

A Simple Surgical Technique of Trans Articular K Wires Fixation Through Sinus Tarsi Approach for Treating Intra Articular Calcaneal Fractures : A Large Case Series

Sampat Dumbre Patil¹, Gurunath Wachche², Harsh R. Vyas¹, Rohil Singh Kakkar¹,
Vaishali Dumbre Patil³

Abstract

Introduction: Calcaneum fractures are the most common tarsal bone fractures accounting for 2% of all bone fractures and approximately 60% of tarsal bone fractures. Management of intra-articular calcaneal fractures have evolved from conservative to open and minimally invasive surgeries till date. There are still some controversies in treating intra articular displaced calcaneum fractures and treatment modalities continue to evolve with different surgical techniques and implants. We present a large retrospective study series of a safe and simple technique of managing intra-articular calcaneum fractures through sinus tarsi approach and fixation with transarticular Kirschner wires with or without sustentacular screw.

Methods: This retrospective study was done from January 2016 to March 2019 and aimed to evaluate the radiological and functional outcomes in a series of 226 patients with displaced intra-articular fractures of calcaneum managed with a simple surgical technique treated with trans articular K wires with or without sustentacular screw through sinus tarsi approach. Statistical analysis was performed utilizing independent t-test using the p-value ≤ 0.5

Results: All 226 cases achieved union of fracture within 4 months of follow up and as per American Orthopaedic Foot and Ankle Society (AOFAS) scoring, 57.96% cases had excellent results, 23.45% cases had good and 18.58% cases had fair results respectively. Conclusion Fixation of displaced intra-articular calcaneum fractures with trans articular K wires with or without sustentacular screw through sinus tarsi approach is a soft tissue preserving surgical technique which restores the near normal biomechanics of the calcaneum.

Keywords: Calcaneum fractures, heel injuries, sinus tarsi approach, minimally invasive surgery, calcaneum fixation, K wire fixation

Introduction

Calcaneum fracture is the most common tarsal bone fracture accounting for 2% of all bone fractures and approximately 60% of tarsal bone fractures [1-4]. There is variety of options to treat displaced intra-articular fracture calcaneum and therefore, pendulum tends to swing to and fro between conservative to operative options continuously. Conservative treatment may not adequately recreate height, width, axial alignment of the calcaneum and joint congruity. Operative treatment, in contrast, is associated with issues of soft tissue healing [5, 6]. We present a large series of treating intra-articular displaced fractures of calcaneum by sinus tarsi approach through trans articular K wires with or without sustentacular screw. This is a simple technique with predictable soft tissue healing which maintains articular congruity, axial alignment, height, width and length of calcaneum [7].

Materials & Methods

After obtaining Institutional Ethics Committee approval, a retrospective study was conducted at Sahyadri Super Speciality Hospital, Hadapsar, Pune, India on 226 cases of intra articular calcaneal fractures (Sanders Type II, III and IV) who were undertaken

for surgical fixation through sinus tarsi approach with trans articular K wires with or without sustentacular screw from January 2016 to March 2019. All of the patients were followed for at least 2 years and evaluated radiologically and functionally through x-rays and American Orthopaedic Foot and Ankle Society (AOFAS) scoring [8]. Statistical analysis was done utilizing independent t-test with implication of p-value < 0.5 .

Pre-operative protocol

Prior to the surgery, patients were temporarily immobilized with a below knee slab, underwent routine investigations and obtained pre operative workup clearance. Radiological evaluation of calcaneum through CT scan and plain radiographs (anteroposterior, lateral, axial and Broden view) were done to assess fracture geometry through MedSynapse radiology software.

Surgical approach and technique

Patients were operated in a lazy lateral position with the operative leg up and the contra lateral limb down with knee and hip flexed. A pillow was kept between the two legs. Before preparing the limb under sterile

¹Department of Orthopaedics, Sahyadri Super Speciality Hospital, Hadapsar, Pune, Maharashtra, India.

²Department of Orthopaedics, Dr. V M Government Medical College, Solapur, Maharashtra, India.

³Department of Radiology, Oasis Orthopaedic and Sonography Clinic, Hadapsar, Pune, Maharashtra.

Address of Correspondence

Dr. Harsh R. Vyas

Department of Orthopaedics, Sahyadri Super Speciality Hospital, Hadapsar, Pune, Maharashtra.

