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Clinical study of functional outcomes in calcaneal fractures who underwent surgical management in tertiary care hospital

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Abstract

Background: Calcaneus is the largest of the tarsal bones of the foot and is the first tarsal bone to ossify. No treatment, conservative treatment, open reduction and internal fixation, primary subtalar arthrodesis, delayed primary arthrodesis and calcanectomy are treatment options in the literature. Present study was aimed to study functional outcomes in calcaneum fracture underwent surgical management at a tertiary hospital. **Material and Methods:** Present study was single-center, prospective, observational study, conducted in patients from age group of 16 to 60 years, all gender, with isolated calcaneum fracture, underwent surgical management. **Results:** Total of 30 cases were enrolled, which underwent operative management. Majority were males (86.67 %), from 0-30 years (46.67 %), mean age was 34.87 ± 12.0 years. Of all the fractures 53.3% were present on left side and 46.7% on right side. Most of the patients had fall from height i.e.in 66.67 % of all the fractures. Majority were of Sander's type I (53.33 %), followed by type II (33.33 %) & type III (13.33 %). C N Scores of pre treatment (83.3 ± 6.2), Sander's type II (85 ± 5) & Sander's type III (87 ± 5.7) were measured. Mean C N Score was good in majority cases (66.67 %), followed by excellent (20 %) & fair (13.33 %) outcome. Among the operative group CRIF with CC screw were 33.3%, ORIF with reconstruction plate with CC screw were 40% and ORIF with Calcaneum AC plate were 26.7%. In present study, mean union time was 17.9 ± 3.3 weeks **Conclusion:** The goal of treating displaced and comminuted calcaneal fractures is to achieve an anatomical reduction and restore Bohler's angle.

Keywords: calcaneal fractures, Bohler's angle, Sanders fractures, functional outcome.

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Introduction

Calcaneus is the largest of the tarsal bones of the foot and is the first tarsal bone to ossify. The articular surfaces of the calcaneus are on its anterior half. Fractures of the calcaneus remain among the most challenging for the orthopedic surgeon. Calcaneal fractures account for approximately 2% of all fractures, with displaced intra-articular fractures comprising 60% to 75% of these injuries.[1,2]

These fractures are uniformly caused by an axial load mechanism, such as a fall or a motor vehicle accident, and may be associated with other axial load injuries, such as lumbar, pelvic, and tibial plateau fractures.[3] Subtalar joint stiffness and arthritis, heel widening,

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peroneal impingement, implant-related problems and heel pad pain are the potential complications.[4]

No treatment, conservative treatment, open reduction and internal fixation, primary subtalar arthrodesis, delayed primary arthrodesis and calcanectomy are treatment options in the literature.[5] Studies in fracture patterns, soft-tissue management, and outcomes of calcaneal fractures have led to the debate on the optimal management of calcaneal fractures. Orthopaedic surgeons have aimed to treat severe calcaneal fractures to accelerate recovery and reduce pain and deformity. Surgical treatment is more effective in intra-articular calcaneus fractures compared to conservative treatment according to clinical, radiological and patient-reported outcomes.[6] Present study was aimed to study functional outcomes in calcaneum fracture underwent surgical management at a tertiary hospital.

Material And Methods

Present study was single-center, prospective, observational study, conducted in Department of Orthopedics at Basaveshwara Teaching and General Hospital in Kalaburagi, affiliated with M.R Medical College Kalaburagi, India. Study duration was of 18 months (1st March 2021 to 31st August 2022). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- All patients from age group of 16 to 60 years, all gender, with isolated calcaneum fracture, underwent surgical management, willing to participate in present study

Exclusion criteria

- Open fractures and Soft tissue compromise for open reduction and internal fixation
- Medically unfit patient like patients with stroke, paralysis, poliomyelitis.

Study was explained to patients in local language & written consent was taken for participation & study. This study was done to evaluate the results of operative management for calcaneum fractures on basis of subjective, clinical and radiological criteria. The patients were evaluated clinically and through imaging every two weeks, as well as six months after the start of treatment, using appropriate assessment tools. At first visit, a comprehensive history was taken, including information on the time and cause of the injury, as well as any relevant past medical history, particularly diabetes and smoking. During the physical examination, special attention was given to whether the fracture was open or closed, signs of severe swelling, fracture blisters, indications of compartment syndrome, and any other related injuries.

Routine laboratory tests were conducted as needed (CBC, PT INR, RFT, LFT, Serum Electrolytes, Urine Routine, Blood Grouping, HIV, HBsAg, RBS, ECG, Chest X-ray). The diagnosis was confirmed through anteroposterior (dorsoplantar), lateral and axial radiographs. CT scans were also done to examine the fracture pattern, the displacement of fracture fragments, the degree of comminution, and to categorize the fracture using Sander's classification. Bohler's angle was also measured.

