

Original Research Article

Evaluation of results of minimally invasive per cutaneous surgeries in management of calcaneal fractures

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ABSTRACT

Background: To analyze the outcome percutaneous surgeries in fractures of the calcaneum.

Methods: 20 patients admitted in a tertiary care center in Ahmedabad were followed up from admission to until 2 years post operatively and functional outcomes in them following operative intervention were analyzed using AOFAS and Maryland scoring system.

Results: Majority of patients have excellent or good outcome following percutaneous surgery in fractures of the calcaneum. The results were evaluated for 22 people with intraarticular calcaneum fractures using the Maryland foot score and AOFAS score. The mean AOFAS score was 86. There were 6 excellent, 12 good and 4 fair results.

Conclusions: Percutaneous fixation in fractures of the calcaneum is a middle path in treatment of calcaneum fracture having the benefit of better reduction of ORIF plating and lesser soft tissue injury or chances of infection of conservative management.

Keywords: Calcaneum, ST pin, Percutaneous fixation calcaneum, Intraarticular calcaneum

INTRODUCTION

Calcaneum fractures consist of a majority (60%) all tarsal fractures. Most commonly they are following an incident of fall from height (Figure 1).¹ The ideal treatment for this fracture is still debatable, where conservative treatment used to be the treatment of choice in the past, open reduction plating has become the treatment of choice these days, both having their own brickbats and benefits.²⁻⁴

Open reduction though returns the anatomical reduction, technical problems, infection and rarely the need for amputation, prejudiced surgeons against operative treatment. Compared to open procedures, minimally invasive procedures offer the prospect of good reduction with fewer complications.

The purpose of this study is to review our experience of such a minimally invasive reduction and Steinmann pin fracture fixation in the treatment of intraarticular fracture of the calcaneum.



Figure 1: Intraarticular displaced calcaneum fracture: lateral and axial view.

METHODS

This is an observational study carried out over a period of two years at V.S. Hospital, Ahmedabad, Gujarat from 2010 to 2012. Appropriate institutional ethical committee approval was taken before carrying out the study. A total of 20 patients with 22 (two bilateral) displaced calcaneal fractures were studied. Inclusion criteria were skeletally mature patients of both sexes; closed displaced calcaneal fracture; no neurological or vascular deficit; patients giving informed written consent. Exclusion criteria were any pathological fracture; open fracture; patient with any form of neurological involvement or distal vascular deficit; patient not giving consent. Included patients were treated by closed reduction and internal fixation with percutaneous fixation by Essex Lopresti technique.

Procedure of the percutaneous minimally invasive technique

All procedures were done in well-equipped orthopedics operation theatre. Surgeries were performed under general or spinal anesthesia. Patient was kept on simple table in lateral position with a tourniquet. Appropriate painting and draping were done using strict aseptic precautions.

Operative technique

The aim is direct reduction of the displaced fragments to articular surface reconstruction under Image Intensifier control with indirect reduction of the general alignment of the calcaneum. The patient is placed in a lateral decubitus position on a radiolucent operating table with the injured limb uppermost. IITV is introduced and good lateral, axial and Broden's view are obtained before operating.

Step 1

Pin introduction, disimpaction and correction of valgus/varus malalignment to sustentaculum tali. This is achieved with a 4.5 mm ST pin.

Step 2

Reduction of the articular surface under image-intensifier control. In joint depression type, entry is made through the sole while in tongue type entry is made superiorly beside the tendo-achilles. In complex fractures both techniques are combined. Once reduction is confirmed with the image intensifier, the fracture is held with a 2 mm K-wire. An additional 2 mm K-wire is usually placed parallel to the pin, medial to the tendo-achilles.

Step 3

Compression of the heel in order to impact the lateral wall.

Finally, the pins are cut flush with the skin and a sterile, bulky dressing is applied. If needed 4 mm cannulated cancellous screw were inserted to maintain reduction.

