Institute of trauma and orthopedics Bangalore.
Dr Sindhu B*	Resident in orthopedics Sanjay Gandhi Institute of trauma and orthopedics Bangalore. *Corresponding Author
Dr Chandrashekar H S	Director Department of orthopedics Sanjay Gandhi Institute of trauma and orthopedics Bangalore.

ABSTRACT

Calcaneum is the most commonly fractured tarsal bone. Intra-articular fractures account for approximately 75% of calcaneus fractures. Open reduction and internal fixation (ORIF) with anatomical plate gives the best possible opportunity to bring about near-anatomical joint surface reduction and prevention of subsequent arthritis.

AIM: This study was conducted to determine functional, radiological outcome and the complications of displaced intra-articular calcaneum fractures treated with open reduction and internal fixation with calcaneal plates.

METHODOLOGY: 20 patients admitted with displaced intra-articular calcaneal fractures and managed with Open Reduction Internal Fixation were studied from January 2018 to February 2019 in Sanjay Gandhi Institute of Trauma and Orthopedics, Bengaluru. They were operated through extensile lateral approach with calcaneal locking plates. Regular follow ups are made at 6 weeks, 3 month and 6 months and 12 months. Functional result was compared by using American Orthopedic Foot and Ankle Society (AOFAS) score and Bohler's angle.

RESULTS: All 20 patients were thoroughly evaluated postoperatively for functional outcome using American Orthopedic Foot and Ankle Society (AOFAS) score. Out of 20 patients 4 patients (20%) had excellent, 12 patients (60%) had good, 3 patients (15%) had fair, 1 patient (5%) had poor outcome.

CONCLUSION: Open reduction internal fixation is the ideal treatment for displaced intra-articular calcaneal fractures. Proper surgical timing and meticulous operative technique can give better results in majority of patients, avoiding many complications.

KEYWORDS

Calcaneum, Intra Articular Fracture, Open Reduction And Internal Fixation, Radiological And Functional Outcome, Complications

INTRODUCTION:

The calcaneum (Os calcis) is the largest tarsal bone and most commonly fractured tarsal bone. Calcaneal fractures are one of the most disabling fractures, with occurrence during the wage-earning period of life¹. Calcaneal fractures can be extra-articular (sparing the subtalar joint) or intra-articular (involving the subtalar joint). Approximately 75% of these injuries are intra-articular, and almost all occur due to an axial load such as a fall from a height or a motor vehicle accident. Approximately 10% of patients will have a spine fracture as well due to the axial load. Approximately 10% of injuries are bilateral and fewer than 5% are open. Many calcaneal fractures are work-related, as they result from a fall from height, especially in male age 35-45 years^(2,3). Restoration of congruency of the posterior facet of subtalar joint, restoration of the height of calcaneus (Bohler's angle), reduction of the width of calcaneus, decompression of the sub fibular space available for the fibular tendons, realignment of tuberosity into a valgus position and anatomic reduction of the calcaneocuboid joint if it is fractured are the main goals of any method of fixation.

Displaced intra-articular calcaneal fractures are complex and highly disabling injuries⁴. Displaced intra-articular calcaneal fractures can be treated nonoperatively or operatively. The appropriate surgical procedures, which may involve open reduction and internal fixation (ORIF), closed or percutaneous reduction and minimally invasive fixation, external fixation, or primary subtalar arthrodesis, must be carefully selected based on the type of fracture, the condition of the surrounding soft tissue envelope, and the characteristics and general medical condition of the patient.

Open reduction and internal fixation of calcaneal fractures can have many wound related complications, neurovascular injury, skin necrosis, infection. Wound infections are the most common complication of surgical treatment. Acute neurologic injury can occur iatrogenically. Sural nerve is most at-risk for injury due to recent popularity of the lateral approach. There are lot of controversies with management of calcaneal fractures. This study was done to evaluate the results of operative management for intra-articular os calcis fractures on basis of clinical and radiological outcome.

AIM:

To evaluate the functional and radiological outcome in patients following open reduction and internal fixation of displaced intra-articular calcaneal fractures conducted in Department of Orthopaedics, Sanjay Gandhi institute of trauma and orthopedics, Bangalore from January 2018 to February 2019.