The specific technique used for reduction and fixation were decided on the type of fracture, the surgeon's expertise, any other injuries present, and the patient's ability to pay for the procedure. Surgery was performed through closed reduction within the first 48 hours of injury or through open reduction and fixation, as long as the patient's wound was healing well and the surgery was performed within 3 weeks of injury. The goal of the surgery was to restore the joint to its normal alignment and achieve a congruent subtalar joint.

Preparation of the part was done on the day of surgery. Prophylactically Tetanus Toxoid injection and intravenous analgesics were given and intravenous antibiotics were given if required to all patients pre-operatively. All the cases were operated under sub-arachnoid block. Patients underwent CRIF with CC screw , ORIF with Reconstruction plate with CC

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screw or ORIF with Calcaneum anatomically countered locking compression plate.

Closed Reduction & Internal Fixation (CRIF) with CC screw

Under the action of sub-arachanoid block the patient was placed prone on the operating table.. The ankle and foot were scrubbed thoroughly with betadiene 7.5% and 10% solution, painted with betadiene 10% solution and draped under aseptic precaution. Under the guidance of fluoroscopy stab incision was taken over the calcaneal tuberosity two guide wires were inserted in such manner that fracture would get compressed when screw fixed through them. Self- tapping 6.5 mm partial threaded CC screw was inserted after drilling. Reduction was confirmed under fluoroscopy.

Post Operative care and rehabilitation - Post operatively below knee slab applied, at 4 weeks slab was removed, ankle Dmovements were initiated with non weight bearing. Complete weight bearing was started after union was seen radiologically. Functional and radiological evaluation was done using Criegton Nebrasaka health foundation scoring system score and measurement of Bohler angle.

Figure 1: Patient draped in prone position

Figure 2: Preliminary K-wire fixation

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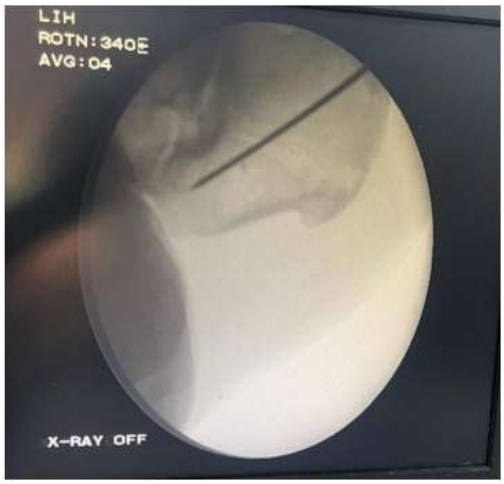

Figure 3: C-arm image showing preliminary k-wire fixation

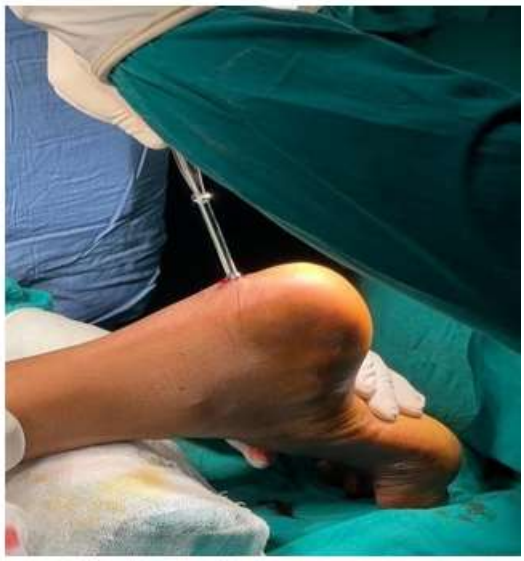

Figure 4: 6.5mm CC screw fixation

Open reduction and internal fixation (ORIF) with Reconstruction plate with CC screw

Under the action of sub-arachanoid block the patient was placed lateral on the operating table. The ankle and foot were scrubbed thoroughly with betadi 7.5% and 10% solution, painted with betadine 10% solution and draped under aseptic precaution. Among the 12 patients 8 were approached through sinus tarsi approach and 4 through extensile lateral approach. In sinus tarsi approach incision made in line with the tip of the fibula and the base of the 4th metatarsal, extensor digitorum brevis retracted cephalad to expose sinus tarsi and posterior facet ,peroneal tendons retracted posteriorly, K-wires inserted for provisional fixation aimed towards the sustentaculum one or two screw are placed lateral-to-medial to engage sustentaculum and support facet one 6.5mm CC screw from posterior-to-anterior to support axial length of calcaneus, 3.5mm reconstruction plate was applied underneath a well developed soft tissue envelope with screws engaging anterolateral and tuberosity fragments. In case of lateral approach extensile lateral L-shaped incision made vertical portion in between posterio fibula and achilles tendon horizontal portion in line with 5th metatarsal base. Full-thickness skin, soft tissue, and periosteal flaps were developed peroneal tendons was retracted superiorly lateral calcaneal wall visualized provisional fixtaion was K-wires and later definitive fixation with plates and screws was done.

