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A FISTFUL OF FRACTURES

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Billy Bob Blasted comes in Sunday afternoon to see you in the emergency department with wrist pain after a fall last night. The x-rays of the wrist are negative but there is tenderness in the anatomic snuffbox. What is the current treatment for Billy?

Scaphoid (Carpal Navicular) Fracture

Fractures of the wrist are common because gravity and bipedalism create falls and self preservation makes us stick our arms out to break a fall. (It is better to break the arm than the neck.) The carpal navicular is the most commonly fractured of the carpal bones in all ages. An emergency physician should be aware of the possibility of poor patient outcomes as well as the diagnostic dilemmas that surround this injury. (1,2)

Mechanism

The carpal navicular (scaphoid) is usually injured by a fall on the outstretched pronated hand (FOSH). (1,2) That this mechanism would injure the scaphoid is not surprising since it spans the two rows of carpal bones stabilizing the wrist. A FOSH mechanism applies extension stress across the waist of the scaphoid bone and fracture is a relatively common result. (60% of carpal fractures are of the scaphoid bone.) (2) (Figures 1a, 1b)

Figure 1a-AP view of carpal bones

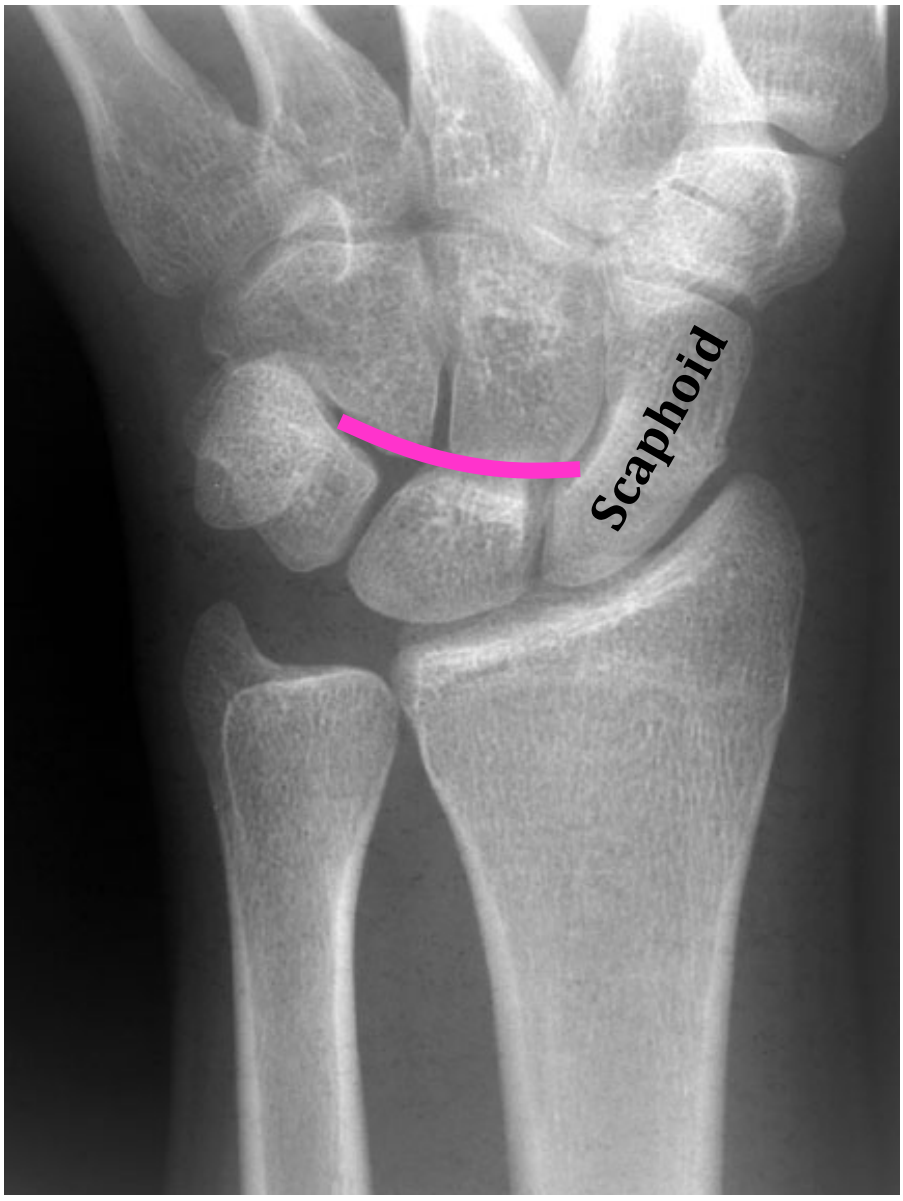

Figure 1b-Figure 1a with line inserted through the two rows of carpals illustrating the bridging scaphoid bone

Scaphoid fracture is an injury of younger patients. The wrist of an elderly patient is more likely to fail at the distal radial metaphysis. Thus, suspecting a scaphoid fracture in a patient more than 50 years old is itself a suspect activity. (3)

Physical findings

Tenderness in the anatomic snuffbox is the most important physical finding associated with a scaphoid fracture. The scaphoid bone's waist is located in the anatomic snuffbox when the wrist is in ulnar deviation. (Figure 2)

