Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 13542 – 13549
Received 25 April 2021; Accepted 08 May 2021.

Early Outcomes of Operative Treatment and Fixation to Intra-Articular Calcaneal Fractures via T-Shaped Plates

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ABSTRACT

Background: Calcaneal fractures correspond to 2% of skeletal fractures and about 60% of fractures of the tarsal bones. Displaced intra-articular calcaneus fracture is still until now a controversial topic among orthopedic surgeons. There is no single treatment option to manage all different fractures.The aim of this study was to the assessment and evaluation of providing and maintaining stable fixation by the use of T-shaped plate for displaced intra-articular calcaneal fractures. **Patients and Methods**: The study conducted in the orthopedic and traumatology department of Zagazig university hospital from August 2020 to April 2021 with follow-up period of six months.In this study, 18 patients were conducted between the ages of 18 to 50y, all patients with closed D.I.A.C.F with no morbidity. All patients undergo proper clinical and radiological evaluation before making the operation via ELA or STA according to each patient and pattern of fracture, and all cases were fixed by the use of small T-shaped plates. **Results**:This study, showed highly significant improvement ($p<0.001$) between different preoperative and final follow up measurements including; Bohler angle, Gissane angle, and calcaneus height and significant improvement ($p<0.05$) regarding to the calcaneus length and width.**Conclusion**:T-shaped plates can provide stable support and rigid fixation as they maintain proper reduction and alignment to displaced intra articular calcaneus fractures.

Keywords:Surgical, calcaneus fracture, T-Shaped Plates

INTRODUCTION

Displaced intra-articular calcaneus fracture is still until now a controversial topic among orthopedic surgeons.There is no single treatment option to manage all different fractures[(1)].

Historically non-operative management was the treatment of choice, but conservative management as concluded in **Bing LI et al.** Shows poor functional outcomes and results comparing to surgical management which shows earlier weight-bearing and returning to work (5.8 vs. 7.5 weeks, $p<0.001$) [(2)].

So over the past decades, operative management has become more prevalent with studies showing improved outcomes following surgical treatment.

Surgical intervention can be performed with extensile lateral approach (ELA) which provide excellent visualization and higher ability to restore the subtalar joint and anatomic parameters including; length, height, width and alignment and minimally invasive procedures especially the sinus tarsi approach (STA) which can minimize the time from injury to surgery as concluded in **Nosewicz et al.** [(3)].Also **Peng Ye et al**. Who referred to the liberal time of surgery that STA provide[(4)]. But less invasive techniques come with the probability of an imperfect reduction[(5)].

Making STA is the only viable option for surgical management of variable calcaneus fracture types, including tongue-type calcaneal fractures and joint-depression fractures

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without significant comminution of the posterior facet.This study was performed to the assessment and evaluation of providing and maintaining stable fixation by the use of T-shaped plate for displaced intra-articular calcaneal fractures.

PATIENTS AND METHODS

Randomized controlled study was conducted on 18 patients and 19 feet with displaced intra-articular fracture of calcaneus operated with O.R.I.F. via extensile lateral approach to 12 patients (66.6%) and with M.I.P.O. via sinus tarsi approach to 6 patients (33.3%). T plates were the method of fixation for all patients.

Classification of fracture:

The fracture has been classified according to both Essex Leprosti classification on plain x-ray and Sanders classification on CT scanning.

According to Essex classification, 12 patients (66.6%) were joint depression type and 6 patients (33.3%) were tongue type fracture. According to Sanders classification, 11 patients (61.1%) were classified as sanders type II and 7 patients (38.8%) were sanders type III .

Exclusion criteria; Fractures treated conservatively due to the patient's own reasons or lack of surgical indication. Lack of adequate skin condition, edema, and blisters in the lateral aspect of the foot, not resolved by the date of the surgery.Presence of clinical comorbidities such as vascular disorders, heart disease, or decompensated diabetes.

Pre-operative:

All patients in this study undergo proper planning and management before proceeding to the surgery. This management includes; proper clinical assessment by taking full and detailed history with general and local examination, radiological assessment by plain x-ray (axial, lateral, and AP views) and computed tomography to fully understand the pattern and the nature of the fracture. Routine preoperative laboratory tests were done including; complete blood count, blood typing, renal function, liver function, coagulation profile, blood sugar and C reactive protein.

