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Functional outcome of intra-articular tongue type of calcaneus fractures treated with percutaneous technique

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ABSTRACT

Background: Intra-articular calcaneus fracture is relatively rare and morbidity correlates with displacement and relative alignment of fragments. The treatment should address both components to maintain mechanics of foot. Among the available options open reduction and internal fixation is associated with major soft tissue complications and wound healing problems. As an alternative percutaneous fixation offer fewer complications yet good results for less severe calcaneus fractures. Our study aimed to contribute paucity of data available for these rare fractures and help to propose a preferred method of treatment.
Methods: A hospital based study carried out on 20 patients over period of 2 year with closed displaced intra-articular tongue type of calcaneal fracture treated with percutaneous fixation and outcome was evaluated using clinical, radiological criteria and American Orthopaedic Foot & Ankle Society (AOFAS) score. All patients were followed up for minimum 9 months with mean follow up of 13.5 month.
Results: All patients had evidence of union within 2 month follow up. Mean correction in Bohler angle and Gissane angle was 23.2° and 25.4° respectively at final follow up. Mean change in heel height was 3.15 mm and width change was 2.75 mm compare to opposite side. Mean eversion inversion arch was 28° and near normal ankle range of motion. Functional outcome calculated on bases of AOFAS score revealed 18 patients (90%) had good results and 2 patients (10%) had fair results. Mean AOFAS score was 81.25. Complications were reported in three patients, one had signs of peroneal tendinitis and two had persistent pain and heel widening.
Conclusions: We believe percutaneous fixation should be considered as a preferred method for mild to moderately displaced tongue type of intraarticular calcaneus fractures. It potentially allows anatomical fracture reduction with lesser complications and good functional outcome.

Keywords: Calcaneus fracture, Tongue type, Intra-articular, Percutaneous technique

INTRODUCTION

Calcaneal fractures are a cause of significant concern and long term morbidity in patients. It account for approximately 2% of all fractures and displaced intra-articular fractures comprising 60% to 75% of these injuries.[1] The management of such fractures has evolved through years from non-invasive plastering techniques to aggressive open reduction and plate fixation in recent years.

The ideal choice of treatment, operative technique and postoperative management for displaced intra-articular calcaneal fractures has still remained controversial. The recent consensus, based on evidence from numerous studies with large patient cohorts suggest that anatomic

restoration of the calcaneal shape and joint congruity predict higher functional scores and a lower incidence of post-traumatic subalar arthritis with potentially less need of secondary subtalar fusion.[2-5] The wound complications however remains a major concern with open reduction because of the thin and vulnerable skin over the lateral calcaneal wall which is exposed during surgery which may succumb to marginal necrosis and infection. Reported rates of wound edge necrosis and infection is significantly associated with extended lateral approach.[2,3,6,7] Therefore, a number of authors have proposed closed reduction and minimally invasive fixation to minimize soft tissue problems in the treatment of calcaneus fracture.[2,3,8-10]

The method of closed reduction with percutaneous pin leverage and subsequent plaster immobilization was introduced by the German surgeon Westhues in 1934.[11,12] In a review compiled in 1938, C.W. Goff of Hartford, Conn., described and illustrated more than 40 different operative treatment methods for displaced calcaneal fractures, most of which included some form of percutaneous reduction and skeletal traction.[13] The Westhues method was later modified and popularized by Gissane and Essex-Lopresti in the literature.[14,15]

The purpose of this study was evaluation of functional outcomes in terms of clinical and radiological criteria in percutaneous screw fixation of Essex-Lopresti 'tongue' type intra-articular calcaneal fractures. We believe our observation presented in this study will contribute to the paucity of data available for these rare fractures and help to propose a preferred method of treatment.

METHODS

A hospital based study was performed spanning 2 years from May, 2014 to April, 2016. Total 46 patients (64 feet) with intraarticular calcaneus fracture were treated. Of those, 20 patients treated with percutaneous method were selected for study based on inclusion and exclusion criteria. Informed and written consents were taken from patients prior to their inclusion in study. Only skeletally mature patients with closed Essex–Lopresti tongue type of fractures treated with percutaneous method were included in study. All patients with Essex-Lopresti joint depression fractures, open fractures, patients with other fractures in the ipsilateral lower extremity, patients treated other than percutaneous method and patients lost follow-up were excluded from the study. All patients had standard lateral and axial radiographs taken for evaluation of the fracture pattern. All fractures were classified according to Essex-Lopresti classification.[15]

Surgical method

All patients in study were operated within 1-6 days from date of injury (average 2.8 days). The patients were operated on a radiolucent table in lateral position with the affected side up. Fractures were fixed using 4.5 mm cortical screw, 4 mm and 6.5 mm cannulated cancellous and cancellous screws either alone or used in combination according to the requirements of fracture.

