

Functional Outcome in the Calcaneus Fracture

Sajid Khawaja^{1*}, Levent Bayam² and Jan Muhammad³

¹Consultant Orthopedic and Trauma, Maryam Memorial Hospital, Rawalpindi, Pakistan

²Assistant Professor, Sakarya University Hospital, Turkey

³Specialist Registrar Northampton General Hospital, UK

***Corresponding Author:** Sajid Khawaja, Consultant Orthopedic and Trauma, Maryam Memorial Hospital, Rawalpindi, Pakistan.

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Abstract

Management of the calcaneus fracture has been a debate among surgeons. There are plenty of publications suggesting and proving different management plans for the calcaneus fracture to achieve better functional outcome.

This retrospective analysis of literature is to find out the optimal management of the calcaneus fractures to achieve better functional outcome.

Literature was reviewed keeping in view the optimal management of the calcaneus fractures. Internet, Google search engine and hospital library for recent surgical journals were searched.

Keywords: *Functional Outcome; Calcaneus Fracture*

Introduction

The calcaneus is a cancellous bone, which usually breaks after road traffic accidents or fall from height. The calcaneus fracture accounts 2% of all adult fractures. 30% of the fracture of the calcaneus is extra articular while around 70% are intra articular. Posterior articular facet of the calcaneus is the main weight bearing area in subtalar joint and is involved mostly in intra articular fracture of the calcaneus.

Of all the fractures of the calcaneus approximately 15% are open and about 10% involve spine, pelvis or contra lateral side of the calcaneus.

Fracture of the calcaneus leads to complications. Some patients are not able to get back to previous work, wear same size of shoes or continue sports activities. It leads to long term hospital stay, potential complications of operative intervention, long term rehabilitation and socioeconomic burden.

Fracture of the calcaneus can be managed without operation that is with elevation of foot above heart level, rest, ice packs application over foot, plaster application and non-weight bearing over the fractured side for about 8 to 12 weeks depending on clinical and radiological evidence of healing of the bone.

The fatalism surrounding the intra articular fracture of the calcaneus has directed treatment toward a predominance of nonsurgical or semi open options. Although surgical procedures were attempted in past, because of a lack of thorough understanding of the patho anatomy and perhaps the lack of fixation devices, results were poor and these procedures were soon abandoned. Patients were basically

told that either they would develop hind foot stiffness with tolerable pain and would be able to live with their disability or that a subtalar fusion would be performed at a subsequent date if necessary. With the development of the CT scan and improved fixation techniques, a trend toward Open reduction and internal fixation (ORIF) has developed over the last 10 to 15 years [1-5].

The study of management of fracture of the calcaneus dates back to 18th century. The School of Non-Reduction and Conservative Treatment was Founded in France in 1720 by Petit and Desault who advised "Rest until the Fragments have consolidated" [6].

In 1908, Cotton reported closed reduction to reduce disability caused by such fractures [7].

In 1922, Leriche published first time the internal fixation of fracture of the calcaneus [8].

In 1927, Wilson documented open reduction and also subtalar arthrodesis through lateral approach on 26 patients with excellent results in fresh fractures [9].

In 1928, Lenormant explained that defects created during open reduction and internal fixation of intra-articular fracture of the calcaneus can be filled up with bone grafts. Bone graft can be autogenously or allogeneous, Polymethylmethacrylate cement (PMMA) or synthetic bone substitutes. Though usually bone graft is not required during surgery of the calcaneus and there is no strong supportive evidence of its use as well.

In 1943, Gallie described posterior approach for subtalar fusion [10].

In 1943, Amendola too used bone graft for fusion of subtalar joint [11].

In 1946, Gallis advised traction with three pins and used ring with adjustment followed by sub talar arthrodesis. Later Gissaine recommended elevation of depressed fracture of the calcaneus using Gissaine Spike [12].

In 1948, Palmar devised open reduction and elevation of depressed fragment of the posterior articular surface and advised fixation by a pin [13].