All patients were complaining of heel pain, swelling, and inability to bear weight, so initial treatment was done with analgesic, elevating the foot, cold compresses and slab in a neutral position to avoid more swelling and skin blister which will interfere with the ability to perform the surgery, especially with those indicated to surgery by the extensile lateral approach.

Surgical technique:

All patients were operated on spinal anesthesia (15 patients), except in the patients with associated spine injury (3 patients) where general anesthesia was used. A pneumatic thigh tourniquet was used up 300mmHg with pre squeeze to the limb with setting the time of application of the tourniquet. Antibiotic (3rd generation cephalosporin) is given before the application of tourniquet by 30 minute. Kirschner wires inserted to hold the skin flap back and perform non-touch technique, the 3 K wires placed on the fibula, talus and cuboid bone (Figure 1).

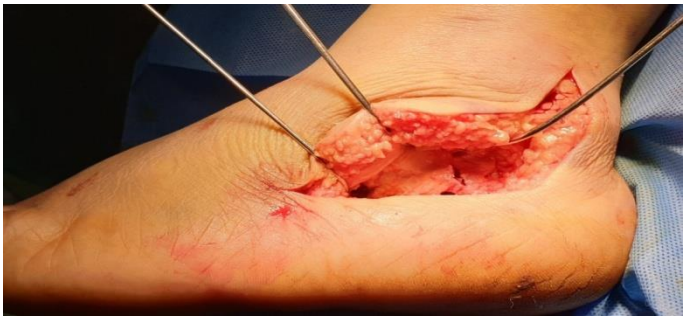

Figure 1: Full-thickness flap non-touch technique

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Steinmann pin was inserted (under fluoroscopy guide) from lateral to medial in the inferior part of the posterior of the calcaneus. Reduction is started from medial to lateral then from posterior to anterior and by the tuberosity fragment, then restoration of calcaneal height and length with valgus and varus alignment is done (figure 2).

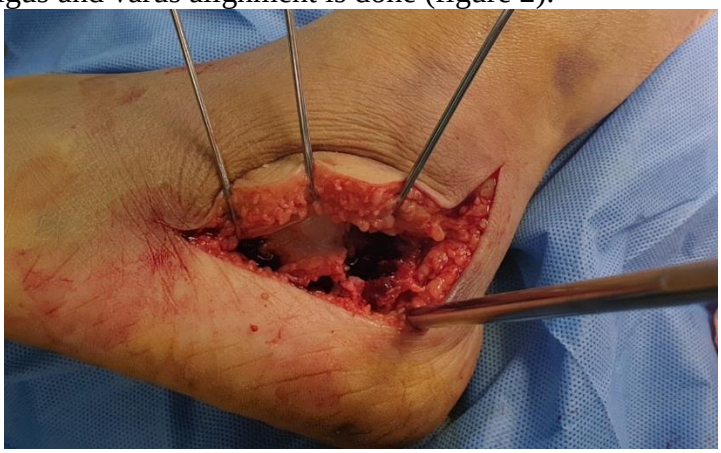

Figure 2: Steinmann pin insersion for traction

After reduction and restoration of the calcaneus alignment is done a 2.5 or 3mm k wires were inserted as a temporary fixation (under fluoroscopy guide), these k wires may be removed after the fixation by the T-shaped plate before closure or after 2 to 3 weeks postoperatively if further fixation is required. A lag screw is used in some patients in addition to a T-shaped plate, the screw is inserted anterior and medial with slightly angled inferiorly into the sustentaculum tail across the tuberosity into the good bone of the medial side of the calcaneus. A small T-shaped plate 3.5mm is placed on the lateral wall of calcaneus to check the proper size and location before fixation, after placement of the plate in the proper position it is fixed with suitable screws (Figure 3).

Figure 3: T-shaped plate final fixation

K wire used for temporary fixation was removed in the operation or 3 weeks postoperatively according to the condition of fracture and amount of fixation required.
There was no need for the use of bone graft in all cases. Irrigation and proper hemostasis was done and closure was done in a layered fashion with absorbable suture vicryl (2-0), and a drainage tube is also used (Figure 4).

