

Percutaneous Reduction and Steinmann Pin Fixation for Tongue-Type Intra-Articular Fractures of the Calcaneum

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Abstract:

Introduction: Intra-articular displaced fracture of the calcaneus is the most common of all tarsal fractures (60%) and accounts for almost 2% of the fractures in adults. Approximately 75% of the tongue-shaped calcaneal fractures are intra-articular and occur due to an axial load such as a fall from height or a motor vehicle accident. All these techniques have certain steps in common including disimpaction of the fragments, reduction of the displaced fragments either manually or percutaneously and protection of reduction with pins and plasters, external fixation or open reduction, and internal fixation.

Material and Methods: this was a prospective study that was done at the Department of Orthopedics, MGM Medical College, and MY hospital, Indore. Between September 2018 to September 2021. The patients that were included in the study had calcaneum fractures, were aged 18 years or more, were of both sexes, presented within 2 weeks of injury, close or open grade 1, tongue-type intraarticular fractures of calcaneum included in the study.

Results: The mean pre-operative Bohler's angle improved from 7.74 ± 3.7 , to 23.91 ± 8.17 immediately postoperatively and to 23.77 ± 8.32 at the final follow-up of 6 months. The mean Maryland Foot Score was 82.31 ± 7.14 (range 62 to 93). In 16 (26.7%) patients the Maryland Foot Score was excellent, in 38 (63.3%) patients it was good and in 6 (10%) patients it was fair. The mean union time was 10 ± 1.40 weeks (range 8 to 12 weeks).

Conclusion: Closed reduction and percutaneous pin fixation are good treatments for tongue-type fractures of the calcaneum. The procedure provided stable fixation and allowed early mobilization. The complication rate associated with the procedure was found to be low. The morphology of the calcaneum improved and was properly maintained in terms of Bohler's angle.

Keywords: Bohler's angle (BA), Gissane's angle (GA), Maryland Foot Score (MFS).

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Introduction

Intra-articular displaced fracture of the calcaneus is the most common of all tarsal fractures (60%) and accounts for almost 2% of the fractures in adults [1]. Approximately 75% of the tongue-shaped calcaneal fractures are intra-articular and occur due to an axial load such as a fall from height or a motor vehicle accident [2,3]. These fractures very frequently result in long-term disability and can lead to severe economic impact on the patient as many patients fail to return to their original occupation after the trauma [4].

Regarding the involvement of the articular surface, calcaneal fractures are descriptively categorized into extra-articular and intra-articular types. The compression of the talus against the calcaneus is responsible for the intra-articular type, while extra-articular fractures are avulsion injuries arising from twisting

or shearing forces. The outcome of extra-articular fractures is, on average, better than intra-articular types [5]. Thus treatment of these calcaneal fractures requires the re-apposition of multiple fracture fragments and restoration of the subtalar joint anatomy, which is the interface between the calcaneus and talus and is the primary load-bearing joint of the foot, along with providing respect to the thin subcutaneous tissue covering overlying calcaneum [6].

Intra-articular calcaneal fracture is one of the most challenging fractures for orthopedic surgeons all over the world to treat properly. Historically most fractures were treated non-operatively because open reduction and internal fixation were associated with high complication rates and did not result in significantly improved outcomes. 1-s With a better understanding of fracture patterns and improved surgical

and fixation techniques, there appears to be a renewed interest in the surgical treatment of displaced intra-articular fractures of the calcaneus. [7-11] Over the years, various techniques have been developed to accomplish this goal. All these techniques have certain steps in common including disimpaction of the fragments, reduction of the displaced fragments either manually or percutaneously and protection of reduction with pins and plasters, external fixation and open reduction, and internal fixation. [12] The technique of closed reduction and percutaneous fixation was introduced by Westheus in 1934 and popularized by Gissane. [13] But the credit for describing the technique and introducing the shoe plaster goes to Essex-Lopresti. [14,15] The effectiveness of this technique in the restoration of Böhler's angle and calcaneal height in tongue shape is well documented. [16], Among the popularly used techniques, open methods have the significant issue of repeated surgeries, associated soft tissue trauma, and a high rate of wound healing problems while among the closed methods K-wires and pins have the advantage of easy implant removal without the need for repeat surgery [17,18]. Hence we evaluated the outcome of close reduction and pin plaster technique in 30 tongue type intra-articular calcaneal fractures.