Firstly, a Steinmann pin was inserted transversely over postero-inferior portion of calcaneal tuberosity and posterior talocalcaneal joint was distracted using manual traction manoeuvre. Next step was elevation of the displaced tongue fragment using Steinmann pin inserted under image intensification into the posterior superior portion of calcaneal tuberosity inside depressed fragment, directed forwardly and downwards avoiding penetration into subtalar joint (modified Essex-Lopresti manoeuvre).[15-17] Heel varus/valgus was corrected using the transverse Steinmann pin. Following reduction provisional fixation of the fragments was done using multiple Kirschner wires (K-wires) if reduction unstable. The reduction was assessed intra-operatively using the lateral, axial and Broden's views.[18,19] Final fixation of the fragments was done using screws. Primary fracture line was fixed first followed by secondary fracture line. Each major fragment was fixed to another fragment using screws improving the fixation construct. Final fixation and subtalar motion was checked and confirmed for stability and quality of reduction of the fracture under image intensifier.[3,16,17]

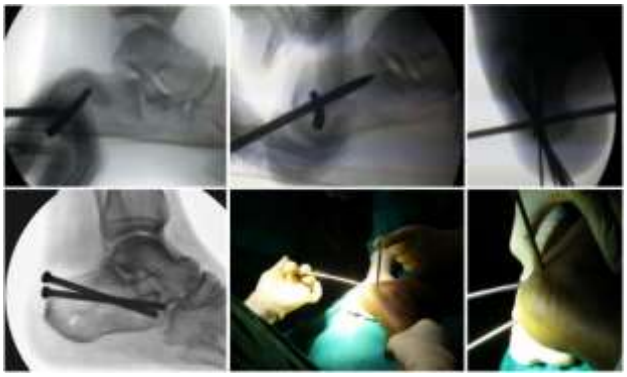

Figure 1: Intra-operative fluoroscopic and clinical images.

Postoperatively, below knee plaster given for a period of 4 weeks after which ankle and foot mobilizing exercises were allowed. All patients were kept non-weight bearing on the injured limb for a period of 8 weeks following which gradual progression to unassisted full weight bearing gait was allowed.[3]

The patients were evaluated subsequent monthly follow-up minimum up to 9 months (average 13.5 months). Standard radiographs of the affected as well as the normal calcaneus were taken (lateral, axial views). They were evaluated for union and loss of reduction as well as for the Gissane and Bohler angles.[14,20] Clinically the patients were evaluated using the AOFAS scoring system to quantify functional outcome.[21] This score assigns a maximum of 40 points for pain, 50 for function, and 10 for alignment resulting in a total maximum of 100 points.

A score of 90-100 was graded as an excellent result; 75 - 89 as good; 50-74 as fair, and less than 49 points was graded as a failure.[21] Ankle - foot movements and dimension measured. Heel height and width and the angles of Bohler and Gissane on preoperative and immediate postoperative radiographs were compared with the follow-up values and with normal values of the opposite uninjured limb.[21] Data statistically evaluated using SPSS Software.

RESULTS

There were 18 (90%) male and 2 (10%) female in studied group with mean age 39 year (range 28-51 year). Among them fall from height was most common cause (85%) followed by road traffic accidents (15%). All patients were operated within average 2.8 days (range 1-6 days) with average hospital stay of 5.9 days (range 4-12 days).

During subsequent follow up, radiological evidence of union was observed within 2 months in all patients. Pre-operatively mean Bohler angle was 2.9° and 26.1° postoperatively which changed to 24.95° at final follow up (minimum 9 months with average 13.5 months). Gissen angle was 131.15° preoperatively and 108.3° at final follow up. We have used Wilcoxon index for analysis as our data was not evenly distributed. Based on Wilcoxon index calculated P value was <0.0001.

Table 1: Statistical analysis of correction in radiological parameters.

Radiological Parameter	Pre op	Post op	Final follow up	Wilcoxon Index	P Value
Bohler Angle	2.9±11.37	26.1±10.70	24.95±10.37	3.921	<0.0001
Gissen Angle	131.15±14.66	105.75±11.65	108.3±11.61	3.681	<0.0001

At final follow up heel height was average 58.15 mm on affected side compare to opposite side (61.3 mm) difference was 3.15 mm and heel width on affected side was 55.85 mm and on opposite side was 53.1 with difference been 2.75 mm.

Table 2: Physical dimension of heel at final follow up.

Physical dimension of heel at final follow up	Affected side	Opposite side	Difference
Heel Height	58.15 mm	61.3 mm	3.15 mm
Heel Width	55.85 mm	53.1 mm	2.75 mm

Range of inversion/eversion was 25°-40° in 75% patients and 10°-25° in 20% of patients and 5-10° in 5% patients (average 28°). Ankle range of motion was near normal in all cases. At final follow up 90% had good result and 10% had fair result. Mean AOFAS score was 81.25 (range 70 - 87).

Figure 1: Pre-operative and post-operative x-ray. a) case-1 b) case- 2.

One patient had pain over lateral aspect of heel during 2 month follow up; he was diagnosed with peroneal tendinitis and was treated conservatively with oral NSAIDs. Two patients had persistent pain and heel widening at average 6 month follow up which required footwear modification and physical therapy. Wound and implant related complications were not observed.

Figure 3: Clinical images.