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Figure 4: **Closure and drainage**

Postoperative care and follow-up:

Antibiotic is given in the first 24 to 48hr. Motion and exercise are avoided until the wound is healed (exercise is induced as soon as the wound is healed and the patient tolerant to avoid the stiffness to subtalar joint and movements like inversion and eversion are encouraged). Sutures and k.w removed after 2 to 3 weeks. Clinical and radiological evaluations are made in monthly interval. Partial weight bearing is encouraged only when signs of the union are confirmed by the x ray which normally occurred in a period of 8 to 10 weeks (delayed in old, smokers, obese and diabetic patients). Full weight bearing is encouraged after that according to each patient's tolerance. Functional assessment was done according to A.O.F.A.S (American orthopedic foot and ankle society) on 3rd and 6th months postoperatively.

RESULTS

According to the American orthopedic foot and ankle hindfoot scale, results were graded as excellent if score 95 and above, good between 94 and 75, fair between 74 and 51 and poor score if less than 50.

In this study, the scoring results of 3 patients (16.6%) were excellent, 13 patients (72.2%) were good and 2 patients (11.1) were fair with no poor results (Diagram1).

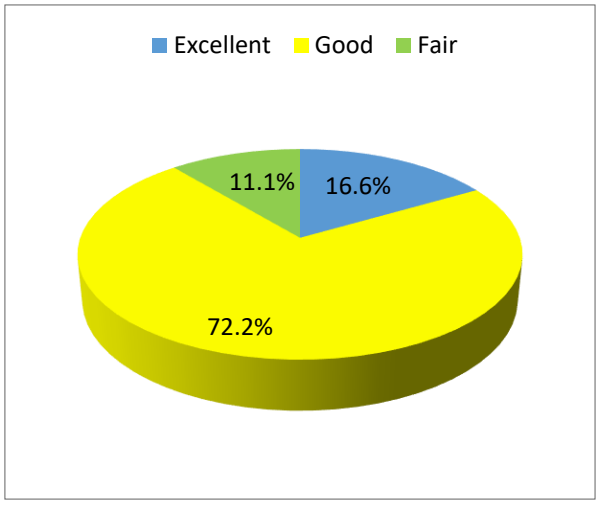

Diagram1: A.O.F.A.S. scoring results.

Essex classification and A.O.F.A.S. end result:

According to the Essex classification of calcaneus fracture, 12 patients (66.6%) in this study were joint depression type while 6 patients (33.3%) were tongue type. There was no

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significant correlation between Essex classification and A.O.F.A.S. hindfoot scale end results as the p-value is greater than the significance level (0.05) as showing in (Diagram 2).

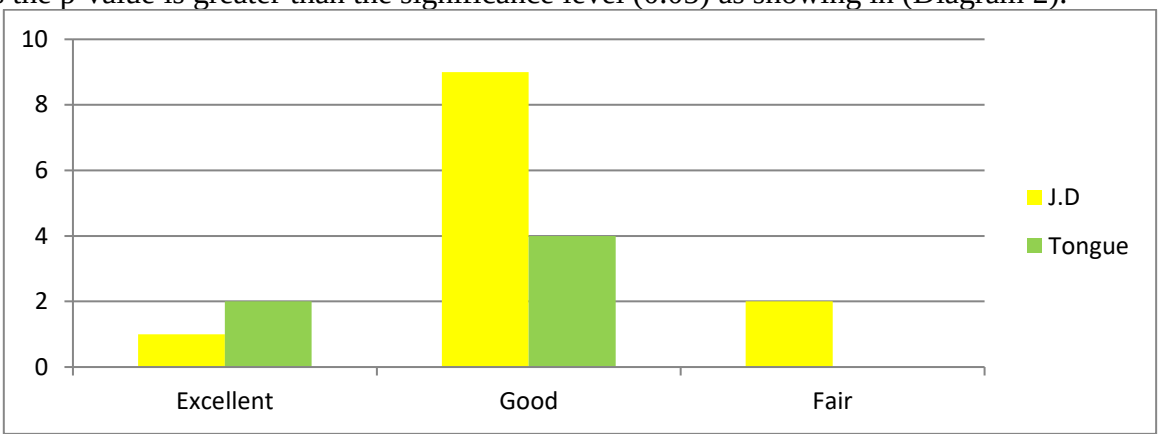

Diagram 2: **Essex fracture classification and A.O.F.A.F. end result relationship**

Sanders classification and A.O.F.A.S. result:

According to Sanders classification of calcaneus fracture, 11 patients (61.1%) were Sanders type II and 7 patients (38.8%) were Sanders type III. There was a significant correlation between Sanders classification and A.O.F.A.S. hindfoot scale end results as the p-value is equal to the significance level (0.05) as showing in (Diagram 3).

