CT Scans Oriented Along the Longitudinal Scaphoid Axis Do Not Change Surgical Management of Scaphoid Fractures

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Introduction

It is imperative that the correct patients with scaphoid fractures to offer surgery to be identified, as some scaphoid fractures can be managed non-operatively.[1] CT scans can be useful because they allow surgeons to make precise measurements. For example, CT scans can be used to measure whether >1mm of displacement is present, which is often a surgical indcation.[2,3] CT scans are more accurate than plain radiographs in determining the degree of fracture displacement[4,5]but operative treatment is being offered with greater frequency to active patients as an approach to reduce the period of cast immobilization. Computed tomography is more useful for evaluating displacement than standard radiography. Displaced fractures are at greater risk for nonunion and malunion-both of which have been associated with the development of radiocarpal arthritis in long-term studies–and should therefore be treated operatively. Surgical treatment is also recommended for complex fractures (open fractures, perilunate fracture-dislocations, and scaphoid fractures associated with fracture of the distal radius and can also be used to make more specialized measurements such as height-to-length ratios and intra-scaphoid angles[3,6]

Reformatting CT scans along the long axis of the scaphoid improves the detection of scaphoid fractures.[7] However, it is unclear whether these reformats affect the clinical decision to perform open reduction internal fixation (ORIF). Our null hypothesis was that assessing scaphoid fractures in the longitudinal scaphoid axis would not lead to different surgical recommendations than those from those made from the wrist axis.

Methods

After obtaining IRB-approval, we retrospectively identified 30 patients using an online database (Montage Healthcare Solutions, Nuance Communications Inc.) of radiology reports with acute scaphoid fractures. All enrolled patients were identified from one institution. All identified CT scans were removed of patient identifiers. Each CT scan was then re-formatted along the longitudinal axis of the scaphoid using the TeraRecon™ software system. These reformats were then compared against the wrist axis CT scans.

The anonymized scaphoid axis and wrist axis CT scans were evaluated by two musculoskeletal radiologists and two board certified orthopedic hand surgeons. Each specialist independently read the CT scans in a random, blinded fashion. On each CT scan, the following measurements were made: fracture gap, displacement of articular surface, intrascaphoid angle, and height-to-length ratio.[8,9] To assess our null hypothesis, each scaphoid CT was assigned a designation of "Requires Surgery" if any one of the following cutoffs was met: fracture gap >1mm, articular displacement >1mm, intrascaphoid angle >35, or height-to-length ratio >0.65.[9,10] The determination of surgery based on wrist versus scaphoid axes was then compared using McNemar's test and a p value was calculated.

Results

87% of the fractures evaluated resulted in the same surgical recommendations on both the scaphoid and wrist axis, while 13% resulted in discordant surgical recommendations. To determine whether these differences were statistically significant, the McNemar's test was used. A two-tailed p value of 0.21 was obtained, demonstrating no statistical significance.

Discussion

We failed to reject our null hypothesis that reformatting CT scans along the scaphoid axis would lead to different surgical recommendations. We used very specific cutoffs to determine which patients would be offered surgery and we acknowledge that not all hand surgeons would ascribe to these exact parameters. However, demonstrating that measurements of scaphoid fracture displacement and deformity do not differ depending on CT formatting is important. While exact cutoffs for individual surgeons may differ, our study indicates that the measurements are not affected.

There are several limitations to this study. Chief among these limitations is that we analyzed only thirty scaphoid fractures, which makes our study prone to a type II error, especially given that no differences were found.

Additionally, making the above measurements of displacement and deformity are also subject to variability based on the clinician making the

Table 1. Surgical Assignments Based on Wrist and Scaphoid Axes for all Fractures

	Requires Surgery based on Wrist Axis	Does not Require Surgery based on Wrist Axis
Requires Surgery based on Scaphoid Axis	103 (86%)	5 (4%)
Does not Require Surgery based on Scaphoid Axis	11 (9%)	1 (1%)

measurements and which specific CT slice they choose. More studies are needed to determine the best technique or CT slice for making these measurements.

References

1. Ibrahim T, Qureshi A, Sutton AJ, *et al*. Surgical Versus Nonsurgical Treatment of Acute Minimally Displaced and Undisplaced Scaphoid Waist Fractures: Pairwise and Network Meta-Analyses of Randomized Controlled Trials. *J Hand Surg Am.* 2011;36(11):1759-1768.e1. doi:10.1016/j.jhsa.2011.08.033.

2. Inagaki H, Nakamura R, Horii E, *et al.* Differences in radiographic findings between scaphoid fracture patterns. *Hand Surg.* 2004;9(2):197-202. http://www.ncbi.nlm.nih.gov/pubmed/15810106. Accessed August 14, 2017.

3. Bain GI, Bennett JD, MacDermid JC, *et al*. Measurement of the scaphoid humpback deformity using longitudinal computed tomography: Intra- and interobserver variability using various measurement techniques. *J Hand Surg Am.* 1998;23(1):76-81. doi:10.1016/S0363-5023(98)80093-2.

4. Ring D, Jupiter JB, Herndon JH. Acute fractures of the scaphoid. *J Am Acad Orthop Surg.* 8(4):225-231. http://www.ncbi.nlm.nih.gov/pubmed/10951111. Accessed August 11, 2017.

5. Gilley E, Puri SK, Hearns KA, *et al*. Importance of Computed Tomography in Determining Displacement in Scaphoid Fractures. *J Wrist Surg.* July 2017. doi:10.1055/S-0037-1604136.

6. ten Berg PWL, Dobbe JGG, Strackee SD, *et al*. Quantifying Scaphoid Malalignment Based Upon Height-to-Length Ratios Obtained by 3-Dimensional Computed Tomography. *J Hand Surg Am.* 2015;40(1):67-73. doi:10.1016/j.jhsa.2014.10.037.

7. Mallee WH, Doornberg JN, Ring D, *et al.* Computed tomography for suspected scaphoid fractures: comparison of reformations in the plane of the wrist versus the long axis of the scaphoid. *Hand (N Y).* 2014;9(1):117-121. doi:10.1007/s11552-013-9556-z.

8. Amadio PC, Berquist TH, Smith DK, *et al.* Scaphoid malunion. *J Hand Surg Am.* 1989;14(4):679-687. doi:10.1016/0363-5023(89)90191-3.

9. Cheema A, Niziolek P, Kneeland B, *et. al*. Height-to-Length Ratios to Assess Flexion Deformity in Scaphoid Fractures - a Comparison of Measurement Techniques. *Univ Pennsylvania Orthop J.* 2017;27:43-44. http://upoj.org/wp-content/uploads/v27/043_Cheema.pdf. Accessed August 11, 2017.

10. Gupta V, Rijal L, Jawed A. Managing scaphoid fractures. How we do it? *J Clin Orthop trauma.* 2013;4(1):3-10. doi:10.1016/j.jcot.2013.01.009.