In 1952 Essex and Lopresti suggested classification of fracture of the calcaneus. They Described Open reduction, elevation and bone grafting in the cavity so created with cortico- cancellous bone from the ileum [14].

Dick in 1953 and Hall MC, Penal GF in 1960 suggested and reported results of Primary sub talar Arthrodesis for comminuted fractures of the calcaneus [15].

In 1975, Robert, Seour and Remy described Open Reduction and of Thalamic Fractures of the calcaneus by Rotation and use of Kirschner (K) wire for Fixation [1].

Historically fracture of the calcaneus has been treated non-operatively. Until 1970 non-operative treatment of the calcaneus was more popular because of complications related to surgical intervention. With advancement of AO/ASIF (Association for Osteosyntheses/Association for the Study of Internal Fixation), implants and surgical techniques post-operative complications of fracture of the calcaneus are remarkably reduced.

Optimal management of fracture of the calcaneus is controversial. There are multiple trials to judge the clinical outcome in operative and non-operative intervention of fracture of the calcaneus.

Parameters which are measured in clinical outcome are pain score, return back to work, and wear same size of shoes as before operative intervention, need of subsequent subtalar joint fusion, injury specific score, radiological improvement after specific treatment of fracture, worker's compensation affected outcome and general health outcome measures. Different scales and parameters have been used in different clinical trials, some of the questions in functional outcome have been answered and some still need to be explored.

The Cochrane data base review

The Cochrane data base was reviewed in 2013, in which four clinical trials were reviewed to compare operative vs. non-operative treatment in displaced intra articular fracture of the calcaneus. Buckley conducted one of the largest randomised control trials, multi-center, 424 participants who had surgical intervention with plate, screws and wire fixation with follow up 2 to 8 years [16]. He found no significant clinical difference in outcome in both groups. Though he found around 17% superficial and 5% deep wound infection in operative group. He also noticed more patients who were on conservative treatment underwent for subtalar arthrodesis for symptomatic subtalar arthritis and had 1% patients who needed metal work to be removed later.

He also suggested that those patients who have anatomic reduction of intra articular fracture of the calcaneus have better outcome and those patients who does not have anatomical reduction with surgical intervention have no better outcome than those who are managed without any surgical intervention.

Patients who were not on Worker's compensation and young women had better satisfactory score with surgical intervention.

Other three trials were conducted by the Chrintz, Parmar and Thordarson.

Parmar conducted single center study with 66 patients who underwent K wire fixation [17]. With 1 to 2 years follow up.

He found no difference in two groups of patients who were managed operatively and non-operatively in terms of ability to walk unlimited distance or walking without a limp and pain.

Chrintz also found no difference in functional outcome in operative and non-operative group of patients with fracture of the calcaneus.

Though a small trial conducted by Thordarson., *et al.* but proved better results in surgical intervention of intra articular fracture of the calcaneus [18]. Thordarson's operative technique was open reduction and internal fixation with plate and screws. He found that more patients were able to wear all kind of shoes who were treated with surgical intervention and more patients developed subtalar arthritis that were treated non-operatively.

A recent multicenter randomised control trial of 151 patients with displaced intra articular fracture of the calcaneus was conducted by Griffin and Parsons., *et al.* and published in 2014 [19]. They compared operative and non- operative intervention of the calcaneus with 2 years follow up. They found no difference in functional outcome in two groups and found more complications in patients who were treated surgical.

Randle., *et al.* did perform a meta-analysis in which he reviewed 6 articles where operative and non-operative treatment of intra articular fracture of the calcaneus was compared [20]. He found better functional results in patients who were treated operatively in terms of getting back to original work and he also found that operative group of patients had less painful foot

Better long term functional results were found in surgically treated patients with intra articular fracture of the calcaneus by Agren., *et al.* in his randomised multicenter controlled trial [21]. The main aim of surgical intervention in fracture of the calcaneus is to restore anatomy of the calcaneus and congruity of subtalar joint which provides better range of movement, early recovery and get back to work and avoid long term complications. Advancement in surgical technique have improved functional outcome in fracture of the calcaneus though it is still challenging for surgeons.