Postoperative management

The patients were started range of movement exercises of the ankle and subtalar joint on the second post-operative day and allowed to walk without bearing weight on the affected limb. Most patients with unilateral fractures were discharged after three to four days.

The ST pins were removed after a mean of 8 weeks (8 to 10), depending on the type of fracture and the degree of union, and partial weight-bearing was allowed with full weight-bearing at a mean of 13 weeks.

The present study included 22 cases of calcaneal fractures treated by Essex-Lopresti's technique of closed reduction with percutaneous minimally invasive surgery using percutaneous screws, steinmann pins/K-wires. The basic aim of the surgery was to achieve as near anatomical realignment and optimum subtalar joint congruity as possible.

Assessment of the final result of the study was made using Maryland Foot-score and American Orthopaedic Foot and Ankle society score. The results were statistically analysed using arithmetic mean At follow up, Bohler's tuber joint angle was measured in normal foot, and affected foot at radiological union and ratio was calculated. A watch for development of complications was constantly made.

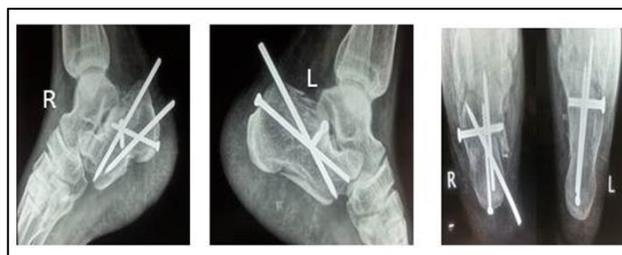


Figure 2: Postoperative intra-articular calcaneum fracture managed with CC screw and ST pin fixation.

RESULTS

In this series of 20 patients, the age distribution is from youngest-around 20 to oldest 49. Maximum age incidence is from 25-34 (81%- 18 patients) the mean age being 30. There is male predominance of the patients in our study with 18 patients being males (90%) and 2 patients being females (10%). Among the 22 fractures, 9 had right side (40.91%) and 11 were left side (50%) and 2 were bilateral (9.09%).

In this series fall from different ground level comprises the major mode of Injuries accounting 16 patients

(72.73%) (Table 1). Majority of the fractures were isolated fractures not involving any other part of the body (77.27%). Injury to the spine was present in 2 patients (Table 2).

Table 1: Mode of injury.

Mode of injury	No. of patients	Percentage (%)
Fall from height	16	72.73
Slipped	2	09.09
RTA	4	18.18
Total	22	100

Table 2: Associated injuries.

Associated injury	No. of patients	Percentage (%)
None	17	77.27
Spine	2	09.09
Others	3	13.64
Total	20	100

In this series 18 cases (81.81%) were intra-articular with 11 (50%) were Joint depressing and 7 (31.81%) were tongue type and 4 (18.19%) were of extra-articular variety of tuberosity or sustentaculum type.

Table 5: Clinical and radiological outcome.

Parameters	Joint depressing	Tongue type	Extra-articular	Total	Percentage (%)
Bohler Angle					
<20 degree	2	2	1	4	18.2
>20 degree	9	5	3	18	81.8
Impalnts used					
Screws ± ST pins	9	6	1	16	72.73
ST pin ± K wires	2	1	3	6	27.27
Complications					
Broadening of heel	5	1	2	8	36.36
Loss of height	5	2	0	7	31.81
Varus	2	0	1	3	13.63
Restricted movement	3	1	0	4	18.18
Wound complication	1	0	1	2	09.09
Removal of implant	0	1	0	1	04.54
Mal-union	1	0	0	1	04.54
Subtalar arthritis	1	1	0	2	09.09
Change of job	3	2	1	6	27.27
Limp	1	1	0	2	09.09
Pain	3	2	1	6	27.27
Flat foot	1	0	0	1	04.54
Results					
Excellent	3	2	2	7	31.82
Good	5	5	2	12	54.55
Fair	3	0	0	3	13.63
Poor	0	0	0	0	00
Total	11	7	4	22	100

In this series of patients operated by minimally invasive percutaneous technique 16 (72.73%) were treated through screws ± ST pins and 6 patients (27.27%) with ST pin ± K wires (Table 3). The average duration after the injury when patient was operated is 2 days in our study (Table 4). Earlier operation does not have any correlation with incidence of infection.