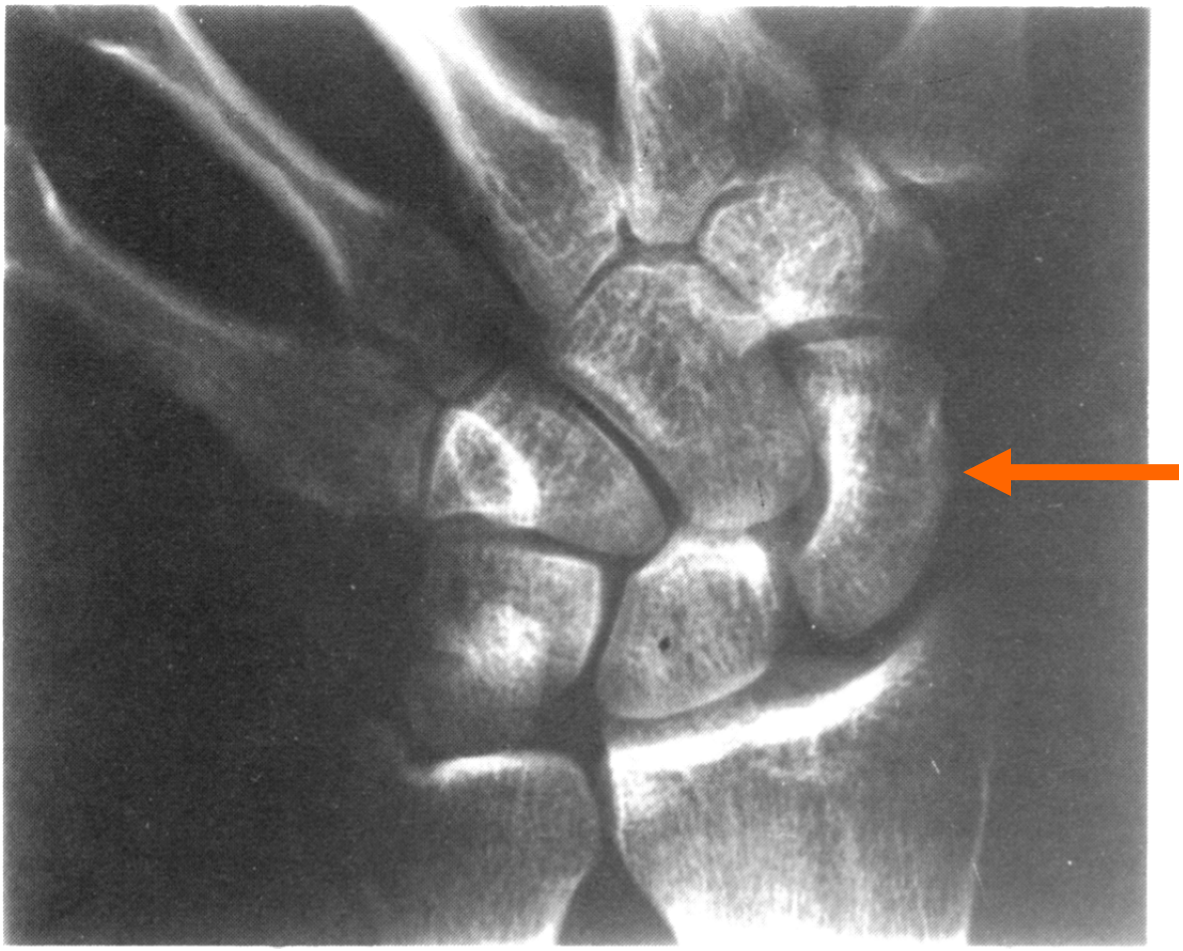

Figure 2-Arrow points at the scaphoid bone from the anatomic snuffbox

Surface anatomy locates the anatomical snuffbox in the hollow between the extensor pollicis longus, abductor pollicis longus and the radial styloid. (Figures 3a, 3b)

Figure 3a-Anatomic snuffbox

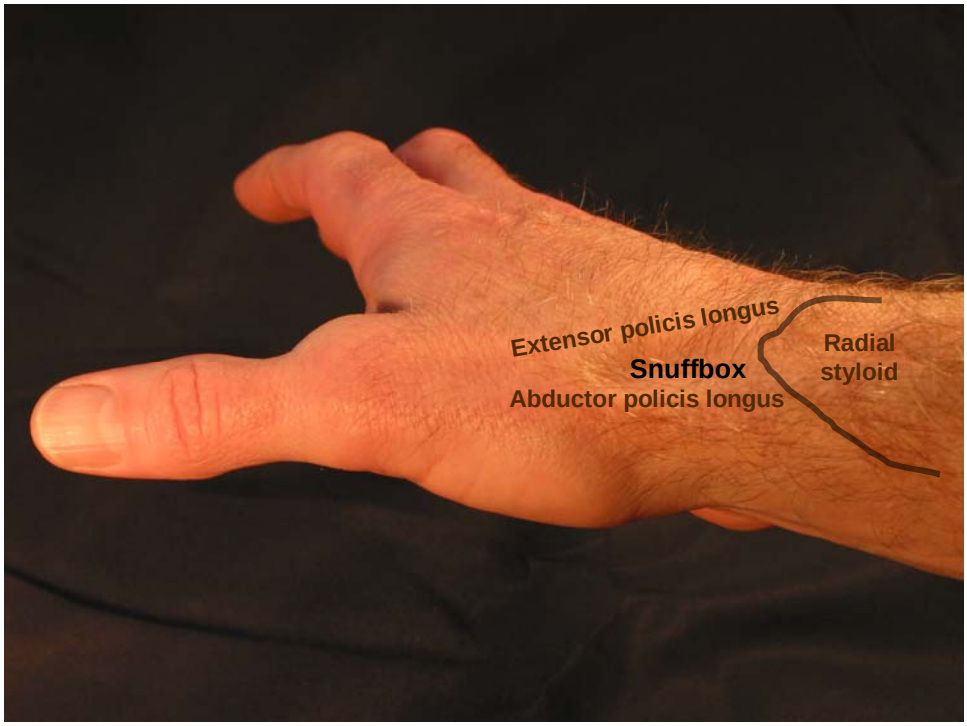

Figure 3b-Figure 3a labeled

A less well-known or under-utilized physical examination finding is scaphoid tubercle tenderness. The scaphoid bone rotates from a longitudinal orientation in wrist ulnar deviation to an anterior/posterior orientation when the wrist is in radial deviation. (Figures 4a, 4b, 4c, 4d)(4)

Figure 4a-Wrist in ulnar deviation

Figure 4b-Figure 4a with orientation of scaphoid demonstrated

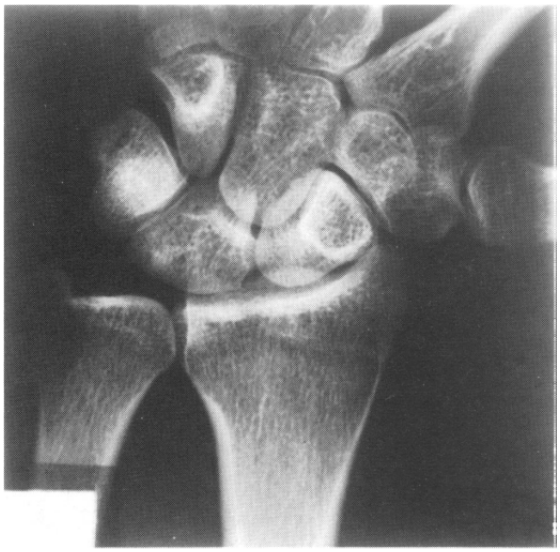

Figure 4c-Wrist in radial deviation

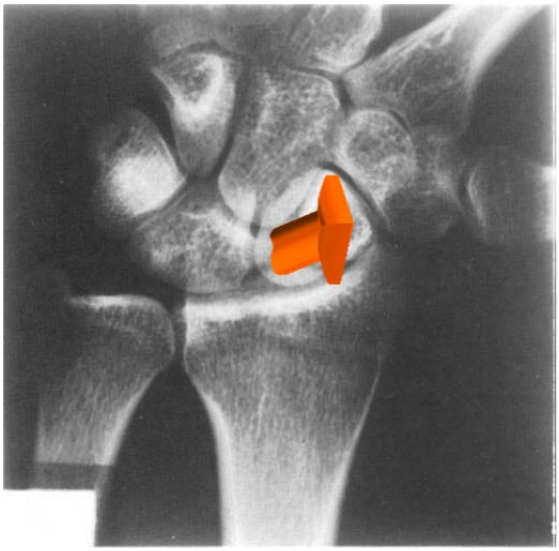

Figure 4d-Figure 4c demonstrating AP orientation of the scaphoid bone

The scaphoid tubercle is easily palpated as a volar prominence that forms the radial border of the carpal tunnel. (Figure 5) It is most prominent when radial deviation of the wrist places it in its AP orientation. (Figure 6)