E-mail: drharshvyas333@gmail.com

Submitted: 06/04/2023; Reviewed: 22/04/2023; Accepted: 09/06/2023; Published: 10/06/2023

Trauma International ISSN 2455-538X | Available on www.traumainternational.co.in | DOI- <https://doi.org/10.13107/ti.2023.v09.i01.33>

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Figure 1: Patient positioning and Sinus tarsi surgical approach.

antiseptic precautions, lateral, axial and Broden views were confirmed under image intensifier. Axial and Broden views were obtained by externally rotating the leg and 30 degrees cephalad tilting of the image intensifier. After painting and draping, sinus tarsi approach was taken starting from the lateral malleolar tip towards 4th metatarsal base exposing the posterior facet. Incision was deepened in layers and peroneal tendons were retracted posteriorly. Calcaneo-fibular ligament was cut to open the subtalar joint. One 2.5 mm temporary K wire was passed from lateral to medial aspect in the inferior tuberosity. Sterile cotton roller bandage was applied in a sling fashion on this K wire to give longitudinal traction for correction of the axial alignment and height of calcaneum. Displaced posterior facet of calcaneum was mobilized with the help of Hohman's retractor. Posterior facet of calcaneum was aligned to the posterior facet of talus. Articular reduction of medial and lateral fragments of posterior facet was confirmed under direct visualization and fixed with a K wire (1.8 mm) passed from lateral to medial aspect into the sustentaculum tali. One 1.8 mm K wire was passed from plantar aspect of calcaneum through lateral facet of calcaneum into talus. Another 1.8mm K wire was utilized to fix the inferior tuberosity to the medial fragment and then into the talus. In the cases where anterior process of calcaneum was fractured, separate K wire was used after reduction of calcaneo-cuboid joint from calcaneum into cuboid. Number of trans articular k wires used varied from one to three depending on fracture geometry. These trans-articular K wires were introduced from plantar aspect and kept outside the skin. Purpose of putting it through the plantar aspect is that they do not irritate the plantar aspect of heel in lying down position. In cases where calcaneocuboid joint was involved, k wire was passed from posterior tuberosity of calcaneus into cuboid. This k wire was brought out through cuboid and bent outside the skin over cuboid bone. No k wire was kept projecting out of posterior tuberosity of

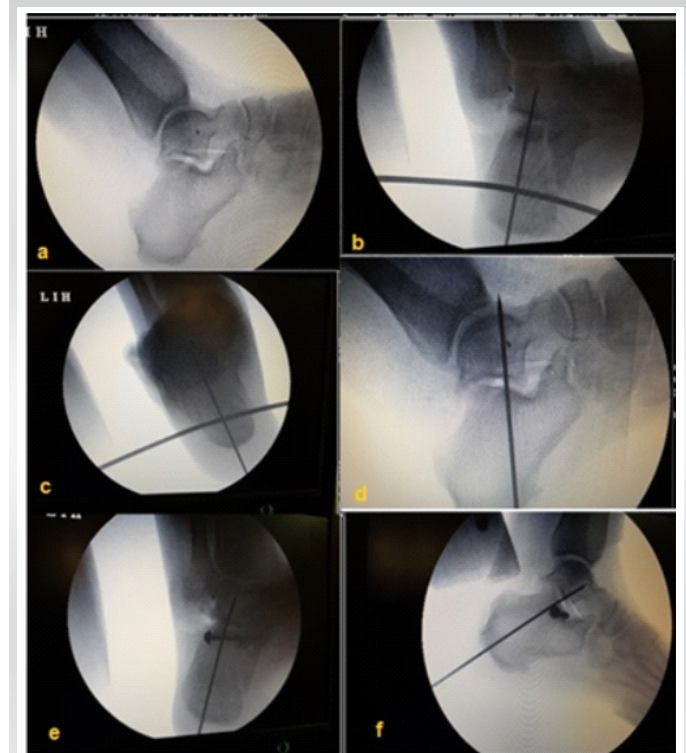


Figure 2: Surgical technique.

calcaneus. These trans articular wires helped maintaining joint congruity, axial alignment, height, width and length of calcaneum. In some cases, where there was distraction between medial and lateral fragments of posterior facet, an additional single sustentacular screw was added from lateral to medial side. Fixation was confirmed through intraoperative C-arm images and closure was done in a standard manner. (Fig 1 and 2)

Post-operative protocol

Postoperatively, the operated limbs was elevated to minimize the swelling and immobilized by below knee slab. Immediate post-surgery check radiographs were taken to evaluate fixation and alignment. Anti DVT and non-weight bearing exercises were started immediately after the surgery. Sutures were removed after 2 weeks and below knee slab was given for 3 weeks for soft tissue healing. Trans-articular K wires were removed after 6 to 8 weeks in the outpatient department and simulated weight bearing exercises were started in bed to prevent



Figure 3: Figure 3a illustrates a case of Sanders Type III injury in a 55 years old gentleman. Figure 3b depicts immediate post surgery x-rays. Figure 3c-d depicts 4 and 8 weeks post operative radiographs respectively. Figure 3e-f shows radiological and clinical union achieved at 12 weeks post operatively.



