

# Bridging Internal Fixation for Comminuted Navicular Fractures: Report of Three Cases

Isaiah Song DPM<sup>1</sup>, Caroline Ko DPM<sup>2</sup>, Matthew D. Doyle DPM, MS, AACFAS<sup>3</sup>, Tenaya A. West, DPM, AACFAS<sup>3</sup>,  
Jesse T. Yurgelon, DPM<sup>3</sup>, FACFAS, Nicholas W. Todd, DPM, FACFAS<sup>3</sup>

<sup>1</sup>Resident, Swedish Medical Center, Seattle, WA

<sup>2</sup>Resident, Kaiser Permanente Vallejo, Vallejo, CA

<sup>3</sup>Palo Alto Medical Foundation, Mountain View, CA

## Statement of Purpose

Comminuted navicular fractures are complex injuries with severe consequences on patient function. There are multiple ways to treat comminuted navicular fractures which include open reduction internal fixation, bridging external fixation, a combination of the two, or bridging internal fixation. Few studies have described bridging internal fixation for these injuries. **This case series evaluates three cases of bridging internal fixation for comminuted navicular fractures to restore medial column length and stability, maintain reduction and articular congruity while preserving vascular supply.**

## Literature Review

Open reduction and internal fixation (ORIF) of navicular body fractures has historically had poor results with a high rate of arthritis and avascular necrosis (AVN). In Sangeorzan's 1989 study, only 6 of 21 navicular fractures with lag screw fixation were adequately reduced (1). 17 of 21 patients thought they did not have a "so-called normal foot". Six of 21 patients went on to develop AVN. Plate fixation has not had better results. Coulibaly looked at navicular fractures treated with either a small one-quarter tubular plate, a mini fragment plate or a 2.7 mm plate and found a 85.4% rate of secondary osteoarthritis (2). Due to the high impact nature of the injury, comminuted navicular body fractures, specifically, are more prone to post-operative complications such as; posttraumatic arthrosis, AVN, and late collapse. Coulibaly noted a positive correlation between increasing fracture severity and secondary osteoarthritis (2). Sangeorzan achieved adequate reduction in only 50% of type 3 comminuted navicular fractures with lag screw fixation (1).

In a retrospective study by Evans, all 24 comminuted navicular body fractures treated with minifragment plate fixation reached bone union without loss of reduction (3). However, 4 patients subsequently developed joint arthrosis (16.7%) and 1 patient showed radiographic evidence of AVN (4.2%). Cronier et al. investigated locking plates in 8 patients with comminuted navicular body fractures (4). Post-operative CT scans showed mal-reduction in 50% of cases and increased bone density of the lateral navicular signifying osteonecrosis in 1 patient (12.5%). Definitive bridging external fixation has rarely been described in the literature due to the lack of direct stability to the fracture and the possibility of pin tract infections (5). Schildhauer et al. in 2003 first described temporary internal bridge plating to directly stabilize the medial column and maintain distraction across the adjacent joints (5). A 2.7 mm plate was placed from the medial talar neck to the first metatarsal with additional screws in the navicular or through all three cuneiforms. Hardware was either removed or replaced to mobilize the talonavicular joint 3 months post-operatively. All cases healed without loss of reduction, loosening of implants, or infection. Apostole modified the technique by spanning the plate from the navicular to the medial and intermediate cuneiforms allowing for motion at the talonavicular joint (6). He was successful in two patients without evidence of AVN. One patient required an additional hardware removal procedure. In this case series, we describe three cases of comminuted navicular fractures treated with bridging internal fixation. After fracture consolidation, patients were allowed to weight bear and hardware was removed.

