

## OUTCOME OF JOINT DEPRESSION TYPE CALCANEAL FRACTURE TREATED BY OPEN REDUCTION AND INTERNAL FIXATION USING CALCANEAL PLATE

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### HOW TO CITE THIS ARTICLE:

Abhishek Pathak, Ashish Goyal, Sanjiv Gaur. "Outcome of Joint Depression Type Calcaneal Fracture Treated by Open Reduction and Internal Fixation using Calcaneal Plate". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 38, August 25; Page: 9717-9726, DOI: 10.14260/jemds/2014/3257

**ABSTRACT: INTRODUCTION:** Calcaneal fractures account for approximately 2% of all fractures and about 75 % of all calcaneal fractures are intraarticular. Although open reduction and internal fixation of these fractures is widely recommended outcomes of these fractures remain understudied. In present study we evaluate functional outcome of joint depression calcaneal fracture treated by open reduction and calcaneal plating with minimum follow up of 1 year. **MATERIAL AND METHODS:** Using Essex-Lopresti radiological classification, Twenty patients of joint depression calcaneal fractures with mean age of 35 years were treated by open reduction and calcaneal plating using extended lateral approach. Out of these, 17 were males and 3 were females. Patients were followed up for an average period of 1 year and 4 months and were evaluated by AOFAS score at final follow up. **OBSERVATION AND RESULTS:** Most common cause of injury was fall from height(90%). Mean duration between injury and surgery was 10 days. In post-operative period, 4 patients(20%) developed wound edge necrosis out of which 1 patient developed deep infection. During follow up, One patient(5%) developed discharging sinus and in one patient(5%) screw was broken. Mean Bohler's angle and Gissane's angle at final follow up were 25.13 degree and 121.8 degree respectively. At final followup, the average AOFAS score was 81.7, there were 8 excellent (40%), 8 good (40%), 3 fair (15%) and 1 poor (5%) results. **CONCLUSION:** Open reduction and internal fixation of joint depression type calcaneal fracture using calcaneal plate gives good to excellent functional outcome in majority of patients. Restoring Bohler's angle as anatomically as possible and appropriate reduction of posterior joint surface by open reduction and internal fixation followed by early mobilization and delayed weight bearing is a good option in treatment of this fracture.

**KEYWORDS:** Calcaneal Fracture, Intraarticular, Internal Fixation

**INTRODUCTION:** Calcaneal fractures account for approximately 1-2% of all fractures<sup>(1)</sup> and about ¾th of all calcaneal fractures are intra articular.<sup>(1)</sup> Intra articular fractures can have long term consequences in terms of pain and disability. There is controversy with regard to the best method for the treatment of calcaneal fractures, with some authors advocating open reduction and internal fixation<sup>(1-9)</sup> and others recommending closed treatment.<sup>(10, 11)</sup>

The conservative treatment of intra articular fracture often leads to increase in morbidity due to incongruence of articular surface, widening of heel, talar dorsiflexion, loss of talocalcaneal lever arm and peroneal tendon impingement.<sup>(2)</sup> Clearly, the conservative approach leaves much to be desired. On the other hand, open reduction and internal fixation requires substantial expertise and perfect anatomical reduction to achieve a good outcome.

The long term outcomes of open reduction and internal fixation remain understudied and only few studies have been done so far to address these concerns. Keeping this in view, we conducted the present study to evaluate the outcomes of treatment of displaced intra articular calcaneal fracture by open reduction and calcaneal plating.

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**MATERIAL AND METHODS:** The present study was conducted in Department of Orthopaedics and Traumatology, Gandhi Medical College Bhopal from July 2009 to Dec. 2011. All the patients presenting with calcaneal fracture were first clinically evaluated and X-rays antero posterior, lateral and axial views of calcaneum were done. Patients were classified according to Essex-Lopresti classification system.<sup>(12)</sup>

Joint depression type calcaneal fracture with or without comminution presenting within 3 weeks of injury and with minimum follow up of 1 year were included in the study. Compound fractures and medically unfit patients were excluded. The mean age of the patients included in study was 35 years (range 20yrs-52 yrs).

Majority of patients were in 3<sup>rd</sup> decade. Among 20 patients, 3(15%) were females & 17(85%) were males. Fall from height was responsible for calcaneal fracture in 18 patients (90%), while road traffic accidents accounted for fracture in calcaneum in 2 patients (10%). Two patients (10%) had bilateral fractures.