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Post Operative care and rehabilitation - Post operatively below knee slab applied, at 4 weeks slab was removed, ankle movements were initiated with non weight bearing. Complete weight bearing was started after union was seen radiologically. Functional and radiological evaluation was done using Criegton Nebrasaka health foundation scoring system score and measurement of Bohler angle

Figure 5: Skin incision using extensile lateral approach.

ORIF with Calcaneum anatomically countered locking compression plate

Under the action of sub-arachnoid block the patient was placed lateral on the operating table.. The ankle and foot were scrubbed thoroughly with betadine 7.5% and 10% solution, painted with betadine 10% solution and draped under aseptic precaution. Among the 8 patients 6 were approached through extensile lateral approach and 2 were approached through sinus tarsi approach Approach was similar to reconstruction group here after reduction was fixed with k wire later definitive fixation was done with calcaneum anatomically countered plate. two patients had void posterior facet which was filled with ipsilateral autologus bone graft.

Post Operative care and rehabilitation - Post operatively below knee slab applied, at 4-6 weeks slab was removed, ankle movements were initiated with non weight bearing. Partial weight bearing was started after 10-12 weeks and later converted to full weight bearing. Functional and radiological evaluation was done using Criegton Nebrasaka health foundation scoring system score and measurement of Bohler angle.

Figure 6: Calcaneum plate fixation by extensile lateral approach; Figure 7: Calcaneum plate fixation by sinus tarsi approach

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Post operatively below knee slab applied, at 4 weeks slab was removed, ankle movements were initiated with non-weight bearing. Complete weight bearing was started after union was seen radiologically. Functional and radiological evaluation was done using Creighton Nebraska health foundation scoring system score and measurement of Bohler angle. Statistical analysis was done using IBM SPSS software version 20.00. Chi- square test was applied for qualitative data analysis.t-test and ANOVA test was applied for quantitative test. $p<0.05$ was considered significant.

Results

Total of 30 cases were enrolled, which underwent operative management. Majority were males (86.67 %), from 0-30 years (46.67 %), mean age was 34.87 ± 12.0 years. Of all the fractures 53.3% were present on left side and 46.7% on right side. Most of the patients had fall from height i.e.in 66.67 % of all the fractures.

Table 1: General characteristics

	No. of patients	**Percentage**
Age groups (in years)		
0-30	14	46.67
31-40	10	33.33
41-50	2	6.67
>50	4	13.33
Mean age (mean±SD)	34.87 ± 12.0	
Gender		
Female	4	13.33
Male	26	86.67
Side		
Left	16	53.33
Right	14	46.67
Mode of injury		
Fall	20	66.67
RTA	10	33.33

Majority were of Sander's type I (53.33 %), followed by type II (33.33 %) & type III (13.33 %).

Table 2: Sander's type of fracture

Sander's type	**No. of patients**	**Percentage**
Type I	16	53.33
Type II	10	33.33
Type III	4	13.33
Type IV	0	0

Mean pretreatment Bohler's angle was 12.5 ± 2.59, while mean post treatment Bohler's angle was 28.4 ± 1.88 & difference of mean post and pre- treatment Bohler's angle was 15.87 ± 2.59.

Table-3: Bohler's angle

Bohler's angle	**Mean value (mean ± SD)**
pre treatment	12.5 ± 2.59
post treatment	28.4 ± 1.88

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Difference of mean post and pre- treatment	15.87 ± 2.59

C N Scores of pretreatment (83.3 ± 6.2), **Sander's type II (**85 ± 5) & **Sander's type III** (87 ± 5.7) were measured.

Table 4: mean C-N score

C-N score	**Mean value (mean ± SD)**
pre treatment	83.3 ± 6.2
Sander's type II	85 ± 5
Sander's type III	87 ± 5.7

Mean C N Score was good in majority cases (66.67 %), followed by excellent (20 %) & fair (13.33 %) outcome.

