REVIEW ARTICLE

The Value of Snuffbox Tenderness: A Sign of Things to Come

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ABSTRACT: The scaphoid is the most commonly fractured bone within the carpals, accounting for up to 70% of all carpal fractures and frequently occurs following a fall onto an outstretched hand. Despite the high frequency of injury and a common mechanism of injury, it is common for a scaphoid fracture to go undiagnosed. In this setting, the patient is now at risk for numerous long-term complications. Using a case report of a 30-year-old male who had improper management of an acute scaphoid fracture, this article will review the proper management in the acute setting with advanced imaging and briefly discuss the long-term complications of an improperly treated fracture.

HISTORY, PHYSICAL EXAM, AND DIAGNOSTIC ASSESSMENT

A 21-year-old male presented to the Emergency Department (ED) complaining of increasing left wrist pain at the base of the thumb. He states that he crashed his All-Terrain Vehicle (ATV) during a motocross race one day prior, subsequently landing on his stomach with his hands outstretched in front of him. The physical exam was positive for snuffbox tenderness while the wrist is in ulnar deviation. Plain film radiographs were taken of his left wrist *(Figure 1)*. No fracture was reported, and he was discharged from the ED with a diagnosis of a left wrist sprain, immobilized in a removable thumb spica splint, and instructed to follow up with his primary care physician (PCP) in two weeks.

On follow up with PCP the patient's wrist pain was still present and the physical exam remained positive for snuffbox tenderness. He was then instructed to continue wearing the thumb spica splint and return in two weeks if the pain persisted. The patient returned to his PCP reporting no improvement of symptoms, and a technetium-99 scan was ordered *(Figure 2)*. The technetium scan read positive for evidence of bone pathology in the left wrist, and at this time was placed in a short arm cast and instructed to follow up in four weeks. On return visit, he reported no improvement of symptoms and was subsequently referred to an orthopedic surgeon. At the initial visit with the surgeon, plain film radiographs of the left wrist were ordered and showed evidence of fracture of the left scaphoid *(Figure 3)*.

At that point, he was then referred to a hand and wrist specialist for further management. After reviewing the case, it was decided to continue with nonoperative management and he was placed in a short arm cast with daily bone stimulator treatments. The patient continued to follow up with the hand specialist for repeat imaging every month to assess the status of the fracture. At month nine the fracture was labeled nonunion, and the surgeon recommended no further treatment and the patient was subsequently removed from the cast and told to return to activity as tolerated with no further follow up visits scheduled. Unfortunately, images from the hand and wrist specialist were not available.

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FIGURE 1:

Plain film radiographs - left wrist

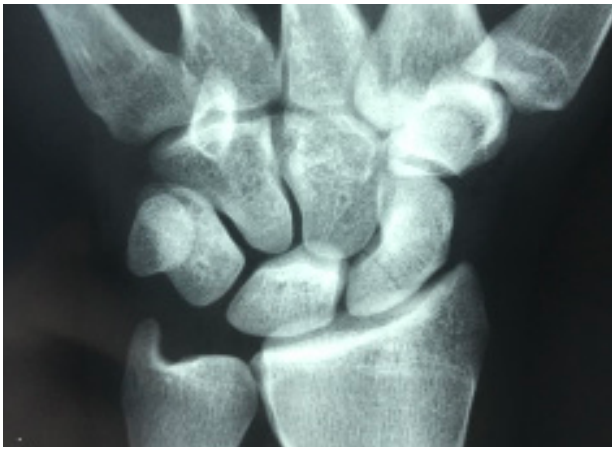


FIGURE 2:

Technetium-99 Scan

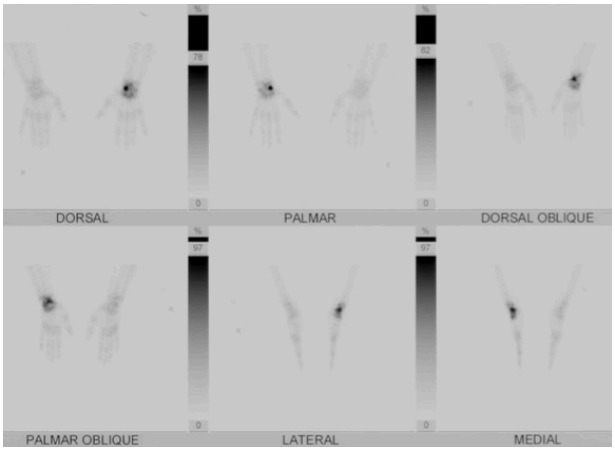


FIGURE 3:

Plain film radiographs - evidence fracture left scaphoid

INTRODUCTION

Carpal fractures comprise approximately 18% of all hand fractures.[1] When considering fractures within the carpal bones, the scaphoid is the most commonly affected, accounting for 60-70% of all carpal fractures.[1] Despite being the most commonly fractured carpal bone with a telltale mechanism of injury, a fracture of the scaphoid bone can be a difficult diagnosis to make. This is likely due to an array of nonspecific symptoms and a lack of evidence of a fracture on initial plain film radiographs.[2] Due to the nature of the scaphoid structure, function, and its blood supply, there is an increased likelihood that trauma to the scaphoid can lead to long term complications. If a scaphoid fracture is suspected but the plain film radiographs are negative, it warrants further investigation in a timely manner.

ANATOMY

As depicted by its name, the scaphoid has a curved or "boat" shape to it. The scaphoid itself rests in a concave groove within the distal radius where it articulates with the radius and four carpals; the lunate, trapezium, trapezoid, and capitate[1] *(Figure 4)*. Due to its extensive articulation and small size, roughly 82% of the bone is covered in articular cartilage, leaving limited access for its arterial supply.[3] Due to a study performed in 1980 by Gelberman et al, it has classically been taught that the primary blood supply for the scaphoid was supplied by the radial artery via a dorsal and volar branch, which enter through a bony foramina located at either the waist or the distal aspect in 93% of people.[4] This study showed that the two arteries that enter at the dorsal ridge supplied 70-80% of the proximal scaphoid via intraosseous retrograde flow and the distal 20-30% was supplied by branches surrounding the tubercle.[4,5] However, more recently it has been shown using cadavers that the scaphoid blood supply is more extensive than previously thought.[3,5] In some of the cadavers, the proximal, middle, and distal third of the scaphoid all may receive a direct blood supply. Although there is some anatomical variance described between the cadavers as far as the presence or absence and the size of the vessels, the surrounding arteries are able to compensate if one branch is completely missing.[3]

FIGURE 4:

Anatomy of the scaphoid

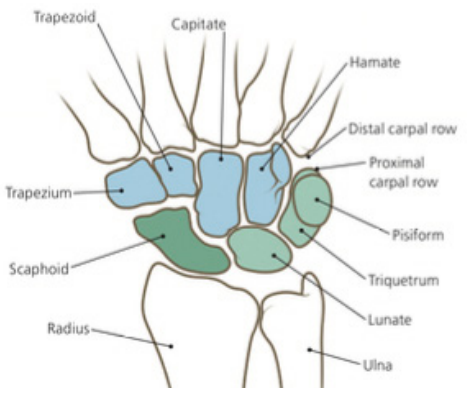
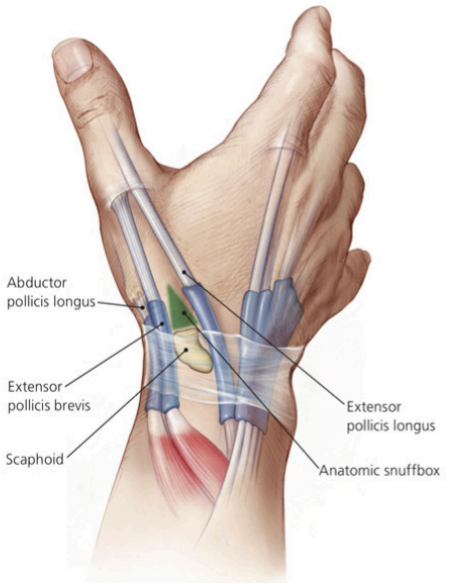