METHODOLOGY:

It was a prospective study of 20 patients with closed displaced intra articular calcaneum fractures treated with open reduction by lateral approach and internal fixation with plates and screws. All patients with displaced intra-articular calcaneal fractures presented at Sanjay Gandhi institute of trauma and orthopedics were treated by initial resuscitation and temporary stabilization of fracture by below knee slab and limb elevation. Compound injuries, fracture more than 3 weeks old, associated peripheral vascular disease and patients who were noncompliance for surgery were excluded. Complete history of the patient is taken after which his/her demographic data, vitals, neurovascular examination and local and systemic examinations were recorded. X-ray ankle AP and Lateral view were taken. X-rays of opposite limb, spine and pelvis were also taken to assess any associated injury. Bohler's angle was measured. Computerized Tomographic scan was taken. Sander's classification was used to classify the fracture patterns and compare the outcome. Skin condition was assessed and definitive surgery was planned only after wrinkle sign was positive.

Surgery was performed within 2 weeks from injury. Extensile lateral approach was used. Patient was put in lateral decubitus position with affected limb up. A full thickness "L" shaped incision starts approximately 2 cm above the tip of the lateral malleolus, just lateral to the Achilles tendon. Reduction of fracture and articular surface was achieved under direct vision and fluoroscopic imaging and fracture was fixed with locking plates. Autologous bone graft was used to fill the defect. Patients were given a below knee POP slab after surgery which is maintained until wound healing and suture removal is usually done on the 14th day after surgery. At second week, active range of ankle movements were started. Weight bearing was allowed after 12 weeks depending on union rates.

Clinical and radiological assessment was done at 6 weeks and 3,6,12 months. Clinical assessment was done using American Orthopedic

Foot and Ankle Society (AOFAS) score. A score of 90-100 is taken as an excellent outcome, 80-89 as good, 70-79 as fair and a score less than <69 is considered a poor outcome. Radiological parameter was assessed by Bohler's Angle.

RESULTS:

A total of 20 patients with displaced intra-articular calcaneal fractures, treated with open reduction and internal fixation were assessed in the study. A total of 12 months follow up data was obtained of all patients. Out of 20 patients, 16 were males and 4 were females. Age distribution ranged from 20 to 60, with mean age 40.2 yrs. 15 patient had fracture after fall from height and 5 were caused as a result of road traffic accident (table 1).

Table 1: Table showing mode of injury

Mode of injury	Frequency	Percentage
Fall from height	15	75%
RTA	5	25%

Nine cases were right sided, 8 cases were left sided and 3 were bilateral. There were 3 cases of lumbar spine injury among which 2 were managed conservatively and one was operated with short segment transpedicular screw fixation, 1 case of distal end radius fracture treated conservatively and 1 case of posterior column acetabulum fracture treated surgically with recon plates, one case of proximal tibia fracture treated with buttress plating (table 2).

Table 2: Associated bony injuries

Associated bony injuries	Frequency	Percentage
Spine fractures	3	15%
Distal end radius	1	5%
Acetabulum	1	5%
Proximal tibia	1	5%

All fractures were subdivided according to Sander's classification system based on CT findings. (table 3).

Table 3: Sander's classification

SANDERS CLASSIFICATION	Frequency	Percent
Sander's Type II	8	40%
Sander's Type III	5	25%
Sander's Type IV	7	35%

Surgery was delayed until the appearance of wrinkles on skin in all patients, for appropriate wound closure and to avoid the complication of wound dehiscence. The number of days from the injury to surgery varied from 2 – 14 days (table 4).