Table 3: Operative intervention.

Type of operation	No. of patients	Percentage (%)
Screws ± ST pins	16	72.73
ST pin ± K wires	6	27.27
Total	22	100

Table 4: Time after injury when operated.

Time after which operated (days)	No. of patients	Percentage (%)
01	7	31.82
02	12	54.55
03	3	13.63

In this series, there were 11 joint depression type fractures. Their average MFS score was 86.2 and AOFAS score 84.5. Of these, 3 had excellent outcome, 5 had good and 3 had fair results. There were 7 tongue type fractures, whose mean MFS score was 85.1 and AOFAS score was 88.7. Of these, 2 had excellent, and 5 had good outcome. There were 4 extraarticular fractures whose mean MFS score and AOFAS score was 91 and 92.3 respectively. Of these, 2 had excellent and 2 had good outcome.

There was radiological union in 21 (95.45%) patients. In most 16 (72.73%) cases duration of incapability was 4 months. Loss of reduction was seen in 1 (4.54%). Pain remained in 3 (13.64%) cases. Two (9.09%) cases recorded infection at operated site with 4 (81.82%) had difficulty in wearing shoes on follow ups. There was subtalar joint arthritis in 2 (9.09%) cases and flat foot in 1 (4.54%) case. Table 5 tabulates the clinical and radiological outcome in our study correlating with the fracture type.

In this series the Gissane's angle was restored to <130 degrees in 21 out of 24 cases. Out of the 3 cases which did not reach <130 of Gissane's, 2 had fair outcome while the third has good. The Bohler's angle was restored to within the normal range of 20-40 degrees in or study in 20 out of 24 cases. In the 4 cases where it was not achieved, 2 had fair outcome whereas 1 had Good and 1 had excellent outcome.

In this series, 16 patients (72.73%) were able pursue their routine work and around 4 patients (18.18%) needed to change the job and around 2 patients (9.09%) yet to resume.

DISCUSSION

Calcaneus fractures are usually affecting young males with economically active age group which contributes to significant socio-economical loss.

In present study, by observing the stratified distribution of the patients, it was shown that 90.91% were within 20 to 40 years old, and only 9.09% were old aged, goes with the statement that this condition affects individuals who are working for economic reasons. Nambiar noted that 56% of his patients were in the 3rd to 4th decade of life, Parmar noticed age range between 16-64 with mean age 50.9 years and Buckley noted that in his study the maximum age incidence was between 30-39 years (60%) with age range between 15-68 years.⁴⁻⁶

In this present study 20 patients were males (90.91%) and 2 patients were females (9.09%), showing male preponderance (M:F- 9:1). Parmar noted male to female ratio of 2.3:1, Pozo 4:1, Nambiar 10:1 and Paley 6:1.^{4,5,7,8} In our society, male population works for earning to serve the family.

The most common mode of injury of calcaneus intra-joint fractures, as reported by literature, is the fall from different ground levels, which was confirmed by this study, where this, kind of fall accounted for 72.73% of the fractures.⁹⁻¹¹

Due to the axial mechanism of trauma, existence of associated injuries is possible. Various authors report this fact occurring in percentages ranging 8.5 to 46% of patients.¹¹ In this study, other injuries were found in 22.72% of the patients. Hildebrand reported associated spine fractures in 10% , Buckley reported 15% and Nambiar reported 21% associated spine injuries whereas in this study spine injuries accounted 09.09% of cases.^{4,6,12}

In accordance to Essex-Lopresti's classification, intra-articular fractures may be tongue-type or joint depression-type.¹³ In most of the case series, joint depression-type fractures are the most prevalent, accounting for 61% of intra-joint fractures.¹⁴⁻¹⁶ In this study, we found 50% of joint depression-type fractures and 31.81% tongue-type fractures. The kind of fracture were related to outcome and return to work.

