Management of Scaphoid Nonunions

Thanapong Waitayawinyu, MD, FRCOST,
H. James Pfaeffle, MD, PhD, Wren V. McCallister, MD,
Nicholas M. Nemechek, Thomas E. Trumble, MD*

KEYWORDS

• Vascularized bone graft • Scaphoid nonunion
• Avascular necrosis • 1,2 ICSRA

Scaphoid nonunions present a challenging problem because of the geometry of the fracture and vascular pattern of the scaphoid. Fractures that are proximal to the perforating vessels on the dorsal radial surface of the scaphoid can cause significant bone ischemia of the proximal pole. A delay in diagnosis, inadequate initial treatment, proximal location, avascular necrosis, and associated carpal instability with acute scaphoid fractures can lead to either nonunions of the scaphoid waist or the proximal pole.[1] Nonunion can exist with or without avascular necrosis (AVN) of the proximal fragment. AVN of the proximal pole can occur with a scaphoid waist nonunion, but there is almost always a loss of blood supply in proximal pole nonunions. Nonunions involving the scaphoid waist usually have significant bone loss and carpal collapse, with palmar rotation of the distal pole to produce an apex dorsal humpback deformity. If left untreated, scaphoid nonunions can progress to carpal collapse, AVN, and a predictable pattern of radiocarpal arthrosis.[2] The goals of surgery for a scaphoid nonunion include not only uniting the fracture but also restoring alignment. Evidence suggests that operative treatment provides better results when care is taken to correct any deformity and address the vascularity of the scaphoid.

Cast immobilization, with or without adjunctive treatments such as pulsed electromagnetic fields, is not as effective as surgical intervention, and is typically not recommended to treat scaphoid nonunions.[3] Immobilization with long-arm casts for prolonged periods of time (longer than 6 months) can have a significant impact on a patient's wrist and elbow motion, as well as quality of life. Because union rates with pulsed electromagnetic fields are inferior to those with surgery, electromagnetic fields should only be used as an adjunct to surgery, or in cases in which surgery is not possible. Several reports indicate that few nonunions remain stable or nondisplaced and free of arthritis after 10 years.[2,4] Because of the evidence linking nonunions with osteoarthritis, surgery is recommended for most young, healthy patients, even if they are free of symptoms and have normal wrist mobility. Most hand surgeons recommend open reduction and internal fixation of the nonunion combined with a bone graft.[5–8]

Surgical treatment for correction of scaphoid nonunions with bone grafting and internal fixation is contraindicated in cases of progressive arthrosis. Relative contraindications include chronicity of the nonunion,[9] smoking,[10,11] and patient age,[12] all of which are important to consider when evaluating the potential for success after treatment of a nonunion.

APPROACH TO TREATMENT

Determining the location of the nonunion, the degree of collapse, and viability of the proximal fragment are important steps in approaching the treatment of scaphoid nonunions. Without AVN, waist fractures are best treated via a volar approach, and proximal pole fractures via a dorsal

This article originally appeared in *Orthopedic Clinics of North America* 2007;38(2):237–49.
Department of Orthopaedics and Sports Medicine, University of Washington, 4245 Roosevelt Way NE, Box 354743, Seattle, WA 98195-4743, USA
* Corresponding author.
E-mail address: trumble@u.washington.edu (T.E. Trumble).

Hand Clin 26 (2010) 105–117
doi:10.1016/j.hcl.2009.08.011
0749-0712/09/$ – see front matter

approach. Fractures with AVN of the proximal pole are best served by a dorsal approach with a vascularized bone graft.

Plain radiographs are helpful, but not foolproof, in determining whether or not the scaphoid fracture involves the proximal pole. The fracture often angles from distal volar to proximal dorsal, which can make the plain radiographs deceiving. CT can help differentiate nonunions in the waist from those in the proximal pole, especially when there is substantial bone resorption (**Fig. 1**).

CT scans provide the most precise definition of the osseous anatomy. The sagittal images, parallel to the long axis of the scaphoid, obtained from CT scans provide the best view to determine the extent of collapse (the so-called ''humpback deformity''), and assist in planning for bone grafting procedures. The lateral intrascaphoid angle (**Fig. 2**A) described by Amadio and colleagues,[13] and the height-to-length ratio of the scaphoid (**Fig. 2**B) described by Bain and colleagues[14] can be accurately measured with a CT scan. These measurements, obtained from sagittal images parallel to the long axis of the scaphoid, can help to accurately identify the magnitude of collapse and angulation of the scaphoid.

The classic radiographic signs of sclerosis, cystic changes, and areas of significant bone resorption are not always reliable indicators of the presence of avascular necrosis in scaphoid nonunion. Recent studies have established the value of MRI in assessing vascularity of the proximal pole.[15–18] Low signal on both T1- and T2-weighted images appears to be associated with the greatest compromise of vascular supply and poor healing rates when traditional nonvascularized grafts are used. Proximal fragments with an absence of T1-weighted marrow signal (**Fig. 3**) have demonstrated osteonecrosis, empty bone lacunae, and poor uptake of fluorescent bone labels on biopsy.[18] In contrast, retention of some proximal pole signal has been associated with viable bone when examined histologically, and normal uptake of fluorescent labels. When the MRI demonstrates avascular necrosis of the proximal pole, the authors recommend a vascularized bone graft.

Fig. 1. Sagittal CT scan shows the location of nonunion site over proximal pole of scaphoid, which helps in determining the surgical approach.

The recommended techniques for surgical correction of a scaphoid nonunion with bone graft and internal fixation are as follows:

- Scaphoid waist nonunion with a viable proximal pole: palmar approach
- Proximal pole scaphoid nonunion with a viable proximal pole: dorsal approach
- Proximal pole scaphoid nonunion with an avascular proximal pole: dorsal-radial approach with vascularized graft
- Scaphoid waist nonunion with an avascular proximal pole: volar-radial approach with vascularized graft

SCAPHOID WAIST NONUNION WITH A VIABLE PROXIMAL POLE: PALMAR APPROACH

The palmar approach is widely used for bone grafting and internal fixation of nonunions of the scaphoid waist. It allows access to the distal pole and waist for nonvascularized bone grafting, retrograde internal fixation, and correction of the humpback deformity that can result after scaphoid collapse. The palmar approach is used for scaphoid waist nonunions with a viable proximal pole, so as to preserve the remaining dorsal blood supply. The palmar approach is not recommended for nonunions of the proximal pole. Nonunions of the proximal pole of the scaphoid, with or without avascular necrosis, should be addressed via a dorsal approach. If the nonunion extends into the proximal pole and a palmar approach is used in contrast to a dorsal approach, adequate fixation in the small proximal pole fragment may not be achieved. A preoperative CT scan can help to avoid this problem if there is any doubt based upon plain films. A preoperative MRI can help identify AVN that is not seen on plain radiographs, so that a vascularized bone graft (best placed via a dorsal approach) can be considered during surgical planning.[18]

General anesthesia is used routinely, and is necessary if one plans to harvest bone graft from the iliac crest. The patient is positioned supine with the operative extremity on a radiolucent arm table. The arm is cleansed with antimicrobial solution and draped sterilely. Exsanguination is performed with an Esmarch's bandage and an