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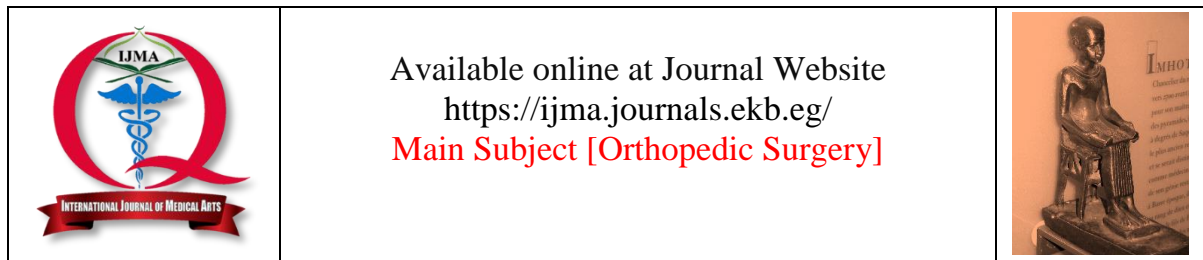


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## Original Article

# Functional Outcomes of Tongue-Type Calcaneal Fractures Treated with Percutaneous Screw Fixation

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## ABSTRACT

### Article information

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**Background:** Calcaneal fractures are the prevailing fractures among the tarsal bones, accounting for around 60% of such fractures and constituting approximately 2% of all fractures in the human body. Primarily, it arises from the occurrence of high-energy trauma, such as incidents involving falls from elevated positions or accidents involving motor vehicles.

**Aim of the work:** This study aimed to evaluate the functional and radiological outcomes of tongue-type calcaneal fractures treated by percutaneous screw fixation.

**Patients and Methods:** Twenty-two surgical procedures of closed or open reduction and percutaneous screw fixation in tongue-type calcaneal fractures in twenty cases were involved in this prospective research design, which took place at Al-Azhar University Hospital at New-Damietta and Elsheikh Zayed Specialized Hospital between January 2020 and August 2023.

**Results:** According to MFS [Maryland foot score], satisfactory results were obtained in 15 cases with an excellent score [90–100] and another 5 with a good score [75–89]; this yielded 90.9% of the cases with satisfactory results. Two cases [9.1%] obtained fair results [50–74]. None of our patients got a lower score. As regard Böhler's angle and the crucial angle of Gissane, there were highly significant differences between preoperative and postoperative values, which meant improvement of these angles after fixation.

**Conclusion:** Percutaneous screw fixation and closed reduction could be the most suitable treatment plan for tongue-type calcaneal fracture, as long as the reduction technique used allows for satisfactory reduction of the fracture fragments and congruent articular surface and the fixation is stable.

**Keywords:** Tongue-Type Calcaneal Fractures; Percutaneous Screw Fixation; MFS Score.



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## INTRODUCTION

Calcaneus, also known as the heel bone or os calcis, is the biggest tarsal bone destined to tolerate and support the daily axial loads of weight bearing [1].

Calcaneal fractures are the most common fractures of the tarsal bones [60%] and account for around 2% of all human fractures. A male predominance of such injuries is reported, commonly aged between 35 and 45 years, with a bilateral compromise in about 10% of patients and open fractures in less than 5% [2]. Calcaneal fractures mostly result from exposure to great energy trauma, as in falling from a height and generating a massive axial load with the heel striking the ground, which stands behind about 60% of these fractures or motor-vehicle accidents, and to a lesser extent, low energy trauma, as in sports [3].

The subtalar joint is involved in about 75% of calcaneal fractures. Displaced intra-articular calcaneal fractures are incapacitating injuries that are commonly encountered by young active people in their prime labor period, making their socio-economic impact worse on both individuals and society and needing special attention [4].

Calcaneal fractures are considered one of the most antithetical chapters of traumatology because of the unique anatomical and biomechanical features of the calcaneus [5]. The delicate soft tissue enveloping the calcaneus, along with the multifaceted structure articulating with the talus, cuboid, and navicular bones, pose a great challenge concerning their ultimate management, which is still very contentious to the point that the need for surgical procedures might be called into doubt. The ideal surgical technique for operative cases has yet to be identified [6].

It is agreed now that there is no single management option that fits all calcaneal fractures. The management plan should be tailored properly with regard to the fracture's pathoanatomic features, associated soft tissue insult, other concomitant injuries, functional demand, and the patient's comorbidities [7].

The purpose of this investigation was to evaluate the functional and radiological findings of tongue-type calcaneal fractures treated by percutaneous screw fixation.