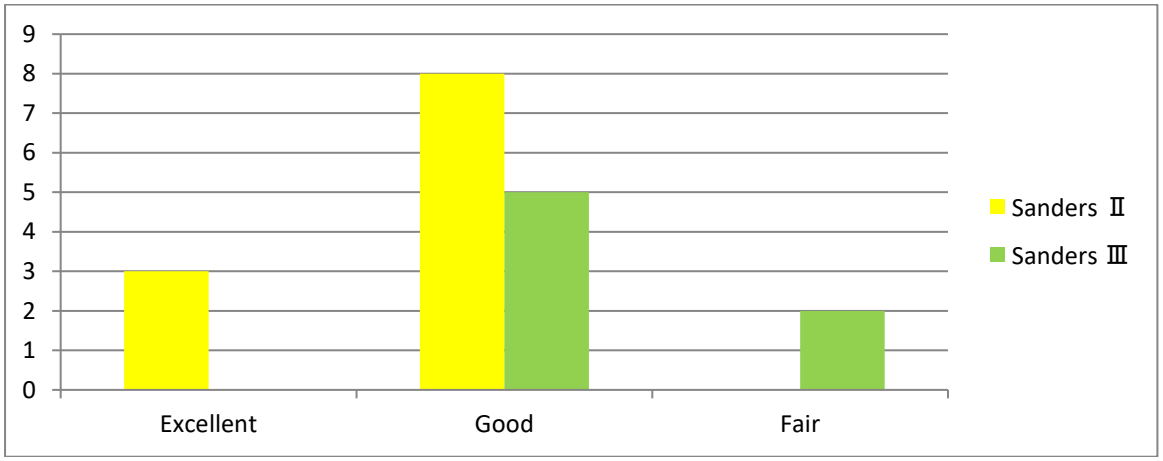

Diagram 3: **Sanders classification and A.O.F.A.S. end results relationship.**

Radiological results of angles:

In this study, there was a highly significant improvement ($p<0.001$) in Bohler angle between pre, immediate postoperative and final follow-up measurements.

The mean preoperative Bohler angle was 12.6^0 and immediate postoperative was $28.^0$ and in final follow up Bohler angle was 27.6^0.

In this study, there was a highly significant improvement ($p<0.001$) in Gissane angle between pre, immediate postoperative and final follow-up measurements.

The mean preoperative Gissane angle was 137.9^0 and immediate postoperative was 122.8^0 and in final follow-up Gissane angle was 122.8^0.

Complications:

In this study, complication occurred in 5 patients (27.7%) (diagram4) Wound infection in two patients (11.1%) 13 to 15 days postoperative, both patients' fractures classified to sanders type III and operated by extensile lateral approach. One of them was heavy smoker, both treated with debridement and antibiotic coverage with continuous follow-up and

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dressing change without the need to remove the hardware and the end result to these patients according to A.O.F.A.S. hindfoot scale was 85 (good) and 89 (good).

