Original Article With Video Illustration

Retrospective Comparative Outcomes Analysis of Arthroscopic Versus Open Bone Graft and Fixation for Unstable Scaphoid Nonunions

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Purpose: To compare union rates and clinical and radiologic outcomes after arthroscopic and open bone grafting and internal fixation for unstable scaphoid nonunions. **Methods:** Between March 2009 and November 2014, patients with unstable scaphoid nonunion underwent arthroscopic (group A) or open (group O) bone grafting and internal fixation. One senior surgeon alternatively performed either arthroscopic or open osteosynthesis for the same surgical indications. Visual analog scale score, grip strength, active range of motion, Mayo wrist score (MWS), and Disabilities of Arm, Shoulder, and Hand score were assessed preoperatively and postoperatively. Union was determined by computed tomography 8 to 10 weeks postoperatively with bridging trabecula at the nonunion site. Scapholunate angle (SLA), radiolunate angle (RLA), and lateral intrascaphoid angle (LISA), plus height/length ratio (HLR) served to gauge carpal bone alignment in preoperative and postoperative radiographs. Those outcomes of patients with carpal collapse deformities, who met following conditions; (1) LISA of >45° or HLR of >0.65 on computed tomography images or (2) SLA of >60° or RLA of >10° on plain radiographs, were also compared. **Results:** Overall, 62 patients qualified for study (group A, 28; group O, 34). Union rates did not differ by patient subset (group A, 96.4%; group O, 97.1%; $P \risingdotseq 1$); and visual analog scale score, grip strength, range of motion, Mayo Wrist Score, and Disabilities of Arm, Shoulder, and Hand scores were similar at last follow-up. In radiographic assessments, SLA, RLA, and LISA were similar, whereas scaphoid HLR excelled through open technique (group A, 0.59 ± 0.07; group O, 0.55 ± 0.05; $P = .002$). Subgroup analysis of patients with carpal collapse deformities (group A, 9; group O, 14) showed that all radiographic measures in group A (vs group O) reflected lesser correction (SLA, 56.7° ± 7.3° vs 49.2°±9.1° [$P = .049$]; RLA, 9.2° ± 2.0° vs 5.7° ± 3.0° [$P = .005$]; LISA, 34.8° ± 4.8° vs 25.6° ± 13.0° [$P = .028$]; HLR, 0.66 ± 0.04 vs 0.54 ± 0.07 [$P < .001$]). **Conclusions:** Arthroscopic and open bone grafting and internal fixation in treating unstable scaphoid nonunions, did not show any significant differences in clinical and radiologic outcomes at the minimum of 2 years after operation. In scaphoid nonunions with carpal collapse deformities, open bone grafting restored better carpal alignment than arthroscopic bone grafting, although there were no differences in clinical outcomes between the 2 techniques. **Level of Evidence:** Level III, retrospective comparative study.

Unstable scaphoid nonunion may culminate in carpal instability or humpback deformities that lead to degenerative arthritis (also known as scaphoid nonunion advanced collapse). Restoring normal kinematics of the wrist through scaphoid healing and correction of any carpal deformities is crucial to prevent arthritis.[1] Debridement and reduction of nonunion, bone grafting, and then rigid internal fixation are essential steps in realization of these goals.[2,3] Surgeons must decide on the nature of bone graft (cancellous bony inlay,[4-6] wedge,[7,8] or vascularized bone[9-12]), taking into account any related carpal collapse deformity and proximal fragment viability, using either a volar or dorsal approach. However, such conventional techniques may damage ligamentous structures and joint capsules, compromising scaphoid vessels and proprioception of the carpus.[13,14]

Recently, all arthroscopic procedures involving debridement, bone grafting, and internal fixation of scaphoid nonunion have been regarded as minimally

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invasive and potentially advantageous, thought to preserve ligaments and capsule, scaphoid vascularity, and carpal proprioception,[13-17] although this kind of arthroscopic technique requires a high learning curve.[17,18] However, most of the earlier data originated from minimally displaced scaphoid nonunions with negligible sclerosis. Furthermore, arthroscopic reduction and bone grafting may be limited in terms of restoring normal carpal alignment, especially in patients with carpal collapse deformities.[13-16] It is our contention that an arthroscopic procedure with cancellous inlay bone graft[4,5] has the same indications as open procedures, which reportedly applies equally to stable and unstable scaphoid nonunions.[6,19]

Although arthroscopic management has become popular, the efficacy and safety of doing so remain unclear when compared with conventional open procedures. Thus, the purpose of this study was to compare union rates and clinical and radiologic outcomes after arthroscopic and open bone grafting and internal fixation for unstable scaphoid nonunions. We hypothesized that similar results are anticipated in all aspects except for carpal alignment, which likely would fare better with conventional open procedures.