Materials and Method

this was a prospective study that was done at the Department of Orthopedics, MGM Medical College, and MY hospital, Indore. Between September 2018 to September 2021, adult patients with intra-articular fractures of calcaneum were admitted. So altogether 60 patients who satisfied the criteria were included in the study. All the patients coming to the Trauma center were initially given first aid in the form of splintage, in the form of a below-knee slab, supportive care, analgesics, IV fluids, and routine relevant investigations were carried out. Basic radiological investigations of the nature of the fracture sustained were done in addition to the standard trauma series of investigations.

After the initial management, all patients were assessed for any other medical ailment and patients were managed accordingly. Informed consent was taken from all patients.

Stable patients were taken to the surgery at the earliest after the pre-anesthetic evaluation. All fractures

were classified using Essex-Lopresti classifications based on pre-operative radiographs. Pre-operative, at the time of intervention, and final follow-up radiographs were reviewed and Böhler's angle and Gissane's angle were measured.

Study design and population: The patients that were included in the study had calcaneum fractures, were aged 18 years or more, were of both sexes and presented within 2 weeks of injury, close or open grade 1, tongue-type intraarticular fractures of calcaneum included in the study. The patients who were excluded from the study were the ones who had grossly compound fractures, neurovascular injury, pathological fractures, and also the ones who refused to sign the consent to be included in the study. We studied 60 cases of fractures of the calcaneum.

Method (surgical technique): The procedure was performed under routine OT protocol. All routine investigations were carried out and pre-operative fitness was obtained. The patient was taken in OT with all aseptic precautions, Suitable anesthesia (ankle block or spinal anesthesia) was given and the patient was put in a lateral position with the affected limb above.

The patient was taken in a Lateral position & c arm view was taken (fig 1), The Foot was painted with providence iodine scrub and painting draping done, Steinmann pin was inserted from calcaneal tuberosity and advanced without crossing the fracture line (fig 2), With forefoot in plantar flexion the pin was pulled down-ward and poked towards the planter surface and disimpaction of the fragment was done by joysticking (fig 3), After elevation of the depressed fragment, first Steinmann pin was inserted from the superior external side of calcaneal tuberosity towards the tarsal bone, holding the reduction (fig 4), 2nd pin or K- the wire was inserted inferior to the first Steinmann pin for fracture fragment stabilization as well as fixation (fig 5), Joysticking pin was removed (fig 6), 3rd K wire inserted from the posterior of the calcaneum tuberosity, traversing the fracture fragment and reaching towards the tarsal bones. (fig 7) Intraoperative lateral and axial C-arm views were taken to confirm the reduction and restoration of Bohler's angle within the range of 20-40 degrees (fig 8) Pin tract dressings were done and below the knee, a cast was applied after the pins were shortened with help of Harrington rod cutter. (fig 9,10,11)



Figure 1:

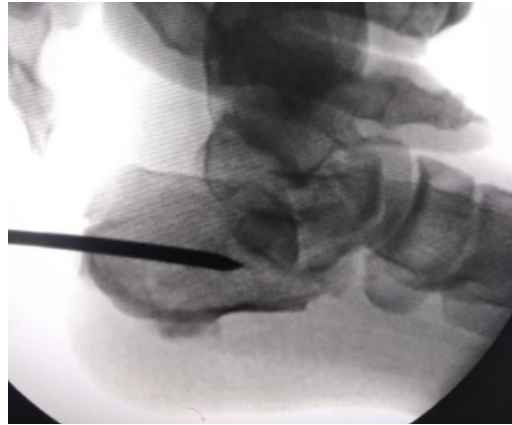


Figure 2:



Figure 3:



Figure 4:

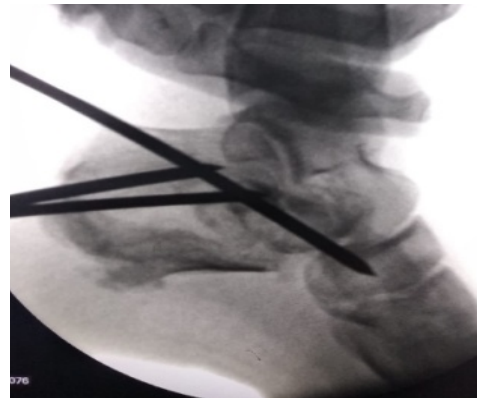


Figure 5:



Figure 6:



Figure 7:



Figure 8:



Figure 9:



Figure 10:



Figure 11:

Post-operative protocol Active toe movements were started on post-op day 1.

A single dose postoperative intravenous antibiotic was given (to prevent infection).

Oral analgesics and antibiotics were given for 3 days. Cast care was explained to the patient as well as to relatives

Follow-up protocol: Patients were followed in the first week to check if the plaster was loose or tight. Pinplaster was kept up to 6 weeks (minimum) or 8 weeks.

