



### RESEARCH ARTICLE

## CLOSED REDUCTION AND FIXATION OF CALCANEAL FRACTURES USING MODIFIED JESS (M- JESS) FIXATOR WITHIN 24 HOURS OF INJURY - A PROSPECTIVE INSTITUTIONAL STUDY

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### Abstract

**Background:** High energy trauma causes intra articular calcaneal fractures which are a challenge to heal due to the obnoxious blood supply to the skin and soft tissues at the heel area. There always have been a debate regarding the best management options for intra-articular calcaneal fracture fixation.

**Patients and methods:** Between January 2022 and January 2023, a prospective study was done on 30 patients who presented with intra-articular calcaneal fractures sustained due to fall from height and were managed with minimally invasive fixation using Joshi's External Stabilization System(JESS) and External Fixator, together called as Modified JESS (M-JESS), within 12 hours of injury.

**Results:** The mean follow up period was 16.14 months. Clinical evaluation was carried by using the American Orthopedic Foot and Ankle Society (AOFAS) score. The mean AOFAS score was 84.4. There was evidence of fracture healing without collapse until the final follow-up. Complications encountered were superficial skin tract infection, pain and stiffness over sub-talar joint.

**Conclusion:** The use of M JESS decreases the surgical time, has less radiation exposure to the surgeon and patient, is managed with minimal antibiotics and encourages for the management of calcaneal fractures without need of swelling to subside. It is shown to be a minimally invasive method of choice for immediate management of calcaneal intra-articular fractures.

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### Introduction:-

Intra-articular calcaneal fractures are most common injury sustained due to fall from a height<sup>[1]</sup>. Literature mentions various non-surgical and surgical methods for fixation of calcaneal fractures<sup>[2]</sup>. There is still a debate regarding the best surgical management strategy for treating intra-articular calcaneal fractures due to a poor kinked blood supply over the heel area. Various options in management include classical conservative method by using a cast or modern surgical methods that include stabilisation and fixation with a plate, screws or external fixators. There have been various discussions regarding the same and much recently it has been agreed that these injuries should be managed surgically with restoration of the articular surface and fixation of fragments near normal to the anatomy<sup>[3]</sup>. It has been

concluded the calcaneal height, with and length should be restored to avoid long term post-traumatic arthritis, deformity over the hind foot and chronic pain due to non-restoration of anatomical alignment. These long term complications lead to a high financial and emotional burden to the patient and family.

Open reduction and fixation with plating through lateral approach with extensive exposure offers for direct visualization and fixation with reduction of the articular fragments<sup>[4-6]</sup>. Many research studies reported a high incidence of soft tissue compromise, delayed healing and a prominence of metal plate in patients, specially who had uncontrolled diabetes and chronic smokers<sup>[7]</sup>.

Closed reduction and fixation with schanz screws offers a better approach method as there is lesser soft tissue damage. Although this method carries a risk of non-adequate reduction of the articular surface, it has a lesser learning curve and this method can be used as an immediate method for fixation giving a pain and swelling relief due to alignment of the fragments<sup>[8,9]</sup>.

An ideal management method is the one that offers a direct visualization and restoration of near-anatomical placement of the fragments and offers articular surface alignment to prevent the long term complications. This study aims at restoring the near-normal anatomical alignment of the articular surface, calcaneal fracture fragments and minimizing the exposure of radiation and antibiotics.

### **Patients and methods:-**

Between January 2022 and January 2023, we conducted a study on 30 patients who presented to our hospital, within six hours, with a history of fall from height and had sustained an intra-articular calcaneal fracture. Surgical intervention was carried out within 12 hours of injury using M-JESS fixation in all the patients. Patients included in the criteria were aged between 25 years to 55 years, had sustained a closed uni-lateral intra-articular calcaneum fracture due to fall from height and had presented to the hospital within six hours of injury. All the patients had developed a diffuse swelling over the heel and ankle.

Patient who had a peripheral vascular disease, chronic illness or a pre-existing ankle or foot injury or deformity were excluded from this study. Radiographic evaluation was done on presentation for all the patients with a standard antero-posterior, lateral and Harris axial view Xrays.

Classification of the injury was done using Sander's Classification for intra-articular calcaneum fractures<sup>[10]</sup>. 12 patients(40%) had sustained type 2A fracture, six patients(20%) had type 2B, four patients(13.33%) had type 2C, two patients(6.67%) had type 2C, and six patients(20%) had type 4 fracture calcaneum. 20 patients(66.67%) were males and 10 patients(33.33%) were females. 12 patients(40%) had right side and 18 patients(60%) had left side fracture calcaneum. The mean age was  $42.28 \pm 2.25$  (ranging from 25 to 55 years). A written informed consent after thorough explanation to the patient and attenders was taken.