FIGURE 5:

Trapezium and scaphoid – forming snuffbox floor



The scaphoid can be palpated in three locations within the wrist. The tubercle of the scaphoid is the most prominent feature of the scaphoid and can be palpated on the palmer aspect of the wrist while it is in ulnar deviation. The remaining two locations are within the anatomic snuffbox and on the dorsal aspect of the wrist approximately in the same location as the scaphoid tubercle. The anatomic snuffbox is located on the radial aspect of the wrist at the level of the carpals. It is defined by the extensor pollicis longus (EPL) tendon medially, the extensor pollicis brevis (EPB) and abductor pollicis longus (APL) tendons laterally, the proximal border is the radial styloid process, and the distal border is the approximation of the EPL, EPB, and APL tendons. The floor of the snuffbox is formed by the trapezium and the scaphoid *(Figure 5)*.

MECHANISM OF INJURY

The most common mechanism of injury in a scaphoid injury is a fall onto an outstretched hand or a direct axial load.[1] A fall onto an outstretched hand imposes a forceful combination of wrist dorsiflexion usually exceeding 95 degrees, ulnar deviation, and intercarpal supination. With this motion, the midbody, or "waist," of the scaphoid that articulates with the distal radius is then forced against the dorsal lip of the radius, causing injury.[1]

PHYSICAL EXAM

In the acute setting, a patient will typically present reporting an injury related to either of the two mechanisms previously mentioned with pain and swelling over the radial aspect of the wrist.

While performing a physical exam on a patient with a possible scaphoid injury, there are a few special tests that should be performed in addition to the standard orthopedic assessment of an injured wrist. The first of which is palpation of the anatomic snuffbox *(Figure 6)*. As previously mentioned, the floor of the snuffbox consists of the scaphoid, and pain with direct palpation is indicative of a scaphoid fracture and should be treated as such until proven otherwise.[6] Snuffbox tenderness has a sensitivity of 86% and a specificity of 30%.[7] Another physical exam test is known as scaphoid tubercle tenderness. This requires the examiner to locate the scaphoid tubercle on the volar aspect of the wrist and apply direct pressure.[6] As the name implies, if there is tenderness with direct pressure, this is considered a positive test and points towards a scaphoid injury *(Figure 7)*. Scaphoid tubercle tenderness has a sensitivity of 95% and a specificity of 74%.[7] The Watson shift test is another physical exam maneuver designed to identify a scaphoid injury. The patient must sit with their elbow resting on the table and forearm pronated. With one hand, the examiner must slightly extend the wrist and then place it in ulnar deviation. With the other hand, the examiner must apply pressure to the volar aspect of the scaphoid with the thumb and place the fingers on the dorsal aspect of the wrist to provide counter pressure *(Figure 8)*. The examiner should then radially deviate and slightly flex the patient's wrist. If there is instability of the scaphoid due to a fracture or ligamentous disruption, the dorsal pole of the scaphoid will sublux or "shift" over the dorsal rim of the radius, reproducing pain. If there is only pain on this maneuver, it is indicative for a scaphoid fracture, but if the "shift" is felt, this may also point towards damage to the scapholunate ligament.[6] The Watson shift test has a sensitivity of 43% and a specificity of 30%, which are relatively low, but the test can still be useful when the diagnosis is not clear.[7]

FIGURE 6:

Palpation of the anatomic snuffbox

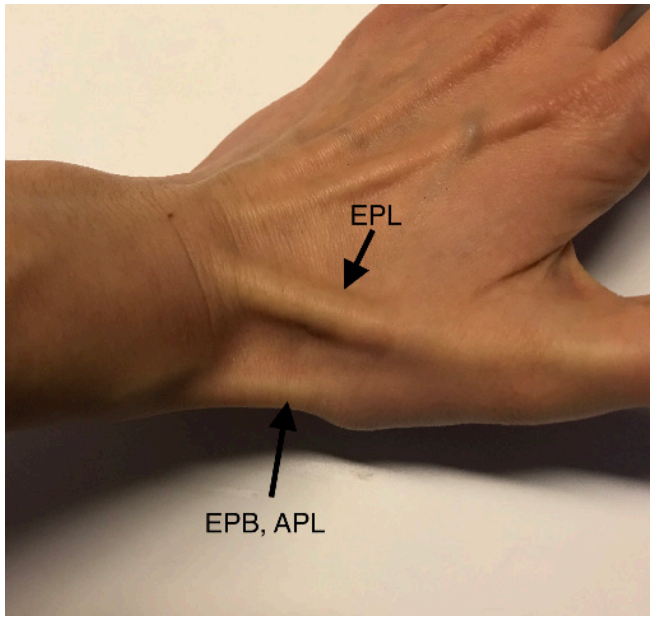


FIGURE 7:

Scaphoid tubercle tenderness

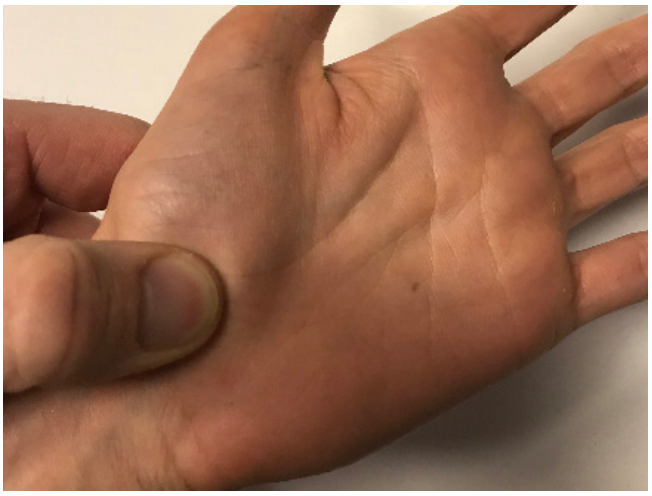


FIGURE 8:

Watson shift test

None of these tests can definitively rule in or rule out a scaphoid fracture; instead, they offer information to help steer the clinical judgment of the examiner. It should be noted that in the acute setting of a wrist injury, these tests may reproduce pain in the setting of other wrist pathology, which explains the relatively high sensitivity but low specificity. If any of these tests are positive, the patient should be treated as if they have a fractured scaphoid until proven otherwise. This will help reduce the amount of missed scaphoid fractures and related injuries.

DIAGNOSTIC IMAGING

The typical radiographic workup for patients presenting with a scaphoid fracture includes a posteroanterior view with the wrist in neutral position, lateral view, oblique views with the wrist pronated 45 degrees, and a scaphoid view with the wrist in 45-degree ulnar deviation.[2] However, plain film radiographs have a false negative rate of 20% for scaphoid fractures in the acute setting, and in this situation, it is common practice to place the patient in a thumb spica splint and repeat imaging two weeks later.[1] However, it is unlikely that a repeat radiograph will show a fracture on a second review.[8] If there is a high suspicion of a scaphoid fracture with negative plain films, other modalities such as bone scintigraphy, computed tomography, or magnetic resonance imaging should be obtained.[2]

