

The Use of Bone Scan SPECT/CT Imaging in Clinically Concerning, Radiographically Occult Scaphoid Injuries

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INTRODUCTION

Scaphoid fractures are the second most common fractures of the upper limb after distal radial fractures¹. Unfortunately, about 10-15% of scaphoid fractures can be missed on plain film radiographs obtained at the time of injury, making plain film radiographs an insensitive study². Even follow-up plain film radiographs at two weeks has a sensitivity of 82%³. In the clinical scenario of a suspected acute scaphoid fracture in an adult with normal radiographs, there is currently no consensus for the optimal or most practical workup and management. From a clinical perspective, a missed diagnosis can result in many adverse situations such as non-union, carpal instability or early arthritis. Being too cautious in the acute or subacute clinical setting can result in unnecessary repeat clinic visits, unnecessary immobilization, and increased costs to both the patient and the health care system, including cast material, and time off work.

Numerous studies have investigated magnetic resonance imaging (MRI), computed tomography (CT), and nuclear medicine bone scan imaging for the additional workup of these types of injuries. Regarding the nuclear medicine imaging studies, historically the literature has investigated planar imaging and found high sensitivity, but poor specificity. However, this has applied to planar bone scan imaging, rather than SPECT/CT imaging (see side panel). Bone scan with SPECT/CT imaging has proven to be useful in localizing injuries and lesions in multiple other musculoskeletal injuries⁴ and could be useful in the application of occult scaphoid injury. Previously, only one study⁵ and one case report⁶ have investigated the use of SPECT/CT with acute wrist injuries.

OBJECTIVES

The primary objective of this prospective case-controlled study was to determine if nuclear bone scan imaging with SPECT/CT can be used as a practical, sensitive and specific tool for diagnosing scaphoid fractures that are negative on plain film radiographs. A secondary objective was to evaluate three common clinical maneuvers (snuff box, palmar tubercle, and axial loading tenderness) for their sensitivity and specificity in diagnosing scaphoid and other wrist injuries. Finally, this study sought to institute a clearer role for nuclear medicine imaging in the management pathway of acute scaphoid fractures.

METHODS

Patients with an isolated unilateral acute or subacute wrist injury and with clinical suspicion for a scaphoid fracture presenting to a local urgent care center (Sheldon Chumir Urgent Care Centre, Calgary, AB) were recruited. At least one necessary physical examination finding of tenderness in the anatomic snuffbox, snuffbox axial pressure tenderness or palmar tubercle tenderness was required. If initial and 10-14 day wrist and scaphoid radiographs were negative, but there was continued clinical concern with these clinical findings, patients were enrolled in the study and underwent a nuclear medicine bone scan SPECT/CT. Study exclusions included those unable to participate with follow-up, multiple injury or polytrauma patients, pregnancy, or pediatric (<18yo).

One of two Board Certified Nuclear Medicine Radiologists (AF, AS) reported the study using one of five result outcomes (Figure 1). Within five days after the bone scan results, a return clinical assessment and management plan was initiated. For patients not requiring specialist referral based on the results, a six-week follow-up clinical and radiographic assessment was performed for all as a surrogate gold standard.

