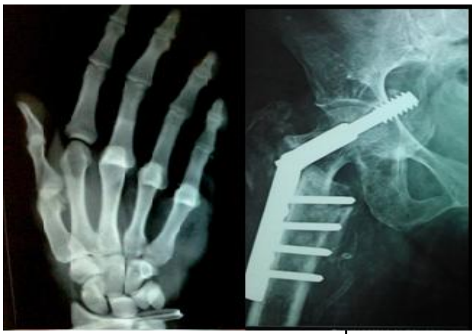

International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(1): 226-230

https://www.orthopaper.com
Received: 13-10-2022
Accepted: 20-12-2022

Dr. Abilash
Assistant Professor, Department of Orthopaedics, SLIMS, Villianur, Puducherry, India

Dr. Abhay Vikram Singh
Post Graduate, Department of Orthopaedics, SLIMS, Villianur, Puducherry, India

Corresponding Author:
Dr. Abilash
Assistant Professor, Department of Orthopaedics, SLIMS, Villianur, Puducherry, India

Herbert screws fixation of high-energy navicular body fractures

Dr. Abilash and Dr. Abhay Vikram Singh

DOI: https://doi.org/10.22271/ortho.2023.v9.i1d.3300

Abstract
Background: The purpose of this study was to assess the ability of Herbert screw fixation in navicular fractures to restore medial column stability, maintain reduction and determine the impact this approach may have on the development of avascular collapse of the navicular. We hypothesized that Herbert screw fixation of comminuted fractures of the navicular can be safely reduced and maintained to union with a low incidence of avascular collapse.
Materials and Methods: A retrospective chart review was performed on 7 patients with navicular body fractures treated with open reduction and internal fixation with Herbert screw fixation at Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry over a period of 2 years.
Results: All fractures united. No patient developed a deep infection. There was no loss of reduction, implant failure with excellent functional and radiological outcome Conclusion: Herbert screw fixation provides excellent functional and radiological outcome for isolated navicular body fracture.

Keywords: Navicular, avascular necrosis, talonavicular arthritis, midfoot injuries, high-energy

Introduction
High energy disruptions of the midfoot and tarsal bones are being seen with increasing frequency at trauma centers, as improvements in automobile safety, particularly airbags, result in improved survival of patients with severe high energy foot injuries [8]. These injuries are subtle and often not initially recognized in the polytraumatized patient [2]; however, these injuries have significant impact on overall outcome and long-term function and frequently resulting in long-term pain and stiffness [7]. Despite this, they receive little attention in the modern literature. The most frequently injured lesser tarsal bone is the navicular. Acute navicular fractures have been classified into three types: avulsion fractures, tuberosity fractures, and body fractures [2]. Navicular body fractures are more likely to result from high energy forces, representing a unique difference in mechanism from avulsion and tuberosity fractures, and deserve special attention.

Due to its critical roles as both the primary mobile joint of the medial column and involvement in the transverse tarsal locking mechanism, every effort should be made for anatomic reduction of fracture dislocation and there by reconstructing the talonavicular joint. Additionally, the navicular forms the uppermost portion of the medial longitudinal arch and thus represents the keystone for vertical stress on the arch [2]. Significant force is required to disrupt these ligaments resulting in displacement of the navicular [1]. Several mechanisms of navicular fractures have been proposed, all involving an axial load to the foot [3, 5, 6, 9, 10, 14]. Often the significant amount of force involved in these fractures causes not only comminution of the navicular, but injuries to the remaining midfoot and hindfoot as well.

Combining the displacement, comminution, soft tissue injury and the tenuous blood supply to the navicular, fractures of the navicular body present several technical challenges to the surgeon attempting to restore function. While the goals of treatment are primary reconstruction of the talonavicular articulation and restoration of the medial column support of the foot, there is no available literature on how these goals can be most effectively accomplished.

Treatment recommendations have evolved from closed management by closed reduction and percutaneous fixation, to open reduction and internal fixation.

The results of severely comminuted fractures have been poor, with only 25% good results in a study conducted by Sangeorzan *et al*. in 1989 [11], leading some authors to recommend primary triple fusion [2], or talonavicular form fusion [5]. The most common technique of internal fixation utilizes independent lag screws placed through an anteromedial approach. This was felt to provide access to the major fragment for reduction while preserving the tenuous blood supply to the navicular. Sangeorzan described a dual approach (anteromedial and lateral) to be used in cases involving lateral comminution in order to restore a smooth articulation at the talonavicular joint and maintain the length of the medial column.

