MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.36478/makrjms.2024.8.597.603

OPEN ACCESS

Key Words
calcaneus, mini-invasive approach, sinus tarsi, fractures, complications

Corresponding Author
Jaysinh Chauhan,
Department of Orthopedics, Government Medical College, Sir T Hospital, Bhavnagar, Gujarat, India
chauhanjaysinh35@gmail.com

Author Designation
[1]Senior resident
[2]Associate professor
[3,5]First year resident
[4]Third Year resident

Received: 5 June 2024
Accepted: 15 August 2024
Published: 20 August 2024

Citation: Jaysinh Chauhan, Narendra Mishra, Saurabh Sharma, Indrajeet Patel and Mohit Goswami, 2024. Functional Outcomes of Sinus Tarsi Approach for the Treatment of Calcaneus Fractures. Res. J. Med. Sci., 18: 597-603, doi: 10.36478/makrjms.2024.8.597.603

Functional Outcomes of Sinus Tarsi Approach for the Treatment of Calcaneus Fractures

[1]Jaysinh Chauhan, [2]Narendra Mishra, [3]Saurabh Sharma, [4]Indrajeet Patel and [5]Mohit Goswami
[1-5]Department of Orthopedics, Government Medical College, Sir T Hospital, Bhavnagar, Gujarat, India

ABSTRACT
To describe functional and radiographic outcomes, and complications of osteosynthesis in calcaneus fractures with the sinus tarsi approach. 54 displaced articular calcaneus fractures Patients were assessed through preoperative foot radiographs (anteroposterior and lateral) and computerised tomography. AP and lateral radiographs were obtained in the immediate postoperative period (without weight bearing), after 6 and 12 weeks (with weightbearing) and at the end of follow-up, measuring the Böhler angle and quantifying the degree of subtalar and calcaneocuboid osteoarthritis. The AOFAS score was determined, registering wound complications, neurological injuries. Follow-up time was 30.8 months. The series consisted of 6 women and 48 men. The patients' average age was 39.40±14 years (18-65). There were 42 Sanders type II, 11 type III and 1 type IV fractures. The AOFAS score was excellent (12 patients), good (25), regular (12) and poor (5). The Böhler angle was 10.8°±10.4° before surgery and 30.77°±8.24° at the end of follow-up ($p<0.00001$). 3.7% of the patients presented minor wound complications, while 5.6% presented major wound complications. The sinus tarsi approach allows for acceptable reduction with good and excellent outcomes in most patients, coupled with few soft-tissue complications.

INTRODUCTION

Calcaneus fractures represent 60% of traumatic foot injuries in adults and 2% of total fractures[1]. The treatment of displaced calcaneal joint fractures is still controversial, although open reduction and osteosynthesis through the extended lateral approach (ELA) have been the reference pattern in the last three decades[2,3]. The high rate of published complications[4,5] has led to the development of less invasive surgeries[6,7] to reduce soft tissue trauma and the risk of complications, with acceptable success.

The minimally invasive sinus tarsi approach allows for adequate visualisation and reduction of the fracture, reducing the rate of complications[8]. The aim of our study was to describe the radiographic and functional outcomes of calcaneus fracture osteosynthesis through the sinus tarsi approach.

MATERIALS AND METHODS

Our retrospective analysis comprised 54 displaced calcaneal joint fractures patients, treated with osteosynthesis through the sinus tarsi approach between 2018 and 2022.

The Inclusion Criteria:

- Age 18-60 years
- Sanders type 1,2,3,4
- Closed fractures

The Exclusion Criteria:

- Pathological fracture
- Congenital deformity
- Compound fracture

The fractures were classified according to Sanders and Essex-Lopresti. The exposed fractures were treated with a surgical mechanical toilet plus intravenous antibiotics, according to Gustilo's classification[9].