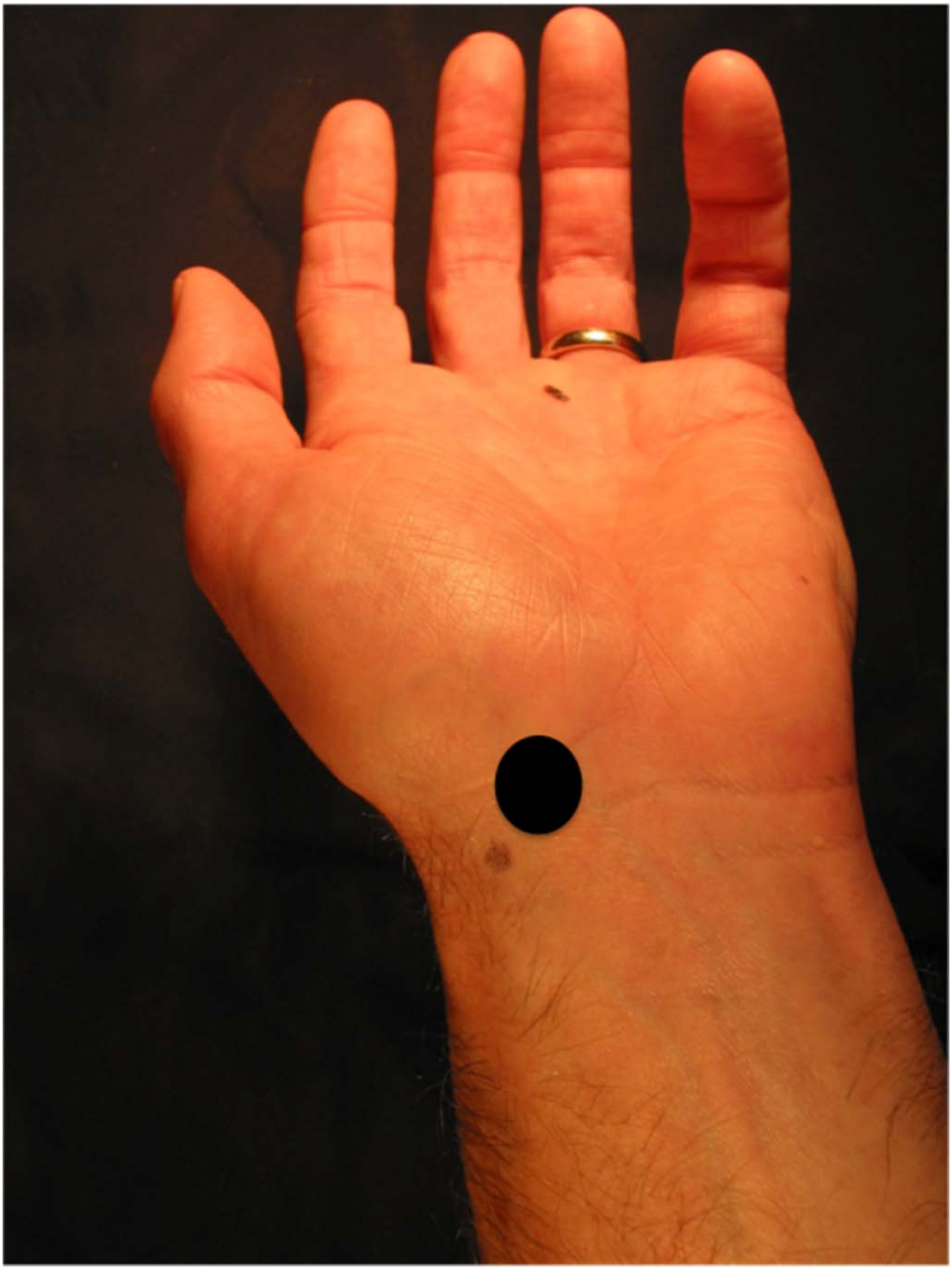

Figure 5-Location of scaphoid tubercle (black circle)

Figure 6-Scaphoid tubercle (black circle) location during radial deviation of the wrist

Freeland (4) found that tenderness over the scaphoid tubercle was as sensitive (87%) as snuffbox tenderness (90%) but slightly more specific (57% vs 40%). In a post hoc analysis, neither test alone

picked up all 30 cases of scaphoid fracture but the combination did (suggesting the combination might be useful).

The scaphoid compression test is still another physical finding that may be helpful in identifying scaphoid fractures. This test is performed by holding the patient's thumb and applying pressure down the long axis of the first metacarpal toward the scaphoid bone. (5)(Figure 7)

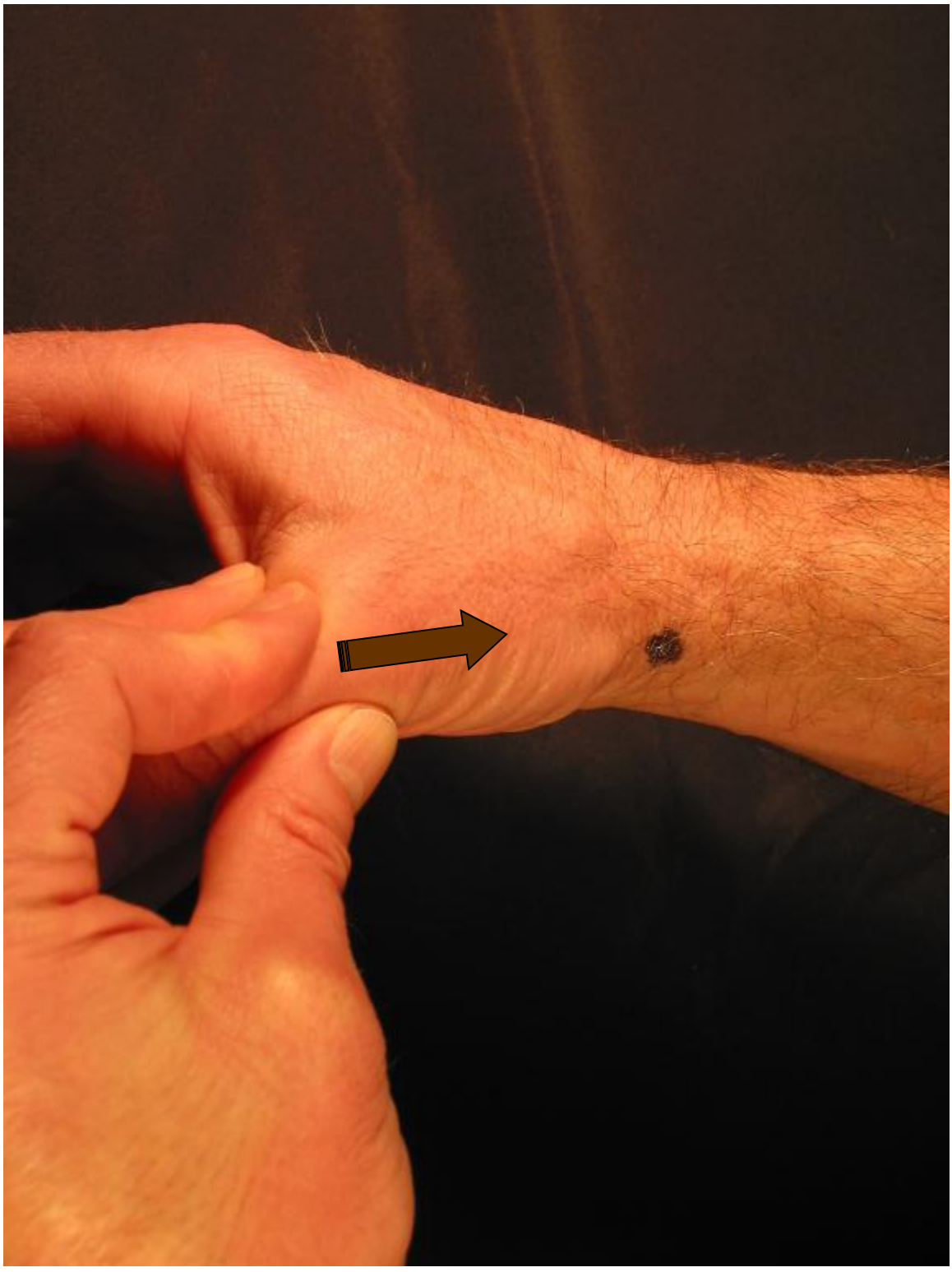

Figure 7-Scaphoid compression test

In a very small patient sample Grover (5) found scaphoid compression to be more specific than either snuffbox tenderness or scaphoid tubercle tenderness. Yet, Waizenegger (6) found the same test to be inaccurate.