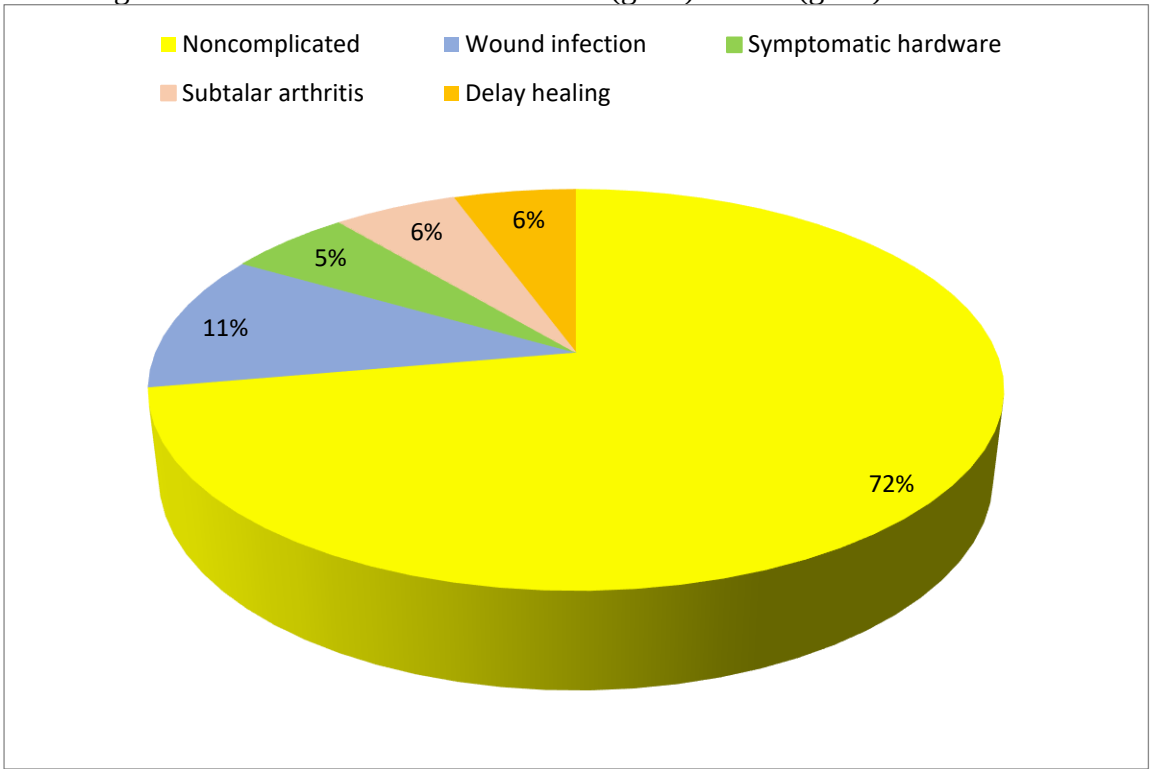

Diagram 4: **Complications of surgery.**

DISCUSSION

In this study, the patients mean age was 33y with the youngest patient was 18y and the oldest 50y, **Jain et al.**, in their study assessing 28 cases ranged from 24-49 years with a mean age of 31.6 years[6]. In **Santosha et al.**, the average age was 37.5 years ranging from 17 to 59 years[7].

In this study, fall from height was the main mechanism of the injury that caused the fracture to 16 patients (88.8%) and road traffic accident caused the fracture to the remaining 2 patients (11.1%), in **Jain et al.**, their study assessing 28 cases most common mode of injury was fall from the height in 21 patients while road traffic accident was in 3 patients[6].

Pendse et al., in their study noted the mechanism of injury was fall from the height in 26 patients and road traffic accidents in 3 patients[8].

In this study, according to Essex classification 12 patients (66.6%) were joint depression type and 6 patients (33.3%) were tongue type fracture**,** in **Santosha et al.**19 (63.3%) patients had joint depression fracture and eleven (36.6%) had tongue type fracture configuration[7]. A study conducted by**Mostafa et al.**, comprising 18 cases noted 12 cases were of joint depression type and six cases were of tongue type fractures[9].

In this study, assessment and evaluation of outcome and results are based upon radiological evaluation mainly to Bohler and Gissane angles and calcaneus parameters like length, height and width together with the clinical evaluation according to A.O.F.A.S. hindfoot scale which the mean end result at the last follow up was 86.61, excellent in (16.6%), good in (72.2%), fair in (11.1%) and no poor results.

Peng y et al., who operated on 24 feet using calcaneal plates and the A.O.F.A.S. result of the study was 80.29[4]. **Nair et al.,** who operated on 20 patients via extensile lateral approach the A.O.F.A.S. mean result was 79.9[10].

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In this study, complications are seen in 5 patients (27.7%), two patients with wound complications 11% (low incidence due to use of STA in many patients and non-touch technique with ELA) treated with debridement, antibiotics and dressing change and there was no need for further surgery, one patient with symptomatic hardware 5% where screw extraction was done, one patient with delay union 5% (old and heavy smoker patient) and one patient 5% with a subtalar arthritis scheduled for arthrodesis.

Jain et al., whose noted flap necrosis in 3 patients (11%) at the incision site and one had a superficial infection, Subtalar arthritis was seen in 5 patients (17%) whereas sural nerve hypoesthesia in one patient 4%[(6)]. **Weber et al.**, noted wound dehiscence in one patient[(11)].

CONCLUSION

T-shaped plates can provide stable support and rigid fixation as they maintain proper reduction and alignment to displaced intra articular calcaneus fractures.

With comparable results regarding to radiological parameters like Bohler angle, Gissane angle and calcaneus dimensions like length, height and width and functional outcome by using A.O.F.A.S. hindfoot scale when compared to different calcaneal plates.

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