The cortical rim is often just a thin shell that is easily penetrated by the Herbert screw head, rendering the screw in providing interfragmentary compression. Some authors have recommended cerclage wire augmentation [4].

Frequently, this technique is performed via two incisions for adequate visualization of the joint surfaces along with bone grafting of defects. The first purpose of this study was to assess the ability of Herbert screw fixation in navicular fractures to restore medial column stability, maintain reduction to union, and determine the impact this approach may have on the development of avascular collapse of the navicular. The second purpose was to identify frequently associated ipsilateral injuries to the midfoot and hindfoot. We hypothesized that comminuted fractures of the navicular can be safely reduced and maintained to union with Herbert Screw fixation with a low incidence of avascular collapse.

Materials and Methods

It is a retrospective study in which database of all navicular body fractures that were presented in Sri Lakshmi Narayana Institue of Medical Sciences, Puducherry were collected.

All operatively treated navicular fractures using Herbert screw fixation between 2020 and 2022 were identified and chart and radiographic review was performed. The average patient age was 31 years. The average time from injury to definitive fixation was 12 days.

Average radiographic follow up was 16 months. Average clinical follow up was 16 months. Data collected included patient age , associated hindfoot injuries, time from injury to definitive fixation, evidence of infection, hardware failure, development of arthrosis, navicular collapse due to avascular necrosis, and need for hardware removal or salvage fusion .

Fractures were classified according to the method of Sangeorzan et al.11 In Type I navicular body fractures, the primary fracture line is transverse in the coronal plane, with the dorsal fragment consisting of less than 50% of the body, and on the anteroposterior radiograph, the medial border of the foot does not appear to be disrupted. In Type II fractures, the fracture line traverses from dorsal-lateral to plantar-medial across the body of the tarsal navicular. The major fragment is dorsal medial, with a smaller, often comminuted, plantar-lateral fragment. Type III injuries include fractures with central or lateral comminution. The major fragment is usually medial and the medial border of the foot is often disrupted at the cuneonavicular joint and the forefoot is laterally displaced.

Due to the high-energy nature of these injuries, dramatic swelling frequently prohibited safe early definitive care.

Our protocol was to allow a period of soft tissue rest for swelling to diminish before definitive intervention. This was based on surgeon experience and averaged 12 days.

Approaches used for visualization, reduction and implant placement included an anteromedial approach utilizing the interval between the tibialis anterior tendon and the tibialis posterior tendon. The lateral approach utilized a dorsal incision over the lateral aspect of the navicular, using fluoroscopic guidance for precise placement, allowing the best access for reduction and implant placement. Deep dissection was carried out after identifying the dorsalis pedis artery and deep peroneal nerve. These structures were gently mobilized and retracted in order to work on both medial and lateral sides of the neurovascular bundle for cleaning the fracture lines and applying clamps or other provisional fixation. Adequate visualization was imperative for achieving a good reduction and it was greatly facilitated with the use of a temporary towel clips, typically applied to both the fracture fragments.

Fixation was then carried out using two Herbert screws. Screws were applied medial to lateral depending on the location of primary fracture disruption.

At closure, the medial capsule was repaired if possible.

Postoperatively, patients were splinted in neutral and later converted to a cast. Non weight bearing was recommended for 8 weeks, allowing for modification based on treatment of associated injuries. This sometimes included an extended period of NWB, but generally not longer immobilization.