Combining all 3 tests was prospectively studied by Parvizi et al in 1998 and they found that each test was 100% sensitive but had poor specificity (as low as 19%). (7) Requiring all three tests to be positive would result in the same 100% sensitivity but increase the sensitivity to 74%. They recommend use of the combination when assessing a patient with suspected scaphoid fracture.

As an interesting aside some authors have suggested that it is easier to make the clinical diagnosis several days after the injury since the point of tenderness is more easily localized and the physical examination may be more reliable. (8) (As all emergency physicians know-the acute injury examination is often confounded by patient anxiety making it suboptimal.)

Imaging

Due to the enclosed position and orientation of the scaphoid bone evaluation is difficult and fractures often hard to see with x-rays. In order to ensure the best views of this difficult bone one should order wrist x-rays *with scaphoid views*. This is typically 4 views: posteroanterior, lateral, semipronated oblique, and posteroanterior with ulnar deviation. (9) There have been a number of special films proposed but x-ray departments have a standard scaphoid series of films planned. It is the onus of the emergency physician to request a scaphoid series when interested in this particular bone.

Scaphoid fracture x-rays follow. (Figures 8, 9a, 9b, 10a, 10b, 11a, 11b, 12a, 12b)

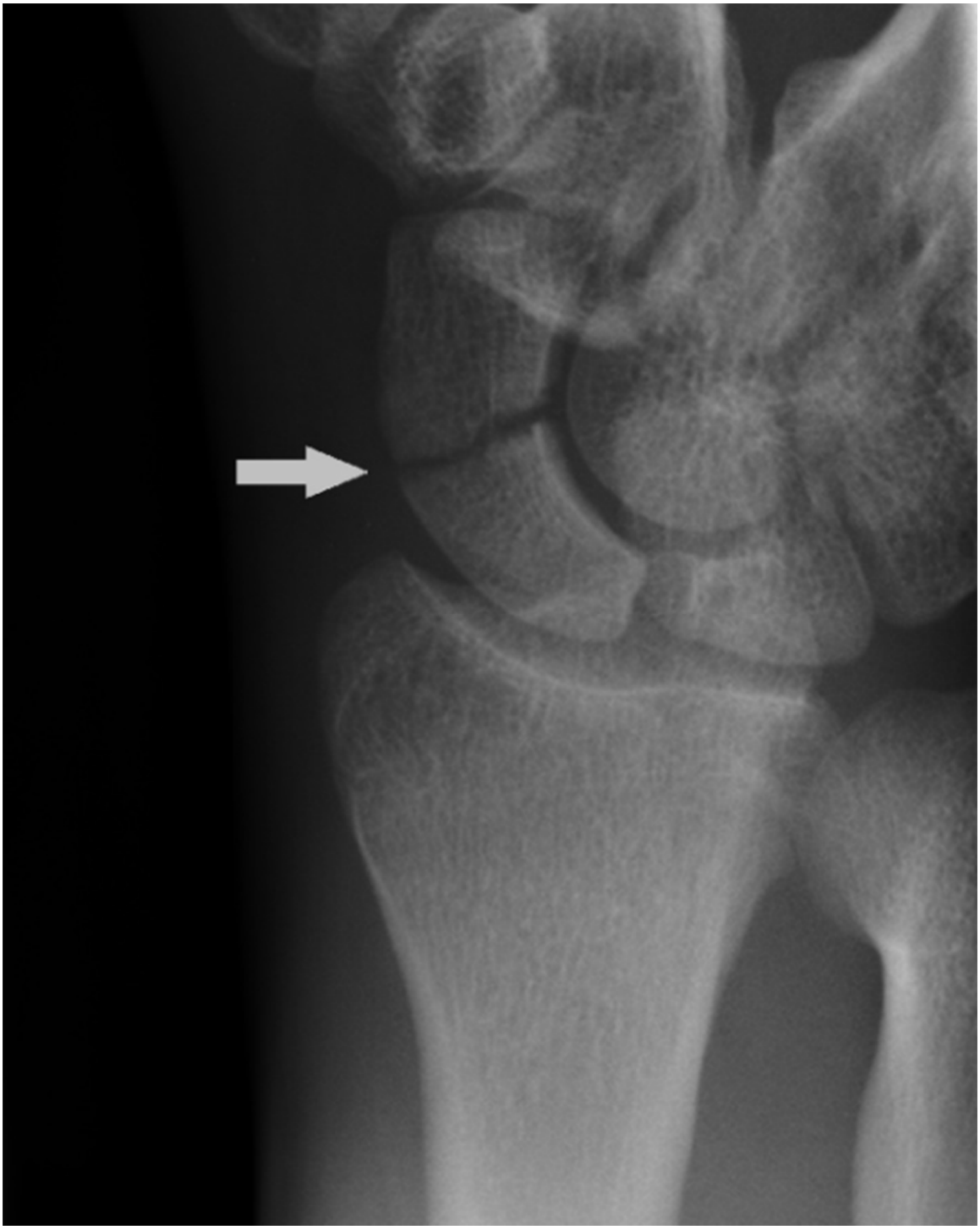

Figure 8-Scaphoid fracture indicated by arrow

Figure 9a-Scaphoid waist fracture

Figure 9b-Figure 9a with fracture outlined in orange

Figure 10a-Scaphoid waist fracture

Figure 10b-Figure 10a with fracture indicated by orange line

Figure 11a-Proximal scaphoid fracture

Figure 11b-Figure 11a with fracture indicated by orange line

Figure 12a-Fracture of the distal pole of the scaphoid. Healed fracture of the waist from 8 months before.

