The Anterolateral Corner of the Radial Metaphysis as a Source of Bone Graft for the Treatment of Scaphoid Nonunion

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As a source of corticocancellous grafts for treating scaphoid nonunions, the anterolateral corner of the distal radial metaphysis has several advantages over other alternatives: it provides good-quality corticocancellous bone, it allows one to harvest the graft and treat the scaphoid through the same incision, it does not require general anesthesia, and it has less morbidity than occurs when obtaining the graft from the iliac crest. *(J Hand Surg 2012;37A:1258–1262. © 2012 Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand.)*

Key words Bone graft, distal radius, nonunion, scaphoid, wrist.

Treatment of a nonunited scaphoid must emphasize healing the bone, but also restoring its normal shape and length. Even if solidly united, a deformed scaphoid may be as dysfunctional as an unresolved nonunion. To avoid converting a nonunion into a malunion, most authors advocate restoring the normal dimensions of the bone by intercalating a structurally solid bone graft from the iliac crest in the nonunion site.[1] Although the iliac crest provides high-quality corticocancellous bone, this is at the expense of a second surgical field, general anesthesia, and considerable donor site morbidity.[2,3] These drawbacks can be avoided by obtaining the graft from the anterolateral corner of the distal radial metaphysis, where the cortical bone is thin and the subcortical cancellous bone is suitably dense (Fig. 1). According to some authors, taking the graft from the radius can be as effective as using an iliac crest graft, with the added advantage that the entire operation is done under regional anesthesia, through 1 single wrist incision.[2,3] However, not all sectors of the distal metaphysis provide bone grafts of equal quality. This article suggests the anterolateral corner of the radial metaphysis as one of the best sources of grafting material for the treatment of unstable scaphoid nonunion with a "hunchback" deformity.

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INDICATIONS AND CONTRAINDICATIONS

Most carpal defects requiring autologous bone grafting (ie, nonunions, intraosseous cysts, corrective osteotomies) may benefit from this donor site alternative. Although the radial metaphysis has excellent potential to recover from excision of large segments of bone, there are no studies indicating what the size limit is. In our practice, if the required graft is more than 15 mm wide, 10 mm long, and 10 mm deep, an iliac crest graft is preferred.

SURGICAL ANATOMY

The anterolateral corner of the distal radius has much denser subchondral bone than the central portion of the metaphysis. Bone trabeculae in that area are surrounded palmarly and laterally by thin cortices forming a rounded angle of approximately 90° (Fig. 2). Incidentally, the anterolateral corner of the scaphoid waist has a similar shape and dimension. This is the basis for our

