The Outcomes and Complications of 1,2-Intercompartmental Supraretinacular Artery Pedicled Vascularized Bone Grafting of Scaphoid Nonunions

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Purpose: Over the past decade vascularized bone grafts that use a 1,2-intercompartmental supraretinacular artery (1,2-ICSRA) pedicle have gained popularity in the treatment of scaphoid nonunions. The purpose of this study was to evaluate critically the outcome, complications, and failures of 1,2-ICSRA–based vascularized bone grafting at our institution to understand better the appropriate indications, methods, and possible contraindications.

Methods: From January 1994 through July 2003, 50 scaphoid nonunions in 49 patients were treated with 1,2-ICSRA–based vascularized bone grafts. A retrospective review of the clinical and radiographic information was performed. Two patients were lost to follow-up study. Nine female and 38 male patients averaging 24 years of age were followed-up for an average of 7.8 months.

Results: Thirty-four scaphoid nonunions went on to union at an average of 15.6 weeks after surgery. Complications occurred in 8 patients and consisted of graft extrusion, superficial infection, deep infection, and failure of fixation. Univariate risk factors for failure included older age, proximal pole avascular necrosis, preoperative humpback deformity, nonscrew fixation, tobacco use, and female gender.

Conclusions: Although previous researchers have concluded that vascularized bone grafts based on the 1,2-ICSRA are efficacious in the treatment of scaphoid nonunions, we determined that a successful outcome is not universal and depends on careful patient and fracture selection and appropriate surgical techniques. (J Hand Surg 2006;31A:387–396. Copyright © 2006 by the American Society for Surgery of the Hand.)

Type of study/level of evidence: Therapeutic, Level IV.

Key words: Scaphoid nonunion, treatment, outcome, complications, vascularized bone graft.

The scaphoid is the most commonly fractured of the carpal bones and accounts for more than 60% of all carpal fractures.[1] Fracture union of most scaphoid fractures can be accomplished by cast immobilization, electrical stimulation, or open reduction combined with internal fixation and/or conventional bone grafting. Despite this there has been an estimated nonunion rate of 5% to 15%.[2] Factors contributing to the nonunion of scaphoid fractures have included treatment delay, fracture displacement, proximal location, avascular necrosis (AVN), and associated carpal instability.[3] Avascular necrosis is seen in approximately 3%, with the highest risk seen in fractures involving the proximal third of the scaphoid.[4]

Vascularized pedicled bone grafts have been useful in the treatment of scaphoid nonunions and Kienböck's disease.[5] Zaidemberg et al[7] reported the use of a dorsal radial pedicle graft and achieved healing in 100% of 11 long-standing scaphoid nonunions. The vascular anatomy of the dorsal distal radius was defined by Sheetz et al,[7] who included an accurate description of Zaidemberg's graft among others from the dorsal distal radius that are of potential use in the carpus. The vessel described originally by Zaidemberg[6] as the "ascending irrigating artery" is known now as the 1,2-intercompartmental supraretinacular artery (1,2-ICSRA).[7] Union rates of 100% with the 1,2-ICSRA pedicled vascularized bone graft have

been reported by several researchers[3,8–10]; however, others[11,12] have reported less-than-ideal healing rates with the same dorsal distal radius pedicled bone graft. Recently a meta-analysis found that vascularized bone grafting achieved an 88% union rate versus a 47% union rate with screw and intercalated wedge fixation in scaphoid nonunions with AVN.[13]

The purpose of this study was to evaluate a large series of 1,2-ICSRA bone grafts performed for scaphoid nonunions to determine the complications associated with this procedure and also to evaluate critically the outcomes and risk factors for failure of 1,2-ICSRA vascularized bone in scaphoid nonunion surgery.

Materials and Methods

A retrospective review of all medical records of patients with a diagnosis of scaphoid nonunion treated with 1,2-ICSRA vascularized bone graft was conducted with the approval of our institutional review board. Between January 1994 and July 2003, 50 scaphoid fracture nonunions in 49 patients treated with a 1,2-ICSRA pedicled vascularized bone graft were identified. Of the 49 patients 2 were lost to follow-up study. Medical records and radiographs were reviewed, and in addition to patient demographics factors specific to scaphoid union were evaluated. These factors included tobacco use, fracture location, vascularity of the proximal pole, type of fixation, outcome of surgery, time to union, complications, and subsequent surgery.

Demographics

Nine female and 38 male patients with 48 scaphoid nonunions and an average age of 24 years (range, 14–66 y) were followed up for an average of 7.8 months (range, 2–49 mo). The duration of the scaphoid nonunion was known for 40 fractures and averaged 23 months (range, 2–156 mo). There was 1 nonunion that reportedly was of 2 months' duration but that had a radiographic appearance of chronic nonunion. There were 22 right-sided and 26 left-sided surgeries. The nonunion was located in the proximal third in 25 and at the waist in 23 of the fractures. Thirteen of the 47 patients reported that they were tobacco users (smokers).

Surgical Procedure

All patients had the 1,2-ICSRA vascularized bone grafting of their scaphoid nonunions via a dorsal approach by 1 of 9 board-certified hand surgeons at our institution (average number of cases per surgeon, 5.3; range, 1–11). Surgical indications were broad and included scaphoid waist nonunions in addition to proximal nonunions with AVN. The surgical technique has been well documented in the literature[5] (Fig. 1) and was followed closely by all surgeons, with variations in the method of fixation or stabilization based on individual circumstances and surgeon preferences. At the time of surgery the quality of the proximal pole was evaluated and the vascularity was determined by the quality of the proximal pole, color, presence or absence of punctuate bleeding, and consistency.[14] Fibrous tissue and any avascular bone were curetted and the 1,2-ICSRA graft was used to fill the void, frequently with additional nonvascularized distal radius cancellous bone graft when necessary. After surgery all patients were placed into a long-arm splint or cast, followed by continued casting and/or splinting until radiographic union.

Type of Fixation

Twenty-six fractures were stabilized with cannulated scaphoid screws, 15 with K-wires, and 4 with both screws and K-wires. Three fractures were grafted without any type of fixation. The choice of fixation was decided by the surgeon based on fragment size and stability.

Radiographic Evaluation

All patients had plain radiographic studies before surgery and computed tomography (CT) or tomograms after surgery to assess union. Seven patients had magnetic resonance imaging (MRI) studies to evaluate proximal pole vascularity. The presence of proximal pole hypovascularity was determined by commonly applied clinical methods consisting of intraoperative observation of punctate bleeding in the proximal pole, radiographic findings of proximal pole sclerosis, and characteristic changes in MRI studies when available. Bone biopsy examinations were not performed. Changes consistent with proximal pole hypovascularity were present in 24 scaphoids.

All postoperative radiographs were reviewed for fracture union, graft status, advancement of arthritis, and scaphoid fragmentation (when it occurred). The criteria for fracture union were strict. Union was established by bridging trabeculae crossing the fracture site on both plain radiographs and on computed or trispiral tomograms. In all x-rays the fracture location and pattern and proximal pole size were recorded, as were other observations including fragmentation, collapse, and presence of carpal instability.

Statistical Methods

Univariate associations of potential risk factors with the failure of vascularized bone grafts were