After pin plaster removal patient was advised to continue active physiotherapy. Weight-bearing was allowed only after 12 weeks.

Patients were assessed for any residual pain, ROM of affected joints, union on X-ray, and presence of any complication. Maryland Foot Score was used for evaluation of functional outcome and Radiological outcome was assessed by measuring Bohler's and Gissane's angles on X-Ray. Lateral (fig 12) and axial (fig 13) view of the heel of a 19-year-old male showing tongue-type calcaneal fracture with preoperative Bohler's Angle of 7.6° & Gissane's angle of 131.6° , Immediate postoperative lateral (fig 14) and axial (fig 15) views after Essex Lopresti maneuver showing improved Bohler's & Gissane's angle to 34.4° & 116.3° respectively. final 6 months post-operatively lateral (16) & axial (17) views showing Bohler's and Gissane's angle of 34.2° and 114.2° and MFS as 91.



Figure 12:



Figure 13:

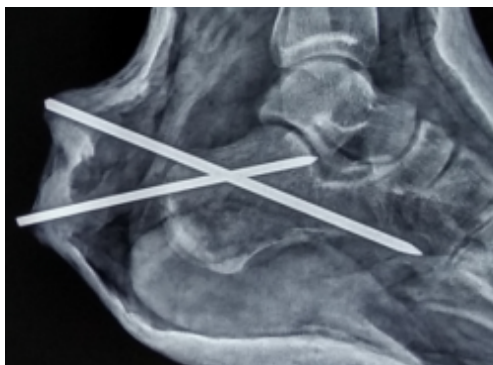


Figure 14:

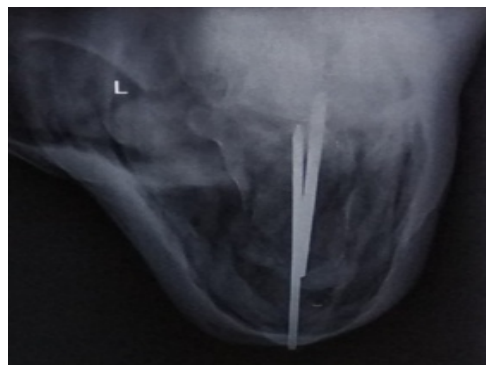


Figure 15:



Figure 16:

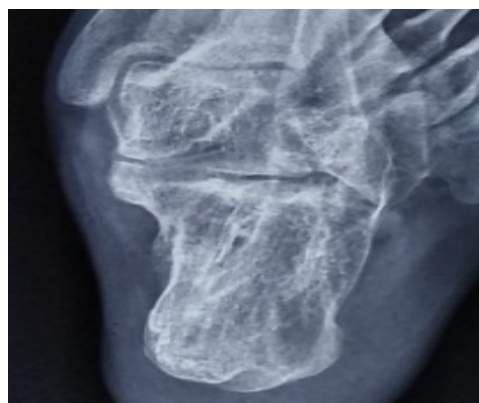


Figure 17:

Results

Table 1: Distribution of patients according to age

Age Group	Number	Percentage
18-20 years	12	20
21-40 years	38	63.3
41-60 years	10	16.7
Total	60	100.0

The mean age of the patients was 30.73 ± 10.39 years with a range from 18 years to 54 years.

Table 2: Distribution of patients according to sex

Sex	Patient		Limbs	
	No.	%	No.	%
Female	12	23.0	15	25
Male	40	77	45	75
Total	52	100.0	60	100.0

Table 3: Distribution according to side involvement

Side	Number	Percentage
Left	37	61.7
Right	23	38.3
Total	60	100.0

The prevalence of injury to the left side was more in comparison to the right side.

Table 4: Distribution according to mode of injury

Mode of Injury	Number	Percentage
Fall from height	42	70.0
RTA	12	20
Slipped	6	10
Total	60	100.0

Fall from height was the most common mode of injury

Table 5: Duration between injury and surgery

The time between injury and surgery	Number	Percentage
0 days	4	6.7
1-3 days	50	83.3
4-7 days	3	5
>7 days	3	5
Total	60	100.0

The majority of the limbs were operated within 1-3 days of injury. The mean duration of surgery was 11.50 ± 3.45 minutes with a range between 7 minutes to 13 minutes

Table 6: Comparison of Bohler's Angle at different time intervals

Time Interval	Mean \pm SD	't' Value	P value
Preoperative	7.74 \pm 3.7	-10.783, df=29	0.001*
Postoperative	23.91 \pm 8.17		
Preoperative	7.74 \pm 3.7	-10.574, df=29	0.001*
At 6 months	23.77 \pm 8.32		
Postoperative	23.91 \pm 8.17	1.908, df=29	0.067, NS
At 6 months	23.77 \pm 8.32		

Unpaired' test applied. P value < 0.05 was taken as statistically significant.