Radiographic Evaluation: The patients were evaluated before surgery with anteroposterior and lateral foot radiographs. Before surgery, a CT scan with multiplanar reconstruction was performed.Anteroposterior and lateral foot radiographs were taken without weight-bearing in the immediate postoperative period, and with weight-bearing at weeks 6 and 12 and at the end of follow-up.On the lateral radiograph, the Böhler angle was measured, consisting of two lines, one from the highest point of the anterior tuberosity to the highest point of the posterior facet, and the other, tangential to the superior border of the posterior tuberosity. Their value ranges from 20°-40°[10]. It was quantified if there were changes >5° that indicate a collapse of the calcaneal height[7]. The degree of osteoarthritis in the subtalar and calcaneocuboid joints was evaluated[11]. The CT scan was taken to detect any involvement of the calcaneocuboid joint. Clinical evaluation was conducted using the AOFAS (American Orthopaedic Foot and Ankle Society) scale. The result was classified as: excellent >90, good >80, fair >70 and poor $\leq$70[12]. Subtalar range of motion was evaluated comparatively. Wound complications were recorded and divided into minor (edge necrosis, superficial dehiscence) and major (deep infection or dehiscence, and osteomyelitis)[13]. Neurological injury and the need for additional surgeries were also evaluated, such as the removal of osteosynthesis material and subtalar arthrodesis. The statistical analysis was carried out through descriptive measures (mean and standard deviation, maximum and minimum). $p<0.05$ as statistically significant.

Surgical Technique: The patient is placed in the lateral decubitus position and a 3-5 cm approach is performed on the sinus tarsi, 1 cm distal to the fibula up to the fourth metatarsal (Fig. 1). The peroneals are retracted posteriorly, proceeding to the capsular opening to observe the subtalar joint, the anterior tuberosity, and the lateral wall (Fig. 2).

One distractor with a 5 mm cancellous Schantz or a Kirschner pin of the same diameter is placed on the posterior tuberosity and a second one is placed on the lateral part of the talus-to recover height-or on the cuboid-to restore length-(Fig. 3).

Fig. 3. Placing of Kirschner pins on the posterior tuberosity and the lateral part of the talus, and mounting of the distractor on them. If necessary, the medial fragment is reduced by direct incision. Afterward, the posterior tuberosity is aligned percutaneously with the distractor's Schantz of Kirschner and fixed with a needle to the medial segment. Then, the superolateral fragment is stabilised to the medial fragment before disimpacting and elevating it, in Sanders type II cases. In Sanders III or IV fractures, the intermediate fragments are reduced and then fixed with Kirschner pins.

The talus's lower surface is used as a mold. 6.5 mm full-thread or partially threaded screws and 3.5 mm cortical screws without compression are placed from the posterior tuberosity up to the medial fragment; 3.5 mm screws are used from the superolateral to the medial fragment (Fig. 5).

2.7 mm or 3.5 mm locking plates are placed from the joint surface to the anterior tuberosity (Fig. 6).

An intraoperative Broden view of the calcaneus with image intensifier was used to verify the reduction of the posterior facet and to assess the existence of joint gap or step-off (Fig. 7)[14].

In the postoperative period, a posterior splint is placed for 10 days and ankle and subtalar range of motion is initiated. Partial weight-bearing with crutches and a splint starts at week 4 and progresses until weeks 10-12, when weight-bearing is total.

RESULTS AND DISCUSSIONS

The average follow-up was 30.8±23.2 months. 6 patients were women and 48 were men. The age was 39.40±14 years (range 18-65). The trauma mechanism had been a fall from height (74%) and traffic accidents (26%). The 2% were exposed fractures and the 8% were bilateral. The fracture patterns were of the joint depression (63%) and tongue (37%) types. Based on the Sanders classification, 42 fractures were type II., 11, type III and one, type IV. There was involvement of the calcaneocuboid joint in 37% of cases. The time between injury and surgery was 9.2±6.3 days (range 1-31). No correlation between this parameter and the restoration of the Böhler angle was found. The AOFAS scale score was excellent in 12 patients, good in 25, regular in 12 and poor in five. The Böhler angle was 10.8°±10.4 before surgery., 32.5±7.73 (range 22-54) in the immediate postoperative period and 30.77±8.24 (range 17-54) after six weeks and at the end of follow-up. These values were statistically significant ($p<0.00001$).

A loss of more than 5° was observed between the immediate postoperative period and the end of follow-up in four patients: one case of early withdrawal of the material due to infection and three cases of insufficient fixation in fractures with significant comminution. The patient whose osteosynthesis material was withdrawn due to infection was the only one who remained with a <20° Böhler angle. 44.4% of grade I developed subtalar osteoarthritis., grade II, 7.4% and grade III, 3.8%. There was no relation between subtalar osteoarthritis and the AOFAS scale score. All patients lost subtalar range of motion to some degree: 72.2% had moderate restriction., 11.1%, severe restriction and 16.7%, mild restriction.