Fig 1: Post injury X-ray showing fracture of body of navicular bone

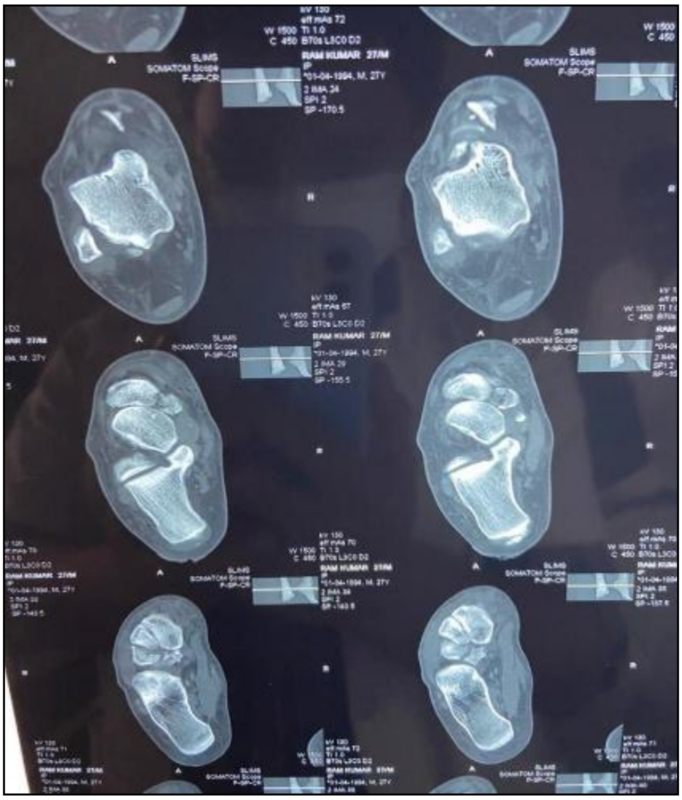

Fig 2A

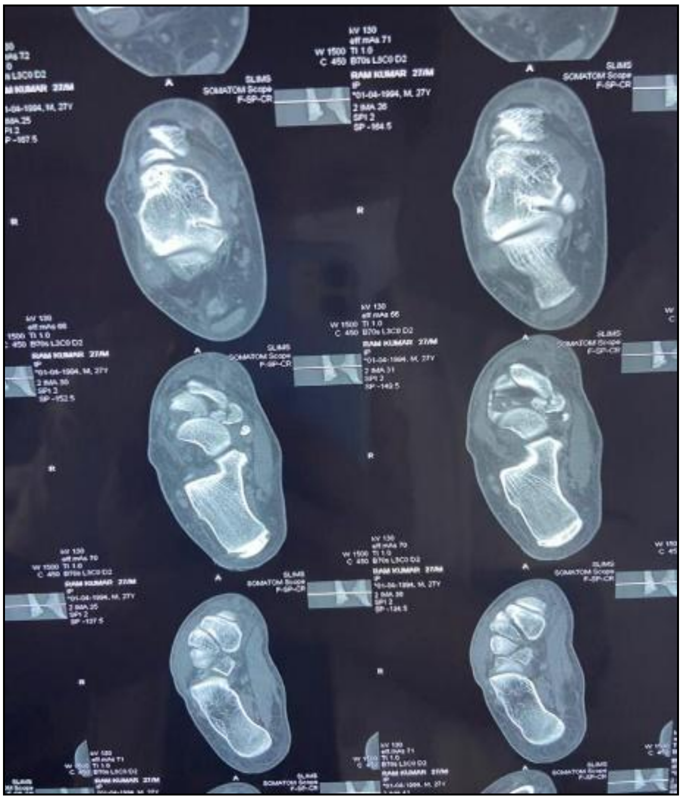

Fig 2B

Fig 2C

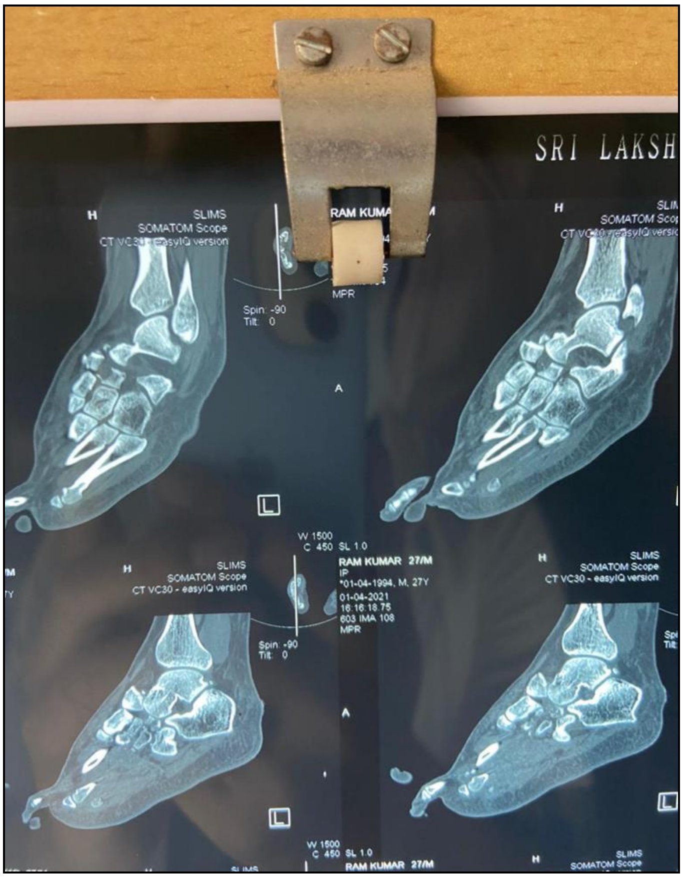

Fig 2D

Fig 2A, 2B 2C & 2D: Post injury X-ray showing fracture of body of navicular bone

Fig 3A

Fig 3B

Fig 3A & Fig 3B: Showing open reduction internal fixation done with Herbert screw

Results

There were 7 displaced navicular body fractures identified that were treated with internal fixation using Herbert screw.

No patient in this series had bilateral injuries. Mechanism was motor vehicle collision in three patients, motorcycle collision in three patients, fall from height in one patients. According to the Sangeorzan classification, there were four (57.14%) Type II fractures and three (42.85%) Type III fractures.

All fractures healed with bony union determined by plain films. No patient developed a deep infection. There was no loss of reduction.

One patient (14.28%) underwent screw removal for painful prominent hardware following fracture healing. One patient (14.28%) developed radiographic arthrosis of the talonavicular joint.

No patient underwent a fusion procedure; however, one patient with radiographic talonavicular arthrosis was considering a talonavicular fusion after obtaining only moderate relief following removal of the hardware.

Discussion

In this series there were seven navicular body fractures identified as isolated injuries; however, this term is perhaps not clearly defined, as the displacement pattern seen would most likely classify them as fracture-dislocations of the talonavicular joint.

CT scanning of the foot can provide helpful information regarding associated foot injury and also to define the fracture geometry.

The navicular is similar to the talus in that a large percentage of its surface is covered by cartilage. The blood supply to the navicular is received via an anastomosing arcade of vessels from both a branch of the dorsalis pedis and the medial plantar artery. Vessels enter radially, supplying the outer two-thirds, but with poor penetration, they leave the central one-third relatively avascular. Combining surgical approaches with initial trauma can further compromise the already marginal blood supply and potentially lead to increased incidence of avascular necrosis and collapse. While the increased risk of disruption of the blood supply was understood, the ability to restore talonavicular congruity and medial column stability were critical for successful treatment, and appropriate access for reduction and placement of implants was paramount. The relative merit of achieving an anatomic reduction with the inherent risk of potential increased incidence of avascular collapse must be weighed against potentially leaving a malreduced, unstable midfoot that will reliably lead to painful post-traumatic arthrosis.