The above table shows the comparison of the mean Bohler's angle between different time intervals.

The mean Bohler's angle preoperatively was 7.74 ± 3.7 , at immediate postoperative was, 23.91 ± 8.17 and at 6 months it was 23.77 ± 8.32 .

The mean Bohler's angle increased significantly from the preoperative level to the immediate

postoperative level ($p=0.001$). There is a significant increase in the mean Bohler's angle from preoperative level to at 6 months ($p=0.001$). The mean Bohler's angle remained comparable between the immediate postoperative level at 6 months ($p=0.067$).

Table 7: Comparison of Gissane's Angle at different time intervals

Time Interval	Mean \pm SD	't' Value	P value
Preoperative	132.93 \pm 6.72	8.795, df=29	0.001*
Postoperative	121.95 \pm 8.48		
Preoperative	132.93 \pm 6.72	8.573, df=29	0.001*
At 6 months	122.35 \pm 8.51		
Postoperative	121.95 \pm 8.48	-1.668, df=29	0.106, NS
At 6 months	122.35 \pm 8.51		

Unpaired' test applied. P value < 0.05 was taken as statistically significant. The above table shows the comparison of Mean Gissane's angle between different time intervals. The mean Gissane's angle preoperatively was 132.93 ± 6.72 , at immediate postoperative was 121.95 ± 8.48 , and at 6 months it was 122.35 ± 8.51 . The mean Gissane's angle decreased significantly from the preoperative level

to the immediate postoperative level ($p=0.001$). There was a significant decrease in Gissane's angle at 6 months in comparison to the preoperative level ($p=0.001$). While the mean Gissane's angle remained comparable between the immediate postoperative level to at the 6-month level ($p=0.106$).

Table 8: Distribution according to radiological union (weeks)

Radiological Union (Weeks)	Number	Percentage
8 weeks	2	3.3
9 weeks	3	5
10 weeks	12	20.0
11 weeks	25	41.7
12 weeks	18	30
Total	60	100.0

The majority of the limbs achieved radiological union by 10 weeks with a mean union time of 10.5 ± 1.40 weeks and a range of 8 to 12 weeks.

Table 9: Distribution according to Maryland Foot Score (MFS)

Maryland Foot Score (MFS)	Number	Percentage
Excellent	16	26.7
Good	38	63.3
Fair	6	10
Poor	0	0.0
Total	60	100.0

The majority of the patients had good to excellent Maryland Foot Score. The mean Maryland Foot Score was 82.31 ± 7.14 with a range from 62 to 93.

Table 10: Distribution according to complications

Complications	Number	Percentage
Major complications:		
➤ Subtalar arthritis	3	5
➤ Reduction loss (implant loosening)	3	5
Minor complications:		
➤ Pin tract infection	5	8.3
➤ Calcaneal spur	2	3.3
No complications	47	78.3
Total	60	100.0

Table 11: Distribution according to follow-up period (months)

Follow-up Period (Months)	Number	Percentage
6 months	20	33.3
7 months	14	23.3
8 months	13	21.6
9 months	3	5
10 months	4	6.7
11 months	2	3.3
12 months	4	6.7
Total	60	100.0

The mean follow-up period was 7.20 ± 2.30 months with a range from 6.0 to 12.0 months.

Table 12: Correlation between Bohler's Angle Achieved and Maryland Foot Score

Pair	'r' value	P value
Bohler's Angle (Achieved) to Maryland Foot Score	0.678	0.001*

Pearson Coefficient of Correlation 'r' test applied. P value < 0.05 was taken as statistically significant.

The above table shows the correlation between Bohler's angle (Achieved) and Maryland Foot Score.

There is a strongly positive correlation between Bohler's Angle (Achieved) and Maryland Foot Score and also this correlation is statistically significant ($p=0.001$).

Table 13: Correlation between Bohler's Angle (Loss) and Maryland Foot Score (MFS)

Pair	'r' value	P value
Bohler's Angle (Loss) to Maryland Foot Score (MFS)	0.783	0.001*

Pearson Coefficient of Correlation 'r' test applied. P value < 0.05 was taken as statistically significant. The above table shows the correlation between Bohler's angle (Loss) and Maryland Foot Score (MFS).

There is a strongly positive correlation between Bohler's Angle (Loss) and Maryland Foot Score and also this correlation is statistically significant ($p=0.001$).