Table 4: time interval between injury to surgery

Injury to surgery time period	Frequency	Percentage
1-5 days	4	20%
6-10 days	10	50%
11-14 days	6	30%

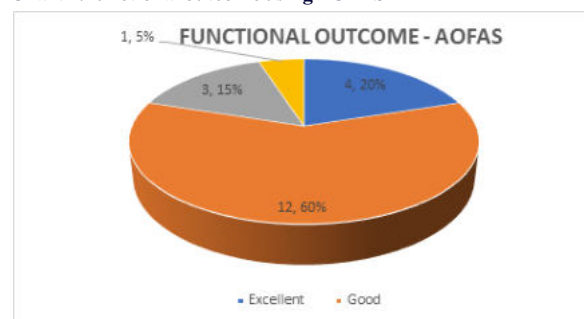
Duration of hospital stay varied from 6-14 days with mean (12.6 days). All 20 cases were operated with extensile lateral approach. Autogenous bone graft from iliac crest was used to fill the bone defect in 13 cases. All the operated patients had an increase in the Bohler's angle and decrease in the Gissane's angle with statistically significant p value. The mean pre op Bohler's angle was 12.2 and Gissane's angle was 126.9. The mean postoperative Bohler's angle was 32.4 and Gissane's angle was 110.26 (table 5).

Table 5: comparison of pre and postoperative radiological parameters.

	Preop	Postop
Bohler's angle	12.2	32.4
Gissane's angle	126.9	32.4

At 12 weeks of follow up, x rays of 16 fractures out of 20 fractures showed radiological signs of union. Mean duration of radiological union was 13.38 weeks. Functional outcome was assessed using American Orthopedic Foot and Ankle Society (AOFAS) score. Out of 20 patients 4 patients (20%) had excellent, 12 patients (60%) had good, 3 patients (15%) had fair and 1 patient (5%) had poor outcome (chart 1).

Chart 1: functional outcome using AOFAS



Post-operative complications include ankle and foot stiffness in 2, implant prominence in 1 and 2 patients had superficial wound infection and 1 patient had deep wound infection (table 6).

Table 6: complications following surgery.

complications	frequency	percentage
Ankle and foot stiffness	2	10
Implant prominence	1	2
Superficial wound infection	2	10
Deep wound infection	1	2

DISCUSSION:

The treatment of intra articular calcaneal fracture, in recent years, has been systematized by the use of careful classification systems and treatment algorithms. Despite many systems for classifying displaced intra-articular fractures, there is no consensus amongst surgeons as to which is the most practical one. In the previous years, operative treatment of displaced intra-articular calcaneus fracture has become a preferred treatment method with the advantage of less complication rates and better quality of life after the surgery⁽⁸⁻¹⁰⁾.

Some studies with more than 100 cases have showed good results after open reduction and internal fixation of intra-articular calcaneal fractures⁽¹¹⁻¹³⁾. Brauer's cost-effectiveness analysis of surgery versus conservative treatment for intra-articular calcaneal fracture showed economical advantages of open reduction internal fixation in 2004⁽⁸⁾. In a prospective randomized control trial by Buckley et al. found better results in patients after surgery⁽¹⁴⁾.

In this study, eighty eight percent patients were younger age group between 20-40 years who are workers, which has a major socioeconomic impact, in terms of loss of productivity. In our study, there were 16 males (80%) and 4 females (20%). It is comparable to the study by Farrell et al. who also reported majority of male population in his study⁽¹⁵⁾. Calcaneus fractures are generally due to high-energy traumas such as a fall from height and traffic accidents. In our study, 17 were unilateral (85%) and only 3 were bilateral (15%) fractures. This is comparable to the study by Farrell⁽¹⁵⁾ who reported more than 80% unilateral fractures.

Mean time duration between injury and surgery in our study was 8.2 days. Operative management was delayed until wrinkle sign was positive to prevent wound complications. We operated within the first 2 weeks of injury, as open reduction internal fixation with more than 3 weeks delay is not recommended^(5,6). The treatment of choice for intra articular calcaneum fractures remains controversial. Earlier, surgical treatment was associated with significant incidence of wound complications, particularly sepsis⁽¹⁶⁾. However, conservative treatment also has its share of complications such as subtalar joint pain, heel varus and peroneal tendon impingement⁽¹⁷⁾. Sanders et al. confirmed that the learning curve for operative treatment of this fracture is steep. Pendse et al.⁽¹⁸⁾ concluded that open reduction and internal fixation with plate in intra-articular calcaneus fractures to restore anatomical articular congruency, early mobilization and primary option for subtalar arthrodesis if needed. Schepers et al.⁽¹⁹⁾ observed that ORIF was the mainstay among all modalities of treatments.

