e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(2); 230-238

Original Research Article

Outcome Assessment of Locking Plate Fixation in Displaced Intraarticular Fractures of Calcaneum

Ranjan Kumar Prakash[1], Kumar Mayank[2], Dilip Kumar Singh[3]

[1]Senior Resident, Department of Orthopedics, JLNMCH, Bhagalpur, Bihar, India
[2]Senior Resident, Department of Orthopedics, JLNMCH, Bhagalpur, Bihar, India
[3]Professor, Department of Orthopedics, JLNMCH, Bhagalpur, Bihar, India

Received: 20-10-2022 / Revised: 25-12-2022 / Accepted: 03-01-2023
Corresponding author: Dr. Kumar Mayank
Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to evaluate the functional and radiological outcome of intra-articular calcaneal fractures managed surgically with a plate in terms of bohler's and gissane's angle, rate of radiological union and AOFAS score.

Methods: The Prospective study was conducted at Department of Orthopedics, JLNMCH, Bhagalpur, Bihar, India for the period of one year and a total of 30 patients with intra-articular calcaneal fractures meeting the inclusion and exclusion criteria were chosen for the study.

Results: In our study, patients between the ages group 18 yr and 60yr with a mean age of 33.36yr were included. The majority of the patients in the study were males, with 90% of the study population. In this study, 60% of the patients had right side involvement and 40% of the patients had left side involvement. The most common mode of injury in the study group was falling from height followed by RTA. The most common fracture type in our study was Sander's type II, followed by type IV. Type III was the least common. In all the patients included in the study, surgery was delayed until the appearance of wrinkles on the skin to avoid the complication of wound dehiscence and for appropriate wound closure. The number of days from the injury to surgery varied from 4 to 14 days with an average of 7.8 days. The average time period for the radiological union was 13.64 weeks in the study population.

Conclusion: We concluded that with proper pre-operative planning, the timing of surgery, intra- operative expertise of the surgeon, and post-operative care, surgical management of intra-articular fracture using a locking plate, gives a better outcome and minimal complications.

Keywords: Calcaneal Fractures, Intra-Articular, High Energy Fractures, Soft Tissue, Operative Techniques.

Introduction

Calcaneal fractures account for up to 75% of all foot fractures and 1–2% of all fractures [1], being more common in males and those who work in an industrial profession. Intraarticular fractures account for approximately 75% of calcaneal fractures and historically have been associated with poor functional outcomes. These fractures are uniformly caused by an axial load mechanism, such as a fall from height or a motor vehicle accident, and may be associated with other axial load

injuries such as lumbar, pelvic, and tibial plateau fractures. [2] Pain and disability are the long term consequences of calceneal fractures. There have been various studies that depict that operative treatment of calceneal fractures result in better outcome than non-operative treatment. [3]

Calcaneum or heel bone fractures are the commonest fractures of the tarsal bones. [4] They result primarily due to high energy trauma and axial loading to the foot. [5] The incidence of calcaneal fracture is 11.5 per 100,000 population annually. It occurs 2.4 times more frequently in males. In males, the age of incidence is noted to range between 20-29 years.4 The appropriate standard operative treatment for calcaneal fractures is a controversy. Several studies in the past have encouraged open reduction and internal fixation as the standard protocol. But, there have been several complications associated with it. [6-9]

The management of intraarticular calcaneal fractures remains controversial, with strong arguments supporting both conservative & operative managements. Recent studies are of varied opinion; some siting no difference between the two & others suggesting operative to be a better option. Significant controversy remains over the results of nonoperative versus operative treatment. The lack of standardization of results has made it difficult to compare studies that have evaluated outcomes. [10] Historically, there have been dramatic changes in management protocols as our understanding of the fracture has evolved. The historical statement by Cotton that ‘‘the man who breaks his calcaneus is done’’. [11] Perhaps it does not hold well in the twenty-first century.

Over the past 25 years, however, marked advances in anesthesia, prophylactic antibiotics, CT scanning, and fluoroscopy have allowed surgeons to improve outcomes when operating on fractures, and these techniques have been applied to calcaneal fractures as well. Overall, operative treatment of acute fractures has become the standard of care for many authors who, critically evaluating their results, have concluded that good outcomes are possible.

The aim of the present study was to evaluate the functional and radiological outcome of intra-articular calcaneal fractures managed surgically with a plate in terms of bohler’s and gissane’s angle, rate of radiological union and AOFAS score.