Discussion

This present study was instituted to analyze the outcome of closed reduction and percutaneous pin fixation for tongue-type calcaneal fractures. In 1951 Essex Lopresti¹⁴ described this technique for

all calcaneal fractures but in a further analysis in 1952 [15], proposed his technique only for tongue-type fractures of calcaneus. This was the time when Gallie's subtalar arthrodesis was the preferred method to treat such fractures. Although Essex Lopresti showed excellent results, his technique was not favored. While ORIF is believed to provide more anatomical reduction [19], the rate of soft tissue problems and long-term non-weight-bearing period may reduce the advantages of this approach. Percutaneous reduction and fixation were performed about 2 days after trauma; early intervention permits the surgeon to perform reduction before fibrous union initiation which facilitates the closed reduction process. We have recorded a much longer period between the injury

and operation time in the ORIF surgery, to reduce wound-related problems.

Consequently, hospital stays were shorter in the CRIF than in the ORIF group, which implies the advantage of the percutaneous approach [20,21]. The basic aim of the surgery was to achieve as near anatomical realignment and perfect subtalar joint congruity as possible. The mean operative time was 11.50 ± 3.45 minutes (range 7 to 13 minutes). The mean pre-operative Bohler's angle improved from 7.74 ± 3.7 to 23.91 ± 8.17 immediately postoperatively and to 23.77 ± 8.32 at the final follow-up of 6 months, respectively. The mean pre-operative Gissane's angle improved from 132.93 ± 6.72 , to 121.95 ± 8.48 immediately postoperatively and to 122.95 ± 8.48 at the final follow-up of 6 months, respectively (fig 2).

The mean union time was 10.5 ± 1.40 weeks (range 8 to 12 weeks). The mean Maryland Foot Score was 82.31 ± 7.14 (range 62 to 93). In 16 (26.7%) patients the Maryland Foot Score was excellent, in 38 (63.3%) patients it was good and in 6 (10%) patients it was fair.

Complications associated with the procedure were implant loosening in 3 patients (5%) and subtalar arthritis in 3 patients (5%). None of the cases had infection or wound-healing problems associated with the procedure.

34 examples with tongue-type calcaneum fractures were examined by Poupa and Priby [22], who used the Creighton-Nebraska scoring system to assess the surgical outcomes. They reported scores that were 20 (58%) exceptional, 10 (29%) decent, and 4 (13%) fair King [23] evaluated the outcomes of 75 consecutive Os calcis fractures involving the posterior facet that were treated using the Essex-Lopresti method. He concluded that fractures of the tongue type produced the best results, while fractures of the joint depression type produced less than ideal-results. Arastu et al. [24] and Parikh et al [25] were able to accomplish corrections between 15° and 20° . Nambiar [26] assessed the effectiveness of percutaneous fixation and closure reduction in 36 intra-articular calcaneum fractures involving 29 patients. They received 61% excellent, 33% good, and 6% poor results in this series. Even in 2007 Pillai [27] recently described a modification of Essex-Lopresti's traditional approach in 2007. In 67% of the patients, they obtained fair to excellent results using the Maryland Foot Score. Tornetta [15] examined 26 patients in a row who had fractures of the tongue similar to those of Essex-Lopresti. Results were 12 (55%) good, 7 (32%) good and 3 (13%) fair. He concluded that the Essex-Lopresti spike reduction is a helpful technique for treating calcaneus fractures of the tongue type, noting that the outcomes were better than those of earlier intra-

articular fracture series treated with open reduction and internal fixation. In 2000, Tornetta [28,29] examined the outcomes of 46 instances once more. 50% of patients had outstanding results, 35% had good results, 15% had acceptable results, and no patients had bad results with an average follow-up of 3.4 years. The Essex Lopresti method of percutaneous fixation of calcaneal fractures has a very short learning curve, requires little expertise, is easily perfected, has a very short surgical time, and can be safely used even in the presence of extensive soft tissue swelling, i.e., immediately following injury. All of these factors reduce hospitalization time and the burden placed on both the patient and the healthcare system.

Conclusion

We conclude that closed reduction and percutaneous pin fixation is a good treatments for tongue-type fractures of the calcaneum. We experienced that this procedure is easy to perform and requires average surgical skill. The final functional outcome correlated well with the post-operative Bohler angle achieved and thus can be used as a prognostic indicator. The procedure provided stable fixation and allowed early mobilization. The complication rate associated with the procedure was found to be low. The morphology of the calcaneum improved and was properly maintained in terms of Bohler's angle. This is a very cost-effective method for fracture fixation as it is a daycare procedure without the requirement of any special instrumentation and is easy to perform.

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