Table 5: CN score

Result	**No. of patients**	**Percentage**
Excellent	6	20.0
Fair	4	13.3
Good	20	66.7
Poor	0	-

In the operative group, among the patients with type II fractures, 4 patient had good result and 2 had excellent result. With type III fracture 6 of them had good and 4 had excellent result and with type IV fracture 10 of them had good results and 4 had fair results.

Table 6: Comparison of C-N scores categories between the groups and Sander's types

Sander's types	**Excellent**		**Fair**		**Good**		**Poor**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Type I	0	-	0	-	0	-	0	-
Type II	2	33.3			4	66.7	0	-
Type III	4	40.0	0	-	6	60.0	0	-
Type IV	0	-	4	28.6	10	71.4	0	-

Among the operative group CRIF with CC screw were 33.3%, ORIF with reconstruction plate with CC screw were 40% and ORIF with Calcaneum AC plate were 26.7%.

Table 7: Techniques used

Surgical technique	**Number**	**Percentage**
CRIF with CC screw	10	33.3
ORIF with calcaneum AC plate	8	26.7
ORIF with reconstruction plate with CC screw	12	40.0

In present study, mean union time was 17.9 ± 3.3 weeks

Table 8: Union time

Groups	**Number**	**Mean time of union (weeks)**
Operative	30	17.9 ± 3.3

Discussion

Several Prospective randomized studies have shown equivocal outcomes with operative and nonoperative treatment. However, recent trends in the literature suggest that restoration of physiologic parameters of length, height, and alignment of the calcaneus may lead to better long-term results. Initial studies using extensile approaches showed higher rates of wound

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complications with operative treatment; however, recent studies have shown lower complication rates with sinus tarsi and other minimally invasive techniques. Regardless of the mode of treatment, calcaneal fractures are associated with numerous complications and guarded outcomes with significant long-term morbidity.

Present study was aimed to study surgical treatment for calcaneal fractures by two different measures (C N Score and Bohler's angle) to evaluate the results. In study by Kamath et al.,[7] mean age was 34.9 years, which is comparable with present study (mean age 34.87 years). In our study Majority were males (86.67 %), which is similar with study by Patrick Pflüger et al.,[8] (male patients were 69.6%). Ravikumar et al.,[9] in their study observed that 72% patients had fall from height and other 28% had RTA. In our study 63.35% patients had fall from height and 36.65% had RTA.

Surgical outcome in present study was good (66.7%), fair (13.3%) and excellent (20%) results, which is comparable to the results of Rowe et al.,[10] Sanders et al.,[11] and Zwipp et al.,[12]. D Makki et al.,[13] concluded that Restoration of Bohler's angle was associated with a better outcome and that prompt osteosynthesis should be considered for intra-articular fractures of the calcaneum in order to restore the shape of the hindfoot.

Paul et al.,[14] concluded that Patients with undisplaced calcaneal fractures had a good outcome. Those with displaced fractures treated surgically who presented at follow-up with a BA >10° had a satisfactory functional outcome and those with displaced fractures who had non-operative treatment had a poor outcome.

Complications observed were, superficial infection (2 patients) which were detected within first 2 weeks postoperative period and it healed within 4 week's time after regular follow up dressings and antibiotics. 2 patients had terminal restriction of range of motion. There were no complications like nonunion, implant failure, re- fracture were noted in present study.

The most common complication following operative treatment of a calcaneal fracture is wound dehiscence, which may occur in up to 25% of cases.[15,16] The incision typically will approximate relatively easily; however, the wound later separates, up to 4 weeks after surgery, most commonly at the apex of the incision. Most of the wounds will eventually heal; deep infection and osteomyelitis develop in approximately 1% to 4% of closed fractures and in up to 19% of open fractures. [15,16]

CT scanning provides excellent information regarding the number of fractures on the posterior facet and its location. It offers data for diagnosis, classification and treatment. CT images. CT evaluation has allowed classification systems to offer prognostic significance. By reducing the need for multiple views of the heel, it reduces the radiation dose and discomfort to the patient. The treatment of calcaneal fractures must be planned according to different factors such as type of trauma, classification of the fracture, skin condition and injury mechanism. Good evaluation, preoperative planning and appropriate treatment bring out better results.

Conclusion

Surgically managed displaced and comminuted fractures tend to have a comparatively improved functional outcome compared to conservative treatment, provided the Bohler's angle is restored. The goal of treating displaced and comminuted calcaneal fractures is to achieve an anatomical reduction and restore Bohler's angle. This is typically achieved through surgery i.e. CRIF/ORIF. The post reduction Bohler's angle is a predictor of functional outcome.

From this study we conclude that, in case of Sanders type II, type III fractures that were managed operatively had better functional outcome considering the restoration of the

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Bholer's angle and the Sanders type IV fracture that were treated surgically had good functional outcome.

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