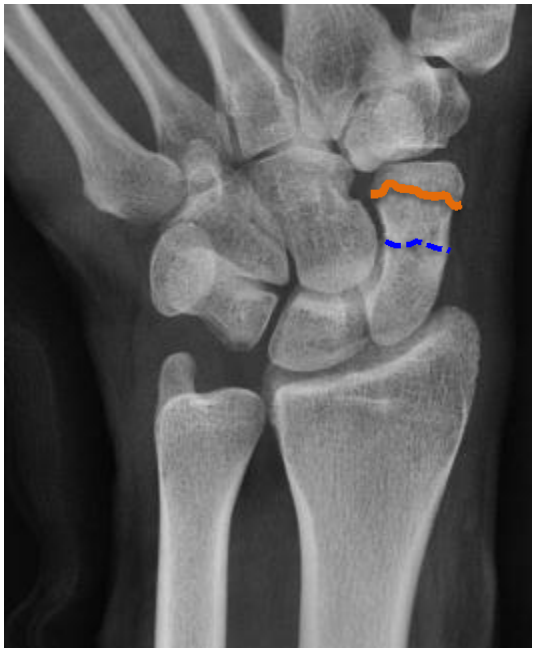

Figure 12b-Figure 12a with new distal pole fracture indicated by an orange line and healed waist fracture indicated in dashed blue

Complications

The blood supply of the scaphoid is from 2 blood vessels: one to the distal tubercle and the other into the dorsal, distal, third that feeds the bone proximally. (2) (Figure 13)

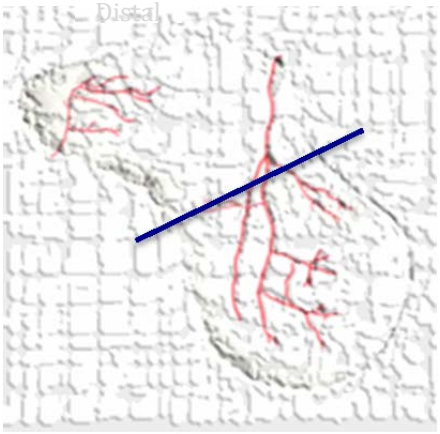

Figure 13-Blood supply of the scaphoid bone with blue line across the waist

Thus, the scaphoid's blood supply is more tenuous proximally. As a result, poor healing is expected and occurs. Nonunion is common ranging from 5%-25% in different series. (2)(Figures 14a, 14b)

Figure 14a-Nonunion of scaphoid fracture of the waist

Figure 14b-Figure 14a with nonunion indicated by an orange line

Factors associated with nonunion include more than 1mm displacement, a proximal fracture, osteonecrosis, vertical oblique fracture and smoking. Mack (10) and Ruby (11) have shown that arthritis and joint degeneration were universal following nonunion with its consequent poor patient outcome. Thus, the problem with healing revolves around blood supply (as is so often the case in orthopedics).

Another common problem with scaphoid fractures is missing a concurrent wrist fracture in 5-13%. (10, 13) These concurrent fractures may be difficult to find just like the scaphoid fracture itself. (Figures 15a, 15b)

Figure 15a-Proximal scaphoid fracture with healed Colles' fracture

Figure 15b-Figure 15a with orange line indicating fracture

The frequency of the dreaded avascular necrosis varies with the site of the scaphoid fracture. Distal pole fractures rarely have a problem, but avascular necrosis occurs in up to 30% of scaphoid fractures of the proximal pole due to the tenuous blood supply. (12) (Figures 16, 17, 18)

Figure 16-Nonunion with dense bone in the proximal pole indicating avascular necrosis

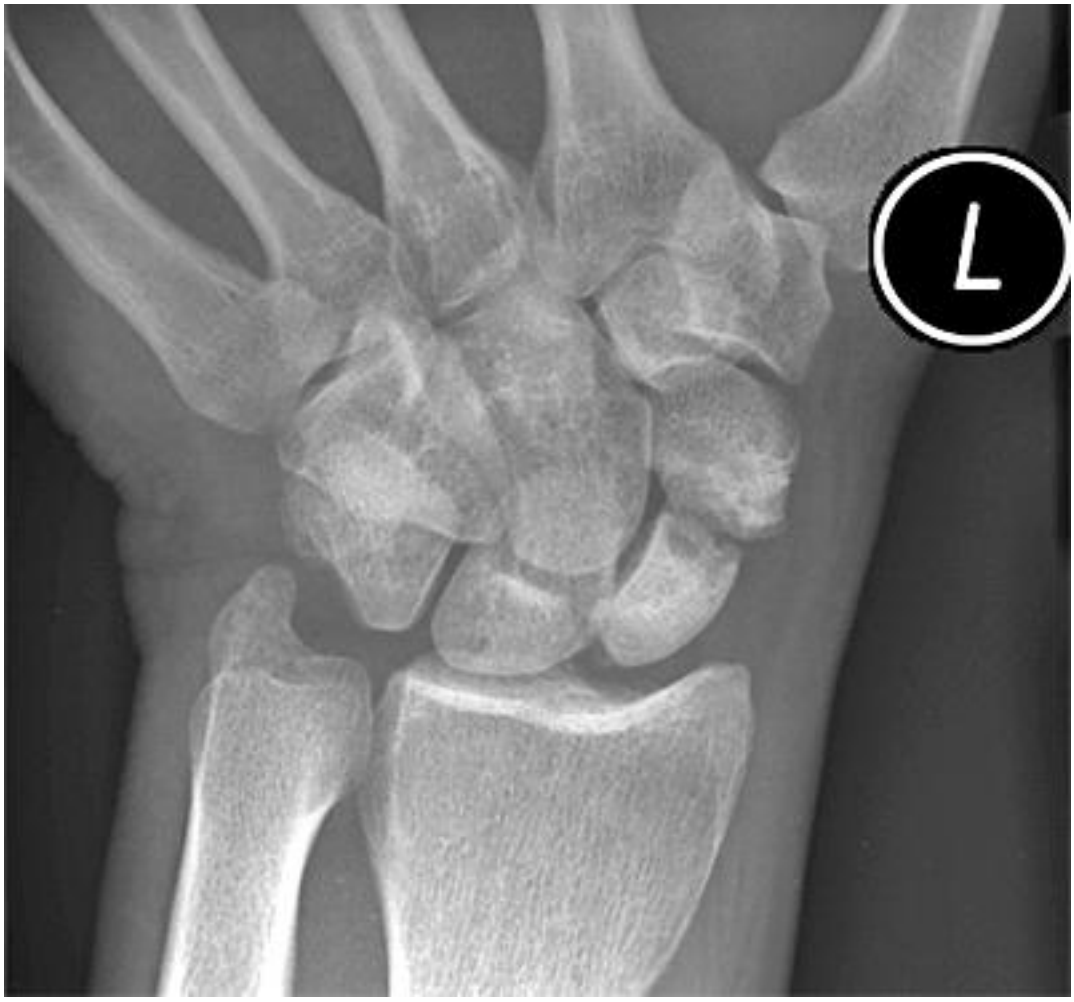

Figure 17-Proximal pole avascular necrosis

Figure 18-MRI with STIR (short TI inversion recovery) demonstrating avascular necrosis of the proximal pole of the scaphoid

Treatment

Thumb spica immobilization is recommended for scaphoid fractures. (Figure 19)

Figure 19-Thumb spica cast

The length of treatment will vary depending on the location of the fracture and the relative stresses on it with motion from 6 to 12 weeks. Initial surgery is recommended by some authors for displaced waist fractures of more than 1mm, proximal pole fractures and nonunions. (2, 14)

Fortunately for emergency physicians the details of how to treat is not our bailiwick and time to definitive treatment is not of the essence with these fractures. Our role involves recognition, immobilization, and referral to an orthopedic surgeon as an outpatient in about a week.

The Problem

A significant number of fractures of the scaphoid bone are not diagnosed by the initial x-rays.

The number of initially missed fractures of the scaphoid varies from a few percent to 22%. (13) However, most series run in the 5-10% range. Since there are always some missed fractures there has been a multigenerational debate about how the initially treating physician should proceed.

Russe's classic algorithm (15) is as follows:
If a patient has anatomic snuffbox tenderness after a FOSH injury and has negative x-rays with special views of the scaphoid bone.