Fig. 1: Sinus tarsi incision

Fig. 2: Facet joint and anterior process of the calcaneus

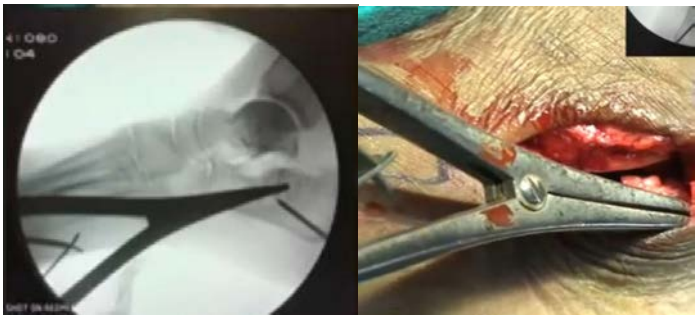


Fig. 3: X-Ray picture of use of distractor to achieve height and restore lenght

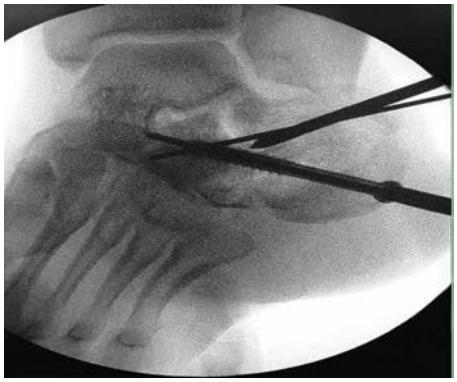


Fig. 4: Clinical picture of distractor to achieve height

Fig. 5: 6.5mm fully and partially threaded screw placed from posterior tuberosity to medial fragment

Fig. 6: 2.7mm or 3.5mm locking plate placed from joint surface to anterior tuberosity

Clinical cases:
Case 1:

Pre Op x ray

Post op x ray

1 year follow up

Case 2:

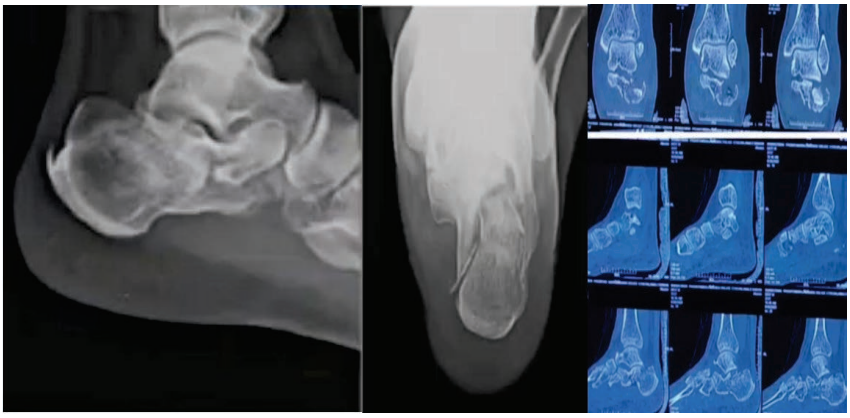
Pre op x ray

Post op x ray

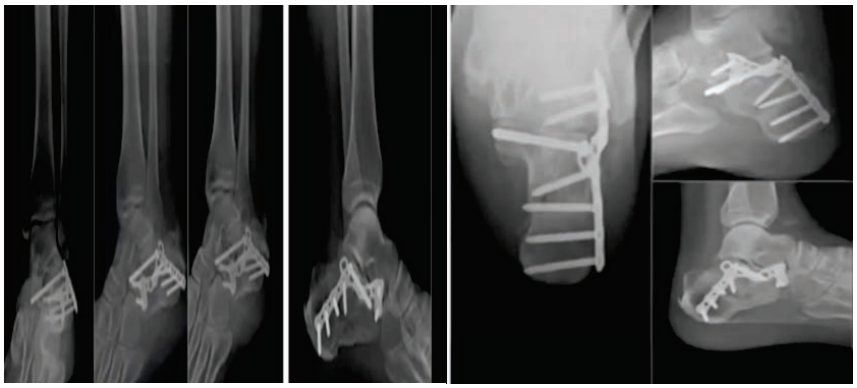
1 year follow up

1 year follow up

Case 3:



Pre op x ray



Post op x ray

1 year follow up

1 year follow up

In 9.3% of cases, it was necessary to remove the osteosynthesis material: two cases were due to infection and three cases due to peroneal tendonitis. Subtalar arthrodesis was performed in 3.7% of the fractures owing to symptomatic subtalar osteoarthritis that did not improve with the conservative treatment 3.7% suffered minor complications in the wound (edge necrosis). The infection rate was 5.6% in 54 fractures. Three patients had temporary sural nerve injuries which disappeared within six months after the surgery Calcaneus fractures account for 2% of all fractures and most occur in adult patients. The issue of treatment remains controversial, as evidence shows similar results for conservative and surgical management[2,15] but most orthopaedic surgeons favour surgery due to its satisfactory results[4]. Surgical approaches continue to generate controversy, although minimally invasive techniques have been proven to reduce soft tissue complications and infections, in comparison with the ELA[7,8].

