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Displaced intra-articular fractures of the calcaneus: Percutaneous reduction and screw fixation

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Abstract
Background: Extensile open technique to reduce and fix intra-articular calcaneal fractures have a high rate of wound complications. A technique of percutaneous reduction and fixation with screws alone was devised to avoid these problems. The clinical results, & radiographs were evaluated in this study after operational treatment using this approach.
Methods: The study looked at 33 patients who had intra-articular calcaneal fractures in Sri Lakshmi Narayana Institute of Medical Science Puducherry from January 2020 to December 2021. At 3 months after the injury, all patients were evaluated for early postoperative sequelae. The clinical outcomes were evaluated for patients who were seen at least 6 months following surgery. The articular reduction was quantitatively analysed in patients who received both preoperative and postoperative radiographic images**.**
Results: No complications were found at the 3-month follow-up. At least 6 months after the injury, screw irritation 9% (3 patients), subtalar osteoarthritis 3% (1 patient) requiring subtalar fusion percent, malunion 9%(3pt), and deep infection 0 percent were among the consequences. The Bohler angle, calcaneal facet height, and width all improved markedly after surgery. The Bohler angle increased by +24.1 degrees on average after surgery, with a loss of 4.9 degrees during the 3-month follow-up, 54.5 percent of patients reported a residual pain level of 3 or lower at the final follow-up.
Conclusion: Based on articular reduction and amount of residual discomfort, this study suggests that percutaneous treatment of intra-articular calcaneal fractures with screws alone could offer acceptable early results.

Keywords: intra-articular, Percutaneous, screw fixation

Introduction
Calcaneal fractures account for about 1% to 2% of all fractures. Approximately 75 percent of calcaneal fractures are intra-articular. The treatment of intra-articular calcaneal fractures is still up for debate. Elevation, ice, early mobilisation, and cyclic compression of the plantar arch are among nonoperative therapeutic options. Closed reduction and percutaneous pin fixation, open reduction and internal fixation, and arthrodesis are among surgical therapy possibilities. Several comparative studies have looked at the effects of operational versus nonoperative therapy [1].
The therapeutic goal has been to achieve correct anatomic reduction and stable fixation with the goal of early functional rehabilitation while avoiding potentially fatal soft tissue problems. It's also well known that pre-existing co-morbidities such as peripheral vascular disease, diabetes, and smoking negatively impact wound healing after calcaneus fractures are treated with open reduction and internal fixation (ORIF) [2].
Because many patients do not return to their old work following the accident, these fractures commonly result in long-term disability, which can have a significant financial burden on the patient. These fractures are difficult to treat because of the uneven morphology, intricate joint mechanics between the tarsal bones, and the fragile soft-tissue envelope in which they reside. Treatment of displaced calcaneal fractures has traditionally ranged from non-operative therapy with or without closed fixation to open reduction with internal fixation using a variety of surgical techniques.

However, open reduction and internal fixation have been linked to a high risk of problems and have not been shown to enhance results. The infection incidence has been reported to be between 5 and 20%, and amputation of limbs owing to persistent osteomyelitis and personal handicap is also a possibility. Non-operative therapy can also cause a widening of the heel, muscular imbalance, loss of mobility, and intractable discomfort. As a result, minimally invasive calcaneal fracture reduction and fixation (MIRF) may be beneficial in patients who are concerned about complications and infections [3].

Aims and Objectives

The primary goal of this study was to describe the surgical approach for employing MIRF in a group of patients who had been diagnosed with an inter-articular fracture and were treated with Steinmann Pins, K-wire, and CC screws.

Materials and Methods

The study looked at 33 patients who had intra-articular calcaneal fractures in Sri Lakshmi Narayana Institute of Medical Science Puducherry from January 2020 to December 2021.

At our institute, we treated intra-articular calcaneus fractures with closed reduction and percutaneous fixation using ST pins, K-wires, and CC screws.

Three radiographic images are used to examine the posterior facet: a lateral view of the calcaneum, a Harris axial view, and an intra-operatively broadened view. In lateral and axial views, Bohler's and Gissane's angles were examined, as well as varus. Each patient was followed until a clinico-radiological union was achieved, followed by a 3 to 6-month post-operative follow-up [4].

Table 1: Demographic data

Characteristics	
Sex, N	
Male	21
Female	12
Height, cm	169.5
Weight, kg	85.6
BMI	28.2
Side of the foot, N	
Left	10
Right	10
bilateral	13
Closed injury/open injury (No. of feet), N (%)	30(90%)/3(9%)
Average age, y	40+- 12.9
Isolated fracture/ polytrauma, no. of feet	23/10
Average time to surgery, d	6.2
Sanders classification, %	
2A	
2B	
3AB	
3AC	
3BC	
4	

Operative Technique

On a radiolucent surgical table, the patients were put in a lateral decubitus posture, with a solid bump below the afflicted foot to support a perfect lateral position. With the C-arm entering the operational field opposite the end of the fluorescent table, the surgeon stood posterior to the patient. The surgeon made certain that the lateral, Broden, and Harris views were all acceptable. To treat joint depression fractures, the tuberosity was initially decreased by threading a corkscrew through the calcaneal tuberosity from lateral to medial, then manipulating the tuberosity out of an obstructive position to facilitate facet reduction. After the tuberosity was decreased, the fracture was temporarily repaired using 1.6-mm Kirschner wires put from the posterolateral side of the tuberosity into the medial sustentaculum [5]. The talus was elevated and the talo-calcaneal joint was distracted and the posterior calcaneal facet was elevated using a percutaneous technique using a back of ST pin or a push screw [4].