Methods

Between March 2009 and November 2014, patients who underwent surgical treatment for scaphoid nonunion at our facility were enrolled in this retrospective study. Inclusion criteria were (1) documented unstable scaphoid nonunion, (2) arthroscopic or open debridement and reduction of unstable scaphoid nonunion, with bone grafting and internal fixation, and (3) available follow-up data for a minimum of 2 years after surgery. Unstable scaphoid nonunion was characterized by at least one of the following preoperative radiographic features: (1) sclerosis, cystic changes, or gapping and/or translation of >2 mm, (2) a lateral intrascaphoid angle of >35°, (3) radiolunate angle (RLA) of >10°, and (4) a scapholunate angle (SLA) of >60°.[3,17,20] The following were grounds for exclusion: (1) stable nonunions without substantial bone loss or gapping/translation of >2 mm, (2) necrosis of the proximal fragment, (3) salvage procedures for advanced wrist arthritis (scaphoid nonunion advanced collapse stage II or greater),[1,3,17] and (4) revision bone grafting surgery owing to the failure of bone healing after initial fixation for scaphoid fracture. All patient data retrieved from medical records and radiographic archives were reviewed retrospectively. Patients were assigned by therapeutic approach to group A (osteosynthesis under arthroscopic guidance) or group O (conventional open technique). The same hand surgeon alternatively performed either arthroscopic or open osteosynthesis for the same surgical indications during the study period. Our institutional review board approved this study, waiving informed consent.

Surgical Technique

Under general anesthesia and with patients in the supine position, each patient's arm was prepared and draped on a hand table and exsanguinated using an Esmarch bandage and a tourniquet. In group A (Fig 1 and Video 1, available at www.arthroscopyjournal.org), the patient's arm was suspended in an Arc Wrist Tower (Acumed, Hillsboro, Oregon), using 5 to 8 kg of traction, after placing the index, middle, and ring fingers in finger traps. The arthroscopy-guided procedure for scaphoid nonunion was described elsewhere.[13,14,21] In brief, midcarpal ulnar portal was created first, and a 1.9-mm video arthroscope was introduced through it, after which scaphotrapezial portal or midcarpal radial portal was made to be used as a working portal (Fig 1D). For debridement of nonunion sites, a fine-angled curette, a motorized 2.0- or 2.9-mm shaver, and a 2.9- or 3.5-mm burr were used across the working portal, until healthy looking cancellous bone was exposed at both sides of nonunion (Fig 1E). Then, traction was released and the nonunion site was reduced using a probe or other instruments under arthroscopic and fluoroscopic imaging guidance. One Kirschner wire was then passed from the scaphoid tubercle to the nonunion site for temporary fixation. To insert a guidewire for headless screw fixation (Fig 1F), the arthroscope was introduced into the 6-R portal and, while flexing the wrist to 30° with traction, a 15-G needle was inserted percutaneously (proximally and along ulna to the original site of 3-4 portal) to achieve an ideal guidewire starting point.[13] A 5-mm transverse incision was subsequently made at the prepositioned guidewire tip, after removing the 15-G needle, and a sharp straight hemostat was used to spread soft tissue and pierce the dorsal capsule (proximal 3-4 portal). A second wire of equal length was passed through the proximal 3-4 portal onto the cortex of proximal scaphoid pole and parallel to the guidewire. The difference in lengths of the trailing wire ends equaled the scaphoid length. The screw size needed was 4 mm less than scaphoid length, thus permitting 2 mm of clearance at each end of the scaphoid. Before reaming along the guidewire, cancellous bone was harvested from the iliac crest via the trephine technique, using a bone biopsy needle through a small incision. A small rongeur was engaged to break the harvested bone into small chips, which were placed within the sheath of a 3.5-mm burr. Next, the bone-packed sheath was introduced through scaphotrapezial trapezoidal or midcarpal radial portal into the nonunion gap under direct arthroscopic vision, emanating from midcarpal ulnar portal. The nonunion gap was filled with cancellous bone using a slightly undersized bone biopsy