The sinus tarsi approach could be considered the current reference pattern, as it yields low soft tissue complications with clinical outcomes similar to the ELA[16]. The significant improvement of the postoperative Böhler angle in this study proves that the calcaneus's height can be restored through this incision. The final, postoperative Böhler angle averaged 30.77°. This is linked to improved clinical outcomes[2,7]. Four patients suffered a >5° Böhler angle loss, which could be ascribed to insufficient osteosynthesis in

three cases and to the early removal of the material due to infection in one patient, who had a postoperative <15° Böhler angle. There are different options to stabilise the calcaneus through the sinus tarsi approach. Schepers recommends placing only screws in patients with fractures without comminution and good bone quality. If the implant is not stable or the calcaneus's width cannot be restored, a plate should be added[17]. Kir *et al.* communicate that stabilisation with plates, in comparison with screws, offers a lower rate of reoperation and implant withdrawal, along with a better reconstruction of the calcaneus's width and improved functional outcomes in Sanders type II and III fractures[18]. Pitts[19] found no difference between plates and screws regarding postoperative Böhler and Gissane angles or wound complications. In a biomechanical study, the stability achieved with intramedullary screws is shown to be higher than with traditional plates, possibly because they are anchored to areas of greater density in the calcaneus[20]. In our series, we combined 2.7 mm locking plates or 3.5 mm plates with 3.5 mm, 4.0 mm and 6.5 mm cannulated screws.

In our study, the rate of wound complications was 3.7%, while Schepers published a 4.8% of wound complications (range 0-15.4) in patients treated with the sinus tarsi approach[21]. Nosewic presents a systematic review and a meta-analysis, informing a 4.9% of wound complications with the sinus tarsi approach, against 24.9% with the ELA7. There have also been cases of neurovascular injury in the 9.1-25% (22-23) with the ELA and in 5% with the sinus tarsi approach[24]. In our series, three patients suffered temporary sural nerve injuries.

Our rate of good and excellent outcomes according to the AOFAS scale (68.5%) coincides with other published results for the sinus tarsi approach[24]. All patients presented some degree of stiffness in the subtalar joint. 83.3% suffered a moderate to severe loss of range of motion. This could be related to the irreversible injury of the articular cartilage[25]. The reduction of the subtalar joint is very important, since a >1 mm step-off alters weight distribution in said joint and produces post-traumatic osteoarthritis[26]. 55.6% of our patients developed osteoarthritis, with 44.4% being grade 1

CONCLUSION

The sinus tarsi approach allows for an adequate exposition of the fracture and an acceptable reduction, with good and excellent outcomes in most patients and few soft tissue complications.

