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Results of intra articular calcaneal fractures treated with internal fixation using sinus tarsi approach

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Abstract
Fractures of the calcaneum are commonly encountered clinical injuries resulting from high-energy trauma such as fall from height or road traffic accidents. In intraarticular displaced fractures, goal is to establish anatomic reduction and subtalar joint alignment, to restore calcaneal width and height and to prevent lateral impingement where the standard surgical method is open reduction and internal fixation via extensile Lateral approach to calcaneum. Minimally invasive fixation of calcaneal fractures is becoming an increasingly described and used technique, with evidence to support its advantages over the more traditional open approach, particularly in terms of lower rates of soft tissue complications and wound related problem. The study represents 20 patients with intraarticular calcaneal fractures (Sander's type II and III) treated with Sinus Tarsi approach between April 2018 to August 2019. Functional recovery was evaluated according to Maryland's Foot score (MFS) Modified by Dr. Rajiv N. Daveshwar. MFS score for16 patients were noted excellent and 4 pateints were good. Fixation with Sinus Tarsi approach provides adequate visualization for Sander's typeII and III intraarticular calcaneal fracture with advantage of no wound releted complication, good exposure to posterior facet and subtalar joint and reduce surgery time.

Keywords: Intraarticular calcaneal fractures, Sanders II & III, Sinus Tarsi approach

Introduction
Fractures of the calcaneum are commonly encountered clinical injuries resulting from high-energy trauma such as fall from height or road traffic accidents. They account for 1 to 2% of all fractures and 65% of all tarsal fractures. According to the results of the computed tomography (CT) scanning, the calcaneal fractures can be classified into four categories, among which the Sanders types II and III fractures are the most common types [1].Currently, open reduction and internal fixation through the lateral L-shape extensile incision has been considered as the gold standard surgical therapy for calcaneal fractures. This approach provides a large view to expose the fractures, allowing accurate reduction of the deformed posterior facet and convenient placement of the plate to achieve a stable fixation. However, the high incidence (approximately 30%) of complications associated with this approach, including wound dehiscence and deep infection, remains a troublesome problem [2, 3].
In Intraarticular displaced fractures, goal is to establish anatomic reduction, subtler joint alignment, restore calcaneal width and height. The standard surgical method is open reduction and internal fixation via extensile Lateral approach to calcaneum. Nevertheless it is often associated with several problems that may predispose the patients to serious comorbidity such as postoperative hematoma, wound necrosis, wound dehiscence and infection. On the other hand minimally invasive fixation of calcaneal fractures with Sinus Tarsi approach is becoming an increasingly described and used technique, with evidence to support its advantages over the more traditional open approach, particularly in terms of lower rates of soft tissue complications and wound related problems. The aim of this study is to evaluate outcome of intraarticular calcaneal fractures treated with Sinus Tarsi approach.

Materials and Methods
The study represents 20 adults' cases of unilateral Intraarticular Sander's type II and III Calcaneal fracture (figure1) between age group of 18-60 years during April 2018 to August

2019 at SSG Hospital, Vadodara. Patients with Pathological fracture, open fracture, Sanders type IV fracture, congenital foot deformity, lower extremity involvement of rheumatic or systemic condition(rheumatoid arthiritis, diabetes, neuropathy etc), prior foot ankle surgery, and unwillingness to accept study treatment modality were excluded from study. After being approved by the local ethics committee of our hospital, the study was performed in accordance with ethical principles set by 1964 Helsinki Declaration. Evaluation of patients were done according to radiological and functional outcome at 4, 8 and 12 weeks. Under spinal anesthesia, the patients were put into the lateral decubitus with ankle tourniquet. A 4-6cm transverse skin incision was made just 2cm below tip of fibula lateraly. Posterior facet was exposed by retracting extensor digit rum brevis proximally and peroneal tendons inferiorly [5]. (Figure 2) The Joint was restored by lifting the posterior facet fragment via the elevator like 3mm k wire or schantz pin. The Steinman pin introduced from tuber calcanei provided correction of calcaneal virus, length and width, which was fixed by temporary k wires. After verifying calcaneal length, height, width, Gissane's and Bohler's angle, locking recon plate was inserted in appropriate position under the guidance of C-Arm fluoroscopy. (Figure 2) Incision was closed securely with layers.

Patients were discharged after dressing on 5th postoperative day and called for follow up after 2 weeks at which suture removal was done. Further follow was done at 4 weeks, 8 weeks and 12 weeks. (Figure 4) At final follow up functional outcome was assessed using Maryland Foot score Modified by Dr. Rajiv N. Daveshwar (MFS) [9] (Table 1).

