

# Scaphoid Plate Fixation and Volar Carpal Artery Vascularized Bone Graft for Recalcitrant Scaphoid Nonunions

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**Purpose** We sought to evaluate the clinical and radiographic outcomes after treatment of symptomatic, recalcitrant scaphoid nonunions using a novel combination of volar scaphoid buttress plating with a pedicled vascularized bone graft.

**Methods** We retrospectively followed 9 patients with recalcitrant scaphoid waist nonunions, characterized by failed prior surgery, long duration of nonunion, avascular necrosis of the proximal pole, or considerable bone loss at the nonunion site. We treated these persistent nonunions through a single volar incision with a pedicled vascularized bone graft, based on the volar carpal artery, and a 1.5-mm precontoured, scaphoid-specific, volar buttress plate. Postoperatively, we assessed objective and subjective outcomes as well as radiographs and computed tomography scans.

**Results** The median duration of nonunion was 15 months, ranging from 6 to 96 months. Postoperative follow-up ranged from 11 to 19 months. Computed tomography scans demonstrated union in 8 of 9 cases. Complications included 1 minor hematoma that spontaneously resolved. One scaphoid failed to unite, requiring revision surgery. Three patients experienced problems with the plate. One plate was removed from a patient who noted persistent clicking, and 2 plates have caused symptomatic clicking, likely requiring future removal. Eight of nine patients reported satisfaction with the procedure, with *QuickDash* scores averaging 8.2.

**Conclusions** We present a series of recalcitrant scaphoid nonunions treated with a novel technique of volar buttress plating and vascularized bone graft. In this series, we found a high rate of union, with consistent radiographic improvement and symptomatic relief. This procedure can be performed using a single incision and with minimal donor site morbidity. Volar plating of a scaphoid nonunion comes with the risk of articular prominence, but offers a new alternative to headless screw fixation. Our early results from this series are promising and support this protocol as a viable alternative for challenging nonunions. (*J Hand Surg Am.* 2016;41(7):e191–e198. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)

**Type of study/level of evidence** Therapeutic IV.

**Key words** Avascular necrosis, recalcitrant scaphoid nonunion, scaphoid fracture, vascularized bone graft, volar scaphoid plate.



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**D**ISPLACED SCAPHOID FRACTURES ARE at risk for nonunion due to a variety of factors, including interfragmentary instability, retrograde vascular supply, and lack of soft tissue attachments on a largely cartilaginous surface.<sup>1–3</sup> When treating physicians recognize and treat scaphoid fractures early (with immobilization or surgical stabilization), union rates are predictably high.<sup>4,5</sup> However, even with appropriate treatment, a portion of scaphoid fractures go on to nonunion. Although no literature exists to follow scaphoid nonunions prospectively, retrospective studies of scaphoid nonunions suggest that the natural history of ununited scaphoid fractures probably includes the eventual onset of radiocarpal and midcarpal arthritis, often accompanied by disabling pain.<sup>6–8</sup> Some scaphoid nonunions are fibrous nonunions, pseudarthroses without considerable bone loss, or still vascularized with mild deformity. Stable, fibrous nonunions can be treated percutaneously or in an open fashion with reliable results.<sup>9</sup> Other scaphoid nonunions are recalcitrant, presenting more challenges, and may not be amenable to standard nonunion repair techniques.

For the purpose of this study, we have assigned the label “recalcitrant” to scaphoid nonunions with failure of prior fixation, avascular necrosis at the proximal pole, bone loss with cystic degeneration of greater than 7 mm at the fracture site, or duration of nonunion of at least 2 years.<sup>10–12</sup> Often, surgeons consider salvage operations such as scaphoid excision and 4 corner arthrodesis or proximal row carpectomy for recalcitrant scaphoid nonunions.<sup>13</sup> Both of these techniques provide pain relief in 84% to 85% of patients, but lead to decreased grip strength and range of motion.<sup>14</sup> Four-corner arthrodesis is also associated with a risk of nonunion. When performed using circular plates, a nonunion rate as high as 26% has been reported.<sup>15</sup> Proximal row carpectomy avoids the risk of nonunion, but is associated with a risk of subsequent radiographic arthrosis.<sup>14</sup> As an alternative to salvage procedures, we attempted to preserve the normal anatomy of the wrist, by restoring the height and stability of the scaphoid. Our technique uses a volar buttress plate, combined with a pedicled vascularized bone graft.

We hypothesized that the use of a volar buttress plate, combined with a pedicled vascularized bone graft, would achieve a high rate of healing for recalcitrant scaphoid nonunions. Given the potential ability of a buttress plate to resist deforming forces at the scaphoid fracture while simultaneously securing a volarly placed bone graft, we believe that this surgical technique may represent an advantageous

alternative to traditional treatment options. We present our early data from a series of patients treated with volar buttress plating and vascularized bone grafting.

## MATERIALS AND METHODS

We retrospectively reviewed 14 patients with recalcitrant scaphoid nonunions treated with volar scaphoid plating (Medartis, Basel, Switzerland), between 2011 and 2015. A variety of factors led to the identification of these patients as recalcitrant nonunions. One patient failed prior surgery with a compression screw. Nine patients demonstrated avascular necrosis (AVN) of the proximal pole. Avascular necrosis was provisionally diagnosed based on the appearance of sclerotic bone on computed tomography (CT) scan. Diagnosis of AVN was confirmed by intraoperative findings of hardened, sclerotic bone without punctate bleeding.<sup>16</sup> The remaining 4 patients' scaphoid nonunions had severe bone loss and cystic erosions with gaps of greater than 7 mm, and the duration of the nonunion was at least 2 years.

Our inclusion criteria for this study consisted of radiographic and clinical follow-up of 6 months after surgery. This time frame was selected to ensure adequate time for union to have taken place. Previous work regarding recalcitrant nonunions reported an average time to union of 4.6 months.<sup>17</sup> Five of the fourteen patients who had the surgery did not present for adequate follow-up, including CT scanning, and as a result we excluded them from this study. The 9 patients included in this study presented with substantial bone loss at the nonunion site with an average gap of  $9.0 \pm 2.5$  mm. All patients demonstrated a humpback deformity.

We present demographic data, including age, gender, injury mechanism, smoking status, prior treatments (if any), and the presence of AVN, in [Table 1](#). The duration of nonunion according to patient history is also noted in [Table 1](#), with a median of 15 months. The duration of follow-up in this series ranged from 6 months to 18 months, with an average duration of follow-up of  $14.2 \pm 3.9$  months. We obtained approval from our institutional review board, and obtained informed consent from each patient.

### Surgical procedure

A single surgeon performed volar buttress plating in conjunction with a vascularized volar carpal artery graft, as previously described.<sup>18,19</sup> In each case, both the scaphoid nonunion and the donor graft site were exposed through a single volar incision. We aggressively debrided the nonunion site of fibrous

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