Calcaneal fracture surgery can be performed using medial, lateral or combined approach⁽²⁰⁻²⁴⁾. A lateral extensile exposure popularized by Benirschke and Sangeorzan was used in all our cases⁽¹⁰⁾. Fundamentals for success with this approach include careful flap elevation, mobilization, and anatomic restoration of the posterior facet; adequate mobilization and reduction of the tuberosity fragment through the

primary fracture line; and stabilization with plate and screws. Plates allowing locking of the screws to the plate have become popular for this fracture. We used locking calcaneal plates in all our cases. The "blow out" of the lateral wall, when present, could be well reduced and held in place with this plate. The contoured plate was fixed extending from anterior process into the most posterior aspect of the tuberosity. If a large defect remains after the procedure, which often is the case, most surgeons recommend the use of autogenous iliac crest bone graft; however, if internal fixation is secure and the fracture is stable, the defect may be accepted. A.K. Singh et al. in his study concluded that Bohler's angle showed improved restoration and the patients returned to full weight-bearing earlier when bone grafting was used in the treatment of intra-articular calcaneal fracture⁽²⁵⁾.

Surgical treatment of displaced intra-articular calcaneal fractures enables anatomical reduction, and restores shape, height and alignment. It also aims to reduce the subtalar and calcaneocuboid joints in order to achieve a reduced lateral wall and peroneal tendons⁽²⁶⁾.

The Bohler's angle⁽²⁷⁾, considered as normal within measurements ranging from 20° to 40°. In this study, we found post-operative mean Bohler angle of 32.4 degree. Paley D et al. stated that Bohler's angle is an indirect measurement of both calcaneal height and the arch angle⁽²⁸⁾. In this study, outcomes measured with AOFAS Score. Out of 20 patients 4 patients (20%) had excellent, 12 patients (60%) had good, 3 patients (15%) had fair and 1 patient (5%) had poor outcome. Biz et al.⁽²⁹⁾ who also measured outcomes with AOFAS score and he found excellent results (90–100 points) in 11 (12.6 %) patients, good results (75–89 points) in 46 (52.9 %) patients, fair results (50–74 points) in 26 (29.9 %) patients, while 4 (4.6 %) patients were graded as failures (<50 points). We also compared our outcomes of AOFAS Score with Voclav et al.⁽³⁰⁾ who found excellent results in 24(32%) patients, good in 28(37%) patients, fair in 14(18%) patients and poor results in 10(13%) patients. We also compared our outcomes with other series of Gusic et al.⁽³¹⁾ and Mohammed et al.⁽³²⁾.

The complications after surgical management adds to the disadvantages for ORIF of calcaneal fractures. In our study out of 20 patients two patients had ankle and foot stiffness, one had implant prominence and 2 patients had superficial wound infection and 1 patient had deep wound infection.

This study has some limitations, which include a smaller number of study population and short duration of follow up. However, this study throw some lights on future long term and randomized study.

CONCLUSION:

Out of 20 cases treated in our study, according to statistical analysis with good anatomical articular reduction and proper post-operative rehabilitation protocol, good to excellent outcomes achieved. Proper quality radiographs like lateral, axial view is necessary in understanding the displacement of major fragments. Preoperative CT scan helps to classify the fracture pattern according to sander's classification and helps in preop planning and assessment of prognosis of fracture. Anatomical reduction of articular surface and stable internal fixation with locking calcaneal plates through extended lateral approach with proper timing and meticulous surgical technique with minimal soft tissue handling and early mobilization are the main factors essential for a successful outcome and minimize the post-operative complications.