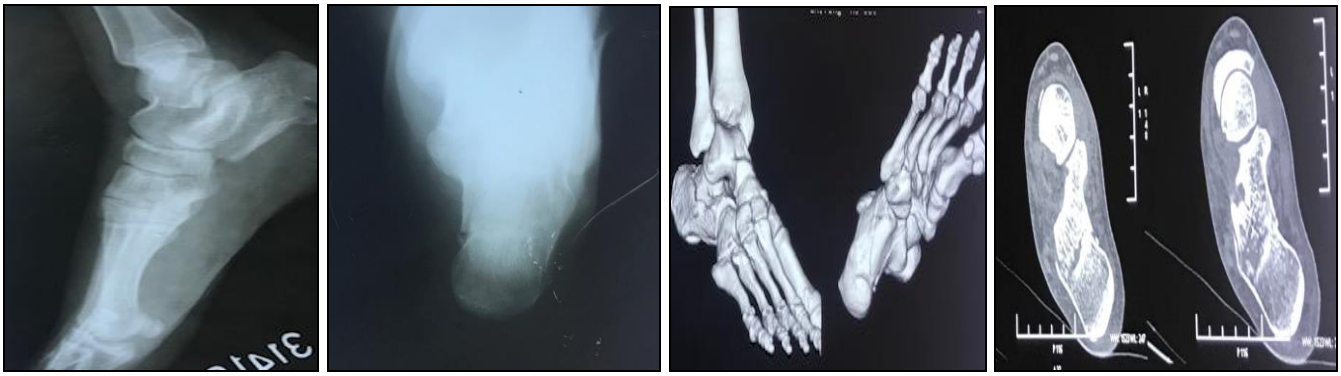

Fig 1: Preoperative x-rays and Computed Tomography

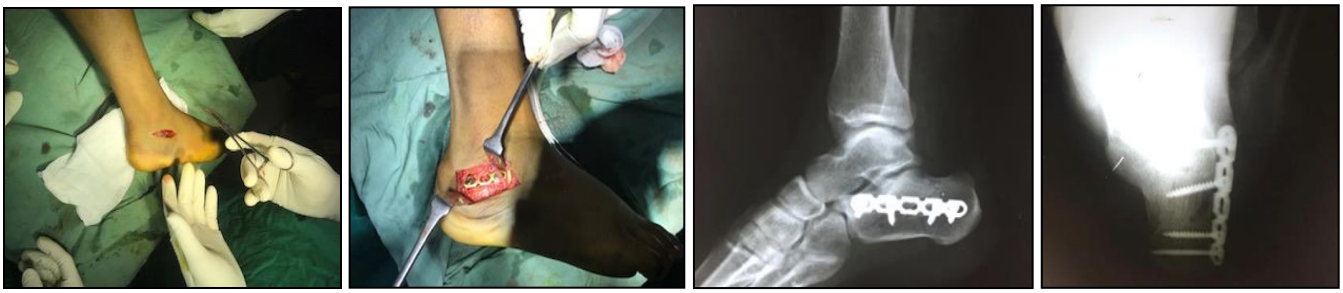

Fig 2: Sinus Tarsi approach and plate placement

Fig 3: Immediate postoperative x-rays

Fig 4: Postoperative x-ray on final follow up

Result

The study represents 20 adults cases of unilateral intraarticular Sander's type II and III calcaneal fracture (Figure 1) between age group of 18-60 years during April 2018 to August 2019 at SSG Hospital, Vadodara treated with internal fixation using Sinus Tarsi approach. There were 18 male and 2 female patients, with mean age of 37.1 years. The mode of trauma was fall from height in 18 patients (90%) compared with road traffic accidents in remaining 2(10%) cases in which 12 cases had right sided injury and 8 cases had left sided injury. In our study 16 patients were Sander's type II and 4 patients were type III. In all cases; Preoperative Bohler's and Gissane's angles were restored to normal degrees postoperatively. Postoperative calcaneal height and length was also reconstructed (Table 2). Parameters which were added to modified Maryland score like sitting cross legs, squatting, heel widening, walking on different terrain, joining work were satisfactorily achieved in all patients. Postoperative complications like wound dehiscence, deep infection, wound edge necrosis, and hematoma formation was not seen in any patients.

