Volar Percutaneous Screw Fixation of the Scaphoid: A Cadaveric Study

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Purpose To test the efficacy of a previously described technique of angiocatheter-assisted instrument positioning in achieving a central screw position in a cadaveric model for volar percutaneous screw fixation (PSF) of the scaphoid and to quantify the damage to surrounding soft tissue and articular cartilage associated with the procedure.

Methods We performed fluoroscopically guided volar PSF of the scaphoid on 10 fresh cadaveric wrists. We then dissected the specimens, analyzed screw position in cross sections of the scaphoid, and described injury to nearby soft tissue structures as well as articular cartilage of the scaphotrapezial joint.

Results All 10 screws were positioned within the central third of the scaphoid on at least 2 of 3 cross sections, and 8 of 10 screws were positioned within the central third of the proximal pole. Two wrists required a transtrapezial trajectory for satisfactory screw positioning. None of the specimens sustained visible neurovascular damage, and 2 wrists revealed minor tendon damage. Trajectories involving the scaphotrapezial joint violated, on average, 7% of the scaphoid articular cartilage. With a transtrapezial trajectory, 11% of the trapezial cartilage was violated

Conclusions Central positioning of the screw is biomechanically superior, and screw position within the central one third of the proximal pole has been associated with faster time to union. Volar PSF achieved satisfactory screw position in the scaphoid. The majority of wrists were amenable to PSF via the scaphotrapezial joint, though a transtrapezial approach was a viable alternative for wrists with restrictive anatomy. Both approaches minimally disrupted the scaphotrapezial joint and surrounding soft tissues. *(J Hand Surg Am. 2014;39(5):867–871.*

Type of study/level of evidence Therapeutic IV.

Key words Percutaneous screw fixation, scaphoid fracture, volar approach.

Percutaneous screw fixation (PSF) is a popular treatment for nondisplaced or percutaneously reducible scaphoid waist fractures. Both dorsal and volar approaches for PSF of the scaphoid have been described. The starting point for the dorsal approach is the scapholunate joint, and either the scaphotrapezial joint or the transtrapezial method is used for the volar approach.[1]

An anatomical study of dorsal PSF suggests that the procedure places nearby structures at risk, namely the extensor digitorum communis to the index finger, the extensor indicis proprius, and the posterior interosseous nerve.[2] A volar approach eliminates the risk of injury to these structures; however, it potentially puts the palmar branch of the radial artery, main radial artery, superficial radial nerve, recurrent branch of the median nerve, and palmar branch of the median nerve at risk.[3] In addition to the risk to surrounding soft tissue structures, there is an undefined amount of articular damage to the radioscaphoid joint or the scaphotrapezial joint from the respective approaches.

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The long-term effect on the articular cartilage is unknown, although volar PSF does not seem to cause symptomatic arthritis in the short to medium term.[4]

Obtaining an optimal scaphoid starting point and axis with the volar approach is often hindered by the trapezium abutting the intended trajectory through the scaphotrapezial joint. A volar PSF technique has recently been described that uses an angiocatheter guide to lever the trapezium ulnarly, potentially allowing for a more central starting point on the distal pole of the scaphoid.[5] The computer simulation and cadaveric studies to date do not take into account the mobility of the trapezium in the simulation models.[6–8]

We aimed to test the effectiveness of the previously described technique[5] in achieving a central screw position for PSF of the scaphoid. In addition, we describe the compromise to nearby soft tissue structures and quantify the damage to the articular surfaces from the volar approach for PSF of the scaphoid.

METHODS

Five whole fresh cadavers (10 wrists) were used in the study. We performed fluoroscopically guided percutaneous screw fixation of the scaphoid using the volar approach described previously.[5] Mini C-arm fluoroscopy was used with the wrist held on the image intensifier in supination, extension, and ulnar deviation by an assistant during screw placement. Screw position was checked on anteroposterior, lateral, and 45° pronated views. The Acutrak Mini (Acumed; Hillsboro, OR) headless compression screw system was used in each specimen, and the screw was placed in accordance with the procedure described in the technique guide.

A 14-gauge angiocatheter cannula was used to percutaneously enter the radial-volar aspect of the scaphotrapezial joint and lever the trapezium in an ulnar-dorsal direction. The bevel of the needle was inserted facing outward, then rotated 180° once in the joint in order to attain a more central starting point. The target starting point was the scaphoid tubercle, although the actual starting point varied on each scaphoid in order to achieve a more central trajectory. The tip of the needle was embedded in the scaphoid to allow a greater leverage force on the trapezium, thus facilitating an optimal trajectory that coincided with the central axis on anteroposterior, lateral, and pronated views. The screw was placed in a transtrapezial fashion in specimens where an adequate starting point or trajectory could not be attained owing to the morphology of the scaphoid or lack of trapezial mobility in response to the angiocatheter leverage maneuver.

After screw placement, dissection was carried out in layers from superficial to deep, and damage was noted to any neurovascular or tendinous structures. The violated structures were measured with a millimeter gauge ruler and expressed as the width of the damaged segment compared with the width of the overall structure.

The scaphoid was then excised. Digital photographs were taken of the scaphoid and trapezial surfaces of the scaphotrapezial joint. Adobe Photoshop CS3 was used to outline the violated cartilage and the intact cartilage and then to calculate the pixel area of each. Articular violation was expressed as a percentage of cartilage damage in relation to the intact scaphoid or trapezial articular surface, thus eliminating the variance of absolute surface area measurements, which would vary with the distance of the specimen from the camera. The screw was removed from the scaphoid. The bone was measured with a millimeter gauge ruler, marked at 3 equidistant points along its longitudinal axis, and then sectioned with a fine bow saw to create 4 quarter-sections of bone perpendicular to the longitudinal axis. Each section was photographed (Fig. 1). Photoshop was used to measure the eccentricity of the screw path (expressed as the percentage deviation from the center of the section in relation to the length and width of the section) at each cross-sectional cut, corresponding to the proximal pole, waist, and distal pole.

RESULTS

All specimens demonstrated normal wrist anatomy, without apparent post-traumatic or degenerative changes. We were able to achieve percutaneous screw fixation with the volar approach in all 10 wrists (maximum number of guidewire passes was 5) without screw prominence in either the scaphotrapezial or the radioscaphoid joint. Eight of the wrists underwent screw placement with a scaphotrapezial starting point, and 2 of the wrists required a transtrapezial trajectory to attain a central position in the scaphoid. These 2 wrists were from separate cadavers.

Screw position

Cross-sectional analysis of screw position within the distal pole, waist, and proximal pole of the excised scaphoids is shown diagrammatically in Figure 2. Screw eccentricity greater than 33% from the center was present in the proximal pole in 2 scaphoids, the waist in 3 scaphoids, and the distal pole in 4 scaphoids. None of the screw trajectories demonstrated