It has been shown that MRI and CT have high sensitivities and specificities (MRI: 98% and 99% respectively) (CT: 94% and 96%).[9] When the provider is faced with the decision of ordering advanced imaging there are a few things to consider for each of the respective studies. An MRI is more sensitive and specific for scaphoid fractures, soft tissue injuries, and bone marrow edema which can be predictive of occult fractures.[10] An MRI is also not associated with any ionizing radiation. However, an MRI of the wrist takes roughly 30 minutes and requires the patient to remain still for the duration of the exam. If the patient has difficulties remaining still secondary to pain or if they are claustrophobic, there may be increased image artifact, making it difficult to make a diagnosis. There may also be a contraindication to obtaining an MRI if the patient has a pacemaker or other implantable metallic constructs. There are also many benefits to obtaining a CT scan as it depicts the bony anatomy better than an MRI does, the duration of the study can be significantly less than an MRI, it is typically more readily available at institutions, and has a smaller financial burden to the patient. However, sensitivity and specificity are slightly inferior to an MRI, and a CT scan is associated with ionizing radiation. Although there is an increased initial cost of treatment with each of these studies, advanced imaging has been shown to be cost-effective in the acute setting by preventing unnecessary immobilization, fewer follow-up visits, fewer long-term complications, and decreased loss of overall productivity of the patient.[1] The decision on which to study to order may vary on a case by case basis and depend on the availability of the resource.[9, 11]

COMPLICATIONS

There are two variables that determine how well a scaphoid fracture heals: time allotted between injury and proper treatment, and whether the fracture is located in the proximal, middle, or distal portion of the scaphoid.[2] Fractures tend to heal at different rates depending on whether the fracture is located in the distal, middle, or proximal third. Fractures in the distal segment tend to heal at a faster rate with fewer complications than if they are located more proximally. As a result of this slower course of healing, fractures in the proximal segment are more likely to result in a nonunion, which can lead to complications in the future.[2] Some of the complications associated with a scaphoid fracture are avascular necrosis (AVN), Dorsal Intercalated Segment Instability (DISI), delayed union, malunion, or nonunion.[1]

AVN is a direct result of a disruption of blood supply to any bone, and in the setting of a scaphoid fracture, it usually affects the proximal fragment.[1] Plain film radiographs will show sclerosis of the proximal fragment, cysts, and collapse of the affected portion of bone as the disease progresses.[12] However, they are often

negative in the setting of pain for the first few months and the disease is fairly progressed when evident on plain film radiograph. MRI can detect AVN at an earlier stage, and it should be ordered if there is a high index of suspicion for AVN.[11]

Malunion is defined by a fractured bone healing in an abnormal position, such as the two fragments being twisted, shortened, or bent relative to their anatomical position.[13] If a patient suffers a scaphoid fracture and does not seek treatment, or the scaphoid bone is not reduced properly prior to casting, this can lead to a malunion.[13] This will lead to abnormal joint structure and function, which will eventually progress to early arthritis and pain in the affected areas.

A common consequence of inadequate healing of a scaphoid fracture is nonunion. The official definition of nonunion is a failure of fracture healing at least nine months since the time of injury, and at least three months with no progression in healing.[13] In the setting of a nonunion there is an increased risk of post-traumatic arthritis due to disruption of the proximal carpal function known as Scaphoid Nonunion Advanced Collapse (SNAC).[14] If left untreated the arthritis of a SNAC wrist progresses in a rather predictable, step-wise fashion within the carpals.[14]

The increased rate of complications, especially nonunion, may be due to a combination of the blood supply and also the relationship of the capitate articulation with the scaphoid. When stressed with load bearing, the capitate applies pressure directly to the scaphoid. This may allow more movement between the two pieces of bone with a proximal break when compared to a more distal fracture.[5] It is also important to consider the metabolic demands of the tissue. While there may be adequate blood for normal metabolic demands of the tissue, it is unknown if the blood supply is enough for the increased metabolic demands required for healing after trauma. [15,16]

CASE OUTCOME

The patient is now 30-years-old and after being released from care with no restrictions approximately eight years ago, the patient began to ease back into his normal activities, which included returning to work in a tool and die shop, lifting weights, and racing motocross. He stopped racing motocross another year later but has continued to lift daily. He is currently asymptomatic other than some slight discomfort while lifting weights, but only with certain movements or grips. Despite being relatively asymptomatic, he chose to establish a relationship with a new hand and wrist specialist for a checkup and long-term management. During the visit with the hand and wrist specialist, plain film radiographs were taken that show a chronic scaphoid nonunion with slight sclerosis of radial-carpal interface, but the two scaphoid fragments appear to be nondisplaced *(Figure 9,10)*. A CT scan was also ordered which shows the scaphoid fragments to be in good alignment with less than 1mm gap between the two fragments, less than 1mm of shifting, and no signs of avascular necrosis *(Figure 11)*.