For the surgical treatment, there is a consensus of waiting sometime between trauma and surgery, ranging from immediate to 5 days for percutaneous surgeries so that edema could be reduced and for preventing blisters to be formed, except in open fractures, which should receive immediate surgical care. In this study, the time interval between trauma and surgery for all the fractures was, in average, 1 to 3 days.

Patients treated using percutaneous technique could be operated on as soon as possible after injury. Levine and Helfet, in their series of intra-articular fractures of the calcaneum treated with a minimally-invasive technique, were surprised that subtalar movement was almost completely preserved despite an articular surface reconstruction described as 'nearly anatomical'.¹⁷ Thermann et al advised minimally-invasive fixation for cases with severe soft-tissue contusion, compound and Sanders type-IV fractures, and in multiply-injured patients.¹⁸ In present case study all patients were treated by minimally invasive percutaneous surgeries

The Bohler's angle, considered as normal within measurements ranging from 20° to 40°, is used for indication changes on the posterior joint facet and for qualifying fracture resolution. Loucks and Buckley performed a prospective and randomized study to evaluate the Bohler's angle and they observed that surgical treatment improved angle graduation as well as the functional status. The stated that fractures with a Bohler's angle markedly reduced at the immediate post-trauma period provided bad outcomes and they suggested that the high energy of trauma produces angle flattening, with a more extensive bone and soft

parts injury. In this study, variations between 10 and 40 degree were found. The value of this angle showed a correlation with the quality of outcome. This study shows that 20 of the reductions with an angle above 20° presented good and excellent outcomes. We have compared our analysis with Paley who did a similar analysis and has similar conclusions.¹⁰

In the evaluation of the results by AOFAS and Maryland foot score scale, we found the results in various clinical studies ranging from 65% to 80% of excellent results for percutaneous surgeries in fracture of calcaneus. In our study, outcomes were considered as good and excellent in 86.36%. O'Farrel et al reported that 66.66% of the patients submitted to surgery returned to work, while in our study 20(90.91%) were managed to return to work of which 16 (72.73%) returned to original work while 4 (18.18%) required a change in job.¹⁹

No major complications are associated with percutaneous approach. In early complications our study shows 2 (9.09%) infection with wound complication which were managed conservatively. In the Late complications our study marks loss of reduction in 1 (4.54%) case, mal-union in 1 (4.54%) case, subtalar joint arthritis in 2 (9.09%) case and flat foot in 1 (4.54%) case. This is comparable to Nambiar (13%), Poupa (17%) and Tornetta (10%) who had reported subtalar arthritis in their series.^{4,20,21}

33% of all calcaneal fractures are extra-articular. These percentages were calculated before the description of various types of avulsion fractures and might have been underscoring the number of extra-articular calcaneal fractures.^{22,23} In our study extra-articular fractures contributed 18.19% comprising of tuberosity (13.63%) and sustentaculum (4.54%) types. Patients with an extra-articular calcaneal fracture were significantly younger but male-female ratio was negligible. This is explained largely by the divergence in trauma-mechanism. The intra-articular calcaneal fractures occur frequently as work-related high-energy accidents and the extra-articular mainly as distortion injuries.^{23,24}

CONCLUSION

The percutaneous fixation method requires neither a specialist nor any expensive technical equipment but also due to its undemanding nature, short hospitalization and less complication it is very acceptable by patients. Application of percutaneous reduction and fixation methods to all types of calcaneal fractures carries a considerable risk to inadequate joint reconstruction and re-dislocation. Also lower Bohler's angle has significant association with unsatisfactory result. Intra-articular fractures in patients at increased risk from a formal open reduction can be treated safely with a minimally-invasive technique. Tongue-type fractures can be successfully treated using a minimally-invasive technique while joint

depression fractures are generally difficult to reduce. In extra-articular fractures treated with surgery the return to daily routine activities is good compared to the conservatively managed extra-articular fracture.

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