### **Surgical method:-**

Three doses of intravenous ceftriaxone was given, one pre-operatively and two post-operatively<sup>[11]</sup> and then seven days of oral antibiotics were administered. Patient was placed in the supine position on the translucent OT table. A pillow was placed below the hip of the same side so as to get a better visualization during reduction and fixation with the C-arm. A denham's pin was inserted in the main calcaneum fragment from lateral to medial side. A tibial pin was inserted over the lower end of tibia from lateral to medial side, 10 inches proximal to the medial malleolus.

A distractor was connected on both the sides of the pins and distraction the main fragment was done that lead to disimpaction of the main fragment. The articular continuity was achieved thus maintaining the alpha and the beta angles to near normal angle, which was confirmed using c-arm<sup>[12]</sup>. The main fragment was secured with the schanz pins placed over the mid foot and a stable rigid construct was made on either side of the foot by connecting the denham's pin with the schanz screws over either side of the mid-foot.

The height of the calcaneum was restored and was compared to the normal calcaneal height intra-operatively. It was compared with the other side by intra-operatively fluoroscopy<sup>[12,13]</sup>. The width and length of the calcaneum was restored by the adjustment of schanz screws over the midfoot. The fragments were aligned to their places by ligamentotaxis and were fixed by using schanz screws that were passed from the posterior aspect of the heel to anterior aspect. Average surgical time was calculated to be 20.2 minutes. The reduction of the fragments was

evaluated using the intra-operative fluoroscope and was compared with the opposite side calcaneum. The lower limb was elevated over the Bohler-Brown splint. All the patients were made to mobilize their toes after 8 hours post surgery, which was pain free for the patient and were allowed to non weight bear walk from the next day, using a walker. After two weeks post surgery, the tibia pin was removed from the lower end tibia and the patients were encouraged for ankle and subtalar movements.

Patients were encouraged for continuation of non-weight bearing mobilization with a below knee slab. The fixator was removed at 12 weeks post surgery and patients were encouraged to mobilize with full weight bearing with a walker, with a below knee slab for another 2 weeks, which the patients were taught to remove and do the ankle and knee range of movements at home under guidance of physiotherapist<sup>[9,14]</sup>. The slab was removed and patient was encouraged to mobilize the ankle at subtalar and tibiotalar joint and was allowed for full weight bearing mobilization with the walker initially as tolerated by the patient.

#### **Evaluation of the outcome:-**

Patients were reviewed and evaluated clinically and radiologically at six, 12, 24 and one year. The height and length of the calcaneum were assessed radiologically along with the calcaneum angles. Patients were encouraged for ankle range of movements under physiotherapist guidance and were encouraged to continue the movements. Clinically American Orthopedic Foot and Ankle Society ankle-hind-foot score (AOFAS ankle-hind-foot score) system was used for evaluation at every visit. The score covered points of pain, functional mobility and alignment of the fragments.

Statistical analysis using the Statistical Package for the Social Sciences (SPSS 17.0) was carried out. Quantitative data was evaluated as mean  $\pm$  standard deviation ( $\pm$  SD). The chi-square (X<sup>2</sup>) test was used to compare proportions between qualitative parameters. A p value of  $<0.05$  was considered significant. The outcome was assessed by a team of two surgeons that were a part of the surgical management.

#### **Result:-**

Our study included 30 intra-articular closed calcaneal fractures sustained due to fall from height. The patients were followed up to a minimum of 12 months post-operatively. The mean follow-up period was 16.14 months (12 months to 24 months). All the included patients presented to the hospital within six hours of injury and were managed surgically within 12 hours of trauma. All patients were evaluated using the AOFAS scoring system. The mean AOFAS score was 84.4 (ranging from 65 to 95)<sup>[15]</sup>. The operative time ranged from 15 minutes to 32 minutes.

The radiological evaluation was sought using the x-ray fluoroscopy and articular surface of talus was compared to be parallel with posterior calcaneal facet as a marker for articular congruity. The angle of Gissane and Bohler's angle were measured. The mean preoperative Bohler's angle and angle of Gissane were 14.5° and 130.2°, respectively, and the mean postoperative Bohler's angle and angle of Gissane were 23.3° and 102.5°, respectively<sup>[16]</sup>.