## PATIENTS AND METHODS

Twenty-two surgical procedures of closed or open reduction and percutaneous screw fixation

in tongue-type calcaneal fractures in twenty cases were involved in this prospective research design, which took place at Al-Azhar University Hospital at New-Damietta and Elsheikh Zayed specialized hospital among January 2020 and August 2023.

**Inclusion criteria:** Patients with tongue-type calcaneal fracture, age group between 15 and 65 years, and both genders.

**Exclusion criteria:** patients with previous calcaneal surgeries on the same side, pathological conditions like tumors and infection, and the age group below 15 or above 65 years.

All patients were subjected to a complete history, including demographic data such as age, sex, occupation, residency and marital status; mechanisms of injury and concomitant injuries; associated co-morbidities; clinical examinations [inspection, palpation, and special tests]; radiological examinations [plain X-rays and CT scans]; and laboratory investigations [CBC, INR, PT, PTT; random blood sugar; liver function tests; and kidney function tests]. A six-month follow-up program was established for them.

**Evaluation:** Clinical evaluation: All patients in this study were evaluated by the MFS system. It is a broadly used assessment tool of foot and ankle function with strict adherence to clinical state, irrespective of the radiological factor. It considers the patient's pain, gait, and daily activities, as well as their cosmetic appearance. Its score scale ranges between 0 and 100 points; a score of <50 points is considered poor, 50–74 points as fair, 75–89 points as good, and a score of 90–100 points is excellent. Radiological evaluation was also important, along with the clinical evaluation, to assess the quality of the reduction. It allowed measuring and comparing the three important angles [Böhler, Gissane, and Sarrafian] and the calcaneal width, which was a good prognostic predictor. Immediate postoperative anteroposterior, lateral, and Harris axial views were acquired for each and every patient, with other follow-up X-rays at 6 weeks and 3 months postoperative. Additional X-rays were obtained at any time, regardless of the protocol followed in cases of severe abnormal pain. Failure of reduction was defined as  $\geq 2$  mm gap or displacement in the articular surface or in the calcaneal body.

**Patients consent and ethical considerations:** Before being included in the study, written informed consent was obtained from all participants [or their caretakers if the participants were children or

elderly]. This agreement included an explanation of the importance of the study as well as the procedures that were started. The institutional review board [IRB] from the Faculty of Medicine at Al-Azhar University gave their stamp of approval to the whole study design.

At every stage of the research, both participants' confidentiality and personal privacy were protected. The data that was collected was not utilized for any other purpose.

**Statistical analysis:** An IBM-compatible personal computer running version 20 of the SPSS statistical software was utilized to gather the data, tabulate the data, and perform the statistical analysis. There were two different kinds of statistical work done: Quantitative data involve number and percentage [%]; descriptive statistics involve mean [x-], standard deviation [SD], median, and range; qualitative data include number [No] and percentage [%]; and analytic statistics include Chi-Square [X2] analysis for qualitative data and Mann-Whitney U test and Student t-test [parametric test] analysis for quantitative data. The levels of significance were as follows: A P-value that was more than 0.05 was deemed statistically insignificant, a P-value that was less than 0.05 was deemed statistically significant.

## RESULTS

Table 1 revealed that the maximum age incidence was between 21 and 30] years old, with 6 cases accounting for 30% of cases. The least age incidence was between 51 and 60] and above 60 years old, with one case per age group [5%]. It also showed that a male predominance evinced

during this study in about 15 cases [75%], while only 5 patients were female [25%].

According to the MFS score, table 2 showed that satisfactory results were obtained in 15 cases with an excellent score [90–100] and another 5 with a good score [75–89]; this yielded 90.9% of the cases with satisfactory results. Two cases [9.1%] obtained fair results [50–74]. None of our patients got a lower score.

According to Böhler's angle, table 3 showed that there were greatly significant differences [p-value = 0.0003] between preoperative and postoperative values, with preoperative variable values ranging from 8° to 22° with a mean of 15.1° ± 3.2 and postoperative values ranging from 20° to 38° with a mean of 26.2° ± 3.6.

As regard the crucial angle of Gissane, patients presented with an angle of 139° to 168°; the mean was 154° ± 7.5. Postoperative measurement of the crucial angle ranged from [124° to 152°] with a mean of [138° ± 6.8]. The finding was observed to be greatly significant [p-value = 0.00027], which meant improvement of the angle after fixation [Table 4].