Facet fragments were then reduced with tiny tools under fluoroscopic guidance through several stab incisions and temporarily fixed with Kirschner wires inserted lateral to medial. The surgeon definitely corrected the fracture(s) using 3.5- and 4.0-mm cannulated screws when the fractures were satisfactorily reduced on the three C-arm views (lateral, axial, and Broden view).

Two 3.2-mm Steinmann pins were put parallel to each other in the facet (tongue) fragment(s) posterior to anterior for tongue-type fractures. Manipulation of the Steinmann pins in conjunction with tiny instrument(s) introduced through stab incision resulted in fracture reduction (s). Multiple 3.5 or 4.0 mm screws were put from posterosuperior to anteroinferior and from lateral to medial into the sustentaculum to support the tongue piece after a successful reduction was confirmed by fluoroscopic examination. The Steinmann pins were then withdrawn, albeit they were sometimes pushed into the cuboid to maintain the reduction and removed after 4 weeks in the most severe instances [5].

Fig 1: showing the positioning of patient & C-arm on surgical table

Fig 2: posterior position of the K-wire on the surgical table

Fig 3: pre-op x-ray

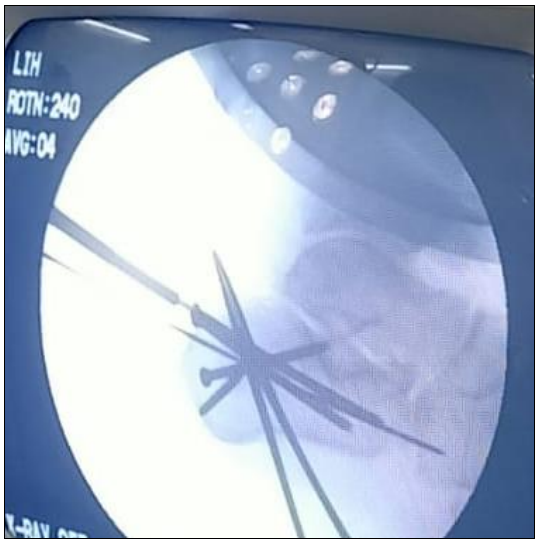

Fig 4: inter-op C-arm pic.

Fig 5: inter-op C-arm pic

Fig 6: post-op X-ray pic.

Fig 7: X-ray pic post-op

Radiographic Measurement Techniques

Bohler angle, Gissane angle, the talocalcaneal angle, calcaneal breadth, height, and length were measured using lateral and Harris view plain radiographs of the fractured calcaneus. These measures were taken on radiographs taken before surgery, just after surgery, three months later, and six months later.

A trained orthopaedic doctor who was not engaged in the patient's treatment completed all radiographic examinations and measurements [6].

Results

Thirteen patients (39.3%) reported a pain VAS score of 0, 8 patients (24.2%) reported scores of 1 to 3, 9 patients (27.2%) reported scores of 4 to 6, and 3 patients (0.09%) reported scores of 7 of 10. Overall, 54.5% of the entire cohort reported a residual pain level of 3 or lower.

The subtalar examination demonstrated normal motion in 20 patients (60.6%), subtalar motion >70% compared to the normal side in 6 patients (18%), subtalar motion 30% to 70% compared to the normal side in 5 patients (15%), and subtalar motion less than 30% compared to the normal side in 2 patients (6.06%).

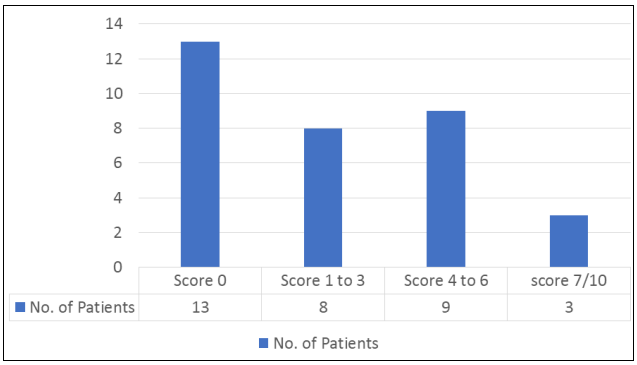

Fig 8: Pain on VAS

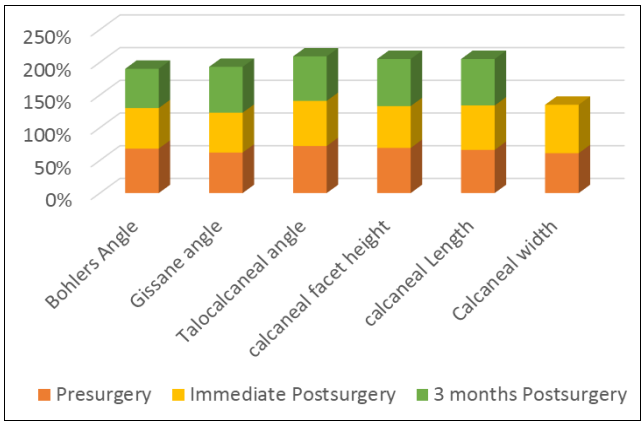

Fig 9: Results of radiographic measurements on plain radiographs in the whole group of patients