All the evaluated patients were completely healed within five months and no patient had a loss of reduction after removal of M-JESS. Three patients had a superficial pin tract infection, which was controlled with oral antibiotics after a culture sensitivity testing without the requirement of removal of pins<sup>[17]</sup>. Nine patients complained of persistent pain till two days following the surgery which was taken care by oral analgesics. One patient had stiffness over the subtalar joint which was relieved by regular and prolonged physiotherapy.

#### **Discussion:-**

The most common cause of calcaneum fracture is associated with a fall from height. There is always a debate regarding the management of calcaneal fracture-operative or conservative. In the recent times, the studies have shown the necessity of fixation of intra-articular calcaneum fractures so as to reduce the chances of post-traumatic arthritis, persistent pain and deformity over hind foot. This often leads to delay in resuming the activities of daily living<sup>[4-6]</sup>. The problem in the classical lateral surgical incision for calcaneal plating arises due to the kinked blood supply over the heel area that leads to necrosis of the skin and soft tissues and thus delays the healing process. Due to this various other approaches were designed to overcome the problem of skin and soft tissue necrosis. Fixation implants include screws, locking plates, schanz screws and kirschner wires.

The dilemma in the classical surgical intervention still arises as to when to fix the calcaneum fracture. This is due to the fact that there is immense swelling over the heel and ankle immediate to the trauma and if operated immediately, can lead to soft tissue complications and even osteomyelitis. In the worst scenario, it can often lead to amputation of the hind foot. Hence, there has been a shift from the classical surgical fixation to a minimally invasive approach for immediate fixation of the calcaneum<sup>[5,6]</sup>. Dingemans et al. Conducted a study, where different methods of fixation were compared and was concluded that none of the methods were found to be superior to one another. They also concluded that locking plate fixation via classical lateral approach offered no advantage over the other methods of fixation.

In our study, we have highlighted the use of M-JESS method for a definitive fixation and as a method of choice for immediate fixation of calcaneum fracture. Rigid fixation using locking plates and screws not only did damage the soft tissue, it also lead to necrosis of the skin and soft tissue and increases the chances of osteomyelitis. Patients have often complained of feeling of a metal implant while walking which has led to disturbed gait and discomfort to the patient<sup>[8,10]</sup>.

Our method proved to be superior to the classical surgical method as it allows the fixation of calcaneum irrespective of the swelling over heel and ankle. It also reduced the need of antibiotics, hospital stay and hence reduced the overall financial burden of the patient<sup>[7]</sup>. Hence it also proved to be more patient compliant. It also allows the patient to be early mobile and hence aids in the lymphatic and venous flow to the heel thus allowing the soft tissues to regain their anatomical position.

Using of multiple schanz screws allowed us to hold and catch together each fragment and reduce and fit it in the near anatomical position which could not have been possible with the open classical surgical method. This method had an advantage of a shorter surgical time and avoided the problem of prominence of metal feel at the heel<sup>[15,16]</sup>. It also allowed for an easy removal of the implants on follow-up visits without damaging the soft tissue and skin<sup>[6,17]</sup>.

The ideal management in calcaneal fractures aims at minimal soft tissue damage, restoration of near-normal anatomy of the hind foot and stable fixation<sup>[9]</sup>. In our study all the three criteria were fulfilled in addition to decreasing the financial burden on the patient. The fixation was stable with no cases reported as a loss of reduction once the implant was removed<sup>[12]</sup>.

The average surgical time ranged from 15 to 32 minutes, which is very less than the classical surgical time of 120 min in the lateral approach. The final followup mean AOFAS score was 84.4 which was much comparable to the results achieved by open reduction and rigid fixation. We also treated the patients who had uncontrolled diabetes and smokers, unlike the previous studies done.

Low AOFAS scores were seen inpatients who were chronic smokers and had uncontrolled diabetes. We also included the radiological criteria along with the AOFAS scoring system for assessment of the patients. Emphasis was also given to restoration of anatomy in lesser time frame so as to let the patients resume their activities and return to work.

Limitations of our study included a lesser number of patients and a lack of control group for comparison. The duration of hospital stay, the cost of implant, exposure time in the operation theater, infection rate and the use of antibiotics was largely reduced. The implant could be removed as a day care procedure without opening up at the level of heel, thus disturbing the blood supply over the area and exposing the underlying bone.

The learning curve is lesser for this method. Considering the results obtained, we would emphasize it as a method of choice for minimal invasive immediate management of calcaneum fractures with few treatment related complications. This method allows for use of ligamentotaxis as an added advantage that aids in soft tissue healing and thus reducing the complications.

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