Figure 1: Bone Scan SPECT/CT Result and Management Plan

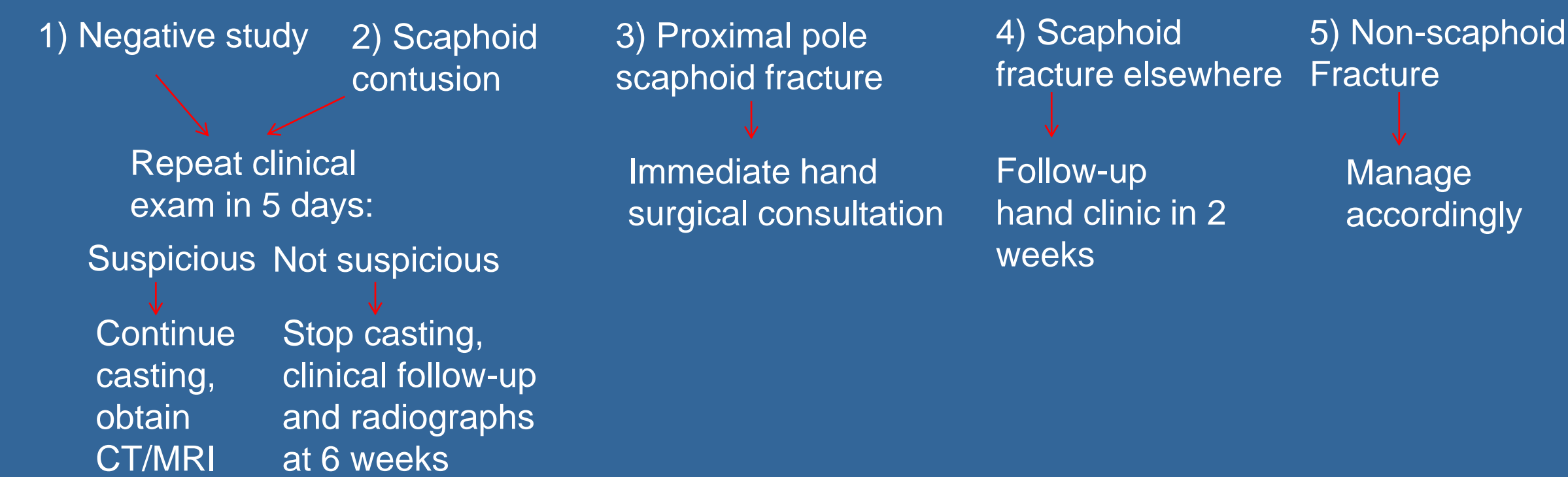
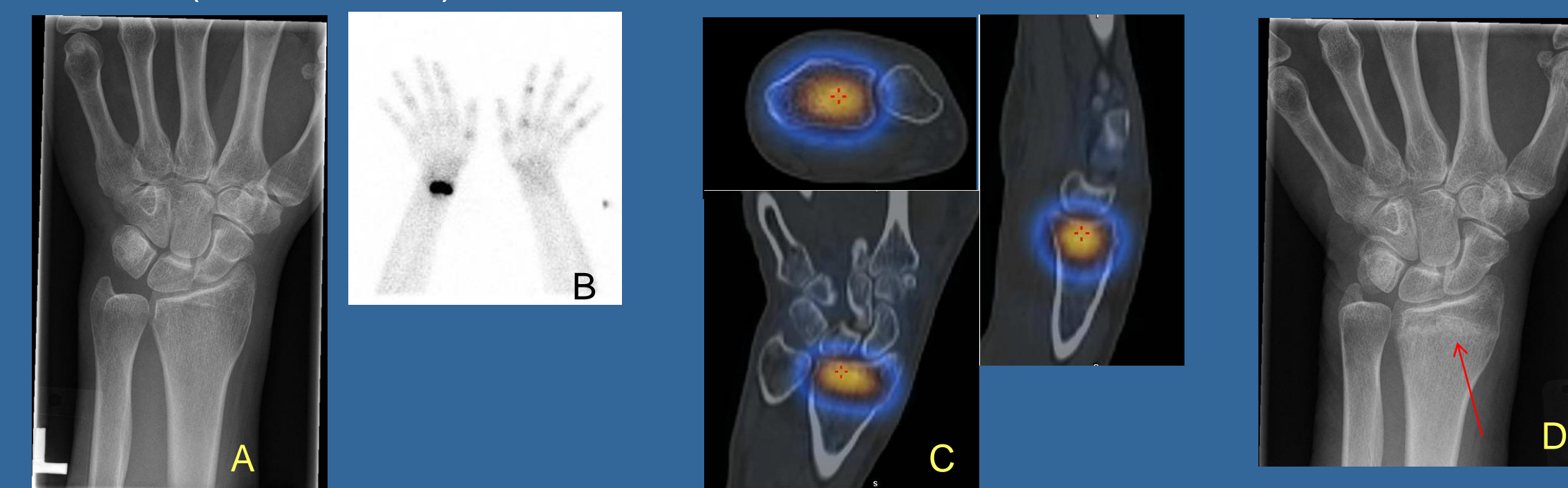


Figure 2: Distal radial fracture in a study patient.