The results of the radiographic measurements on plain radiographs in the whole group of patients (33 patients / 182 feet). There was a significant improvement in Bohler angle 62%, calcaneal facet height 64%, and calcaneal width % postoperative radiographs. On 3-month postoperative radiographs, all measurement parameters were well maintained except the Bohler angle, which decreased on average 68% from 62% postoperatively to 60% degrees at 3 months postoperatively. The Bohler angle increased by +24.1 degrees (that's approx68%) on average after surgery, with a loss of 4.9 degrees (approx62%of the pts) during the 3-month follow-up, 54.5 percent of patients reported a residual pain level of 3 or lower at the final follow-up.

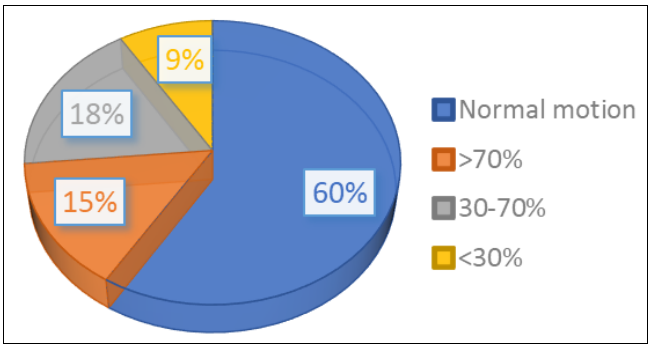

Fig 10: Subtalar Motion

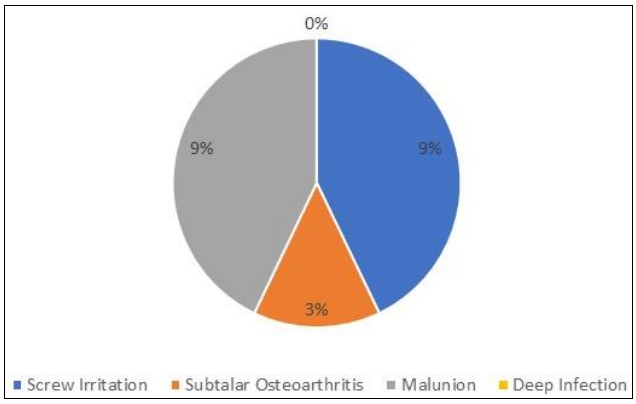

Fig 11: Complications

No complications were found at the 3-month follow-up. At least 6 months after the injury, screw irritation 9% (3 patients), subtalar osteoarthritis 3% (1 patient) requiring subtalar fusion percent, malunion 9% (3pt), and deep infection 0 percent were among the consequences.

Discussion

Among the fractures in the foot bones, the calcaneum fracture is the most frequent and devastating. The location of the fracture line across the posterior facet of the calcaneus, which might be in the medial third at the sustentaculum tali, the central third, or the lateral third near the lateral wall, is the most variable element of this fracture line.

For un-displaced or mildly displaced (less than 2 mm) intra-articular fractures, nonoperative therapy is sufficient, but ORIF is the recommended treatment choice for considerably displaced intra-articular fractures. The result, on the other hand, is highly dependent on the state of the surrounding soft tissues, as well as the surgical insult generated during minimising and mending the fractures utilising typical ORIF methods. All extra-articular fractures, those with less comminution (Sanders type IIc), tongue type fragments, and even certain calcaneus fractures that are a "bag of bones" may be reoriented to a near normal (3D) morphology using minimally invasive techniques [7, 8].

Closed Intraarticular calcaneum fractures can be reduced and fixed percutaneously, resulting in a biological environment with excellent mechanical stability and early mobilisation. It takes care of the calcaneum's varus/valgus alignment, width, and, to the extent feasible, pitches, with a greatly reduced risk of malunion [9].

The lack of a contemporaneous control group treated with different procedures, as well as the short and insufficient follow-up, are major flaws in this study. Inadequate follow-up may be part of the reason for the low rate of late complications like subtalar arthrodesis. Furthermore, the imaging investigations performed in this study's sensitivity may not cover the complete spectrum of aberrant results. After three months, changes in calcaneal alignment, including the Bohler angle, may occur. To summarise, the results of this study on calcaneal fractures reduced percutaneously and treated with screws alone provide the outcomes of a large number of non-selected patients that represent the range of calcaneal fractures encountered at our institution. The method had a low complication rate, and it restored heel height and breadth to levels similar to those described in prior research. At the end of the research, the majority of the patients reported no or just minor discomfort.

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