Apply a cast for 2 weeks and x-ray.

If a fracture is revealed, treat as fractured.
If no fracture but still tender in the snuffbox: recast and repeat the x-ray in 2 weeks.

If a fracture is revealed, treat as fractured.
If no fracture, discontinue therapy since fractures show up by 4 weeks.

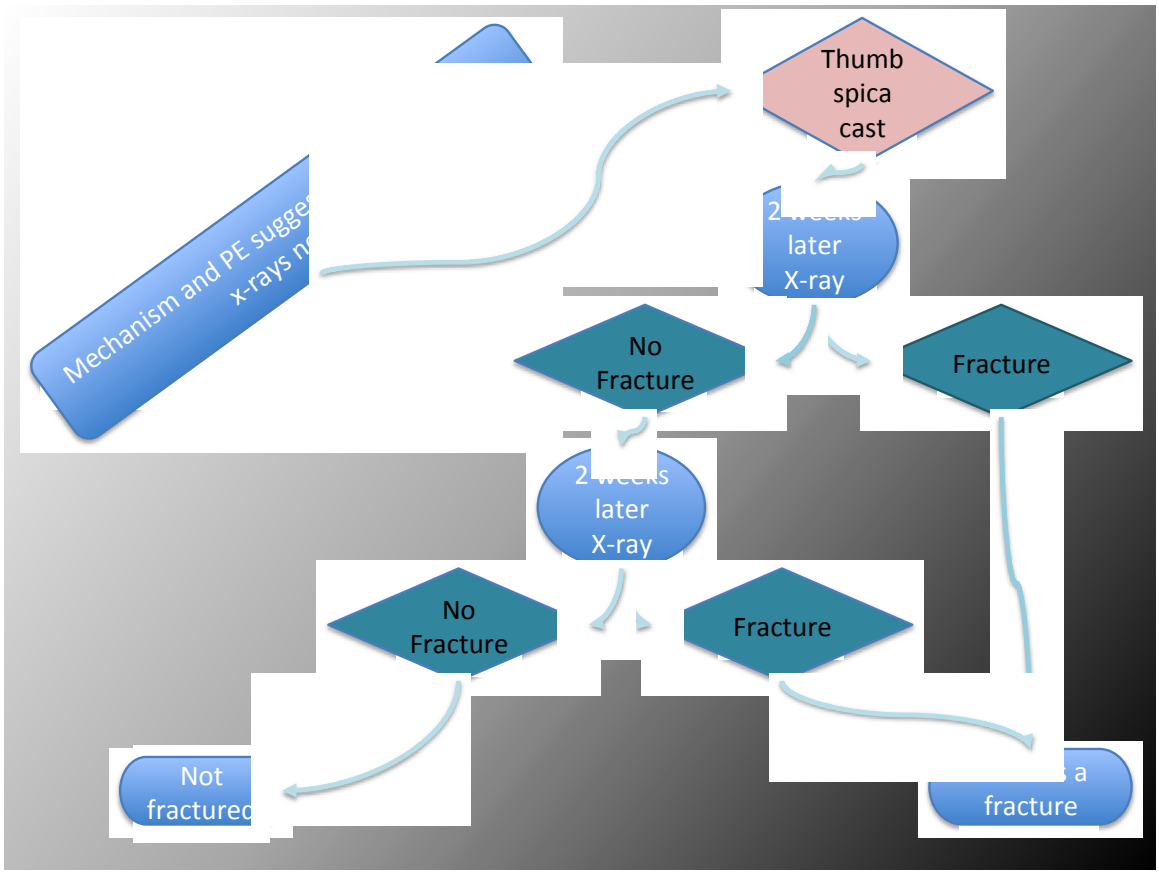

Figure 20-Russe's algorithm

Variations on this theme have been proposed with initial follow-ups at 1 week (16) and another with additional exams fortnightly extending for up to 6 weeks. (17)

This traditional conservative approach is very sensitive but not specific at picking up scaphoid fractures. 85% of the patients are unnecessarily immobilized in some studies. Many authors have questioned this approach citing expense, repeat visits, inconvenience, lost time from work for the patient, and protocol fatigue causing patients to abandon their follow-up. (18) Some authors even

question whether undisplaced fractures have the same natural history as displaced fractures. They suggest that all these occult, undisplaced fractures would heal very well without immobilization. (19) Exasperatingly, others question the very existence of the unseen fracture when adequate x-rays are taken. (13)
(This whole subject seems to be a bit of a mess.)

In order to increase the specificity of the initial physical exam, and decrease the false positive rate, investigators have changed the definition of clinical fracture to include patients with tenderness in the anatomic snuffbox, tenderness over the scaphoid tubercle, and longitudinal compression of the thumb tenderness. (15) As previously mentioned, this had 100% sensitivity and improved the specificity to 74%. This concept has the happy result of fewer over-treated patients.

Early use of advanced imaging has been proposed as an alternative approach to clinically following the occult scaphoid fracture over several weeks. The concept is: Discovery of a fracture at the initial visit will allow definitive treatment. If there is no fracture the patients are not subjected to the burdensome classic clinically guided protocol. The three advanced imaging modalities most likely to help in this area are CT, bone scan, and MRI. (Figure 21a, 21b)

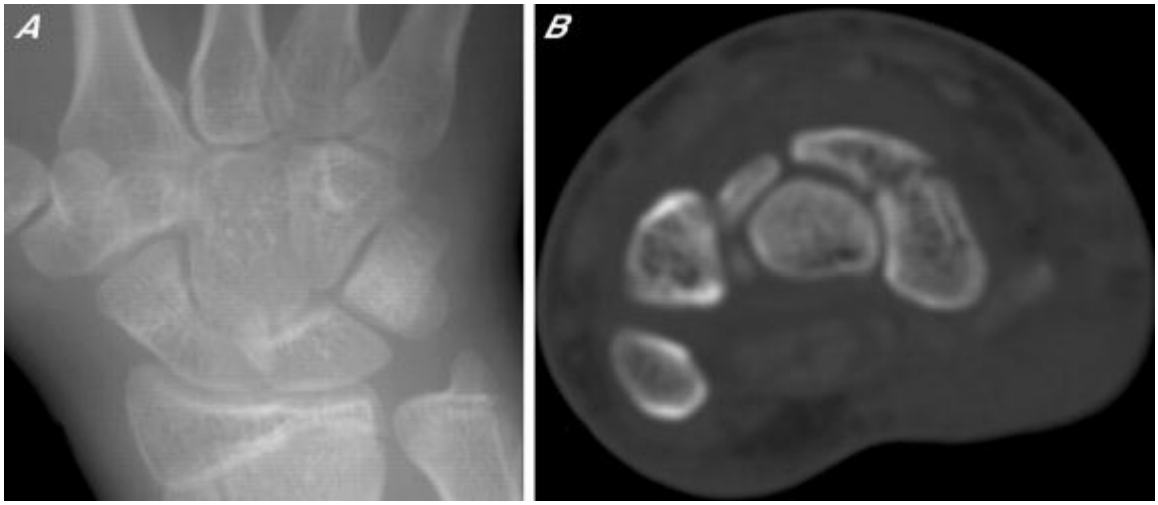

Figure 21a-Normal x-ray wrist (occult fracture) Figure 21b-Fracture of scaphoid waist revealed by CT

There are numerous studies comparing one to another and evaluating cost effectiveness. A recent meta-analysis by Yin summarizes the *heterogeneous* data, plagued by lack of a consistent gold standard, in a cogent manner. (Table 1)(9) (Isn't it always the case that meta-analyses are from heterogeneous data?)