Correction of Buhler's angle

If joint congruity is restored surgically then delayed need of subtalar joint fusion because of degenerative changes is markedly reduced and functional outcome will be better. Importance of correction of Bohler's angle is controversial though some studies have mentioned it one of the prognostic factor.



Figure 1

Paul, *et al.* reviewed 70 patients for 6 years who were managed operatively and non-operatively [22]. He found best outcome in patients who were managed non-operatively for un-displaced fracture of the calcaneus and worse outcome in patients who had surgical intervention for displaced intra articular fracture of the calcaneus and Bohler's angle was not restored.

While Ibrahim, *et al.* in his randomised control trial of 26 patients who were followed up to 15 years, found no correlation in correction of Bohler's angle as for functional outcome in fracture of the calcaneus is concerned [23].

Loucks, *et al.* mentioned Bohler's angle as a prognostic factor for functional outcome in fracture of the calcaneus [24]. Initial depression of Bohler's angle is prognostic factor to predict long term functional outcome in intra articular fracture of the calcaneus.

All above mentioned clinical trials have small number of patients with short term follow up. Further clinical trials at larger scale are required.

Primary subtalar fusion in fracture of the calcaneus

Severely comminuted fractures with significantly reduced Bohler's angle and open fractures carry higher complication rate and functional outcome in these patients is not significantly better whatever the treatment is offered. Schepers have advised primary subtalar fusion in highly comminuted fracture of the calcaneus [25].

Csizy, *et al.* is in favour of primary arthrodesis in Sander's type 4 intra articular fracture of the calcaneus [26].

Janson, *et al.* managed 17 patients of severely comminuted intra articular fracture of the calcaneus with primary arthrodesis and followed up these patients for about 3 years. They found better functional outcome in these patients [27].

Radnay, *et al.* found better functional outcome after subtalar joint fusion in those patients who had open reduction and internal fixation as initial treatment [28].

External fixation of fracture of the calcaneus

Severity of the fracture of calcaneus, intra-articular displacement, comminution and soft tissue condition play important role in deciding choice of implant in surgical intervention of this fracture. External fixator is one of the options in open fracture or severely comminuted intra-articular fracture of the calcaneus.

Besch., *et al.* showed no difference in functional outcome in their 7 year follow up of 37 comminuted and displaced intra-articular calcaneal fractures complicated with severe soft tissue swelling, compartment syndrome and 4 open fractures [29]. They managed half of 37 with hinged external fixator definitively and the other half with internal fixation after initial management with external fixator. They recommended hinged external fixator.

Sengodan in his study of 17 patients with calcaneus fractures, both intra-articular and extra-articular treated with external fixator found that all fractures healed at 55 days, patients could fully weight bear at 11 days and returned to work in 6 weeks [30]. He concluded that external fixator is a better option in manual workers to get them back to work early.

Both the above-mentioned studies have limited number of patients and short term follow up, however, external fixator as definitive treatment is still a better option if satisfactory reduction can be achieved by closed maneuver in a comminuted calcaneus fracture with compromised soft tissue condition.

K wire and screw fixation of fracture of the calcaneus

Minimal intervention of intra-articular fracture of the calcaneus with K wire or percutaneous screw fixation can potentially avoid or minimize wound related complications post operatively which are big concern for surgeons.