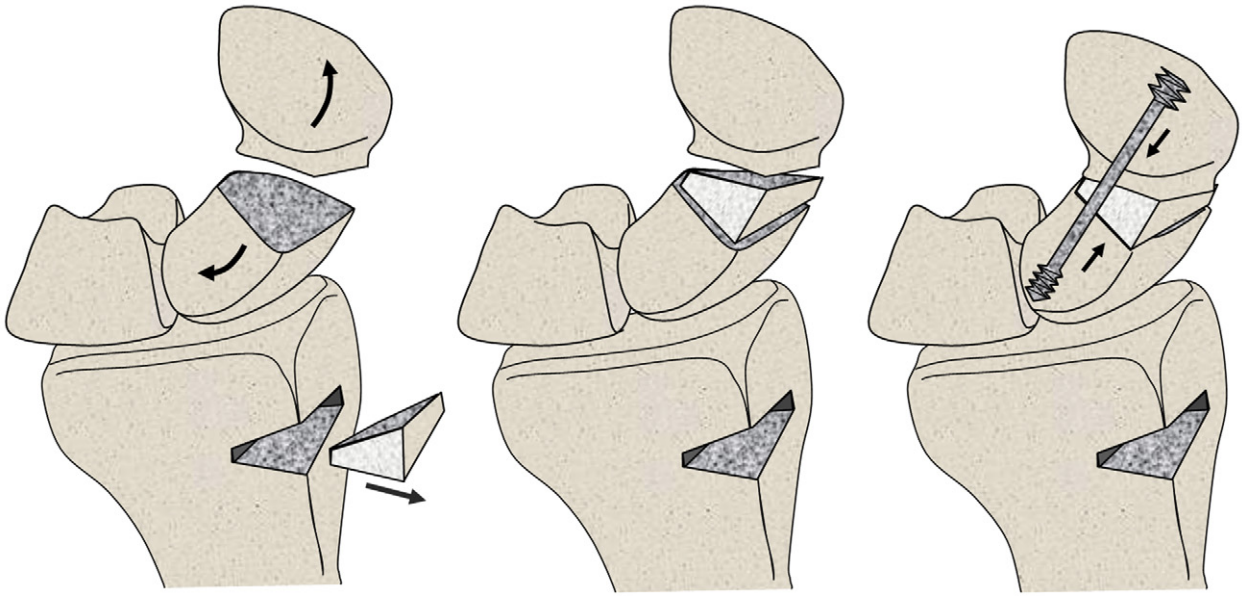

FIGURE 1: Schematic representation of the scaphoid grafting procedure. Once cleared of nonviable bone tissue, the nonunion site is filled with a wedge-shaped graft obtained from the anterolateral corner of the distal radial metaphysis and stabilized with a headless compression screw.

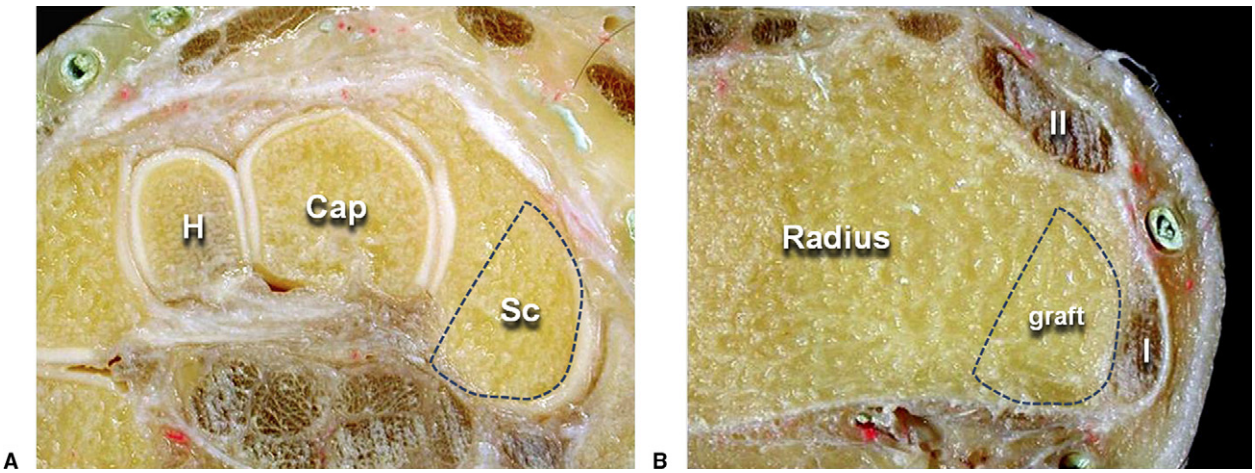

FIGURE 2: Transverse sections of a cadaver arm **A** at the level of the scaphoid waist and **B** the distal radial metaphysis. The dotted lines indicate the similarity in shape and dimensions of the anterolateral border of the scaphoid and those of the distal radial metaphysis at the level of the BR insertion. H, hamate; Cap, capitate; Sc, scaphoid.

recommendation: If the graft is obtained from the anterolateral corner of the distal metaphysis, little trimming of the graft will be necessary to achieve a perfect match with the defect created once the nonunion site has been cleared of nonviable tissue and the 2 scaphoid fragments have been anatomically reduced. Furthermore, the donor site may be covered completely by the distal end of the brachioradialis (BR) tendon and the pronator quadratus (PQ) muscle. The latter will provide a richly vascularized environment, ensuring optimal new bone formation at the donor site.