Of the 20 patients included in study, 3 patients (15%) suffered from fractures at sites other than the calcaneum. One patient had L1 vertebra fracture and tibial plateau fracture. Another patient had fracture of femoral condyle in the opposite limb while the third one suffered from fracture of shaft tibia in the opposite limb.

All patients underwent surgery between 6 to 14 days after the injury. The mean duration between injury & surgery was 10 days. Subsidence of foot swelling decided the timing of surgery.

Below knee slabs with limb elevation was advised to reduce swelling in all the patients. Standard pre-operative work up was done in all the patients. Operation was done when patient was fit for surgery and swelling was reduced as judged by wrinkle sign. All the patients were operated under spinal anesthesia except one patient who was operated under general anesthesia because of fracture of L1 vertebra. In none of the patient bone grafting was done.

**OPERATIVE PROCEDURE:** After application of a tourniquet, the patient was placed in a true lateral position, and the extended lateral approach was used. The full thickness flap was elevated in one piece, and was held out of the way with two 2mm Kirschner wires placed into the talus. The flap was not touched again for the remainder of the procedure. The entire lateral wall of the calcaneus was exposed distal to proximal till the calcaneocuboid joint. The lateral wall was reflected outward to allow an anatomical reduction of the posterior facet. This was held with provisional fixation using Kirschner wires.

The tuberosity was reduced to the sustentacular fragment, and a provisional fixation was performed using axially directed K wire introduced from the heel into the sustentacular fragment. Image intensifier was used to assess overall reduction. The lateral wall was reduced and appropriate size of calcaneal plate was applied that extends from the anterior process of the calcaneus up to the most posterior aspect of the tuberosity. An intraoperative axial view was obtained to confirm neutral alignment before insertion of screws.

Non locking calcaneal plate which comes in small, medium, large size and P, Q, Y shape was fixed according to fracture configuration. The plate was fixed with the help of 3.5mm cortical screws/4 mm fully threaded cancellous screws. After fixation of plate tourniquet was removed and hemostasis was maintained. Wound was washed and closed in layers over drain and a well-padded below knee slab applied.

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**POST OPERATIVE CARE:** Check x-rays anteroposterior, lateral and axial views were taken. Active range of motion was started after suture or clip removal. Weight bearing was allowed only after 12 weeks in all unilateral cases while in bilateral fractures it was started after 15 weeks. Full weight bearing was allowed after 2 weeks of partial weight bearing with crutches. Patients were followed up clinically and radiologically at regular interval for minimum period of one year and results were analyzed by using AOFAS scale.<sup>(13-15)</sup>

Radiological assessment was done and Bohler's angle<sup>16</sup> and Gissane's angle<sup>(17)</sup> were calculated pre-operatively, immediate post-operative and at final follow-up.

Outcome was assessed as per AOFAS scale which include intensity of pain; function, including restraint of activities and the need for support with an orthosis; maximum walking distance measured by blocks; abnormality of gait; sagittal mobility (flexion and extension); hindfoot mobility (inversion and eversion); the antero-posterior and varus-valgus stability of the ankle and hindfoot and the alignment of the foot and ankle.

The AOFAS scores for each item were added together, providing a total between 0 and 100. The results were 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 69.

**OBSERVATIONS AND RESULTS:** In the present study, 22 patients with 24 joint depression fractures of calcaneum (20 unilateral and 2 bilateral) were included and treated with open reduction and internal fixation. Two patients were lost to follow-up and hence were excluded from study. The remaining 20 patients with 22 fractures (18 unilateral and 2 bilateral) were followed up for a minimum period of 1 year with an average period of 1 year and 4 months (range: 1 year to 2 years).

At final follow-up, 10 out of 22 fractures (45.45%) had occasional mild pain for which no medication was needed. One patient (4.5%) had moderate pain which necessitated regular use of analgesics and ultimately plate removal. 11 patients (50%) reported no pain at all at final follow-up follow up. 95% patients did not require any walking support.

One patient (5%) experienced severe pain on daily activities and had to use support while walking. So, maximum number of patients was pain free in carrying out daily activities. 13 patients (65%) could walk on any surface without walking aids. 7 patients (35%) had some difficulties on uneven terrain, stairs, inclines, ladders. No significant gait abnormality was noted in 19 patients (95%) while one patient had painful gait on walking.