Materials and Methods

The Prospective study was conducted at Department of Orthopedics, JLNMCH, Bhagalpur, Bihar, India for the period of one year and a total of 30 patients with intra-articular calcaneal fractures meeting the inclusion and exclusion criteria were chosen for the study.

Inclusion Criteria

1. Patients aged between 18-60yrs.
2. Intra-articular fracture of calcaneum (Sanders classification).
3. Ability to understand the content of the subject information/informed consent form and to be willing to participate in the clinical investigation.

Exclusion Criteria

1. Patients with extra-articular fracture.
2. Open fracture (Gustillo-Anderson type 2 and 3).
3. Patients medically not fit for surgery.
4. Paraplegia/paraparesis as they interfere with the assessment of the functional outcome of the surgery.
5. Old ankle fractures.
6. Fracture in osteoporotic bone.
7. Fracture of the long bone in the ipsilateral limb.
8. Chronic local infection.
9. Sanders type I calcaneal fracture

Methodology and procedure

After admitting the patients with intra-articular calcaneal fractures satisfying the inclusion criteria, relevant investigations were done and fitness for surgery was taken. Appropriate measures were taken to reduce the swelling, such as below knee slab with cotton padding, limb elevation, and ice pack application. Pre-operative x-rays-lateral and axial view of the calcaneam and CT scan of calcaneum were obtained and pre-operative planning was done. Pre-operative Bohler's and Gissane's angles were measured using radiographs and fractures were classified using Sander's classification with the help of a CT-scan. After obtaining informed consent from the patients and ethical committee clearance, the patients were taken up for surgery once the swelling was reduced and the wrinkle sign was positive.

After the patient is anaesthetised, the patient is placed in the lateral decubitus position over a radiolucent table with the operative side up. The lower extremities are positioned in a scissor-like configuration. Protective padding is placed beneath the contralateral limb to protect the peroneal nerve and a pillow is placed between the legs. A pneumatic thigh tourniquet is used, and the limb is exsanguinated with an Esmarch bandage to provide a dry operative field. The limb is painted and draped till mid-calf region and the fracture is approached with a lateral extensile incision starting 2cm above the tip of the lateral malleolus and just lateral to the Achilles tendon and taking it up to the base of the 5th metatarsal in an L shaped fashion. The knife is taken "straight to bone" at this level, taking care not to bevel the skin. Once the initial incision is made, the corner of the flap is now raised as a subperiosteal, full-thickness flap. One K-wire (1.5mm) is passed in the fibula, talar neck and cuboid each to retract the flap using the "no-touch" technique.

Fracture reduction and correction of calcaneus varus, height and width were done under direct vision and with the help of fluoroscopy. K wires were used for the temporary stabilization of fracture fragments. Application of locking calcaneal compression plate and locking screws is done. Intraoperative radiographic evaluation with image intensifier with lateral, axial and Anteroposterior view. Wound wash was given with normal saline. Wound closed with non-absorbable suture (Ethilon) using Allgower-Donati technique. Bulky cotton dressing is done. Patients were given below- knee slab and limb elevation in the post-op period, till wound healing and suture removal, which was usually done on the 14th day. Ankle range of movements were started at 2nd post-op week. Patients were followed up regularly in OPD at 6wk, 12wk, 24wk and 1yr and clinical and radiological assessments were done. Weight-bearing was allowed after 3 months depending upon the fracture union.

Radiological assessment was done by measuring bohler's and gissane's angles, union rate. Functional outcome was measured using American Orthopaedics Foot and Ankle Society (AOFAS) score. A score of 90-100 is taken as an excellent outcome, 75-89 as good, 55-74 as fair and a score less than 50 is considered a poor outcome.

The data collected were entered into a Microsoft Excel spreadsheet and analysed using STATA 14 (StataCorp.2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.)

Results

A prospective study was undertaken of 30 patients with intra-articular calcaneal fractures (Sander's type II, III and IV) treated by calcaneal locking compression plate and screws. Results were analysed in terms of functional outcome of a postoperative range of movement after the union, time for fracture union, early and late postoperative complications.