A limitation of our study was that we did not specifically seek to determine the incidence of avascularity alone. No MRI was performed, and areas of sclerosis can be difficult to ascertain in the presence of implants. Only collapse due to avascular necrosis could reliably be determined by radiographic review. Additionally, the length of time before collapse occurs has not been determined, and it is possible that with longer follow-up that some navicular could eventually collapse. The role of weight bearing on collapse has also not been determined, but the fact that all patients were fully weight bearing on the injured foot at the last follow-up with radiographic union and no collapse at 12 months is encouraging.

Type II and III fractures have been associated with the worst prognosis. Overall a total of one patient underwent repeat operation for removal of hardware.

In cases of isolated screw failure, with general maintenance of reduction, close observation is critical. It may lead to progressive/catastrophic loss of fixation/reduction, or may go on to uneventful healing. Fatigue failure of implants is an indicator of a certain amount of motion. In some cases, the broken implant may allow for a bit of collapse or compression that may ultimately be very beneficial to achieving stability and union. The plate itself doubles as a washer, permitting increased compression across individual comminuted fragments by providing a barrier to cortex penetration by the screw heads, thereby improving overall stability.

The previously reported poor results in operatively treated Type II and III navicular body fractures are largely due to post traumatic arthrosis.

Despite radiographic arthrosis in one patient, no patient had undergone a fusion procedure at the time of last follow-up. While this result is encouraging, it should be interpreted with caution, as clinical manifestations of arthrosis may indicate a fusion with longer follow-up.

Navicular body fractures present many treatment challenges.

Anatomic restoration of the talonavicular articulation and medial column length and stability with the use of Herbert screw fixation can lead to reliable union with a low incidence of reoperation. No patient in our series underwent a midfoot fusion procedure.

