Functional Outcome Estimation of Calcaneum Fractures Treated by Open Reduction and Internal Fixation with Plate and Screws in A Tertiary Centre: A Descriptive Cross-sectional Study

Rajeev Dwivedi,¹ Mandir Khatri,¹ Arjun K C¹
¹Department of Orthopedics, Lumbini Medical College and Teaching Hospital, Tansen, Palpa, Nepal.

ABSTRACT

Introduction: Calcaneum fractures constitute about 60% of all tarsal bone fractures. Intra-articular fractures account for 70% of all calcaneal fractures. There are controversies regarding the operative treatment of calcaneum fractures. Therefore, this study aimed to estimate the functional outcomes of calcaneum fractures treated by open reduction and internal fixation with plate and screws.

Methods: This descriptive, cross-sectional study was carried out at a tertiary care center in the western region of Nepal among the patients with displaced intra-articular calcaneum fractures from February 2017 to July 2020 after approval from the Institutional review committee. Convenient sampling was done to reach the sample size. Fifteen cases were included in the study. Data were recorded in proforma and Data analysis was done in the statistical package for social sciences. The American Orthopedic Foot and Ankle Society Hindfoot score was used to assess the final outcome.

Results: According to the American Orthopedic Foot and Ankle Society hindfoot scores, there were five excellent (33.33%), seven good (46.66%), two fair (13.33%) and one poor (6.66 %) results.

Conclusions: In displaced intra-articular calcaneum fractures, open reduction and internal fixation with plates and screws result in a good number of satisfactory outcomes with few unsatisfactory results. Hence, it can be a better option of treatment in displaced intra-articular calcaneum fractures.

Keywords: calcaneus; intra-articular fractures; treatment.

INTRODUCTION

Although calcaneal fractures are uncommon, comprising approximately 2% of all fractures.¹⁻³ They constitute about 60% of all tarsal bone fractures.¹ Mostly they are due to high-energy axial trauma, mainly due to falls from height.¹,²,⁴,⁵ Intra-articular fractures account for 70% of all calcaneal fractures. They are the most challenging and outcomes are unpredictable.¹ There is no consensus between surgical and conservative treatment in terms of outcomes.²

Due to difficult terrain and frequent motor vehicle accidents in this area, the calcaneal fracture is the most common tarsal bone fracture managed at our center. We are managing these injuries by both operative and non-operative methods. Data regarding outcomes of operative treatment of calcaneum fracture are sparse. Therefore, we decided to conduct this study.

Correspondence: Dr. Rajeev Dwivedi, Department of Orthopedics, Lumbini Medical College and Teaching Hospital, Tansen, Palpa, Nepal. Email: rd172002@gmail.com, Phone: +977-9851091933.
This study aimed to estimate the functional outcomes of calcaneum fractures treated by open reduction and internal fixation with plates and screws.

**METHODS**

This descriptive cross-sectional study was conducted at the Department of Orthopedics, Lumbini Medical College, and Teaching Hospital from February 2017 to July 2020 for over three and a half years. This study was approved by the Institutional Review Committee (IRC -LMC 18-D/020) of LMCTH, Tansen, and Palpa, Nepal. Both the verbal and written informed consents were taken from each of the participants.

The study population is patients who have been admitted to this institution with a diagnosis of calcaneum fracture. Hospital records including case files, operation details, and discharge records were reviewed to enroll the patients for study after due permission from concern authority. Patients aged 18 years and above with displaced intra-articular calcaneum fracture managed with open reduction and internal fixation by calcaneum locking plates and screws were included in the study. Undisplaced calcaneum fractures, compound fracture, patients with impaired sensation in lower limbs, were excluded from the study. Initial evaluation before operation comprised plain radiographs, lateral and axial views of calcaneum, as well as computed tomography (CT) scans. Calcaneal fractures were classified according to the Sanders classification based on CT scans. Age, sex, mechanism of injury, laterality, type of fracture as per Sander’s classification, postoperative wound complication, time elapsed between the injury to surgery were recorded. Patients who visited for follow up themselves and patients who return for follow-up after telephonic communication were examined and final outcomes were measured with validated the American Orthopedic Foot and Ankle Society (AOFAS) Hindfoot questionnaires (Scores). The AOFAS hindfoot score system assesses the intensity of pain and functional disability and mainly includes nine aspects: pain 40 points, function 50 points which include, maximum walking distance (blocks), walking surfaces, gait abnormality, sagittal motion (flexion plus extension), hindfoot motion (inversion plus eversion), ankle-hindfoot stability (anteroposterior, varus-valgus), and alignment 10 points. The score had a maximum of 100 points (best possible outcome). The results are considered as excellent when the scores ranged from 90 to 100, good when between 80 and 89, fair when ranging from 70 to 79 and bad when below 70. At final follow-up, lateral and axial x-rays of calcaneum were taken for radiological evaluation, Bohler’s angle was measured in plain lateral radiograph of calcaneum, 25-40 degrees is considered as normal value, an angle is reduced in displaced intra-articular fracture. Radiographs showing complete bridging callus formation and the absence of radiolucent lines were used to define bone healing.