TECHNIQUE

Most authors advocate approaching the radiocarpal capsule across the flexor carpi radialis (FCR) tendon sheath.[1] However, this creates unnecessary scarring along the FCR tendon and offers suboptimal access to the anterolateral corner of the radius. We believe that a more lateral approach over the trajectory of the radial artery is preferable. A 5-cm-long, longitudinal skin incision, parallel to the FCR tendon and proximal to the palmar crease, is made. The incision is continued dis-

tally in a zigzag fashion up to the level of the trapezium. The superficial forearm fascia is incised longitudinally and the radial artery is identified. After its superficial palmar branch is ligated, the artery is retracted laterally. The deep fascia is released longitudinally, uncovering the lateral insertion of the PQ muscle, which is detached off its lateral insertion and elevated subperiosteally. To uncover the lateral aspect of the radial metaphysis, the volar insertion of the extensor retinaculum is sectioned longitudinally, leaving some tissue for later repair. A small mini-Hohmann retractor is placed under the tendons of the first extensor compartment, protecting both the radial artery and the superficial branches of the radial nerve. With a sharp Beaver blade, the tendon of the BR muscle is detached off the radius, fully uncovering the anterolateral border.

The scaphoid is exposed using the nerve sparing capsulotomy described by Hagert et al.[4] The 2 opposing surfaces of the nonunion site are sliced off with an oscillating saw until healthy bone is observed. The goal is to create 2 flat surfaces of well-vascularized cancellous bone. The Linscheid maneuver is recommended to evaluate the size and shape of the bone defect. Under an image intensifier, the wrist is flexed until the lunate is aligned relative to the distal radius. This position is temporarily blocked with a Kirschner wire entered across the dorsal rim of the radius. The wrist is then extended until the capitate is in neutral alignment relative to the lunate. By placing the wrist in this position, the anterolateral aspect of the scaphoid nonunion opens at an angle that needs to be measured (width, length, and depth); these measurements are used to harvest the graft that will best fit that empty angular space.

At about 2 cm to the tip of the radial styloid, the distal cut is made with an oscillating saw. So as not to cause excessive radial styloid damage, the most distal cut needs to be parallel to the radioscaphoid articular surface. The proximal cut is made, reproducing the shape and dimensions of the previously measured scaphoid defect. The graft is extracted by careful levering maneuvers with a small osteotome (Fig. 3). A slightly oversized corticocancellous graft is preferred. If oversized, it can still be trimmed with a rongeur to perfectly fit the scaphoid defect; if undersized, the scaphoid will not recover its original dimensions. It is important to maximize the contact between the graft and the 2 bone surfaces (Fig. 4). When an optimal fit has been achieved, a Kirschner wire is inserted from distal to proximal, neutralizing the position of the graft between the 2 scaphoid fragments. This wire is advanced until its tip is about to cross the articular surface of the proximal scaphoid. This ensures enough stability