Table 5 showed that sixteen patients started weight bearing at the 12th week postoperatively, while four patients [including two patients with bilateral tongue-type fracture calcaneus] didn't start weight bearing before 16 weeks.

Table 6 shows that our study included 4 patients with postoperative complications; two of them had superficial wound infections, one had subtalar arthritis, and one had tarsal tunnel syndrome.

**Table [1]:** Distribution of patients concerning demographic data

Age group	Frequency	Percentage
Below 20	2	10%
21-30	6	30%
31-40	5	25%
41-50	5	25%
51-60	1	5%
Above 60	1	5%
Total	20	100%
Gender	Frequency	Percentage
Male	15	75%
female	5	25%
Total	20	100%

**Table [2]:** Clinical results concerning the MFS system

Results	No. of cases	Percentage
<b>Excellent</b>	15	68.2%
+ <b>Good</b>	5	22.7%
= <b>Satisfactory</b>	20	90.9%
<b>Fair</b>	2	9.1%
+ <b>Poor</b>	0	0%
= <b>Unsatisfactory</b>	2	9.1%
<b>Total</b>	22	100%

**Table [3]:** Bohler's angle preoperative and postoperative

Böhler's angle	Range	Mean	P-value
<b>Preoperative</b>	8° - 22°	15.1° ± 3.2	0.0003
<b>Postoperative</b>	20° - 38°	26.2° ± 3.6	

**Table [4]:** Gissane angle preoperative and postoperative

Angle of Gissane	Range	Mean	P-value
<b>Preoperative</b>	139° - 168°	154° ± 7.5	0.00027
<b>Postoperative</b>	124° - 152°	138° ± 6.8	

**Table [5]:** Time before weight bearing after operation

Time before weight bearing	No. of patients	Percentage
<b>12 weeks</b>	16	80%
<b>16 weeks</b>	4	20%

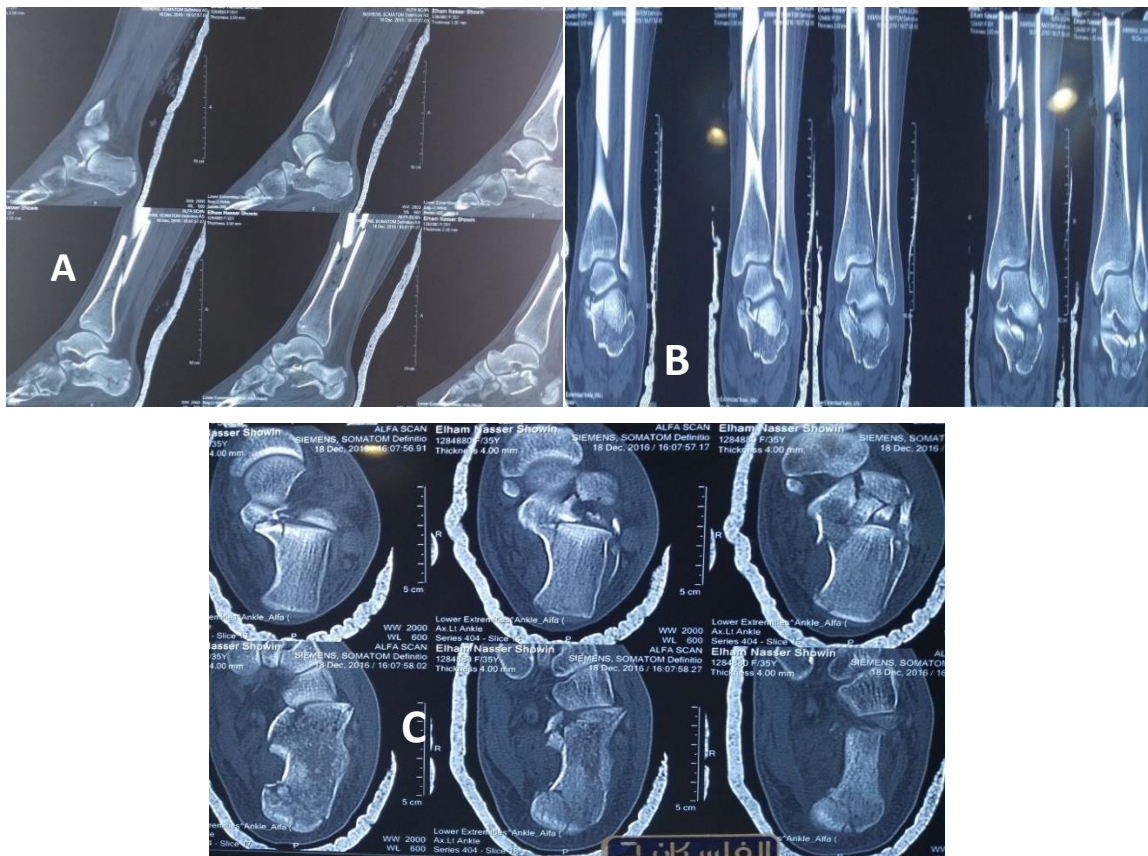
**Table [6]:** Postoperative complications and their percentage