Average range of motion at subtalar joint was 16.32 after final follow up; some restriction of movement at subtalar joint was seen in all the patients. 25-75% of normal joint movement was seen in 13 fractures in 11 patients. While 3 fractures had 75-100% of normal joint motion, less than 25% of normal movement was seen in 6 fractures. Sagittal motion i.e. dorsiflexion and plantar flexion at ankle joint was more than 30° in all the fractures.

Mean Bohler's angle after injury was 6.45 degrees which after correction was 27.18 degrees and at final follow up it was 25.13 degrees. It was maintained in all the patients except three patients (15%) who had highly comminuted fracture

Mean preoperative Gissane's angle was 152.26, while after surgery value was 117.77. The mean value of all the patients at final follow up was 121.18 degrees.

**POSTOPERATIVE COMPLICATIONS:** During post-operative follow up, 2 patients (10%) had superficial infection at incision site, but it responded to antibiotics. Sural nerve hypoaesthesia was

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seen in one patient (5%). Wound edge necrosis developed in 4 patients who responded to local wound care and antibiotics in 3 patients.

But 1 patient had deep infection with associated severe pain which was not controlled by antibiotics; hence implant removal was done 2 months after surgery. In 1 patient persistent discharging sinus was present for which implant removal was done at 9 months after surgery. In one patient who had pain in heel one broken screw was found.

After one year of surgery implant removal was done but broken screw was left inside calcaneum, however patient had good result after implant removal. None of the patients had peroneal tendinitis, complex regional pain syndrome, heel pad pain after surgery.

**AOFAS SCORE:** At final follow-up (average 1 year 4 months) in the 20 operated patients, the average AOFAS score was 81.7. Of these 20 patients, 8 patients (40%) had excellent results, 08 patients (40%) had good results; and 03 patients (15%) had fair result. Only one patient (5%) had poor result after calcaneal plating.

RESULT	NO. OF PATIENTS	PERCENTAGE
• EXCELLENT	08	40
• GOOD	08	40
• FAIR	03	15
• POOR	01	05
<b>TOTAL</b>	<b>20</b>	<b>100</b>

**DISCUSSION:** Treatment of intra articular calcaneal fracture by open reduction and internal fixation is still sparingly used in this country, the chief reason being lack of familiarity with operative technique and fear of post-operative complications.

In the present study, all the patients were operated between 6 to 14 days of injury. The mean duration between injury and the operation was 10 days. The chief determinant of this duration is subsidence of edema in the foot, persistence of which leads to higher rate of infection, while surgery after 3 weeks of injury causes difficulty in reduction secondary to early consolidation of fracture fragments.

Surgical approach is very important for fixation of any fracture. It should be safe, extensile, and easy and give rise to least complications. Kocher et al used lateral approach for calcaneal fractures which had limited access but resulted scarring of peroneal tendons and frequently damaged to the sural nerve. McReynolds et al<sup>(18)</sup> (1982) used medial approach for reduction of this fractures but this resulted indirect and incomplete reduction and found 61% good and excellent results, 32.5% fair and 6.5% poor results.

Zwipp et al<sup>(19)</sup> (1993) used medial and lateral combined approach and found only 61 % good and excellent, 32.5 % fair and 6.5% poor results with 8.3% wound necrosis. Stephenson et al<sup>(20)</sup> (1987) also used combined approach and found 20% poor results with 27% patients had wound edge necrosis. In present series we used extended lateral approach as described by Gould N<sup>(21)</sup> (1984).The goal of incision was to expose the entire lateral face of calcaneus to the level of calcaneocuboid joint.

The majority of recent published series on operative treatment of calcaneal fractures have used this approach through which reduction of the calcaneal body with reconstitution of the height,

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width, and length is consistently reproducible, irrespective of the amount of comminution. Reduction of the joint, when technically possible, is attainable with the lateral approach as well.

One patient suffered from sural nerve injury and four patients (20%) had wound edge necrosis by this approach. None of our patient suffered from damage to peroneal tendon and good and excellent results was obtain in 80% of our patients. Vaclav et al <sup>(8)</sup> (2009) had wound edge necrosis in 10.5% of their patients while Wei et al <sup>(22)</sup> (2001) reported wound necrosis requiring local wound care in 2 of their 18 patients.