Table 1: Patient details

Variables	N%
Gender	
Male	27 (90)
Female	3 (10)
Age groups	
18-30	12 (40)
31-40	10 (33.34)
41-50	5 (16.66)
51-60	3 (10)
Distribution of sides involved	
Right	18 (60)
Left	12 (40)
Mode of injury	
Fall from height	24 (80)
RTA	6 (20)

In our study, patients between the ages group 18 yr and 60yr with a mean age of 33.36yr were included. The majority of the patients in the study were males, with 90% of the study population. In this study, 60% of the patients had right side involvement and 40% of the patients had left side involvement. The most common mode of injury in the study group was falling from height followed by RTA.

Table 2: Distribution types of Sander's classification of fracture in the study population, Time interval between injury to surgery and Distribution of period in weeks for complete radiologic union in patients studied

Sander's type	N%
Type II	12 (40)
Type III	8 (26.66)
Type IV	10 (33.34)
Time interval	
1-5 days	7 (23.34)
6-10 days	17 (56.66)
11-14 days	6 (20)
Time in weeks	
10-13 wks	17 (56.66)
14-16 wks	8 (26.67)
17-19 wks	5 (16.67)

The most common fracture type in our study was Sander's type II, followed by type IV. Type III was the least common. In all the patients included in the study, surgery was delayed until the appearance of wrinkles on the skin to avoid the complication of wound dehiscence and for appropriate wound closure. The number of days from the injury to surgery varied from 4 to 14 days with an average of 7.8 days. The average time period for the radiological union was 13.64 weeks in the study population.

Table 3: Distribution of pre and post-operative Bohler's angle and gissane's angle in the study population

Bohler's angle	Pre-operative (%)	Post-operative (%)
<10°	8 (26.67)	0
10°-20°	22 (73.34)	0
20°-30°	0	14 (46.66)
30°-40°	0	16 (53.34)
Mean	11.75 °	29.67 °
Gissane's angle		
110°-120°	0	16 (53.34)
120°-130°	5 (16.66)	14 (46.66)
130°-145°	16 (53.34)	0
>145°	9 (30)	0
Mean	137.06 °	116.7 °

About 73.34% of patients had a bohler's angle between 10°-20° and in 26.67% of patients, it was <10° in the pre-operative period, with a mean bohler's angle of 11.75°. Whereas in the post-operative period, 46.66% of patients had a bohler's angle between 200-300 and 53.34% had it between 300-400, with a mean post-operative bohler's angle of 29.67°. The difference between pre-operative and post-operative mean bohler's angle was statistically significant with a p value <0.01. The difference between pre-operative and post-operative mean Gissane's angle was statistically significant with a p value <0.01.

Table 4: Functional outcome using AOFAS score

AOFAS score	N%
Excellent	5 (16.66)
Good	19 (63.34)
Fair	5 (16.66)
Poor	1 (3.34)

According to AOFAS score, majority of the patients were good followed by excellent and fair. Only 1 patient had poor AOFAS score.

Figure 1: Pre-op x-ray lateral and axial view

Figure 2: Postoperative radiographs showing lateral and axial view showing the criss cross insertion of the screws with restoration of gissane and bohler's angle.

Discussion

Although calcaneal fractures are uncommon, comprising approximately 2% of all fractures.[12-[14] They constitute about 60% of all tarsal bone fractures.1 Mostly they are due to high-energy axial trauma, mainly due to falls from a height. [12,13,15,16] Intra-articular fractures account for 70% of all calcaneal fractures. They are the most challenging and outcomes are unpredictable. [12] There is no consensus between surgical and conservative treatment in terms of outcomes. [13]

Out of 30 cases there were 27 males (90%) and 3 females (10%). The mean age of the patients was 33.6 years with ages ranging from 18 years to 60 years. In our study, the mean age of the patients was 33.6 years which was comparable to previous studies done by M.J.Mitchell et al. [17] and Farell et al. [18] who also demonstrated that the fracture was more in the younger age group and the majority of the patients were male. The mode of injury was falling from height in 24 cases and 6 cases had a history of RTA. In our study most common mode of injury was falling from height (80%), followed by RTA (20%). This result was comparable with the results of a study done by M.J.Mitchell et al. [17] (fall from height 71.5%).