Postoperative complications	No. of patients	Percentage
<b>Superficial wound infection</b>	2	9.1%
<b>Subtalar arthritis</b>	1	4.55%
<b>Tarsal tunnel syndrome</b>	1	4.55%
<b>None</b>	18	81.8%
<b>Total</b>	<b>22</b>	<b>100%</b>

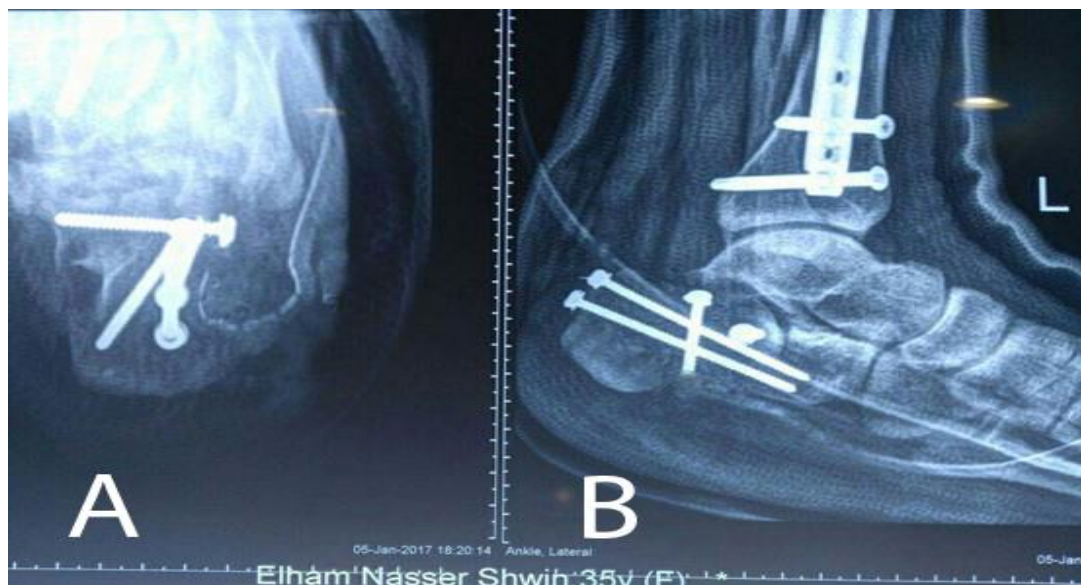
**Case presentation:** A female patient, 35 years old, a housewife, presented to the ER after falling from a height [3<sup>rd</sup> floor] and landing on both feet. She had a free medical history. General and local examinations are done. On examination, she had severe tenderness over both the calcaneus and left leg.



**Figure 1:** Preoperative X-ray [A] Lateral view [B] Axial view. Radiological examination revealed fracture of the left distal tibia and bilateral calcaneus [the left side is tongue-type]. Lateral view: showing Böhler angle 22°, Gissane angle 165°, and posterior inclination angle 50°. Axial view: showing widening and shortening, with some degrees of Varus of the tuberosity.



**Figure 2:** CT scan of fractured left calcaneus [A]: sagittal cuts, [B]: coronal cuts, and [C]: axial cuts showing a fracture of the calcaneus extending to the subtalar joint with widening, shortening, and varus of the tuberosity



**Figure [3]:** X-ray of fracture left calcaneus immediate postoperative A: lateral view B: axial view. Closed reduction and percutaneous screw fixation for both calcaneus and intramedullary nail for the distal tibia were done. Postoperative left calcaneus X-ray: Lateral view: showing Böhler angle  $29^\circ$ , Gissane angle  $142^\circ$ , and posterior facet inclination angle  $58^\circ$ . Axial view: showing decreased Varus deformity of the tuberosity fragment. The patient suffered a superficial wound infection of the left calcaneus, which was treated with antibiotics and dressings for two weeks. Six weeks postoperatively, she started passive range of motion at the ankle and subtalar joints and started partial weight bearing using axillary crutches. She couldn't start full-weight bearing before the 16th week postoperatively. Clinical assessment was done six months postoperatively using the MFS system, and the score for the left side was 76 points, i.e., good.