FIGURE 9:

Plain film radiograph that shows a chronic scaphoid nonunion with slight sclerosis of radial-carpal interface

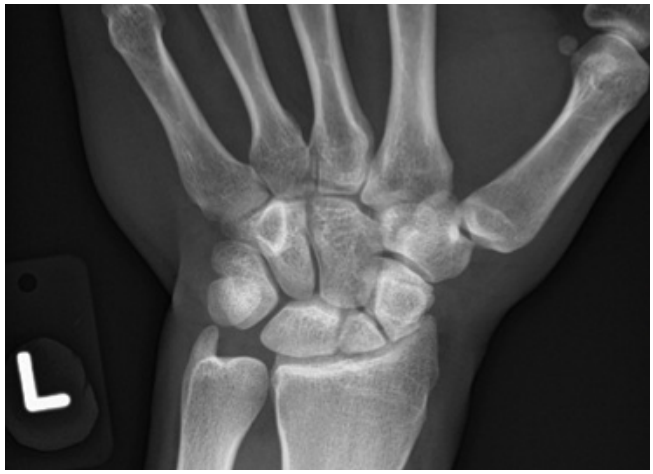


FIGURE 10:

Plain film radiographs showing two scaphoid fragments appearing nondisplaced

At this time, surgical management was decided against as the nonunion is well established and in proper alignment. In the setting of a nonunion, reducing the fragments into anatomical alignment becomes challenging due to the abundance of scar tissue within the original fracture. Due to the difficulty of aligning the fragments, the fragments already being in favorable position, and the patient being relatively asymptomatic with no changes, the surgeon felt that conservative management was the best option for this patient at this time. The patient was advised to continue with his life and follow up for additional imagining on an annual basis, or if something changes and he becomes symptomatic.

FIGURE 11:

CT scan showing the scaphoid fragments in good alignment

DISCUSSION

Looking back at the initial plain film radiograph from the ED, it was clear at that time that this patient did indeed have a fracture of the scaphoid that was missed on the initial exam. As mentioned earlier, there are many complications associated with a fractured scaphoid that can be largely prevented by proper diagnosis and treatment in the acute setting. Not only can these complications cause increased morbidity for the patient, but they also significantly increase the overall cost of treatment.[11,17] The exact length of time between acute injury and development of long term complications can vary greatly from patient to patient. Due to the extended period of time between initial injury and development of complications, some patients can go years thinking there is no issue, only to develop chronic pain one day. This may severely impact their quality of life and can also lead to an increased financial burden on the patient.

The patient has just recently graduated from medical school and is completing the first year of his residency. Throughout school, his goal was to pursue a career in surgery. Now that he is aware of the potential for complications to develop, he has had to add this information into his decision on whether or not a surgical specialty is the best option for him, given the high possibility of one-day developing chronic wrist complications previously discussed.

Given the nature of this injury it is hard to say if this patient would have had a different outcome if he was treated properly in the acute setting, as a nonunion can still occur with proper management.[1] Although it is common practice that snuffbox tenderness is a broken scaphoid until proven otherwise, cases just like this one still slip through the cracks. It is these cases that we, as health care providers, must get better at preventing. If one is suspicious of a scaphoid fracture and plain film radiographs are inconclusive, there is a clear benefit to pursue advanced imaging for a more definitive answer.

AUTHOR DISCLOSURES:
No relevant financial affiliations

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