Our study delayed the operative management until the wrinkle sign was positive to prevent wound complications. We operated within the first two weeks of injury, as open reduction internal fixation with more than 3 weeks of delay is not recommended. [19] The mean time duration between injury and surgery in our study was 7.8 days. The treatment of choice for intraarticular calcaneum fractures remains controversial. Surgical treatment was associated with a significant incidence of wound complications, particularly sepsis. [20] However, the conservative treatment also has its share of complications, such as subtalar joint pain, heel varus and peroneal tendon impingement. [21] Sanders et al. confirmed that the learning curve for operative treatment of this fracture is steep. Sanders observed that the clinical results are a surgeon-dependent learning curve and requires 35 to 50 cases or about 2 years' experience. [22,23]

If a large defect remains after the procedure, which often is the case, most surgeons recommend using an 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. [24] However, studies by Rammelt et al., [25] and Zhongguo et al., [26] suggested that it is not necessary to implant a bone graft for DIACFs. Surgical treatment of displaced intra-articular calcaneal fractures enables anatomical reduction, and restores the 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. [27] Paley D et al. stated that Bohler's angle is an indirect measurement of both calcaneal height and the arch angle. [28] The Bohler's angle [29] is considered as normal within measurements ranging from 20° to 40°. In this study, the post-operative mean Bohler angle was 29.67 degree. In our study, the time for fracture union showed that the meantime for union among patients was 13.64 ±2.56 weeks. Biz et al. [30] reported radiological consolidation of calcaneal fractures in an average period of around 3 months (12weeks), which agreed to the findings of our study. In a study on functional outcomes of different modalities of fixation in intra-articular calcaneus fractures by Rajesh V Chawda et al. [31], it was observed that the radiological union appears between 2-3 months. [32]

In this study, outcomes were measured with AOFAS Score. Out of 30 patients 5 patients (16.74%) had excellent (90–100 points), 19 patients (63.34%) had well (75–89 points), 5 patients (16.64%) had fair (50–74 points) and 1 patient (3.34%) had poor outcome (<50points). Biz et al. [30] who also measured outcomes with AOFAS score and he found excellent results in 11 (12.6%) patients, good results in 46 (52.9%) patients, fair results in 26 (29.9%) patients, while 4 (4.6%) patients were graded as failures. The patients developed ankle and foot stiffness as a result of noncompliance for physiotherapy. As per culture and sensitivity, deep wound infection was treated with implant removal, wound debridement, and antibiotic cover. Superficial wound infection was treated with regular dressings and appropriate antibiotics. Patients with implant prominence were treated with implant removal after the fracture was united at the final follow up.

Conclusion

Good quality radiographs like lateral and axial view and pre-operative CT scan is necessary in understanding the displacement of major fragments and help to classify the fracture pattern according to Sander's classification, which is vital in pre-operative planning and assessment of the prognosis of fracture. The timing of the surgery is a crucial determinant for the treatment outcome and is to be done once the wrinkle sign is positive. If for other reasons operation is done after three weeks, it causes not only soft tissue healing problems and high infection rate but also intra-operative difficulty in fracture reduction, as the fracture would have started consolidating. Surgeon’s expertise in soft tissue handling, anatomical alignment of fracture fragments, maintaining the height of the calcaneum , Bohler’s and Gissane’s angle, Judicious use of bone graft in large void spaces before placing the plate, and proper intra-operative planning and post-operative care are the main factors which can lead to a successful outcome and minimize the postoperative complications.

References

1. Potter MQ, Nunley JA. Long-term functional outcomes after operative treatment for intra-articular fractures of the calcaneus. J Bone Joint Surg Am. 2009;91(8):1854-1860.
2. Susan Ishikawa N. Chapter 88 – Fractures and Dislocations of the Foot,