## DISCUSSION

In this study, twenty patients with twenty-two tongue-type calcaneal fractures underwent percutaneous screw fixation and were assessed functionally according to the MFS system six months post-fixation.

**Budair and Fenton**<sup>[8]</sup> introduced a development of the Essex-Lopresti reduction maneuver in twelve patients with 13 tongue-type calcaneal fractures. They used a Schanz pin as a minimally invasive reducer and fixation of tongue-type fractures via a single incision with percutaneous screws. Short-term follow-up revealed good clinical and radiological findings with no complications.

The mean age in this research was 35.2 years, extending between 15 and 61 years. **Van der Vliet et al.**<sup>[9]</sup> had 49 years  $\pm$  15 as a mean age for the ORIF group and 41 years  $\pm$  18 for the CRIF group, with an overall mean age of 46 years  $\pm$  17 in their study. They obtained a statistically significant association between age and the final findings [P-value: 0.05].

Fifteen cases [75%] of the total patients subjected to this study were males, while only five cases [25%] were females. The same proportion occurred in **Budair and Fenton**<sup>[8]</sup> by 9 males [75%], versus 3 females [25%].

The mean pre-operative Böhler's angle regarding this study was  $15.1^\circ \pm 3.2$ , ranging between  $8^\circ$  and  $22^\circ$ , while the mean post-operative was  $26.2^\circ \pm 3.6$  [range  $20^\circ$  and  $38^\circ$ ].

Böhler's angle had a mean preoperatively of  $12.61^\circ$  and  $26.22^\circ$  postoperatively, as per **Hegde et al.**<sup>[10]</sup>, while **Dalal et al.**<sup>[11]</sup> study, the mean preoperative angle was  $2.9^\circ \pm 11.37$ , the mean postoperative angle was  $26.1^\circ \pm 10.70$ , and the final follow-up was  $24.95^\circ \pm 10.37$ .

The mean Gissane angle at presentation was  $154^\circ \pm 7.5$ , ranging between  $139^\circ$  and  $168^\circ$ , and postoperatively, it was  $138^\circ \pm 6.8$ , with a range of  $124^\circ$  to  $152^\circ$  in our study.

**Dalal et al.**<sup>[11]</sup> had a preoperative mean of  $131.15 \pm 14.66^\circ$  and postoperative  $105.75 \pm 11.65^\circ$ , and at the final follow-up was  $108.3 \pm 11.61^\circ$ .

Moving to complications, we had 4 patients with postoperative complications in our study; two of them had superficial wound infection,

one had subtalar arthritis, and one patient had tarsal tunnel syndrome. **Budair and Fenton**<sup>[8]</sup> recorded no complications in their study. **Hegde et al.**<sup>[10]</sup> had only one patient with subtalar arthritis out of their 23 patients.

All patients were allowed to start assisted weight bearing six weeks following fixation, and 16 patients [80%] of our patients started unassisted weight bearing after 12 weeks, while the other 4 patients [20%] started at the 16th week. **Budair and Fenton**<sup>[8]</sup> allowed their patients to start weight-bearing at 8–10 weeks postoperatively, while non-weight-bearing axillary crutch mobilization was started 3 days post-operatively.

Satisfactory results were obtained in 15 cases with an excellent score [90–100] and another 5 with a good score [75–89]; this yielded 90.9% of the cases with satisfactory results. Two cases [9.1%] obtained fair results [50–74]. None of our patients got a lower score.

**Hegde et al.**<sup>[10]</sup> used the MFS system to assess their patients 24 weeks after fixation, and 13% of their patients got excellent results, 74% got good results, and 13% got fair results. None of their patients got poor results.

This study ensured the efficiency of percutaneous fixation techniques in mild to moderate comminuted fractures of the calcaneus. Other studies concerning the open techniques showed significantly lower results in regard to wound healing and patient satisfaction with relatively equal results related to fracture healing. So, percutaneous techniques seemed to be much more preferable than open ones in compromised patients and fracture patterns without severe comminution.

**Conclusion:** Based on the findings of the current research and with respect to the previous studies in the literature concerning the same technique, percutaneous screw fixation and closed reduction could be the most suitable treatment plan for tongue-type calcaneal fracture as long as the used reduction technique allows for satisfactory reduction of the fracture fragments and congruent articular surface and the fixation is stable.

**Financial and Conflict of Interest:** Nil

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