The original left wrist PA view (A) and 14 day follow-up x-ray as well as scaphoid views show no fracture. Bone scan on Day 15 shows increased activity in the right wrist (B). The SPECT/CT in all three planes localizes this to the distal radius (C). The follow-up x-ray on Day 39 shows interval healing in the originally occult fracture (red arrow, D).



RESULTS

In total, 52 patients were recruited. Ten (19%) acute scaphoid fractures were identified on bone scan SPECT/CT imaging. 19 (36%) patients sustained other fractures as follows: 6 distal radius, 4 triquetrum, 3 hamate, 3 trapezium, and one each of the 4th metacarpal, pisiform and trapezoid. Clinically, snuffbox tenderness was the most sensitive test for detection of both the acute scaphoid fractures (90% sensitivity, 12% specificity) and the other fractures (87% sensitivity, 10% specificity), compared to the other clinical exam methods (palmar tubercle 60% and 55%, and axial loading 20% and 39%, sensitivity and specificity respectively).

From the imaging perspective, there were no false negative bone scan SPECT/CT studies (i.e. no patients had persisting clinical complaints or new fractures discovered at the six week follow-up appointment). Four patients had SPECT/CT diagnosed bone contusions; two of these had follow-up cross-sectional imaging studies confirming contusions, and two had no clinical or radiographic follow-up findings, supporting the diagnosis of no acute fracture.

SUMMARY

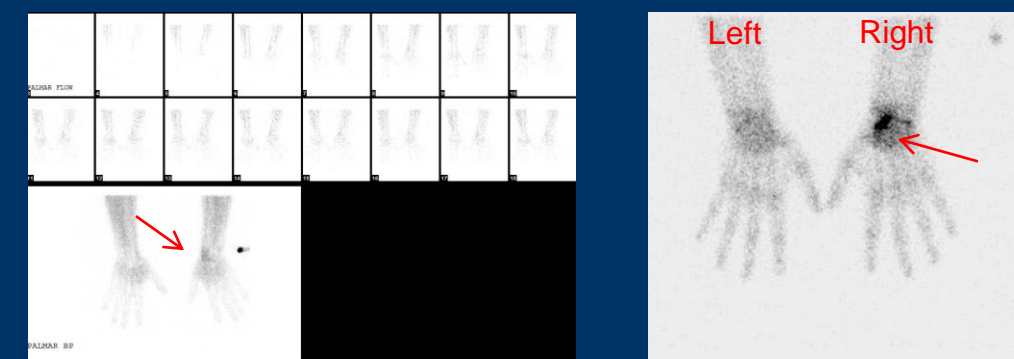
In patients with a strong clinical concern of an acute scaphoid fracture and negative immediate and 10-14 day scaphoid radiographs, this study revealed a large percentage of radiographically occult fractures that can be diagnosed on bone scan SPECT/CT imaging. Snuffbox tenderness had the highest sensitivity for fracture detection. The nuclear medicine bone scan SPECT/CT not only had a high negative predictive value by missing no fractures, but also detected a large percentage of radiographically occult fractures that accounted for the patient's symptoms. As a result, in the setting of strong clinical concern for scaphoid fractures in 10-14 day radiographically occult cases, bone scan SPECT/CT imaging can be considered a very useful next step in the management plan and can potentially be applied in the Family Medicine clinic setting.