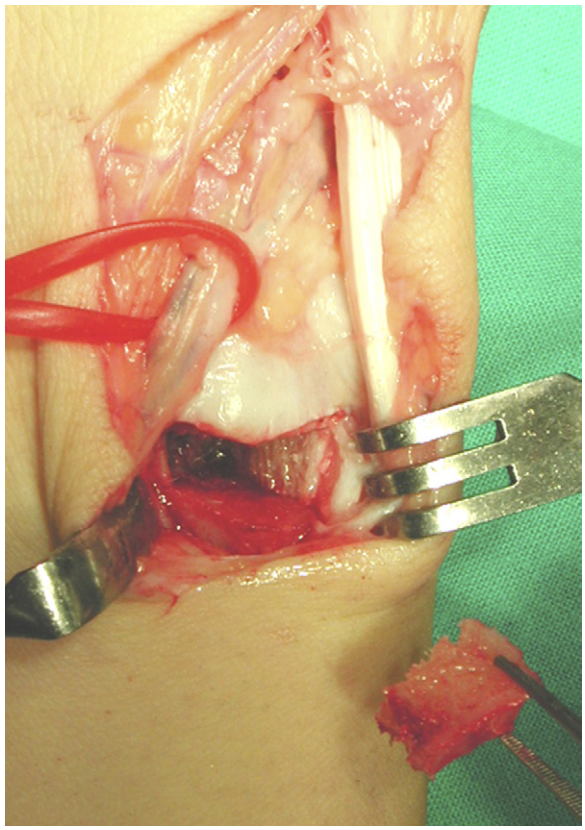

FIGURE 3: Clinical example of a graft obtained from the anterolateral corner of the distal radial metaphysis.

to the scaphoid so that the wire previously inserted in the lunate can be removed. Under fluoroscopy control, a second wire is introduced as close as possible to the main axis of the bone. This wire will be used to guide the insertion of a cannulated headless compression screw. It is important to avoid excessive screw compression that could fracture the intercalated graft and destabilize the construct. If the screw is thought to provide adequate stability to the construct, the first wire can be removed; if not, the wire is left in place until healing is achieved. The donor site defect is finally covered by suturing the origin of the PQ muscle to the most palmar fibers of the BR tendon.

CLINICAL CASE

A 37-year-old, right-handed man presented with dysfunctional pain in the left wrist. Although he could recall no specific trauma, he had experienced intermittent episodes of wrist pain for more than 10 years before seeking medical attention. Clinical examination revealed tenderness at the snuffbox, slight reduction of motion, and decreased grip strength. Plain radiographs showed a middle-third scaphoid nonunion, with sclerotic edges and dorsal intercalated segment instability

