SCIENTIFIC ARTICLE

Comparison of Percutaneous Dorsal Versus Volar Fixation of Scaphoid Waist Fractures Using a Computer Model in Cadavers

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Purpose Percutaneous screw fixation (PSF) is widely used to treat acute nondisplaced scaphoid waist fractures. PSF can be performed through a volar or dorsal approach. The aim of our study was to compare a dorsal versus volar surgical approach for PSF according to the sagittal orientation of the waist fracture (B1 or B2 in Herbert and Fisher's classification scheme, in which B1 and B2 designate, respectively, oblique and transverse nondisplaced scaphoid waist fractures) on computer modeling of cadaver wrists.

Methods We used 12 upper limbs, and for each wrist we performed 3 computed tomography scans in maximal flexion, neutral position, and maximal extension. For each position, a parasagittal slice corresponding to the plane of ideal screw placement was obtained by numerical reconstruction. On each slice, we modeled B1- and B2-type fractures and the placement of the corresponding screws (S1 and S2) inserted through a volar or dorsal approach. Optimal screw orientation was perpendicular to the fracture. For each configuration, we measured the angle between the S1 screw and B1 fracture, which we designated V1 when modeling volar PSF and D1 when modeling dorsal PSF. Similarly, we measured angles V2 and D2.

Results For B2 fractures, virtual screw placement perpendicular to the fracture was achieved equally well with the 2 approaches. For B1 fractures, the virtual screw could not be placed perpendicular to the fracture with either approach, but the dorsal approach with maximal wrist flexion allowed the best screw placement.

Conclusions For B2 fractures, the dorsal and volar approaches allow optimal virtual screw placement, and the choice of the approach depends on the surgeon's preference. For B1 fractures, we recommend the dorsal approach. *(J Hand Surg 2009;34A:1838–1844. Copyright © 2009 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Scaphoid fractures, percutaneous screw fixation.

The scaphoid is the most frequently fractured carpal bone. The annual incidence of scaphoid fracture has been estimated at 43 fractures per 100,000 people,[1] 8 in 100,000 in women, and 38 in 100,000 in men.[2] Most scaphoid fractures are not displaced and involve the scaphoid waist.[3]

Acute nondisplaced fractures of the scaphoid waist can be treated either with cast immobilization or with

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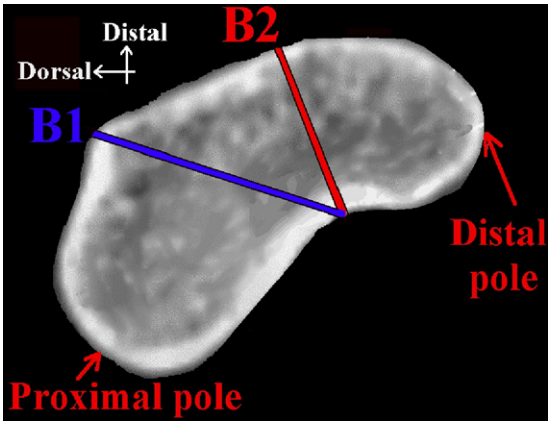

FIGURE 1: Aspect of the scaphoid after reconstruction of the parasagittal slice. Modeling of B1- and B2-type fractures (according to Herbert and Fisher[4]) is shown.

percutaneous screw fixation (PSF). Scaphoid fractures are generally described using Herbert and Fisher's classification scheme,[4,5] in which B1 and B2 designate, respectively, oblique and transverse nondisplaced scaphoid-waist fractures that are good indications for PSF, as explained by Haisman et al.[5] Because of the lack of fracture displacement, no reduction requiring wrist opening is necessary. Moreover, the location of the fracture at the level of the waist allows good fixation of the screw in both the proximal and distal poles. B1 and B2 fractures differ regarding their sagittal orientation (Fig. 1). The screw must be as perpendicular as possible to the fracture to induce maximal compression forces and minimal shearing forces, thereby optimizing the stability of the fixation.[6] Compression loading is an important factor for bone healing.[7–10]

Percutaneous screw fixation for scaphoid-waist fractures can be performed through a volar approach[11–16] or through a dorsal approach.[17–19] Final screw placement in the scaphoid is determined by the entry point and orientation of the screw, which in turn depend on the shape of the scaphoid and on the neighboring bones (radius and trapezium). With the dorsal approach, access to the tip of the proximal pole, and, therefore, optimal screw orientation, are impeded by the posterior margin of the distal radius unless the wrist is flexed maximally. With the volar approach, the trapezium hinders access to the tubercle and optimal orientation of the screw,[20,21] requiring either maximal wrist extension[11–13] or the use of finger traps to hold the wrist in neutral position.[14–16] Thus, PSF for acute nondisplaced scaphoid waist fractures can be done via the dorsal approach with the wrist in maximal flexion, via the volar approach with the wrist in neutral position, or via the volar approach with the wrist in maximal extension.

The objective of this cadaver study was to compare a dorsal versus volar surgical approach, in terms of screw placement, according to the sagittal orientation of acute nondisplaced scaphoid-waist fractures on computer modeling of cadaver wrists.

MATERIALS AND METHODS

Materials

We used 12 upper limbs from fresh-frozen cadavers thawed 24 hours before the study. Of the 12 wrists used in this study, 7 were male and 5 were female. The mean age was 75 years (range, 68–89 years). The humerus was cut at the midshaft and all soft tissues were preserved. Each limb was assessed clinically and by anteroposterior and lateral fluoroscopy of the wrist to rule out previous trauma or surgery, as well as anatomic abnormalities.

Methods

Computed tomography (CT) of each wrist was performed in maximal flexion, neutral position (without radial or ulnar inclination), and maximal extension. An external fixator (Hoffman 2; Stryker, Kalamazoo, MI) maintained each position with pins implanted in the index finger metacarpal and radius. Additional pins were placed in the ulna and the humerus to immobilize the forearm in neutral rotation and the elbow at 90° flexion. For each wrist, the angles of maximal flexion and extension were measured using a goniometer placed on the dorsal side of the radius and third metacarpal. We used a 16-multidetector computerized scanner (Sensation 16; Siemens Medical Solutions, Munich, Germany). Three orthopedic surgeons participated in the study. Each surgeon performed reconstructions and measurements for all CT scans.

Reconstruction protocol

We performed multiplanar reconstructions, image analyses, and measurements using Carestream PACS 10.1 software (Kodak Carestream Health, Rochester, NY). The aim was to build a parasagittal slice of the scaphoid in the plane where an optimally placed screw would be located. We used the optimal screw-placement criteria developed by Menapace et al.[22] The parasagittal slice was obtained using a 2-step procedure, as shown in Figure 2. First, a slice parallel to the lunate surface of the scaphoid was built. Second, this slice was rotated to pass through the center of the proximal pole and tubercle of the scaphoid. The Carestream PACS 10.1 software allowed us to perform real-time 2-dimensional reconstruction with interactive windows. We started from the frontal reconstruc-