Table 1: Maryland foot score modified by Dr. Rajiv N. Daveshwar

Pain	45
Functional	
Distance walked	8
Stability	4
Support	4
Limp	4
Stair climbing	4
Foot wear	5
Terrain	3
Cosmesis	5
Motion	
Inversion	5
Eversion	5
Return to work	2
Ability to sit cross leg	3
Ability to squat	3
Total Score 100	

Descriptive statistical methods (Mean, standard deviation, minimum and maximum) were used analyze data. Spearman's correlation test was used to assess correlation between calcaneal widening and MFS. Chi square test, independent samples t-tests were utilized for parametric values. $P<0.05$ were assessed as statistically significant.

Table 2: Radiological results before and after Surgery

Group	Buhler's angle(°)	Gissane's angle(°)	Calcaneal length(mm)	Calcaneal width(mm)	Calcaneal height(mm)
Preoperative	19.1±6.1	104.1±16.6	60.1±5.0	37.0±3.0	31.6±2.5
4 weeks Post-operative	30.6±6.7	119.8±6.4	64.8±8.0	33.1±3.0	36.9±1.7
8 weeks Post-operative	30.6±6.6	119.8±6.4	65.6±8.0	33.0±3.0	36.9±1.7
Final follow up	30.6±6.6	119.7±6.4	66.6±10.3	33.0±3.0	37.1±1.8

Table 3: Functional outcome score

Maryland score	Mean±SD	Excellent (%) (90-100)	Good (%) (75-89)	Fair (%) (50-74)	Poor (<50)
Total	88.1±8.8	15(75)	5(25)	0(0)	0(0)
Sanders II	88.1±8.8	11(55)	5(25)	0(0)	0(0)
Sanders III	87.8±10.1	4(20)	0(0)	0(0)	0(0)

Discussion

Three dimensional reconstruction of calcaneal anatomy is very critical for foot and ankle functions and development of subtalar arthrosis [10]. Restoration of the contact surface between the talus and calcaneus to its original pre fracture state as much as possible should be main objective of surgery [11, 12]. Randle *et al*. [15] performed a meta-analysis of articles between 1980 and 1996 dealing with calcaneal fractures. Of the 1845 articles, 6 compared operative and non-operative treatment for displaced calcaneal fractures. A statistical summary of information across the 6 articles revealed a trend for surgically treated patients to be more likely to return to the same type of work as compared with non-operatively treated individuals. There was also a trend for non-operatively treated patients to have a higher risk of experiencing pain. Surgical fixation however is not without risk; traditional extensile approaches to the calcaneus have been associated with high rates of soft tissue complications [16].

Incidence of skin necrosis following calcaneal fixation have been reported to vary between 2 and 11 per cent, with soft tissue infections ranging from 1.3 to 7 per cent following an extended open approach. Overall wound problems following such open approaches have been quoted to occur in up to 25 per cent of cases [17–21].

Concerns regarding wound healing complications following an extensile lateral approach have led to the development of alternative methods for the management of these fractures in order to minimise soft tissue trauma [12]. Sinus Tarsi approach provides adequate visualisation of the calcaneal posterior facet and lateral wall in sander's type II and III calcaneal fracture and not only these its provides access to the subtalar joint, assessment of joint and wound related complication as described with lateral approach can be minimized and also reduces duration of the surgery.

In our study statistically significant normalization of Gissane's and Bohler's angle as well as calcaneal length and height compared to preoperative values. It is considered that minimal invasive approach provided sufficient field view for anatomic reduction of all lateral structures from posterior facet to calcaneo-cuboid joint. Calcaneal widening that might develop after calcaneal fracture may cause peroneal tendon impingement. In our study via plate fixation any case of heel widening not seen [13].

In our study, aiming to show that early postoperative functional exercises and gradual weight-bearing reshaped subtalar joint surface and improved functional outcome by correcting residual displacements at articular surface [14]. Partial weight-bearing was started in average for 30 min daily on the 3rd week, where full weight bearing was achieved around 12th week after fracture healing [7, 8]. In our study all fractures were united and average union time was 10.5weeks (9-11 weeks).

In our study has some limitations like single-center nature of the study, absence of the long-term results, relatively few numbers of subjects, and pooling of both male and female patients together. In our study we had not carried out post-operative CT scan to assess reduction of articular fragment with early weight bearing. Limitation of Sinus Tarsi approach

is that calcaneo cuboid joint cannot be visualised. With this approach, Avulsion fracture of calcaneal tuberosity cannot be fixed.

Conclusion

Sinus Tarsi approach for fixation of intraarticular fractures of joint depression type and Sanders II and III type was shown to be associated with lower rate of implant failure and reoperation, better reconstruction of lateral calcaneal widening and better functional outcomes and less soft tissue related postoperative complications.

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