A total of 15 patients (15 heels) with displaced intra-articular calcaneum fractures meeting the inclusion criteria came for final follow up. Two patients had bilateral calcaneum fractures. Since contralateral fracture was undisplaced, it was excluded from the study. Undisplaced fractures were managed by the non-operative method. All patients with displaced intra-articular fractures were treated by open reduction and internal fixation. In all patients’ extended lateral approach was used for exposure of fracture and in all cases low profile calcaneal locking plate and locking head screws were used.

Convenience sampling was done and the minimum sample size was calculated using the formula,

\[ n = \frac{Z^2 \times p \times q}{e^2} \]

Where,

- \( Z \) = 1.96 at 95% CI.
- \( p \) = prevalence of calcaneum fracture 2 % (references 1-3),
- \( q = 1-p \)
- \( e = \) margin of error, 10%

The minimum sample size was calculated to be 8. Selection bias and interpretation bias was minimized as possible. Data were recorded in the proforma form. The data were then coded and entry was done in the statistical package for the social sciences (SPSS) version 16.0. The data were processed and analyzed by using simple descriptive statistics; in terms of percentage and frequency.
RESULTS

The characteristics of study participants are shown (Table 1).

| Characteristics                              | Findings                        |
|----------------------------------------------|---------------------------------|
| Age in years {standard deviation(SD)} years | 32.4 (10.44) range 18-50 years  |
| Male: female                                 | 13:2                            |
| Laterality (Right:Left)                      | (9:6)                           |
| Mechanism of injury                          | Fall from height                |
| Fractures as per Sander’s classification     | Type II 8 (53.33)               |
|                                              | Type III 6 (40)                 |
|                                              | Type IV 1 (6.66)                |
|                                              | 10.87 (1.68) days               |
| The average duration between the injury to surgery(SD) | Range 8 to 15 days             |
| Mean AOFAS hindfoot score(SD)                | 82.33 (11.01)                   |
| Mean Bohler’s angle (SD) degree              | 26.40 (5.98)                    |
| Mean Follow-up duration in months (SD)       | 14.53 (8.63)                    |

According to the AOFAS hindfoot scores, there were five excellent (33.33%), seven good (46.66%), two fair (13.33%) and one poor (6.66%) results. The outcome of patients in a different type of Sander’s fractures is shown (Table 2).

At the final follow-up out of 15 patients, 4 (26.66%) had Bohler’s angle < 20 degree, and 11 (73.33%) patients had Bohler’s angle of 20 to 40 degree. Comparison of outcomes in Bohler’s angle less 20 degree and between 20 to 40 degree are shown (Table 3). All fractures were united at final evaluation. Out of 15 patients, 4 (26.66%) patients had complications in the form of delayed wound healing which improved with regular wound care and antibiotics.

DISCUSSION

Though there is a conflict regarding operative versus nonoperative treatment in displaced intra-articular calcaneum fractures, there are studies supporting operative treatment over nonoperative treatment. With the advancement in implants and wound care, there is a trend towards the surgical treatment of displaced calcaneum fractures. In the present study, overall outcomes of open reduction and internal fixation in displaced intra-articular calcaneum fractures was satisfactory. Average AOFAS score at final follow-up was 82.33 (SD, 11.01), with 12 out of 15 cases (80%) having excellent to good results and 2 (13.33%) and 1 (6.66%) had fair and poor results respectively. There are various other studies, either they have used similar (AOFAS score) or different scoring systems, they have found more favorable results in the operative treatment of calcaneum fractures similar to our study.

