

# Scaphoid Fractures: Nonunion and Malunion

Jessie Janowski, MD,\* Caitlyn Coady, BFA,\* Louis W. Catalano III, MD\*

The treatment of scaphoid nonunion and malunions has undergone a considerable transition since the 1960 modification of Matti's technique by Russe.<sup>1</sup> We present a review of articles with clear data on union rates and functional status to review the current methods of treatment for scaphoid nonunion and malunion. (*J Hand Surg Am. 2016;■(■):■–■. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.*)

**Key words** Scaphoid, fracture, nonunion, malunion.



**A**UTOGENOUS BONE GRAFTING FOR the correction of humpback deformity has been taken from the rib, radius, and iliac crest. Numerous vascularized bone graft options have been presented as solutions to the avascular proximal pole. One could question the use of vascularized bone grafting; is it an advantage that is worth the additional time, cost, and morbidity? Our review will focus on articles that have clear data on union rates and functional status to review the current methods of treatment for scaphoid nonunion and malunion.

Amadio et al<sup>2</sup> demonstrated that if a scaphoid fracture heals without a so-called “humpback deformity,” clinical results are improved. Patients were seen at a mean of 63 months (range, 18–124 months) after a fracture and were observed for a mean of 44.7 months (range, 6–108 months) after union. Patients with greater than 45° of lateral intrascaphoid angulation had a satisfactory clinical outcome only 27% (4 of 15 patients) of the time; 54% (9 of 15 patients) of those patients developed posttraumatic arthritis. This study helped prove that surgeons should reduce

and fix any scaphoid fracture with a lateral intra-scaphoid angle of greater than 35°.

In 2006, Slade and Dodds<sup>3</sup> introduced their classification scheme for the treatment of scaphoid nonunions (Table 1). This classification system can help guide treatment, as outlined in their article. Types 1 to 3 and some type 4 can be treated with rigid fixation alone. In their series, a screw was used for internal fixation. Treatment decisions are difficult for types 5 and 6 and become more complicated by any of the subtype factors.

## PERCUTANEOUS INDICATIONS

In some cases, percutaneous internal fixation may be used to treat minimally displaced or nondisplaced scaphoid nonunions. Slade et al<sup>4</sup> reviewed 15 consecutive patients who underwent rigid fixation using a headless compression screw from a dorsal percutaneous approach. No open or arthroscopic debridement was used; however, arthroscopy was used to confirm appropriate alignment. In some cases reduction was aided by K-wire joysticks. Union was achieved in all 15 patients at an average of 14 weeks. Mahmoud and Kopton<sup>5</sup> prospectively analyzed 27 patients with scaphoid nonunion and notable bony resorption (>2 mm bone loss with no humpback deformity) treated solely with a percutaneous volar headless screw. They achieved radiographic union at a mean of 11.6 weeks (range, 8–16 weeks), with improvement of functional scores and range of motion. These studies demonstrate that percutaneous

From the \*Department of Orthopaedic Surgery, NYU Langone Medical Center, New York, NY.

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**Corresponding author:** Louis W. Catalano III, MD, Roosevelt Hand to Shoulder Center, OrthoManhattan, 485 Madison Avenue, 8th Floor, New York, NY 10022; e-mail: cvstarr@gmail.com.

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**TABLE 1. Treatment Classification System for Scaphoid Nonunions**

Grade	Category	Characteristics of Scaphoid Nonunions
I	Delayed presentation	Scaphoid fractures with delayed presentation (4–8 wk)
II	Fibrous nonunion	Intact cartilaginous envelope, minimal fracture line at nonunion interface, no cyst or sclerosis
III	Minimal sclerosis	Bone resorption at nonunion interface < 1 mm with minimal sclerosis
IV	Cyst formation and sclerosis	Bone resorption at nonunion interface < 5 mm, cyst formation, and maintained scaphoid alignment
V	Cyst formation and sclerosis	Bone resorption at nonunion interface > 5 mm and < 10 mm, cyst formation, and maintained scaphoid alignment
VI	Pseudoarthrosis	Separate bone fracture fragments with profound bone resorption at nonunion interface. Gross fragment motion and deformity is often present.
Subtype	Associated Characteristics	
a	Proximal pole nonunion	Proximal pole has tenuous blood supply and mechanical disadvantage that places it at greater risk of delayed or failed union
b	Avascular necrosis	Scaphoid nonunion with avascular necrosis confirmed by magnetic resonance imaging or intraoperative lack of punctate bleeding. Fracture must heal and revitalize
c	Ligamentous injury	Injury suggested by static and dynamic imaging of carpals or arthroscopic, direct observation
d	Deformity	Scaphoid deformity must be corrected. This requires bicortical structural bone graft and rigid fixation

fixation without debridement or bone grafting can be used for well-aligned nonunions.<sup>a</sup>

Traditionally, even for nondisplaced scaphoid nonunions, full debridement of the nonunion was recommended before bone grafting and fixation. McInnes and Giuffre<sup>6</sup> performed a retrospective study evaluating 12 patients with nondisplaced waist and proximal pole nonunions, with limited (50%) nonunion debridement and screw fixation. No patients had avascular necrosis of the proximal pole based on preoperative radiographs, and during surgery punctate bleeding was confirmed before continuing with the procedure. The authors used 2 K-wires to stabilize the nonunion before burr debridement of only the dorsal half of the nonunion. The distal radius cancellous graft was packed in the dorsal void and a headless screw was placed parallel to the scaphoid axis. The average time to union, defined as cortical union of the grafted portion on computed tomographic scan, was 14 weeks (range, 6–31 weeks). None of the fractures healed on the non-debrided (volar) side, yet all patients were without pain and returned to previous activities and work. Previous studies evaluating the technique of complete nonunion debridement and fixation had defined union as 50%,<sup>7</sup> so this study suggested that a more limited

surgery, with decreased difficulty and surgical time, achieved the same goal.

### TYPES OF BONE GRAFT

In 2012, Aguilera and Garcia-Elias<sup>8</sup> described a novel technique in a case report of one patient for bone grafting a scaphoid nonunion. The authors harvested the anterolateral corner of the ipsilateral distal radial metaphysis, which has a contour similar to that of a typical nonunion defect and consists of dense subchondral bone. The graft can be harvested through the same incision and surgery can be done without general anesthesia because bone from the iliac crest is not harvested.<sup>b</sup>

The Fisk–Fernandez technique uses a triangular or trapezoidal wedge of bone placed between the debrided ends of the nonunion site.<sup>c–e</sup> The graft, typically of iliac crest or distal radius, requires some precision to correct scaphoid length and carpal collapse properly. The Matti–Russe technique uses corticocancellous grafts in the shape of a narrow rectangle that are placed within the cleared nonunion site, but it requires the nonunion to have no humpback deformity. Autograft can be taken locally from the distal radius or the iliac crest. Iliac crest bone had been thought to be more

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