	Sensitivity %	Specificity %	Pos likelihood	Neg likelihood
Bone Scan	**97**	**89**	**8.82**	**0.03**
CT Scan	**93**	**99**	**93**	**0.07**
MRI	**96**	**99**	**96**	**.04**

Table 1-Synopsis of Yin's data

Yin et al.'s conclusions are that: MRI is highly accurate for ruling in and ruling out scaphoid fractures, bone scintigraphy is only useful in ruling out scaphoid fractures, and that CT scan (due to lack of studies) requires more data to assess its proper place in the work-up. (9)

There are other advantages of initial advanced imaging. CT may pick up other occult wrist fractures, which as noted previously are not uncommon. Whether or not this would impact patient outcomes is unknown due to lack of data.

MRI is able to identify alternate causes of wrist pain (sprains, other fractures, etc.) Problems result from over-calling bone bruises as fractures. In addition, MRI has difficultly distinguishing subtle displacement of a fracture, which is important for the orthopedist to know when considering ORIF. Further, a small and as yet unpublished study found numerous false positive examinations and very poor interobserver reliability. They question the use of MRI as the gold standard. (20)

Diagnosis and best treatment has been debated by orthopedists for more than a generation with no clear resolution or even an undisputed gold standard test. It is fortunate that most of this debate is unimportant to emergency physicians. As much as things change, for us, they have stayed the same. It seems appropriate to still recommend initial treatment for a suspected scaphoid fracture is the same as for a definitive fracture, thumb spica splinting and referral to orthopedics for reevaluation as an outpatient in the 1-2 week time period.

The Solution

In the right setting examine a patient using all 3 physical examination tests for scaphoid bone fracture. X-ray with special scaphoid views. If occult fracture is suspected apply a thumb spica splint and refer to orthopedics for reevaluation in 1-2 weeks.

References (Scaphoid fracture):

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Clinically Suspected Scaphoid Fractures in Children
J Pediatr Orthop 2009;29:352-355

2) Haisman JM et al.
Acute Fractures of the Scaphoid
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Acute Fracture of the Scaphoid
J Am Acad Orthop Surg 2000;8:225-231

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Scaphoid tubercle tenderness: a better indicator of scaphoid fractures?
Archives of Emergency Medicine, 1989;6:46-50

5) Grover R
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J Hand Surg 1996;21B:341-343

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Clinical Signs in Scaphoid Fractures
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7) Parvizi J, et al.
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J Hand Surg 1998;23B:324-327

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Injury 1988;19:149-152

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18) Khalid M, et al.
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Fracture of the Carpal Navicular (Scaphoid) Bone: Gradations in Therapy Based upon Pathology
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Sam B. Sotted, a 23-year-old man fell during a Saturday sojourn. Sunday afternoon he visits the emergency department because his wrist hurts when he awakens. His friends have video of a "watch this" event. This video reveals Sam falling forward with the injured arm to the side breaking the fall. Examination demonstrates slight swelling dorsally and a little ecchymosis. There is no snuffbox tenderness. The lateral wrist x-ray reveals the avulsion fracture shown in Figure 1.

Figure 1

The problem:
What do I do with a dorsal avulsion fracture of the wrist?

Triquetrum Avulsion Fracture

The triquetrum is the second most commonly fractured carpal bone. Avulsion fracture of the dorsum is *the* most common fracture of the triquetrum. (1) This is because the dorsal process protrudes and is a site of attachment for numerous dorsal ligamentous structures. (Figures 2a, 2b)

Figure 2a

Figure 2b-Figure 2a with the dorsal triquetrum outlined in orange

The black dot in Figure 3 locates the dorsal process of the triquetrum.

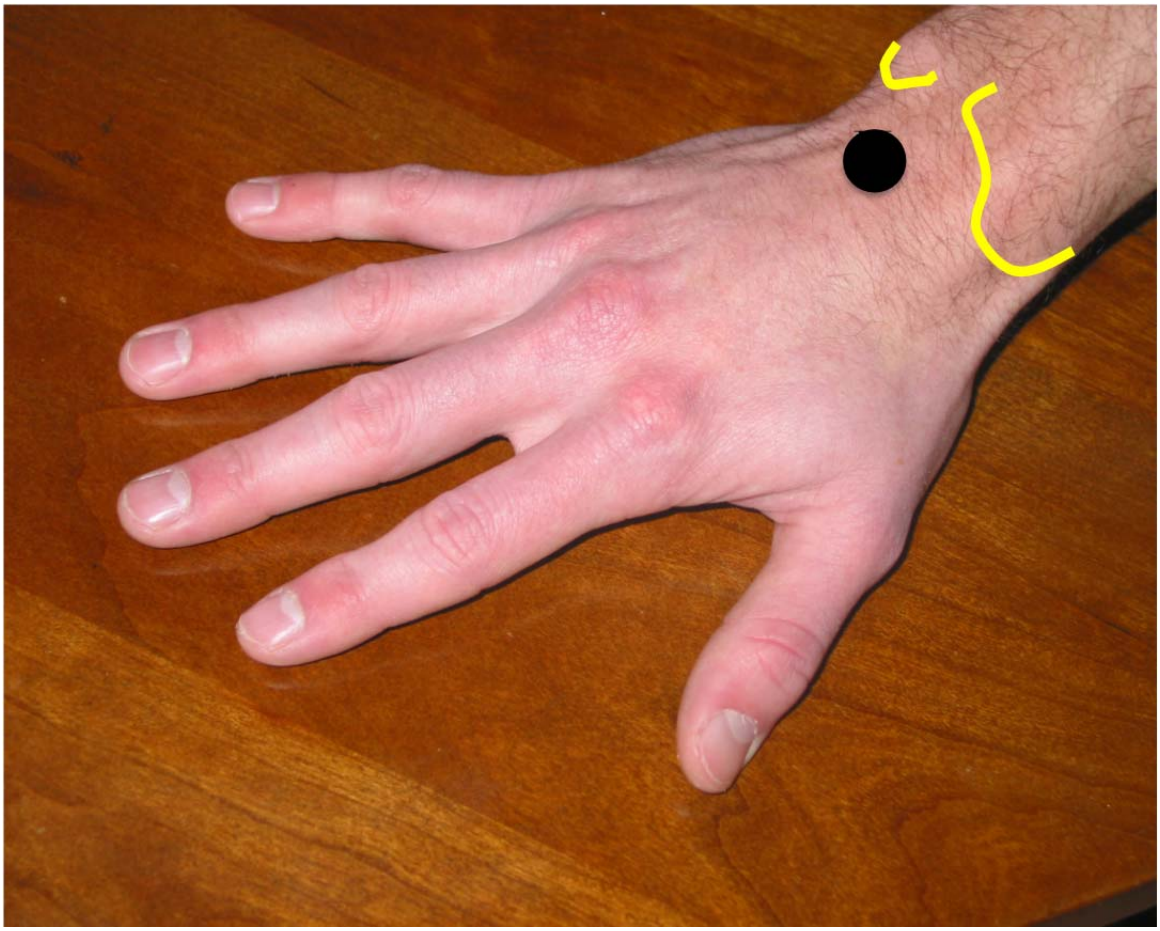

Figure 3-Location of dorsal process of the triquetrum indicated by a black dot

Mechanism of injury

There are two mechanisms for fracturing the dorsal prominence:
First, a fall with hyperextension of the wrist and ulnar deviation may cause the ulnar styloid to shear off the protruding prominence. (Figure 4)