REFERENCES

1. Talarico, L.M., G.R. Vito and S.Y. Zyryanov, 2004. Management of displaced intraarticular calcaneal fractures by using external ring fixation, minimally invasive open reduction, and early weightbearing. J. Foot Ankle Surg., 43: 43-50.
2. Buckley, R., S. Tough, R. McCormack, G. Pate and R. Leighton,et al., 2002. Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures. J. Bone Joint Surg.-Am., 84: 1733-1744.
3. Sanders, R., P. Fortin, T. DiPasquale and A. Walling, 1993. Operative treatment in 120 displaced intraarticular calcaneal fractures. Clin. Orth Rela Res., 290: 87-95.
4. Al-Mudhaffar, M., C.V.R. Prasad and A. Mofidi, 2009. Wound complications following operative fixation of calcaneal fractures. Injury, 31: 461-464.
5. Benirschke, S.K. and P.A. Kramer, 2004. Wound healing complications in closed and open calcaneal fractures. J. Orthop. Trauma, 18: 1-6.
6. Slullitell, G. and M. Seri, 2011. Abordaje miniinvasivo del seno del tarso para el tratamiento de las fracturas del calcáneo. Rev Asoc Arg Ortop Trau., 76: 273-278.
7. Nosewicz, T., M. Knupp, A. Barg, M. Maas, L. Bolliger, J.C. Goslings and B. Hintermann, 2012. Mini-open sinus tarsi approach with percutaneous screw fixation of displaced calcaneal fractures: A prospective computed tomography–based study. Foot amp Ankle Int., 33: 925-933.
8. Schepers, T., M. Backes, S.A. Dingemans, V.M. de Jong and J.S.K. Luitse, 2017. Similar anatomical reduction and lower complication rates with the sinus tarsi approach compared with the extended lateral approach in displaced intra-articular calcaneal fractures. J. Orthop. Trauma, 31: 293-298.
9. Gustilo, R.B. and J.T. Anderson, 1976. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am., 58: 453-458.
10. Böhler, L., 1931. Diagnosis, pathology, and treatment of fractures of the os calcis. J Bone Joint Surg., 13: 75-89.
11. Kinner, B., S. Schieder, F. Müller, A. Pannek and C. Roll, 2010. Calcaneocuboid joint involvement in calcaneal fractures. J. Trau Injury, Infec. amp Crit. Care, 68: 1192-1199.
12. Kitaoka, H.B., I.J. Alexander, R.S. Adelaar, J.A. Nunley, M.S. Myerson and M. Sanders, 1994. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot amp Ankle Int., 15: 349-353.
13. Mangram, A.J., T.C. Horan, M.L. Pearson, L.C. Silver and W.R. Jarvis, 1999. Guideline for Prevention of Surgical Site Infection, Am J Infect Con., 27: 97-134.

14. Looijen, R.C., D. Misselyn, M. Backes, S.A. Dingemans, J.A. Halm and T. Schepers, 2019. Identification of postoperative step-offs and gaps with brodén's view following open reduction and internal fixation of calcaneal fractures. Foot amp Ankle Int., 40: 797-802.
15. Griffin, D., N. Parsons, E. Shaw, Y. Kulikov and C. Hutchinson, et al., 2014. Operative versus nonoperative treatment for closed, displaced, intraarticular fractures of the calcaneus: Randomised controlled trial. BMJ, Vol. 349.
16. Khazen, G. and C.K. Rassi, 2020. Sinus tarsi approach for calcaneal fractures. Foot Ankle Clin., 25: 667-681.
17. Schepers, T., 2019. Sinus tarsi approach with screws-only fixation for displaced intra-articular calcaneal fractures. Clin. Podiatric Med. Surg., 36: 211-224.
18. Kir, M.C., S. Ayanoglu, H. Cabuk, S.S. Dedeoglu and Y. Imren et al., 2018. Mini-plate fixation via sinus tarsi approach is superior to cannulated screw in intra-articular calcaneal fractures: A prospective randomized study. J. Orthop. Surg., 26: 1-7.
19. Pitts, C.C., A. Almaguer, J.T. Wilson, J.H. Quade and M.D. Johnson, 2019. Radiographic and postoperative outcomes of plate versus screw constructs in open reduction and internal fixation of calcaneus fractures via the sinus tarsi. Foot amp Ankle Int., 40: 929-935.
20. Nelson, J.D., T.E. McIff, P.G. Moodie, J.L. Iverson and G.A. Horton, 2010. Biomechanical stability of intramedullary technique for fixation of joint depressed calcaneus fracture. Foot amp Ankle Int., 31: 229-235.
21. Schepers, T., 2011. The sinus tarsi approach in displaced intra-articular calcaneal fractures: A systematic review. Int. Orth., 35: 697-703.
22. Buckley, R.E. and R.N. Meek, 1992. Comparison of open versus closed reduction of intraarticular calcaneal fractures. J. Orthop. Trauma, 6: 216-222.
23. Yeo, Q.Y. and E.B. Kwek, 2014. Open reduction and internal fixation of displaced intra-articular calcaneal fractures with norian skeletal repair system (srs) bone cement: Surgical technique, clinical and radiographical results. Ann. Acad. Med., Sing., 43: 515-516.
24. Geel, C.W. and A.S. Flemister, 2001. Standardized treatment of intra-articular calcaneal fractures using an oblique lateral incision and no bone graft. J. Trau Inj, Infec., Crit. Care, 50: 1083-1089.
25. Sanders, R., Z.M. Vaupel, M. Erdogan and K. Downes, 2014. Operative treatment of displaced intraarticular calcaneal fractures. J. Orthop. Trauma, 28: 551-563.
26. Sangeorzan, B.J., D. Ananthakrishnan and A.F. Tencer, 1995. Contact characteristics of the subtalar joint after a simulated calcaneus fracture. J Orthop Trau., 9: 251-258.