Illustration 1:



Fig 1: 1a- preoperative radiograph showing left calcaneum fracture; 1b- preoperative CT scan showing sander's type 3 fracture; 1c- clinical image showing wrinkle test positive; 1d- immediate post operative radiograph; 1e- 2 months follow up radiograph; 1f- 6 months follow up radiograph; 1g- 9 months follow up radiograph; 1h and 1i- clinical outcomes

Illustration 2:



Fig 2: 2a- preoperative radiograph showing right calcaneum fracture; 2b- preoperative CT scan showing sander's type 4 fracture; 2c- immediate post operative radiograph lateral view; 2d- immediate post operative radiograph axial view; 2e- 4 months follow up radiograph lateral view; 2f- 4 months follow up radiograph axial view; 2g- 9 months follow up radiograph; 2h- plantar flexion at 1 year follow up; 2i- dorsiflexion at 1 year follow up; 2j- tip toe standing.

Illustration 3:

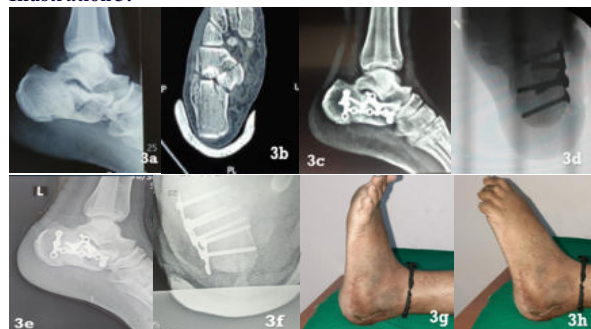


Fig 3: 3a- preoperative radiograph showing left calcaneum fracture; 3b- preoperative CT scan showing sander's type 4 fracture; 3c- immediate post operative radiograph lateral view; 3d- immediate post operative radiograph axial view; 3e- 9 months follow up radiograph lateral view; 3f- 9 months follow up radiograph axial view; 3g and 3h- clinical images on 1 year follow up.

Illustration 4:



Fig 4: 4a- 2 year follow up radiograph of a patient with united right calcaneum fracture operated with plated and screws; 4b- late wound

infection with active purulent discharge; 4c- radiograph after implant removal.

REFERENCES:

1. Sanders R: Displaced intra-articular fractures of the calcaneus. *J Bone Joint Surg Am* 2000; 82:225-250
2. Barei DP, Bellabarba C, Sangeorzan BJ, Benirschke SK. Fractures of the calcaneus. *Orthopedic Clinics of North America*. 2002; 33 (1): 263-85
3. Nicklebur S, Dixon TB, Probe R. Calcaneus fractures. *EMedicine*, July 21, 2004.
4. Sangeorzan BJ, Wagner UA, Harrington RM, Tencer AF. Contact characteristics of the subtalar joint: the effect of talar neck misalignment. *J Orthop Res*. 1992; 10(4):544-551
5. Zwipp H, Rammelt S, Bartels. Fracture of the calcaneus. *Unfallchirurg*.
6. Zwipp H, Rammelt S, Barthel S. Calcaneal fractures-open reduction and internal fixation (ORIF). *Injury*. 2004; 35:SB46-SB54.
7. Lim EA, Leung JP. Complications of intra-articular calcaneal fracture. *CORR*. 2005; 391:7-16. 5
8. Brauer CA, Manns BJ, Ko M, Donaldson C, Buckley R. An economic evaluation of operative compared with nonoperative management of displaced intra-articular calcaneal fractures. *J Bone Joint Surg*. 2005; 87:2471-9.
9. Hart AJ, Eastwood DM. Displaced intra-articular fractures of the calcaneus: what is new? *Trauma*. 2003; 5:9-21.
10. Benirschke SK, Kramer PA. Wound healing complications in closed and open calcaneal fractures. *J Orthop Trauma*. 2004; 18:1-6
11. Sanders R, Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. *Clin Orthop Relat Res*. 1993 May; (290):87-95.
12. Jean-Luc Besse, J.P. Avaro, F. Chotel, J.L. Lerat, B. Moyen. Calcaneal intraarticular fracture osteosynthesis: Clinical and radiological prospective study of 31 cases. *Foot and Ankle Surgery* Dec 2006; 19-27 5
13. Zwipp, Hans, Tscherne, Harald, Thermann, Hajo, Weber, Theresa . Osteosynthesis of Displaced Intraarticular Fractures of the Calcaneus Results in 123 Cases. *Clin Orthop* 1993;290:76-86.
14. Buckley R, Tough S, McConnack R, Pate G, Leighton R, Petrie D, Galpin R. Operative compared with non-operative treatment of displaced intraarticular calcaneal fractures: a prospective, randomised, controlled multicentric trial 6
15. O'Farell DA, O'Byrne JM, McCabe JP, Stephens MM. Fractures of the os calcis: Improved results with internal fixation. *Injury*. 1993; 24:263-5.
16. Lindsay R, Dewar F. Fracture of the os Calcis. *Am J Surg* 1958; 95:555
17. Myerson M, Quill GE. Late complications of fractures of the calcaneus. *IBJS (A)*. 1993; 75(3):331-41
18. Aniruddha Pendse, Daveswar RN, Jay Bhatt, Shivkumar. Outcome after open reduction internal fixation of intraarticular fracture of calcaneum without use of bone graft. *Indian J Orthop*. 2006; 40(2):111-114.
19. Schepers T, Heetveld M, Mulder PG, Patka P. Clinical outcome scoring of intra-articular calcaneal fractures. *J Foot Ankle Surg*. 2008; 47(3):213-8. 16
20. Palmer I. The mechanism and treatment of fractures of the calcaneus. Open reduction with the use of cancellous grafts. *JBJS(A)*. 1948; 30:2-8.
21. Burdeaux BD. Reduction of calcaneal fractures by the McReynolds medial approach technique and its experimental basis. *Clin Orthop*. 1983; 177: 87-103.
22. McReynolds IS. The case for operative treatment of fractures of calcaneus. In Leach RE, Hoaglund FT, Riseborough EJ (eds): *Controversies in Orthopaedic Surgery*. Philadelphia: WB Saunders; 1982. P. 23254. 28
23. Letoumel E. Open reduction and internal fixation of calcaneus fractures. In Spiegel PG (editors). *Topics in Orthopaedic Trauma*. Baltimore: University Park Press; 1984. P. 173-92.
24. Stephenson JR. Surgical treatment of displaced intra-articular fractures of the calcaneus: a combined lateral and medial approach. *OCNA*. 1993; 290: 6875.
25. Singh AK, Vinay K. Surgical treatment of displaced intra-articular calcaneal fractures: is bone grafting necessary? *J Orthopaed Traumatol*. 2013 Dec 1; 14(4):299-305.
26. Sanders R, Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. *Clin Orthop Relat Res* 1993; 290: 87-95.
27. Su Y, Chen W, Zhang T, Wu X, Wu Z, Zhang Y. Bohler's angle's role in assessing the injury severity and functional outcome of internal fixation for displaced intra-articular calcaneal fractures: a retrospective study. *BMC Surg*. 2013; 13:40. Published 2013 Sep 24. doi:10.1186/1471-2482-13-40
28. Sanders R. Intra-articular fractures of the calcaneus: present state of the art. *J Orthop Trauma* 1992; 6: 252-265
29. Biz C, Barison E, Ruggieri P, Iacobellis C. Radiographic and functional outcomes after displaced intra-articular calcaneal fractures: A comparative cohort study among the traditional open technique (ORIF) and percutaneous surgical procedures (PS). *J Orthop Surg Res*. 2016; 11(1):92
30. Voclav Rak D, Ira M. Masck Operative treatment of intraarticular fractures with calcaneal plates and its complications *Indian J Orthop*. 2009; 43(3):271-280.
31. Gusic N, Fedel I, Darabos N, Lovric Z, Bukvic N, Bakota B, et al. Operative treatment of intraarticular calcaneal fractures: Anatomical and functional outcome of three different operative techniques. *Injury*. 2015 Nov; 46 Suppl 6: S130-133.
32. Mohammed Mostafa F, Garna El-Adi, Ehab Hussanin Y, Serry Abdellatif M. Surgical treatment of displaced intraarticular calcaneal fracture using a single small lateral approach. *Strat Trauma Limb Recon*. 2010; 5:87-95.