Canale&Beaty: Campbell's Operative Orthopaedics, 13th ed.; 4276-4290
3. Meena A, Kumar S, Joshi N, Rathore M. Outcome analysis of open reduction and internal fixation with calcaneal plate: an observational study among unicondylar fracture of distal femur. International Journal of Contemporary Medical Research. 2016; 3:1535-8.
4. Mitchell MJ, McKinley JC, Robinson CM. The epidemiology of calcaneal fractures. Foot (Edinb). 2009;19(4):19 7-200.
5. 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.
6. Bajammal S, Tornetta III P, Sanders D, Bhandari M. Displaced intra-articular calcaneal fractures. Journal of orthopaedic trauma. 2005 May 1;19(5) :360-4.
7. Gougoulias N, Khanna A, McBride DJ, Maffulli N. Management of calcaneal fractures: systematic review of randomized trials. British medical bulletin. 2009 Dec 1;92(1):153-67.
8. Jiang N, Lin QR, Diao XC, Wu L, Yu B. Surgical versus nonsurgical treatment of displaced intra-articular calcaneal fracture: a meta-analysis of current evidence base. International orthopaedics. 2012 Aug; 36:1615-22.
9. Zeman P, Zeman J, Matejka J, Koudela K. Long-term results of calcaneal fracture treatment by open reduction and internal fixation using a calcaneal locking compression plate from an extended lateral approach. Acta Chir Orthop Traumatol Cech. 2008;75 (6): 457-64.
10. Susan Ishikawa N. Chapter 88 – Fractures and Dislocations of the Foot, Canale&Beaty: Campbell's Operative Orthopaedics, 13th ed.; 4276-4290
11. Cotton FJ, Henderson FF. Results of fractures of the oscalcis. Am J Orthop Surg. 14:290.
12. Dhillon MS, Bali K, Prabhakar S. Controversies in calcaneus fracture management: a systematic review of the literature. Musculoskelet Surg. 2011 Dec 1;95(3):171–81.
13. Bruce J, Sutherland A. Surgical versus conservative interventions for displaced intra-articular calcaneal fractures. Cochrane Database Syst Rev. 2013 Jan 31;(1):CD008628.
14. Veltman ES, Doornberg JN, Stufkens SAS, Luitse JSK, van den Bekerom MPJ. Long-term outcomes of 1,730 calcaneal fractures: systematic review of the literature. J Foot Ankle Surg Off Publ Am Coll Foot Ankle Surg. 2013 Aug;52(4):486–90.
15. Palmersheim K, Hines B, Olsen BL. Calcaneal Fractures: Update on Current Treatments. Clin Podiatr Med Surg. 2012 Apr 1;29(2):205–20.
16. Pelliccioni AAA, Bittar CK, Zabeu JLA. Surgical treatment of intraarticular calcaneous fractures of sanders' types II and III. Systematic review. Acta Ortop Bras. 2012;20(1) :39–42.
17. Mitchell MJ, et al. The epidemiology of calcaneal fractures. The Foot. Dec 2009;19(4):197-200.
18. O'Farrell DA, O'Byrne JM, McCabe JP, Stephens MM. Fractures of the os calcis: improved results with internal fixation. Injury. 1993 Apr 1;24(4):263-5.
19. Zwipp H, Rammelt S, Barthel S. Calcaneal fractures-open reduction and internal fixation (ORIF). Injury. 2004; 35:SB46-SB54.
20. Lindsay WRN, Dewar FP. Fractures of the os calcis. Am J Surg. 1958; 95:555.
21. Myerson M, Quill GE. Late complications of fractures of the calcaneus. BJS (A). 1993;75(3): z31-41.
22. Sanders R. Fractures and fracture-dislocations of the calcaneus. In

Surgery of the Foot and Ankle, edited by R Mann and M Coughlin Ed. St Louis, Mosby, 1999;7(2):1422-1464.
23. Sanders R. Current concepts review-displaced intra-articular fractures of the calcaneus. JBJS. 2000 Feb 1;82(2): 225-50.
24. Singh AK, Vinay K. Surgical treatment of displaced intra-articular calcaneal fractures: is bone grafting necessary? J Orthopaed Traumatol. Dec 1, 2013; 14 (4):2990-305.
25. Rammelt S, Dürr C, Schneiders W. Minimal-invasive osteosynthese von kalkaneusfrakturen. Oper Orthop Traumatol. 2012; 24:383-95.
26. Zhongguo Gu Shang. A study of 22 displaced intraarticular calcaneal fractures using locking plates with and without bone graft. 2011 Apr; 24(4): 3057.
27. Sanders R, Fortin P, Di Pasquale T, et al. Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. Clin Orthop. 1993,87-95
28. Paley D, Hall H. Intra-articular fractures of the calcaneus. A critical analysis of results and prognostic factors. J Bone Joint Surg Am. 1993;75A:342-354.
29. 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.
30. 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.
31. Chawda RV, Ninama DM, Patel V, Patel J. Functional outcomes of different modalities of fixation in intra-articular calcaneus fractures. National Journal of Clinical Orthopaedics. 2018;2(4):199-204.
32. Zaichick V. Diagnosis of Thyroid Malignancy using Chemical Elements of Nodular Tissue determined by Nuclear Analytical Methods. Journal of Medical Research and Health Sciences. 2022; 5(3): 1808–1824.