DISCUSSION

Conservative management of intra articular calcaneal fracture is associated with poor outcome due to secondary sub-talar arthritis and mal-union.[22] Comparing operative vs. non operative technique, patient treated with operative method shows significant improvement in AOFAS score as described by Thordarson and Krieger in their series.[23] They reported mean AOFAS score, 86.7% in surgically treated patients compare to 55% in non-surgically treated patients.

Among surgical options open reduction and internal fixation by lateral extensile approach is widely used and offers better anatomical reduction but it's associated with higher chances of wound related complications and infection.[2,3,6,7,24-27] Moreover in high risk patients like

diabetics, smokers, drug addicts and open fractures the complication rate further increases. The soft tissue dissection and scarring that follows open procedures further leads to a compromised functional outcome.[26] Percutaneous fixation of calcaneal fracture minimize or virtually abolish the chances of wound and implant related complications those are associated with open reduction by extended lateral approach.[9,16,17] Functional outcome depend upon careful patient selection, surgical timing, meticulous operative reduction technique and post-operative care.

Patients with ipsilateral other bone fracture in lower limb were excluded from study because we believe that it might produce bias in evaluating final outcome and may alter study results. Study published by Stulik et al shows that joint depression fracture is difficult to reduce with percutaneous mini-invasive method and result are inferior so we have excluded these fractures from our study and we do not prefer this treatment for joint depression type of intra-articular calcaneal fractures.[28]

The method we used included slight modification of original technique where reduction is maintain by either Steinmann pin or Kirschner wire that passed from posterior tuberosity to anterior calcaneus or cuboid immediately inferior to facet and left in place till union take place.[15] Instead we used 3.5 mm, 4.5 mm cortical screws and 4 mm, 6.5 mm cancellous and cannulated cancellous screws of various lengths for propping of posterior facet, fixation of sustetacular antero-medial fragment along with primary fracture line and anterior process up to calcaneocuboid joint to hold postero-lateral fragment.

Time between injury and operation plays crucial role in managing patients and possible outcome as far as mini-invasive techniques are concerned. We concur with Stefan Rammelt and Tornetta that early surgery has many advantages as it lessens soft tissue swelling and earlier resolution of the edema as the normal anatomy is regained, it helps in better reduction as mobilization of the displaced fragments is easy initially.[2,16] A delay of more than 14 days makes it difficult for percutaneous reduction methods and conversion to open reduction becomes higher.

Mean correction in Bohler angle by percutaneous method was 18.7° in series published by Mateen et al.[29] Mean correction ≥20° was achieved in series of intra-articular fractures treated with locking and non-locking plates by Vaclav et al.[30] In our series mean correction was 22.1°.

Many studies point out restriction at subtalar joint in both surgically and conservatively treated fractures. The average range of motion is approximately halved compared with the uninjured foot.[31] Similar findings were present in a study published by Levine et al, treatment of intra-articular calcaneus fracture by percutaneous method.[32] They believe that minimal dissection result in less post-operative swelling, less peri-articular scarring and improved range of motion than formal open reduction, despite imperfect restoration of joint surface. In our study 28° of average subtalar motion was observed while in study published by Jain et al it was 17° by open reduction method.[33] In study of treatment by closed method, Schepers et al observed average range of motion 20° (5°-40°) at subtalar joint. Subtalar movement was better preserved in our patients.[34]

The incidence of pin tract infection and superficial infection minimized in close reduction and fixation technique, where screws applied percutaneously and buried underneath the skin.[2,8-10,16,32,35] In our series superficial or deep infection was not seen. Smaller implants were used for treatment so implant related problems were not seen as well. In our series, the radiographic parameters like the Bohler and Gissane angles along with calcaneal height and width were corrected to near normal at follow-up indicating restoration of the normal calcaneal anatomy. In our study, two patients had diffuse post-operative pain over heel on walking and one had pain over lateral aspect of heel while walking which were mild in intensity. The causes of pain were related to deformity, articular damage to posterior facet, heel widening causing impingement over lateral malleolus and disruption of heel pad. In study published by Schepers et al, treatment of intra articular calcaneus fracture by closed method, reported mean AOFAS score was 83 and Zachary et al in their study of treatment by open method, observed mean AOFAS score was 72 whereas Jain et al observed 86.3 in their series of treatment by open method. In our study mean AOFAS score was 81.25 which is comparable to other studies.[33,34,36]

The quality of joint reduction can also be improved using mini-open techniques like the arthroscopy or sinus tarsi approach which provide a direct view for reduction and evaluation of the correction.[2,27] Percutaneous techniques combined with a mini-open approach can increase the indications of using this technique for simple joint depression fractures.[27] Limitations of our study are the small number of patients and no direct comparison with another method of treatment. CT-Scan was not done uniformly in all patients so we have not considered in our study though it provide better information about fracture

CONCLUSION

Percutaneous treatment minimizes soft tissue complications and postoperative scar formation and therefore appears preferable to open reduction and plate fixation via an extended lateral approach in properly selected cases of mild to moderately displaced fractures.

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