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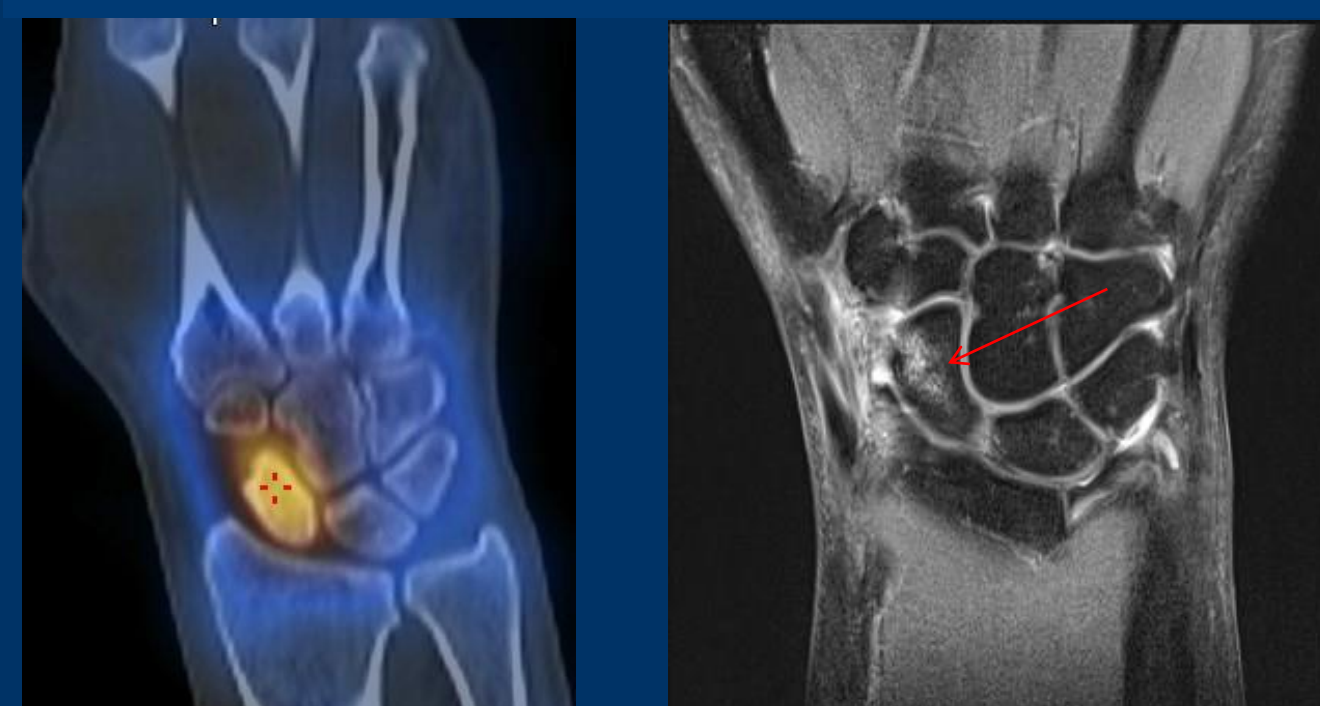
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When performing nuclear medicine Single Photon Emission Computed Tomography/Computed Tomography (SPECT/CT), the gamma camera that obtains the traditional planar images rotates around the imaged structures to ultimately create a tomographic image similar to what you see in CT compared to an x-ray.

The SPECT/CT component can increase the specificity of the bone scan by being able to localize the functional information (osteoblastic activity) overlaid to the anatomic image (the CT component of the SPECT/CT).



The above are typical blood flow, blood pool and delayed phase planar bone scan images in patient's right wrist. In the image on the right, there is increased bone turnover/activity in the right wrist (arrow), but localization to the exact bone involved can be difficult to determine.



The image on the left is the SPECT/CT component of the above bone scan. SPECT/CT allows for more detailed localization of the bone turnover (red target) to confirm the scaphoid bone fracture in this patient. In this case, for non-study reasons, the patient also had an MRI. The MRI shows hyperintense signal in the fracture (red arrow), which confirms the SPECT/CT finding.

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