Almeida, et al,9 studied 44 patients with intra-articular calcaneal fractures, managed by open reduction and internal fixation with reconstruction or Y plate, and outcomes were assessed with AOFAS score. At the final follow up, excellent results were achieved in 31.8%, good results in 11.4%, fair result in 29.5%, and poor result in 27.3%. They concluded open reduction and internal fixation can be recommended as a very good alternative to conservative treatment in intra articular calcaneal fractures.

Santosha, et al,10 evaluated the functional outcome after open reduction and internal fixation of displaced intra-articular fractures of the calcaneum by locking calcaneal plates in 24 patients. According to the AOFAS score results were excellent in 43.3% of the patients, good in 33.3%, fair in 10%, and poor in 13.3% of patients. They concluded open reduction and internal fixation of intraarticular fractures of the calcaneum with locking calcaneal plate gives good results.

In a study conducted by Palange, et al.11 20 patients out of 30 had good results, 7 patients had fair results while the remaining 3 patients had poor results. Postoperatively, wound complications were seen in 2 patients which settled after debridement and...
medications. No other complication was encountered. In the study by Rak et al., the overall results according to the AOFAS score were good or excellent in 30/34 (85%) in patients treated by open reduction and fixation with calcaneum locking plate and screws.

Shrestha R, et al. evaluated the outcome of calcaneum fracture using Maryland Foot Score (MFS) managed by open reduction and internal fixation with Locking Branched Calcaneal Plates through the extensile lateral approach. Seventeen cases (77.13%) had good, four cases (18.2%) had fair, and one case (5.5%) had a poor outcome score, similar to our study. They concluded displaced intra-articular calcaneal fractures treated operatively with open reduction and internal fixation with locking branched calcaneal plates through the extended lateral approach, with proper planning of operation and surgical techniques in soft-tissue handling, results in good clinical as well as radiological outcomes.

In the present study, more number of excellent and good cases had Bohler’s angle between 20 to 40 degrees. Kulkarni, et al. compared operative and conservative treatment in displaced intraarticular fractures of calcaneum (n = 15 in each group). They evaluated restoration of Bohler’s angle along with Creighton–Nebraska (C–N) score for functional outcome. At the end of 12 months, a relatively better functional outcome was observed in displaced and comminuted fractures in plating, provided that the Bohler’s angle was restored. They emphasized post-treatment Bohler’s angle has prognostic importance in functional outcome.

Makki, et al. carried out a retrospective review of 47 intra-articular fractures of the calcaneum treated by open reduction and internal fixation. According to AOFAS score, there were 18 excellent (38.3%), 17 good (36.2%), three fair (6.3%) and nine poor (19.2%) results. In this study restoration of Böhler’s angle was associated with a better outcome. They opine osteosynthesis should be considered for intra-articular fractures of the calcaneum to restore the shape of the hindfoot and Böhler’s angle.

Against the result of our study, there are studies where results are not favorable for open reduction and internal fixation. Buckely, et al. studied 471 displaced intra-articular calcaneal fractures were they used the Short Form-36 (SF-36, a general health survey) and a visual analog scale (a disease-specific scale) for outcome evaluation. The outcomes after nonoperative treatment were not found to be different from those after operative treatment; the score on the SF-36 was 64.7 and 68.7, respectively \( (p = 0.13) \), and the score on the visual analog scale was 64.3 and 68.6, respectively \( (p = 0.12) \).

Jarvholm, et al. compared close reduction with open reduction, they concluded open reduction of the intraarticular fracture of the calcaneus may provide stability, allowing early motion and eventually improved subtalar function. However, postoperative complications are common, the overall results of open and closed treatment are almost equal, and the Primary operation of the fractured calcaneus should therefore rarely be indicated.

In a randomized controlled trial conducted by Griffin, et al. operative treatment compared with non-operative treatment showed no symptomatic or functional advantage after two years in patients with typical displaced intra-articular fractures of the calcaneus, and the risk of complications was higher after surgery. They concluded operative treatment by open reduction and internal fixation is not recommended for displaced intraarticular calcaneum fractures.

A meta-analysis conducted by Wei, et al. to compare operative versus nonoperative treatment of displaced intra-articular calcaneal fractures has shown operative treatment of displaced intra-articular calcaneum fracture may lead to a higher incidence of complications but has better anatomical recovery when compared with nonoperative treatment.

The limitations in our study were the small number of cases, the shorter time of follow-up, and no comparison with cases that are treated conservatively.

CONCLUSIONS

In displaced intra-articular calcaneum fractures, open reduction and internal fixation by extended lateral approach with calcaneum locking plates and screws result in a good number of satisfactory outcomes with few unsatisfactory results. Hence, it can be a better option of treatment in displaced intra-articular calcaneum fractures.

