Scaphoid fracture angle – three dimensional analysis of fracture morphology

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Purpose: Knowing the morphology of any fracture, including scaphoid fractures, is important in order to determine the fracture stability and the appropriate fixation technique. Scaphoid fractures are classified according to their radiographic appearance, and simple transverse waist fractures are considered the most common. There is no description in the literature of the 3Dimensional morphology of scaphoid fractures. Our hypothesis was that most scaphoid fractures are not perpendicular to its long axis, i.e. they are not simple transverse fractures.

Methods: A 3Dimensional analysis was performed of CT scans of acute scaphoid fractures, conducted at two medical centers during a period of 6 years. A total of 124 scans were analyzed (Amira Dev 5.3, Visage Imaging Inc). Thirty of the fractures were displaced and virtually reduced. Anatomical landmarks were marked on the distal radius articular surface in order to orient the scaphoid in the wrist. Shape analysis of the scaphoids and a calculation of the best fitted planes to the fracture s were carried out implementing principal component analysis (Figure 1). The angles between the scaphoid's first principal

(a) A surface model of a scaphoid and the fracture plane (black surface). The green line represents the first principal axis. The two landmarks marked on the articulating plane are used to calculate the palmar-dorsal direction. (b) An isosurface model of the hand region. The scaphoid bone and the fracture plane are segmented
axis to the fracture plane, articular plane and to the palmar-dorsal direction were measured. The fractures were analyzed both for location (proximal, waist and distal) and for displacement.

**Results:** There were 86 fractures of the waist (76 percent), 13 of the distal third and 25 of the proximal third. The average angle between the first principal axis of the scaphoid and the fracture plane was 52.6 degrees (SD 17) for all fractures, 55.6 degrees (SD 17.2) for the waist fractures, both differing significantly from a right angle (p<0.00001). The majority of fractures were found to be horizontal oblique. We found no difference between the angles of the waist fractures which were displaced and those that were not displaced. In contrast, a significant difference was found between the displaced and non-displaced fractures when evaluating the orientation of the scaphoid long axis in relation to the articular plane (139.8 degrees with reduction vs 148.2 without; p=0.036)

**Conclusions:** Most waist fractures were found to be horizontal oblique in relation to the long axis of the scaphoid and not transverse. Although the fracture angle could not explain displacement of the fracture, we found that the orientation of the scaphoid's long axis in relation to the radial articular surface was correlated with fracture displacement. According to these findings, fixation of all fractures along the long axis of the scaphoid should not be the optimal mode of fixation. Optimal fixation of acute scaphoid fractures may call for better analysis of each fracture configuration and the fixation should be guided by this analysis.

**References**