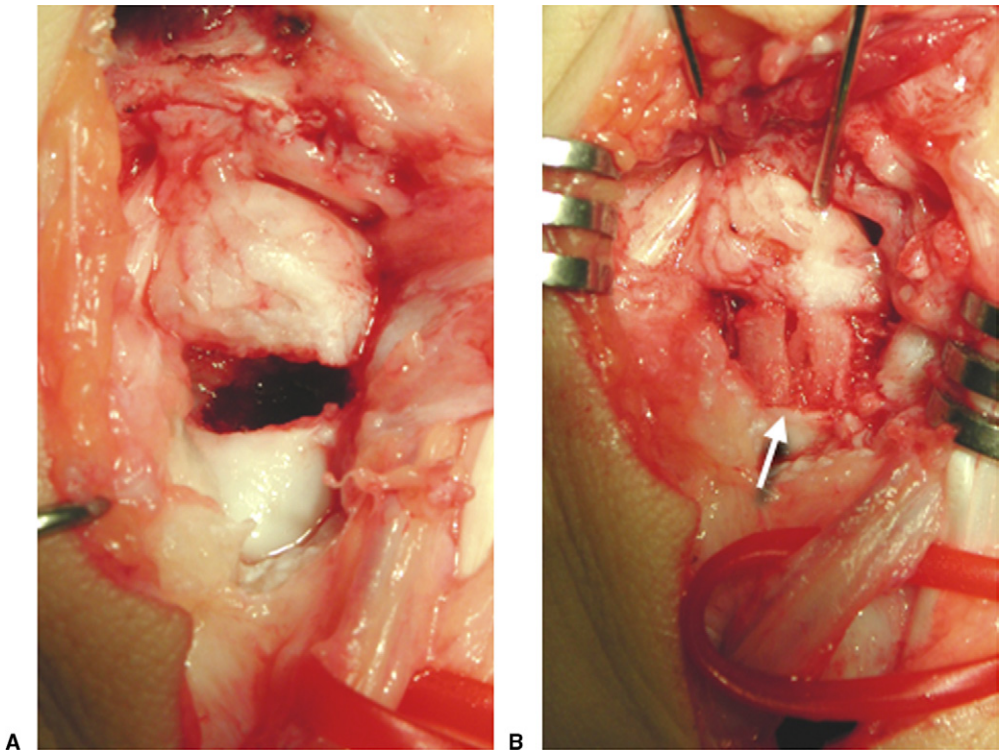

FIGURE 4: Surgical view of a scaphoid nonunion **A** before and **B** after filling the gap with a wedge-shaped corticocancellous graft (arrow) from the distal radial metaphysis.

FIGURE 5: Middle-third nonunion of the left scaphoid. **A** Posteroanterior view obtained before surgery, showing sclerotic borders at the nonunion site and slight sharpening of the radial styloid. **B** At 1 year after surgery, the scaphoid has healed and the donor site appears fully remodeled.

deformity (Fig. 5A). Gadolinium-enhanced magnetic resonance imaging showed good vascularity of the proximal pole.

At surgery, the nonunion was found to be unstable and both surfaces had areas of eburnated bone. After clearing the nonunion site of all nonviable tissue and

creating 2 flat surfaces of well-vascularized cancellous bone, we corrected the flexion deformity using the method described above. We obtained a corticocancellous graft matching the shape and dimensions of the defect from the anterolateral corner of the distal radius and inserted it in the nonunion site with a provisional Kirschner wire, followed by solid bone fixation with a cannulated headless screw. Owing to the presence of degenerative changes at the radial styloid level, we added a small styloidectomy to the procedure.

The patient was immobilized for a total of 2 months, with a protective splint for another month. Radiographs taken at 3 months showed signs of healing, with partial healing of the donor site defect. One year later, satisfactory restoration of both the scaphoid and the donor site was present (Fig. 5B). The patient, who had resumed his former occupation without limitations, regained full function of that wrist.

PEARLS AND PITFALLS

As stated above, the best location to obtain a graft with optimal cancellous bone and thin cortices is under the distal insertion of the BR tendon, 2 to 3 cm proximal to the radial styloid. Removing the graft distal to that point is not recommended because the gap would be too close to the ulnarly inclined radioscaphoid joint, which results in higher risk of a radial styloid fracture. To avoid excessive weakening of this zone, the distal cut should be parallel to the articular surface of the radius, and the wrist should be immobilized to facilitate bone ingrowth in the defect.

A key point of the technique is precise shaping of the graft to fit the scaphoid defect. A good indicator is when the graft fits so tightly in the defect that even without the screw, the wrist can be mobilized passively without destabilizing the construct.

COMPLICATIONS

We have observed no major complications as a result of having obtained our grafts from the anterolateral corner of the radial metaphysis. The hypothetical increased risk of fracture has never materialized, probably because the postoperative immobilization is long enough to allow the radial defect to heal in these cases.

REFERENCES

1. Kawamura K, Chung KC. Treatment of scaphoid fractures and nonunions. J Hand Surg 2008;33A:988–997.
2. Tambe AD, Cutler L, Murali SR, Trail IA, Stanley JK. In scaphoid nonunion, does the source of graft affect outcome? Iliac crest versus distal end of radius bone graft. J Hand Surg 2006;31B:47–51.
3. Jarrett P, Kinzel V, Stoffel K. A biomechanical comparison of scaphoid fixation with bone grafting using iliac bone or distal radius bone. J Hand Surg 2007;32A:1367–1373.
4. Hagert E, Ferreres A, Garcia-Elias M. Nerve-sparing dorsal and volar approaches to the radiocarpal joint. J Hand Surg 2010;35A:1070–1074.