In the present study bone grafting was not done in any patient. Bone union is not a major problem in calcaneal fractures; the main role of bone grafting is to support the reduction of articular surface. In majority of our patients, we were able to achieve acceptable reduction and union without bone grafting. In the present series, collapse was not significant in any of the patients during the follow-up period. O'farrell et al <sup>(23)</sup> (1993) did not use bone grafting and noted no collapse of posterior facet.

Sanders et al <sup>(24)</sup> (1991) did not use bone grafting in their series of 120 fractures and no patient had subsequent loss of articular reduction. Pendse et al <sup>(2)</sup> (2006) in their series did not find bone grafting essential to prevent collapse of subtalar joint. Longino et al<sup>(25)</sup> (2001) in a prospective historical cohort study compared patients who received bone graft supplementation with those who had not and found no functional or radiographic benefit to the use of bone graft in these fractures. However, Leung et al <sup>(26)</sup> (1989) used bone graft in all cases and thought it was needed.

Thordarson<sup>(27)</sup> (1999) used SRS(skeletal repair system) bone cement and found increase in stability and compressive strength of fixation and rapid rehabilitation while Schildhauer et al<sup>(28)</sup> (2000) used Norian SRS cement as bone graft substitute and reported full weight bearing as early as 3 weeks.

Pain is the most important determinant of functional outcome of surgery and quality of life. Its importance is reflected by maximum weightage given to it in AOFAS scale. In the present study, 50% patients (n=10) had no pain at one year follow up and 45% patients (n=9) experienced occasional mild pain. One patient reported moderate pain. In terms of AOFAS score, the average score in our series was 34.5 out of 40 points after one year follow up.

Treatment of intra articular fracture by open reduction and internal fixation resulted in similar pain relief in other studies also. Wei et al <sup>(22)</sup> (2001) reported average pain score of 27.8 points. In the series of Leung et al <sup>(5)</sup> (1993), mean pain score was 28.5 out of 30 point pain scale. Pendse et al <sup>(2)</sup> (2006) reported that 25 out of 30 patients in their series had no pain at all. The pain score in Michael (2009) et al <sup>(1)</sup> series was 24.5+1.2. Thus, overall results show that open reduction and internal fixation of intra articular calcaneal fracture results in impressive pain relief.

The post-operative range of motion at subtalar joint represents adequate reduction of subtalar joint in intraarticular fracture calcaneum. Normal range of motion at subtalar joint is between 30-40 degree. In present study, average post-operative range of motion at subtalar joint was 16.72 degrees. In 13.66% fractures, movement at subtalar joint was >75% of normal while in 59% of fractures it was between 25-75% of normal range of movements, while it was less than 25% of normal in 27.27% fractures.

In the study of Leung et al <sup>(5)</sup> (1993) average range of motion at subtalar joint was 17.8 degrees, while in Wei et al <sup>(22)</sup> (2001) study it was 21.9 degrees. In the study of Pendse et al <sup>(2)</sup> (2006), 85 % of patients had >50% of normal joint movement at subtalar joint. Some restriction at subtalar joint was present in all the patients but this restriction did not cause any difficulty or pain in daily



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activities in most of the patients. So, mild or moderate restriction at subtalar joint did not affect functional outcome in 80% of our patients at final follow up.

Bohler's angle is usually taken as relative measure of compression and deformity of calcaneal fracture. It is decreased after calcaneal fracture and indicates depressed posterior facet. In the present study, it was maintained in all the fractures, except three in whom the fracture was highly comminuted. All these three patients had only fair results on AOFAS score. So restoration of Bohler's angle has prognostic value in joint depression type calcaneal fractures.

These results are in consonance with those of Sciamberg et al<sup>(29)</sup> (1988) who reported average pre-operative Bohler's angle as 6 degree while post-operative value was 26 degree. In Leung et al<sup>(5)</sup> (1993) study, mean post-operative Bohler's angle was 28.9 degrees, while the Wu. Y. Yang (2005) study had, mean pre-operative angle as 5.6 degrees while post-operative angle was 28.2 degrees. Vaclav et al<sup>(8)</sup> (2009) achieved post-operative Bohler's angle  $>20^{\circ}$  in both the groups of fractures treated with locking and non-locking plates. So restoration of Bohler's angle is associated with a better outcome and prompt osteosynthesis should be considered for intra articular fracture calcaneum in order to restore shape of hind foot and Bohler's angle.