Figure 4: A case of 70 years diabetic male. Pre op CT scan and xrays illustrates Sanders Type III injury with disassociation of subtalar joint (Figure 4a). We have treated this with trans-articular K wire and one sustentacular screw (Figure 4b). Radio-clinical union was achieved at 12 weeks post operatively (Figure 4c).



Figure 5: A case of 12 years old pediatric male patient. Pre op x-rays (Figure 5a) illustrate Sanders Type III injury. Figure 5b-c depicts immediate and 2 years post operative radiographs respectively.

Sanders Type	Frequency	Percentage %
Type II	71	31.42
Type III	110	48.67
Type IV	45	19.91
Total	226	100

Condition/Factors	Frequency	Percentage%
Diabetes Mellitus	79	34.95
Smokers	29	12.83
Geriatric patients	34	15.4
Haemophilic patients	2	0.88

Union In Weeks	Number of Cases	Percentage %	p-value
8 Weeks	12	5.3	0.38
10 Weeks	25	11.06	0.23
12 Weeks	176	77.87	0.45
14 Weeks	10	4.42	0.19
16 Weeks	3	1.32	0.4
Total	226	100	0.33

chronic regional pain syndrome. After removal of K wires, patients were guided to follow post-surgery physiotherapy which included manual mobilization of subtalar joint to prevent hindfoot stiffness. Partial weight bearing was started 10 weeks post surgery. Plain radiographs (anteroposterior, lateral, axial and Broden view) and clinical assessment through AOFAS scoring system were evaluated at a regular interval of one month [9-14].

Results

In this series of 226 patients, majority of them were males accounting for 72.56% and patients were mostly in the age group between 19 to 64 years with a mean age of 38.1±4.4 years (p value 0.27). More than half of the cases (74.78%) sustained the injury following a fall/jump from

Radiographic components	Mean results	p-value
Bohler angle post surgery	30.6 degrees	0.21
Bohler angle correction	21.7 degrees	0.19
Gissane angle post surgery	153.1 degrees	0.28
Gissane angle correction	-14.8 (decrement)	0.34
Correction in heel height(mm)	6.1 mm (increment)	0.25
Correction in heel width(mm)	-4.1mm(decrement)	0.42

Study	Total cases	Excellent	Good	Good to excellent rate
Menget al [22]	49	69.38% (34)	12.24% (6)	81.60%
Wanget al [23]	18	61.11% (11)	22.22% (4)	83.3%
Halwai et al [24]	42	16.66% (7)	59.52% (25)	76.19%
Our Study	226	57.96% (131) (p-value 0.39)	23.45% (53) (p-value 0.41)	81.41% (p value 0.40)

height. Fracture geometry according to the Sanders classification was: Type 2 (31.42%), Type 3 (48.67%), and Type 4 (19.91%) respectively (Table 1). Amongst 226 cases, there were 12 bilateral intra-articular calcaneal fractures giving inclusion of 238 feet. According to Gustilo-Anderson grading, there were two cases of grade I and five cases of grade II open fractures. Cases were analyzed radiologically through x-rays and clinically by AOFAS scoring system. Fractures united at an average of 13.1±2.2 weeks (p-value 0.33) (Table 3). As per AOFAS scoring, 57.96% cases had excellent results, 23.45% cases had good and 18.58% cases had fair results respectively (Table 5).

Post operative complications

15 (6.63%) cases had paresthesia over lateral aspect of foot, 35 (15.48%) cases had degenerative changes of subtalar joint. There were no cases of superficial/deep infection, skin necrosis, wound dehiscence, implant failure or non-union.

Post surgery mean outcomes

In this study, Gissane angle improved from a pre surgery mean of 153.1 degrees to 138.3 degrees(post surgery mean) and Bohler angle improved from a pre surgery mean of 8.9 degrees to 30.6 degrees(post surgery mean).

