Computed Tomography for Triage of Suspected Scaphoid Fractures

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Abstract The use of computed tomography (CT) to triage suspected scaphoid fractures is appealing because it is more readily available and less expensive than magnetic resonance imaging (MRI). Twenty-eight patients with suspected scaphoid fractures (defined as tenderness in the area of the scaphoid and initial scaphoid-specific radiographs interpreted as normal) were enrolled in a prospective protocol evaluating triage with CT. Twenty patients reached an endpoint consisting of either (1) identification of a fracture accounting for the patient's symptoms on CT or (2) normal radiographs 6 weeks or more from the time of injury. Only 2 of 28 patients (7%) were diagnosed with a nondisplaced fracture of the scaphoid waist. CT revealed an avulsion fracture of the distal pole of the scaphoid in two patients, nondisplaced fractures of the distal radius in six patients, and nondisplaced fractures of other carpal bones in four patients. Radiographs of the scaphoid taken 6 weeks or greater from the time of injury were interpreted as normal in the six patients with normal CT scans that completed the study. True scaphoid waist fractures are uncommon among patients with suspected scaphoid fractures. CT scans are useful for triage of suspected scaphoid waist fractures because alternative, less-troublesome fractures were identified in 43% of patients and no fractures were missed or undertreated. Immediate triage of suspected scaphoid

fractures using CT in the emergency room has the potential to reduce unnecessary immobilization and diminish overall costs associated with treatment.

Keywords Suspected scaphoid fracture •
Computed tomography

Introduction

A suspected scaphoid fracture may be defined as posttraumatic tenderness of the scaphoid with radiographs of the wrist including specific scaphoid views that are interpreted as normal. Proposed methods for the triage of suspected scaphoid fractures include repeat physical examination and radiographs 2 weeks after initial presentation, bone scans, and magnetic resonance imaging (MRI) [3, 4, 9]. Serial examination and bone scans require a delay that can result in unnecessary immobilization. MRI is not readily available in most centers and is relatively expensive. The use of CT for the triage of suspected scaphoid fractures is appealing because it is available in most emergency departments and it is less expensive than MRI.

We evaluated the use of CT scanning for the triage of suspected scaphoid fractures in a prospective cohort study.

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Methods

A protocol for using computed tomography (CT) to triage patients with suspected scaphoid fractures was approved by our human research committee. Inclusion criteria were: (1) skeletal maturity; (2) posttraumatic radial-sided wrist pain and tenderness of the scaphoid after a fall on the outstretched hand; and (3) radiographs of the wrist and

scaphoid interpreted as normal. Tenderness of the scaphoid was defined by either tenderness on direct palpation of the distal pole at the volar wrist or tenderness in the anatomic snuffbox, or patient with axial thumb compression [6]. CT was performed in planes defined by the long axis of the scaphoid [1, 24]. As in other studies of diagnostic methods for the triage of suspected scaphoid fractures, radiographs obtained 6 weeks or greater after injury were used as the gold standard for the presence or absence of a scaphoid fracture [2, 11, 21, 22, 27, 29]. We evaluated the diagnostic characteristics (sensitivity, specificity, accuracy, and positive and negative predictive values) of CT for suspected scaphoid fractures in a separate study using the data from this study and from another study involving CT of non-displaced scaphoid fractures [1]. The current study evaluated the overall clinical utility of the use of CT (taking into account the diagnosis of other injuries, and the ultimate patient outcomes) in a prospective cohort of patients with suspected scaphoid fractures.

Thirty patients gave informed consent and were enrolled. Ten patients declined completion of the protocol; two before their CT, and eight after a normal CT but before their scheduled 6-week follow-up radiographs. Among the 28 patients that were evaluated with CT, there were 14 men and 14 women with an average age of 36 years (range 17 to 69 years). The left wrist was involved in 16 patients and the right wrist was involved in 12 patients.

Twenty patients reached an endpoint consisting of either (1) identification of a fracture accounting for the patient's symptoms on CT or (2) normal radiographs 6 weeks or more from the time of injury. There were 12 men and 8 women with an average age of 40 years (range 21 to 69 years). The left wrist was involved in 12 patients and the right wrist was involved in 8 patients.

CT scans were obtained using the G.E. Lightspeed Qx/i CT Scanner (GE Medical Systems, Pewaukee, WI, USA) by means of the method described by Sanders [24, 25]. As depicted in this technique, the patient is positioned prone on the table with the arm placed overhead and the forearm crossing the gantry of the CT unit at a 45° angle. The hand is placed flat on the table with the wrist in neutral flexion and neutral radial–ulnar deviation. Scout images are obtained to ensure that the scanning plane corresponds with the long axis of the scaphoid. Sagittal plane images of the scaphoid, defined as scans that provide a lateral view of the scaphoid bone according to the central longitudinal axis of the scaphoid, are obtained in this fashion (Fig. 1). To obtain coronal plane images, defined as images that provide a posteroanterior view of the scaphoid in the anatomic plane in line with the axis of the scaphoid, the forearm is supinated 90° with the wrist held in a neutral position. Images of 1.2 mm thickness and 1.2 mm spacing between images with no overlap were obtained.