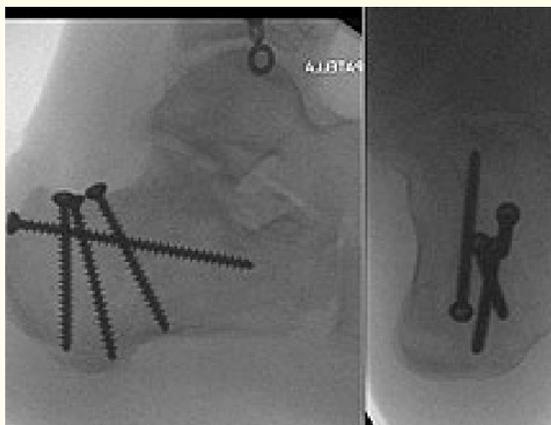


Figure 2

Nagesh., *et al.* studied 37 patients from 2000 to 2011 with closed displaced intra-articular fracture of calcaneus managed with multiple K wires and followed up for 2 to 9 years [31]. They found more than 90% of patients got restoration of heel shape and all returned to work. They found only one patient who had superficial wound issues and had diabetes. They included patients who sustained intra-articular fracture of calcaneus after a fall from height and excluded the patients who sustained the fracture in a road traffic accident. This study though small and does not mention the extent of intra-articular involvement but nonetheless is very cost effective surgical intervention.

Rammelt., *et al.* reported better results in type 2, as per Saunderson's classification, of closed intra-articular calcaneus fractures managed with minimal invasive surgery achieved by closed reduction and percutaneous screw fixation [32]. They found no wound complications and Bohler's angle and heel width were corrected to almost normal.

K wire or percutaneous screw fixation of calcaneus fracture involves minimal soft tissue disruption and hence low rate of infection and wound related issue in such group of patients. The technique and the choice of implant are cost effective and minimally displaced closed fractures of the calcaneus can be managed by K wire or percutaneous screw fixation.

Fracture of the calcaneus in older patients

There is no age-related restriction for operative treatment of the calcaneus fracture, low functional demand patients like elderly and children do well with surgical intervention.

Traver, *et al.* [33] found better functional outcome in the group of patients with age above 50-year-old compared to the group with age less than 50-year-old with ORIF of the calcaneus.

Dolfi, *et al.* they found better range of movements and patients' satisfaction in patients 65 years old or above and treated with open reduction and internal fixation [34].

Fracture of the calcaneus in old children

Fracture of the calcaneus is rare in children but surgical intervention has better outcome in this age group as found by Yu, *et al.* in his clinical trial [35].

Careful selection of patients for operative treatment of fracture of calcaneus is vital to achieve a better functional outcome. Older patients and children who have low functional demand may do better with operative intervention than younger and more active patients. However, older patients with multiple co-morbidities and those who are at high risk for surgical intervention are best considered to be managed conservatively.

Compartment syndrome in fracture of the calcaneus

Compartment syndrome of the foot can be diagnosed clinically and by measuring intra-compartmental pressure. Symptoms and clinical signs of compartment syndrome of foot are;

1. Severe and tense swelling of the foot.
2. Pain out of proportion and increased demand for analgesia.
3. Pain on passive dorsiflexion of toes/ankle.
4. Loss of pulses and sensation (late signs).

Strict bed rest, elevation of foot above heart level and application of ice over the foot can minimize the intra-compartmental pressure in foot frequent examination and timely carried out fasciotomy can prevent long term complications. Established untreated compartment syndrome can lead to clawing of toes, muscular atrophy, decreased or loss of sensation in foot and poor outcome.

Wound infections in post-operative fracture of the calcaneus

Wound related issues after surgical intervention of fracture of calcaneus are not uncommon. Infection rate increases with co morbid factors and open fractures of the calcaneus. Wound related issues after surgical intervention of fracture of calcaneus are not uncommon. Infection rate increases with co morbid factors and open fractures of the calcaneus.

Folk, *et al.* retrospectively reviewed complications in 190 intra-articular fractures of the calcaneus treated surgically [36]. They included patients with open fractures, current cigarette smokers, diabetics and patients who had surgery for bilateral fracture of calcaneus. They found that 25% patients developed wound infection and out of that 21% underwent further surgical intervention of some kind.



Figure 3: Wound infections.

Open fracture of the calcaneus

Berry, *et al.* have reviewed 36 patients with open fracture of the calcaneus who were managed with open reduction and internal fixation [37]. They found no late amputation or deep infection but found worse function in patients who had plantar wound and the ones who had comminuted open fractures.