## Case 1



Fig. 1: Pre-operative CT showing comminuted navicular fracture with displacement



Fig. 2: Post-operative radiograph showing dorsal and medial plates spanning the talonavicular and naviculocuneiform joints



Fig. 3: Post-operative radiograph after hardware removal

## Case 2

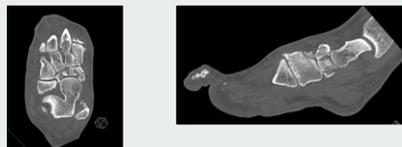


Fig. 4: Pre-operative CT showing comminuted navicular fracture with displacement

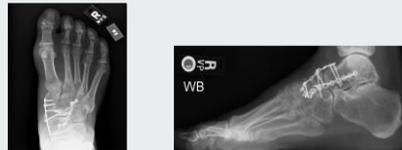


Fig. 5: Post-operative radiograph showing dorsal and medial plates spanning the talonavicular and naviculocuneiform joints

## Case 3

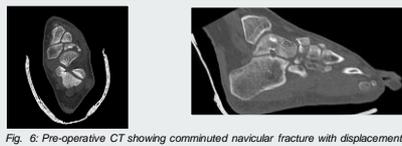


Fig. 6: Pre-operative CT showing comminuted navicular fracture with displacement



Fig. 7: Post-operative radiograph showing dorsal and medial plates spanning the talonavicular and naviculocuneiform joints

## Case Series

This case series presents three patients with comminuted navicular fractures who were treated with bridging internal fixation and eventual removal of hardware with a single surgeon. All three patients had available pre-operative and post-operative radiographs showing a comminuted navicular fracture. Patients were followed radiographically for a minimum of 12 months postoperatively. Postoperative course included 6 weeks of non-weightbearing in a plaster cast, followed by protected weightbearing in a CAM boot, and a course of physical therapy. To date there have been no additional open reduction internal fixation or conversion to arthrodesis.

## Analysis & Discussion

Comminuted navicular fractures are difficult injuries with a multitude of potential complications. Two of the more challenging complications are AVN and a shortened medial column, both of which may lead to deformity and midfoot collapse.

Partial AVN of the navicular can lead to midfoot collapse, while complete AVN can shorten the medial column. Comminution of the navicular can damage the avascular central 1/3 of the navicular (7,8). Bridging internal fixation, minimizes the amount of iatrogenic damage to the navicular with less hardware as compared to traditional ORIF.

Comminution of the navicular makes it difficult to not only reduce the articular fragments, but also maintain the relative length. A shortened medial column can lead to hindfoot varus, forefoot abduction and a painful foot. The bridge plate allows for direct stable fixation of the midfoot reduction and maintenance of the medial column length. Slight distraction at the talonavicular joint through the plate decreases pressure across comminuted joint surfaces.

In this case series, three patients with comminuted navicular fractures were treated with bridging internal fixation and eventual removal of hardware. No patients exhibited signs of AVN or loss of reduction and fractures consolidated without issue. No patients required additional open reduction internal fixation or conversion to arthrodesis.

*In conclusion, the spanning internal fixation protects against two of the more challenging complications of comminuted navicular fractures by protecting the vascularity and stabilizing the medial column. We believe that while there are currently no longer term studies looking at this technique of fixation, a long term outcome studies to see if this prevents foot deformity or decreased rates of arthritis compared to other methods of fixation is warranted.*

## References

1. Sangeorzan BJ, Benirschke SK, Mosca V, Mayo KA, Hansen ST. Displaced intra-articular fractures of the tarsal navicular. *J Bone Joint Surg Am* 1989;71:1504-1510.
2. Coulibaly MO, Jones CB, Siestema DL, Schildhauer TA. Results and complications of operative and non-operative navicular fracture treatment. *Injury* 2015;46:1668-1677.
3. Evans J, Benigsen DM, Agel J, Benirschke SK. Minifragment plate fixation of high-energy navicular body fractures. *Foot Ankle Int* 2011;32:S485-492.
4. Cronier P, Finn J-H, Steiger V, Eggero N, Taha A. Internal fixation of complex fractures of the tarsal navicular with locking plates. A report of 10 cases. *Orthop Traumatol Surg Res* 2013;99:S241-249.
5. Schildhauer TA, Nook SE. Temporary bridge plating of the medial column in severe midfoot injuries. *J Orthop Trauma* 2003;17:513-520.
6. Apostole KL, Younger ASE. Technique tip: open reduction internal fixation of comminuted fractures of the navicular with bridge plating to the medial and middle cuneiforms. *Foot Ankle Int* 2008;29:739-741.