SCIENTIFIC ARTICLE

3-Dimensional Analysis of Scaphoid Fracture Angle Morphology

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Purpose Scaphoid fractures are classified according to their 2-dimensional radiographic appearance, and transverse waist fractures are considered the most common. Our hypothesis was that most scaphoid fractures are not perpendicular to the longitudinal axis of the scaphoid (ie, not transverse).

Methods Computerized 3-dimensional analyses were performed on 124 computed tomography scans of acute scaphoid fractures. Thirty of the fractures were displaced and virtually reduced. The angle between the scaphoid's first principal axis (longitudinal axis) and the fracture plane was analyzed for location and displacement. The distal radius articular surface was used to depict the volar–dorsal vector of the wrist.

Results There were 86 fractures of the waist, 13 of the distal third, and 25 of the proximal third. The average angle between the scaphoid longitudinal axis and the fracture plane was 53° for all fractures and 56° for waist fractures, both differing significantly from a 90°, transverse fracture. The majority of fracture planes were found to have a volar distal to dorsal proximal (horizontal oblique) inclination relative to the volar–dorsal vector.

Conclusions Most waist fractures were horizontal oblique and not transverse. According to these findings, fixation of all fractures along the longitudinal axis of the scaphoid may not be the optimal mode of fixation for most. A different approach may be needed in accordance with the fracture plane. *(J Hand Surg Am. 2015;40(3):508–514.*

Type of study/level of evidence Diagnostic II.

Key words Scaphoid fracture, principal component analysis, fracture morphology, longitudinal axis, wrist fracture.

Lack of proper immobilization or displacement of scaphoid fractures commonly results in nonunion or malunion followed by the development of posttraumatic arthritis.[1,2]

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The common classification of these fractures includes the assessment of the fracture's stability.[3,4] A vertical oblique fracture, which is parallel to the forces acting on the scaphoid, is considered the most unstable.[4,5] Transverse waist fractures, which are considered the most common,[3,4,6] may be unstable because of their relationship to these forces.[3,4] Due to the complex 3-dimensional morphology of the scaphoid, the description of these fractures has been limited, based mainly on radiographs.[4,5] Russe's differentiation into transverse or oblique fractures refers to the relationship between the long axis of the scaphoid and the fracture line on the radiographic dorsovolar view.[4]

We have observed that most waist fractures are not transverse but have some obliquity to them. To

FIGURE 1: Imaging studies of the left wrist of a 19-year-old. The scaphoid fracture was diagnosed a month after the accident. Posteroanterior **A** and lateral **B** radiographs reveal an undisplaced transverse waist fracture. **C**, **D** Coronal and sagittal CT scan reconstructions are compatible with this description of the fracture.

examine this and accurately measure the fracture angle, the longitudinal axis of the scaphoid should be used. The description of the longitudinal axis of the scaphoid using precise methods has been described only recently.[7] The plane of a transverse fracture would then be 90° to this axis.

The study objective was to determine the angle and inclination of scaphoid fractures in relation to the longitudinal axis of the scaphoid. With these data, we examined a possible association between displacement of a fracture and its location and inclination. Our hypothesis was that the majority of scaphoid fractures are not transverse.

MATERIALS AND METHODS

The radiology department archives were searched for computed tomography (CT) scans of wrists with scaphoid fractures taken between 2005 and 2011, as diagnosed by a radiologist (Fig. 1). No additional examinations were performed and the original scans, with no variations, were used. In our practice, all scaphoid fractures are routinely evaluated with a CT scan. The minimal resolution for the scans was 0.3 × 0.3 mm and 1-mm slice thickness. Institutional ethics committee approval was obtained.

All patients between 18 and 60 years old with scaphoid fractures less than 6 weeks old were included,