Conclusion

The calcaneus is one of the most commonly fractured tarsal bones and the most common cause is road traffic accidents and fall from height, being more common in younger age group. Most of the calcaneus fractures are closed intra-articular involving posterior articular surface, subtalar joint and altering Bohler's angle; however, open fractures of the calcaneus are not uncommon either. Calcaneus is cancellous bone and shatters into multiple pieces when fractured. Patients are mobilized non-weight bearing on the fractured site for 8 to 12 weeks regardless of the mode of treatment and a further rehabilitation of about 12 weeks is required. The patients stay out of work during this period and that is a big socio economic burden.

Patients who are selected for conservative treatment should be managed with elevation of the affected leg above heart level, ice application, adequate analgesia and non-weight bearing mobilization on the affected foot.

The development of compartment syndrome is not an uncommon complication in fracture of the calcaneus and can lead to severe disability of the foot. This is more common in comminuted intra-articular fractures. Frequent examination of foot is important. Early detection of compartment syndrome and fasciotomy is limb saving.

Different parameters and scales have been used in different clinical trials. The common parameters which are used in clinical outcome are pain score, return to work, and wearing same size of shoes as before operative intervention, need for subsequent subtalar joint fusion, injury specific score, radiological improvement after specific treatment of fracture, worker's compensation affect outcome and general health outcome measures.

Fracture of calcaneus is uncommon in children and above 50 years of age and most of them is treated conservatively. There is no age limit for surgical intervention and few studies have shown better functional outcome in older patients treated surgically.

Many clinical trials have compared functional outcome in non-operative and operative management as well as different modes of surgical intervention. Most of the clinical trials have short term follow up and limited number of recruited patients and there are no level 1 trials available regarding functional outcome in fracture of the calcaneus.

Minimal invasive surgery of extra-articular fracture or minimally displaced intra-articular fracture calcaneus with K wire, percutaneous screw fixation, Steinmann pin fixation or external fixator application results in better functional outcome and less surgery related complications as compared to open reduction and internal fixation with plate and screws. As mentioned earlier minimal invasive surgical intervention with K wires and Steinmann pin by Parmar and Chrintz showed no significant difference in patients with operative and non-operative intervention of fracture of calcaneus.

Advancement in surgical techniques and implants have improved functional outcome in treatment of fracture of calcaneus but still surgical intervention is technically challenging and not free of risk of complications.

Two Cochrane database reviews published in 2013 and 2014 showed no difference in functional outcome in operative and non-operative groups.

One of the largest clinical trials conducted by Buckley with 426 patients and found no clinically significant difference in operative and no-operative groups of intra-articular fracture of the calcaneus. He found more wound related problems in operative group which were statistically not significant.

There are few clinical trials like Thordarson, Randle and Agren who concluded better functional outcome with surgical intervention but all had small number of patients and short term follow up. Displaced intra-articular fracture of more than 2 mm with altered Bohler's angle reveal better long term functional outcome if treated optimally with surgical intervention but have worse outcome if joint congruity and Bohler's angle are not restored. Initial displacement of Bohler's angle signifies the outcome of treatment and it is concluded in literature that patients with severely comminuted intra-articular fracture and severely depressed Bohler's angle are more prone to develop early subtalar arthritis and have poor outcome regardless of the type of treatment they were offered. Primary subtalar arthrodesis is recommended in Saunder's type 4 intra-articular fractures to achieve better functional outcome and to avoid secondary operative intervention and complications.

Application of external fixator is one of the options for severely comminuted intra-articular fracture with extensive soft tissue damage. Literature shows equivalent results in patients who were managed with external fixator as definitive treatment and who were managed initially with external fixator and later converted to open reduction and internal fixation.

Careful selection of patients, co morbid factors and risk factors like current smoking, diabetes, patient's functional demand, age, occupation, severity of comminution, pattern of fracture, Bohler's angle and soft tissue status are important factors to be considered when treatment is planned. Patient's benefits should be weighed against risks when deciding definitive management. Level 1 clinical trial at larger scale with long term follow up is required to address unanswered questions regarding better functional outcome in treatment of fracture of calcaneus.

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