Longer follow-up and addition of meaningful functional data would be helpful, and represent two limitations of our study. Another potential limitation is determination of union based on plain films rather than CT scanning. There is a certain amount of overlapping structures and implants that may obscure important detail with plain films. Additionally, this study was performed at a Medical College, which serves a large geographic region. It is not uncommon for patients to receive care for injuries acutely, and then obtain follow-up closer to their home. This resulted in exclusion of one patient from final evaluation. Despite these limitations, the authors feel the study conveys information helpful to surgeons managing these injuries.

In conclusion, our results suggest that the treating surgeon should have a high index of suspicion for associated foot injuries. The authors recommend Herbert screw fixation as a good alternative to percutaneous k wires for rigid stabilization of navicular body fractures and we believe may result in improved outcomes compared to previously published series.

This series can provide helpful information when discussing treatment options and anticipated results with patients who sustain these fractures.

Acknowledgement

Not available

Author's Contribution

Not available

Conflict of Interest

Not available

Financial Support

Not available

References

1. Delee J. Fractures of the Midpart of the Foot. In: Edited by Mann RA CM, Surgery of the Foot and Ankle. St. Louis: Mosby-Year Book; c1993. p. 1600-1613.
2. Eichenholtz SN, Levine DB. Fractures of the tarsal navicular bone. Clin Orthop Relat Res. 1964;34:142-157.
3. Kleiger B. The mechanism and the roentgenographic evaluation of fracture of the tarsal bones. Clin Orthop Relat Res. 1963;30:10-19. http://dx.doi.org/10.1097/00003086-196300300-00003
4. Naidu V, Singh SK. Cerclage wire fixation of navicular body fractures-a treatment based on mechanism of injury. Foot Ankle Int. 2005;26:267-269.
5. Nyska M, Margulies JY, Barbarawi M, *et al*. Fractures of the body of the tarsal navicular bone: case reports and literature review. J Trauma. 1989;29:1448-1451. http://dx.doi.org/10.1097/00005373-198910000-00026
6. Puente CA, Alaez JP, Marti DG. Tarsal fracture dislocation with plantar dislocation of the navicular: a case study. Foot Ankle Int. 1996;17:111-113.
7. Richter M, Thermann H, Von Rheinbaben H, *et al*. Fractures of the foot region of car drivers and passengers. Occurrence, causes and long-term results. Unfallchirurg. 1999;102:429-433. http://dx.doi.org/10.1007/s001130050431
8. Richter M, Thermann H, Wippermann B, *et al*. Foot fractures in restrained front seat car occupants: a long-term study over twenty-three years. J Orthop Trauma. 2001;15:287-293. http://dx.doi.org/10.1097/00005131-200105000-00009
9. Rockett MS, Brage ME. Navicular body fractures: computerized tomography findings and mechanism of injury. J Foot Ankle Surg. 1997;36:185-191. http://dx.doi.org/10.1016/S1067-2516(97)80114-7
10. Rymaszewski LA, Robb JE. Mechanism of fracture-dislocation of the navicular: brief report. J Bone Joint Surg Br. 1988;70:492.
11. Sangeorzan BJ, Benirschke SK, Mosca V, *et al*. Displaced intraarticular fractures of the tarsal navicular. J Bone Joint Surg Am. 1989;71:1504-1510.
12. Sangeorzan BJ, Mayo KA, Hansen ST. Intraarticular fractures of the foot. Talus and lesser tarsals. Clin Orthop Relat Res. 1993;292:135-141.
13. Schildhauer TA, Nork SE, Sangeorzan BJ. Temporary bridge plating of the medial column in severe midfoot injuries. Journal of Orthopaedic Trauma. 2003;17:513-520. http://dx.doi.org/10.1097/00005131-200308000-00007
14. Vaishya R, Patrick JH. Isolated dorsal fracture-dislocation of the tarsal navicular. Injury. 1991;22:47-48. http://dx.doi.org/10.1016/0020-1383(91)90162-8
15. Yoshino N, Noguchi M, Yamamura S, *et al*. Bilateral isolated tarsal navicular fracture dislocation: a case report. Journal of Orthopaedic Trauma. 2001;15:77-80. http://dx.doi.org/10.1097/00005131-200101000-00015 Copyright 2011 by the American Orthopaedic Foot & Ankle Society Downloaded from

How to Cite This Article

Abilash, Singh AV. Herbert screws fixation of high-energy navicular body fractures. International Journal of Orthopaedics Sciences. 2023; 9(1):226-230