Figure 1 Fractures that are subtle on radiographs are also subtle on CT. This sagittal CT image shows a distinct, but incomplete fracture (arrow) that was seen on all cuts.

Results

Of the 28 patients who had CT scans performed, CT showed a nondisplaced fracture of the scaphoid waist in 2 patients (7%) (Fig. 1). These were confirmed on radiographs obtained 6 weeks or greater from the time of injury. CT revealed small fractures of the distal pole of the scaphoid in two patients, nondisplaced fractures of the distal radius in six patients, and fractures of the other carpal bones in four patients (two trapezium fractures, one capitate fracture, and one triquetrum fracture) (Figs. 2 and 3).

CT was normal in 14 patients. Eight of the 14 patients with normal CT scans failed to return for additional imaging studies and withdrew from the study. Radiographs of the

Figure 2 This coronal CT image shows an example of an alternative injury—a small avulsion of the trapezium (white arrow) and a line that can be confused with a scaphoid fracture (black arrow). The scaphoid line does not cross the cortices and was not seen on other cuts.

Figure 3 This coronal CT image shows an example of a nondisplaced intraarticular fracture of the distal radius (*arrow*).

scaphoid taken 6 weeks or greater from the time of injury were interpreted as normal in the six patients with normal CT scans that completed the study.

Discussion

The evaluation of a patient with a suspected scaphoid fracture has received substantial attention. If not adequately protected, occult scaphoid waist fractures may go on to delayed union or nonunion [7, 8, 15, 23]. Given these consequences, patients whose presentation and examination are suspicious for fracture of the scaphoid are usually managed cautiously with immobilization of the wrist and thumb, serial examination, and further diagnostic imaging.

Our study is consistent with prior studies in finding that the rate of true scaphoid waist fractures in a population suspected of having a scaphoid waist fracture is less than 10% [1, 16, 17, 19, 28]. This suggests that we are subjecting large numbers of patients to overtreatment, resulting in unnecessary costs, including time lost from work and the expense of medical management. Furthermore, patients suffer the anxiety associated with having a potentially troublesome fracture. They are also inconvenienced by thumb spica splint immobilization. A means of early triage of suspected scaphoid fractures would facilitate management.

MRI has, on average, been slightly more sensitive and specific than CT scanning for the diagnosis of fracture of the scaphoid [5, 12, 13, 18]; however, it is usually more costly and less available [10, 14, 26]. There are very few comparative studies between MRI and CT scanning, but some authors suggest that CT scan is better for detecting occult fractures involving the cortex whereas the MRI scan is better in detecting trabecular fractures [20]. On the other hand, there is some concern that many of these “trabecular fractures” are bone bruises and not true fractures.

Because of the low incidence of true scaphoid fractures (2 of 28 patients; 7%), it is difficult to analyze the diagnostic characteristics of scaphoid CT using the data from this study. We evaluated the diagnostic characteristics of scaphoid CT in another study in which blinded observers reviewed patients with known nondisplaced scaphoid fractures and patients with scaphoids without fracture for evidence of a fracture [1]. The average sensitivity, specificity, and accuracy of CT for nondisplaced fracture of the scaphoid were 89%, 91%, and 89% for the first round and 97%, 85%, and 88% for the second round of observations, respectively. Based on an estimated 5% prevalence of true scaphoid waist fractures among patients with suspected scaphoid fractures, the average positive predictive value (PPV) for the detection of radiographically occult scaphoid fractures with CT of the wrist was only 0.28 (95%CI=0.23–0.32). This is most likely because normal vascular channels can be misinterpreted as a fracture as often or more often than a true fracture will be present in this patient population (Fig. 2). As a result, there is a potential for slight overtreatment of some patients.

On the other hand, the average negative predictive value (NPV) in our prior investigation was 0.99 (95%CI=0.97–0.99). In other words, CT is very unlikely to miss a fracture of the scaphoid waist in a patient with a suspected scaphoid fracture. The current investigation demonstrated the utility of CT scanning, both for identifying true scaphoid waist fractures and identifying relatively benign, radiographically occult fractures of the distal radius and carpus, which were present in 43% of patients.

Among the 14 patients who had negative CT scans, 8 (57%) did not return for follow-up imaging studies. We cannot state definitively why such a high percentage of patients with normal CT scans left the protocol early. However, we speculate that with rapid improvement of symptoms, these patients were no longer motivated to return. In other words, the concern that brought the patient to the emergency department resolved as the pain resolved, suggesting that the patient’s initial concern combined with the physician’s desire not to miss a radiographically occult fracture of the scaphoid are synergistic in enhancing the potential for overtreatment. Given the consistently low prevalence of true scaphoid waist fractures among patients with suspected scaphoid fractures and the ability of CT scans to identify fractures of other bones, the likelihood of a missed fracture in these eight patients is very low.

CT is available in most urgent care settings, and could be used to immediately triage suspected scaphoid fractures. This would help limit the resources devoted to managing patients with suspected scaphoid fractures. It would also limit immobilization and restriction from work or sports, although many of our patients required at least some immobilization and protection for other fractures. Finally,

immediate triage would decrease patient anxiety regarding the potential of having a troublesome fracture.

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