Conflict of Interest: None.
REFERENCES

1. 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. [Full Text | DOI]

2. Bruce J, Sutherland A. Surgical versus conservative interventions for displaced intra-articular calcaneal fractures. Cochrane Database Syst Rev. 2013 Jan 31;(1):CD008628. [PubMed | Full Text | DOI]

3. Veltman ES, Doornberg JN, Stufkens SAS, Luijte JSDK, 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. [PubMed | DOI]

4. Palmsheim K, Hines B, Olsen BL. Calcaneal Fractures: Update on Current Treatments. Clin Podiatr Med Surg. 2012 Apr 1;29(2):205–20. [PubMed | DOI]

5. Pelliccioni AAA, Bittar CK, Zabeu JLA. Surgical treatment of intraarticular calcaneal fractures of sanders' types II and III. Systematic review. Acta Ortop Bras. 2012;20(1):39–42. [PubMed | Full Text | DOI]

6. 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. 1993 May;290:87–95. [PubMed]

7. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 1994 Jul;15(7):349–53. [PubMed | DOI]

8. Böhler L. Diagnosis, pathology, and treatment of fractures of the os calcis. JBJS. 1931;13(1):75–89. [PubMed]

9. Almeida VD, Devasia T, Nikku M, Kamath A. Functional assessment following open fixation of calcaneal fractures. J Evol Med Dent Sci. 2014;3(42):10482–89. [Full Text | DOI]

10. Santosh, Gulrez S, Singh AM, Waikhom S, Pakhrin V, Mukherjee S, et al. Open Reduction and Internal Fixation of Displaced Calcaneum, Intra-Articular Fractures by Locking Calcaneal Plate. J Clin Diagn Res JCDR. 2016 Dec;10(12):RC18–21. [PubMed | Full Text | DOI]

11. Palange N, Prasannakumar G, Shah N, Pawar E. Study of functional outcome of displaced intra-articular fractures of the calcaneum treated with open reduction, bone grafting, and plate fixation. J Orthop Allied Sci. 2019;7(1):22. [Full Text]

12. Rak V, Ira D, Masek M. Operative treatment of intra-articular calcaneal fractures with calcaneal plates and its complications. Indian J Orthop. 2009;43(3):271–80. [PubMed | DOI]

13. Shrestha R, Shrestha D, Kayastha SR, Winker H. Displaced Intra-Articular Calcaneal Fractures: Evaluation of Clinical and Radiological Outcome Following Open Reduction and Internal Fixation with Locking Branched Calcaneal Plate. Kathmandu Univ Med J. 2017;58(2):130–36. [Full Text]

14. Kulkarni HG, Mane VS, Gaonkar KL, Patil PP, Shaha MS, Patel NS, et al. Plating for intra-articular calcaneal fractures: Is it an overkill? J Clin Orthop Trauma. 2015 Sep;6(3):153–9. [PubMed | Full Text | DOI]

15. Makki D, Alnajjar HM, Walkay S, Ramkumar U, Watson AJ, Allen PW. Osteosynthesis of displaced intra-articular fractures of the calcaneum: a long-term review of 47 cases. J Bone Joint Surg Br. 2010 May;92(5):693–700. [PubMed | Full Text | DOI]

16. Buckley R, Tough S, McCormack R, Pate G, Leighton R, Petrie D, et al. Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial. J Bone Joint Surg Am. 2002 Oct;84(10):1733–44. [PubMed | DOI]

17. Järnholm U, Körner L, Thorén O, Wiklund L-M. Fractures of the calcaneus: A comparison of open and closed treatment. Acta Orthop Scand. 1984 Jan 1;55(6):652–6. [PubMed]

18. Griffin D, Parsons N, Shaw E, Kulikov Y, Hutchinson C, Thorogood M, et al. Operative versus non-operative treatment for closed, displaced, intra-articular fractures of the calcaneus: randomised controlled multicenter trial. J Bone Joint Surg Am. 2002 Oct;84(10):1733–44. [PubMed | DOI]

19. Wei N, Yuwen P, Liu W, Zhu Y, Chang W, Feng C, et al. Operative versus nonoperative treatment of displaced intra-articular calcaneal fractures: A meta-analysis of current evidence base. Medicine (Baltimore). 2017 Dec;96(49):e9027. [Full Text]