Discussion

In this study, 226 patients with displaced intra-articular calcaneum fractures were treated with trans articular K-wires with or without sustentacular screw through sinus tarsi approach. This is a soft tissue preserving approach and avoids associated complications of healing [1, 2, 15]. Post reduction, trans articular K-wires across the subtalar joint and in some cases, across the calcaneo-cuboid joint maintained joint congruity, axial alignment, height, width and length of the calcaneum. Also, it promoted to decrease the chances of delayed collapse of the articular facet. A number of minimally invasive fixation methods have emerged in neoteric years, proffering an alternative to conventional open reduction and internal fixation with reconstruction plate and screws. These transpiring techniques include percutaneous, minimally invasive as well as arthroscopic assisted internal or external fixation approaches [15]. In our study, there was a preponderance of fall from height as a mode of injury with Sanders Type 3 fracture configuration which was comparable to a study published by Wallace et al [16]. Age group between 19-64 years were most commonly injured with a mean age of 38.1±4.4 years, and based on gender analysis, there was a predominance of males in our study which was comparable to a study published by Islam et al [17]. All the fractures in our study had united by 16 weeks, both radio-clinically and the results were comparable to a study

published by Meraj et al [18]. It has been reported that wound complications ranged up to 15.4% while utilizing the sinus tarsi approach [19]. In this study, no case suffered from any sort of deep wound complications as well as lateral impingement syndrome. A study published by Weber et al [20] reported 7.69% injuries to sural nerve and Yeo et al [21] stated 5% of sural nerve injuries utilizing minimally invasive sinus tarsi approach.

As per the American Orthopaedic Foot and Ankle Society scoring (AOFAS), post surgery results were satisfactory in all 226 patients with good to excellent functional outcome in 81.41% patients and returned to pre-injury status of daily activities which was comparable to the studies published by Meng et al, Wang et al and Halwai et al [22-24]. Open reduction and internal fixation through conventional extended lateral approach has been considered as a standard method for treating displaced intra-articular calcaneal fractures, however, a study done by Beerekamp et al [25] stated that approximately 15-25% patients have reported associated complications, majorly wound infection and flap necrosis. Our results compare correspondingly with the previous published literature, which illustrates that the restoration of Gissane and Bohler angle results in optimum functional outcomes [23-26]. A study published by Clement et al had depicted significant lofty costs in open procedure comparing to minimally invasive surgery through sinus tarsi approach and hence, MIS was found to be the minimal expensive procedure followed by conservative and open surgery [27]. In this series, Bohler angle improved from a pre-surgery mean of 7.7 to 31.5 degrees and Gissane angle improved from a pre-surgery mean of 155.8 to 139.2 degrees and these results were comparable to a series published by Jain et al [28]. Until now, no patient had to accept subtalar arthrodesis. Our surgical technique is a soft tissue preserving, simple and economic as we have utilized less costly implant like K wires/CC screws. It can be utilized safely in difficult situations like open fractures,

state of compromised soft tissues, fractures in children, elderly and smokers. We have observed good patient compliance of non-weight bearing with this technique due to the fact of patients' knowledge that K wires were projecting from plantar aspect. Percutaneous K wires fixation of calcaneal fractures curtails the chances of soft tissue complications and postoperative scar formation [29, 30]. Today, minimally invasive techniques including the standard sinus tarsi approach have been reported to achieve better clinical and radiological outcomes with fewer wound infections, shorter hospital stays, and early recovery [28-30]. This study has a limitation that it is a retrospective cohort study with no control group. Also, this was not a blinded study, surgeon preference and familiarity with the implant use may influence postoperative outcomes. However, we performed a standard surgical procedure based on basic fracture fixation principles; therefore, the potential for bias should be minimized. To determine the efficacy and comparative precision of the alternative methods, long-term biomechanical analyses, randomized control trials, and multicenter clinical meta-analyses are still remains essential. Further follow up is required to establish the success of this approach in attenuating long term complications.

Conclusion

We present a simple technique which is soft tissue friendly, economic yet effective in difficult situations of displaced intra articular calcaneal fractures. Sinus tarsi approach is a soft tissue preserving approach, and trans articular K wires with or without sustentacular screw after anatomic reduction of posterior facet helps to avoid post operative subsidence of facet, maintains axial alignment, length and width of calcaneum. This can be safely utilized in diabetics, smokers, children and patients with compromised soft tissue.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

Conflict of Interest: None, **Source of Support:** None

Abbreviations: K wire: Kirschner wire. MM: Millimeter. CC screws : Cannulated Cancellous screws. CT scan: Computed Tomography scan. DVT: Deep venous thrombosis. Pre op: Pre operative. Post op: Post operative.

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How to Cite this Article

Patil SD, Wachche G, Vyas HR, Kakkar RS, Patil VD | A Simple Surgical Technique of Trans Articular K Wires Fixation Through Sinus Tarsi Approach for Treating Intra Articular Calcaneal Fractures : A Large Case Series | January-June 2023; 9(1): 18-22 | <https://doi.org/10.13107/ti.2023.v09.i01.33>