The mean Gissane's angle at final follow up in our series was 121.18 degrees which is comparable to Leung et al<sup>(5)</sup> (1993) series in which mean Gissane's angle was 120.1 degrees in operated patients. The Gissane's angle was maintained in all the 22 fractures which is comparable to Pendse et al<sup>(2)</sup> (2006) and Jain et al<sup>(4)</sup> (2007).

Post-operative infection, either superficial or deep, emerged as the most common complication. Patients who had superficial infection were successfully treated with antibiotics. One patient with persistent discharging sinus for which implant removal was done after 9 months of surgery had good outcome on AOFAS score at final follow up. Wound edge necrosis responded to local wound care and antibiotics in all patients, but in one patient implant removal had to be done at 2 months after surgery because of deep infection and wound dehiscence and were considered as a poor outcome.

In contrast to other studies, none of our patient suffered from peroneal tendinitis or complex regional pain syndrome. Similar rates of post-op complications have been reported in other studies. Wei et al<sup>(22)</sup> (2001) reported delayed wound healing requiring local wound care in 2 of their 18 patients. Vaclav et al<sup>(8)</sup> (2009) had superficial infection in 10.5% of their patients, while deep infection was present in 8%.

In the series of Makki et al,<sup>(6)</sup> 10% patients had superficial infection while Zemen et al<sup>(9)</sup> (2008) reported a 6.9% rate of superficial infection that was amenable to antibiotics. Jain et al<sup>(4)</sup> (2007) reported chronic osteomyelitis in one patient and sural nerve hypoesthesia in another patient out of a total of 40 patients in their series.

In present study, the mean AOFAS score was 81.7 out of 100. 80% patients had good or excellent results. From a functional point of view, good and excellent results are considered as satisfactory result. Only 1 patient (5%) had poor outcome which was due to deep infection and the associated pain.

Newer modalities of open reduction and internal fixation include Polyaxial locking plates,<sup>(30)</sup> bioabsorbable screws<sup>(31)</sup> minimal invasive surgeries<sup>(32,33)</sup> and bone cements.<sup>(27,28)</sup> These modalities have been described in small studies and appear promising. Large scale studies will determine their efficacy and role in treatment of calcaneal fractures.

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To sum up, the approach towards the treatment of fracture calcaneum is changing. The paradigm in management has shifted from doing nothing in past to open reduction and internal fixation and minimally invasive surgeries.

Our own experience in this series and other studies elsewhere clearly point that open reduction and internal fixation give better results than conservative management. In our view, a multi centric, randomized study will definitely prove the superiority of this approach.

**CONCLUSION:** Open reduction and internal fixation of joint depression type calcaneal fracture using calcaneal plate gives good to excellent functional outcome in majority of patients. Restoring Bohler's angle as anatomically as possible and appropriate reduction of posterior joint surface by open reduction and internal fixation followed by early mobilization and delayed weight bearing is a good option in treatment of this fracture.

The better the pre-operative preparation, the lesser is the rate of complications. Hence patients should be operated after the wrinkle sign becomes positive and no touch technique should be religiously adhered too. Accurate reduction of fractured fragments decreases complications such as peroneal tendinitis or malunion etc. Complication rate of calcaneal plating is significant, but functional outcome score indicate that satisfactory outcome can be achieved in majority of cases.

In our opinion conservative management of these cases would have yielded much worse outcome. A randomized multi centric controlled study comparing operative and conservative treatment with long term follow up over 3-5 years is required to conclusively demonstrate the superiority of open reduction and internal fixation in treatment of the calcaneal fracture. Newer techniques like Minimal Invasive Surgery and role of Bone Cement need further evaluation.

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**Fig. 1a, 1b: Intraoperative photographs showing joint reduction and plate fixation.**



**Fig. 1a**



**Fig. 1b**

**Fig. 2: Pre-operative x-rays Lateral (a) and axial views (b) of joint depression type calcaneal fracture. Lateral (c) and axial x-rays (d) at final follow-up.**



**Fig. 2**

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**Fig. 3: Lateral (a) and axial radiographs (b) Pre-operative and final follow up (c), (d) Movements at ankle joint at follow-up in same patient. (e, f).**



**Fig. 3**

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Date of Submission: 13/08/2014.  
Date of Peer Review: 14/08/2014.  
Date of Acceptance: 19/08/2014.  
Date of Publishing: 22/08/2014.