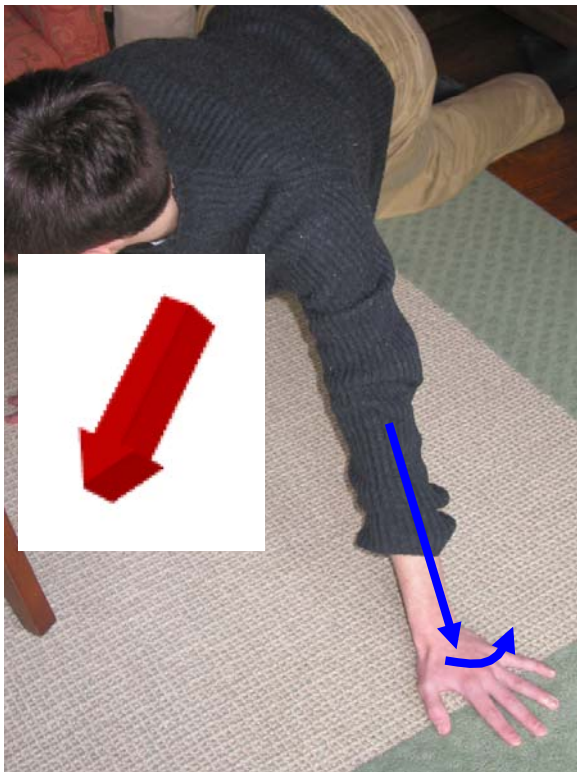

Figure 4-Sam B. Sotted's mechanism

The second mechanism is the more unusual fall with hyperflexion of the wrist and avulsion of the prominence by the attached ligaments. (1) (Figure 5)

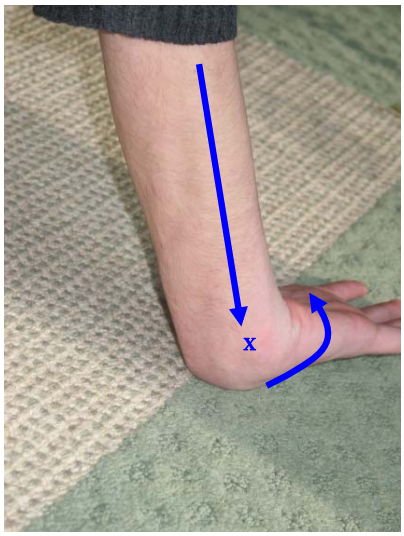

Figure 5-Triquetrum marked with X and forces with blue arrows

In all events, since the exact mechanism is rarely precisely known, a fall on the outstretched hand (FOSH) is the usual presenting mechanism of injury.

Imaging

X-rays will show the avulsion fracture in the lateral view. *There are no os calculi on the dorsum of the hand or wrist*. Consequently, all avulsion-type fragments that show up dorsally in the lateral wrist views are abnormal. If the fragment is not corticated, it invariably represents an acute avulsion fracture of the triquetrum. (Figures 6a, 6b, 7) If the avulsion is corticated, it is an old fracture. Careful attention to the dorsal process of the triquetrum in the lateral view is important to detect this subtle injury.

Figure 6a

Figure 6b-Figure 6a with the avulsion fracture of the triquetrum colored orange

Figure 7

Treatment
Treatment is short arm immobilization with an ulnar gauntlet gutter splint and referral for follow-up in the usual hand specialist/ortho/primary care pattern. 2 or 3 weeks immobilization may be all that is necessary for healing.

This is a fracture that is probably commonly missed. Patients heal well even if the avulsion fracture is not noticed on the x-rays. Avulsion fracture of the triquetrum is important to emergency physicians only as a matter of pride. Discovering the source of the patient's problem in a timely fashion is gratifying to both the physician and the patient.

The Solution
Dorsal avulsion fractures of the wrist are from the triquetrum and short arm immobilization with routine outpatient follow-up are appropriate.

References (Triquetrum avulsion fracture):

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Rockwood and Green Sixth Edition
Lippincott, Williams and Wilkins 2006

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G Kouris
emedicine.medscape.com/article/1238278 February, 2011

A 43-year-old woman presents to the ED with pain in the hypothenar eminence of her right hand of several weeks duration. The pain began when she was hitting a 7 iron out of the rough and it caught a branch ruining the shot (bummer) and bending the club (insult to injury). The last few days she has begun to have pain radiating into fingers four and five. X-rays are negative. Now what?

Hamulus (Hook of the Hamate) Fracture

The hamulus (hook of the hamate) is located in the hypothenar eminence. It is located easily by palpating the pisiform prominence which is on the ulnar side of the distal wrist crease. (Figure 1) The hamulus will be 1 cm away toward the center of the palm. (Figure 2)

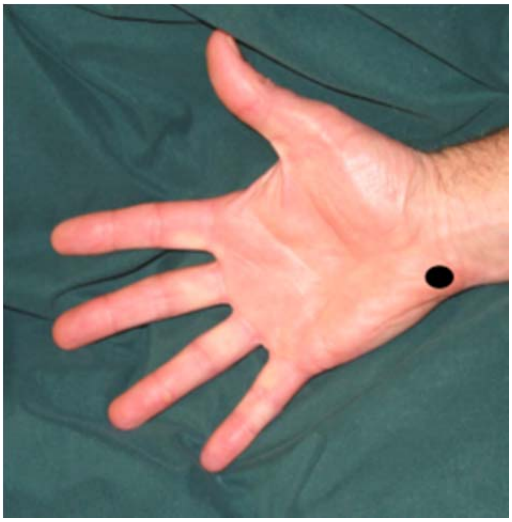

Figure 1-Pisiform marked with black circle

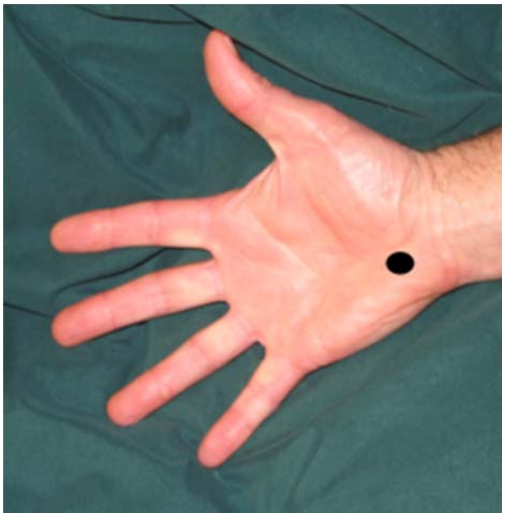

Figure 2-Hamulus marked by black circle

The hamulus serves as the attachment site for several ligaments and intrinsic muscles of the hand. It constitutes part of the ulnar border of the carpal tunnel and acts to redirect flexor digiti minimi toward the small finger. (Figure 3) It also acts as the superomedial border of Guyon's canal that contains the ulnar nerve. (Figures 4, 5) Consequently, damage to the hamulus may cause irritation of flexor digiti minimi or the ulnar nerve.

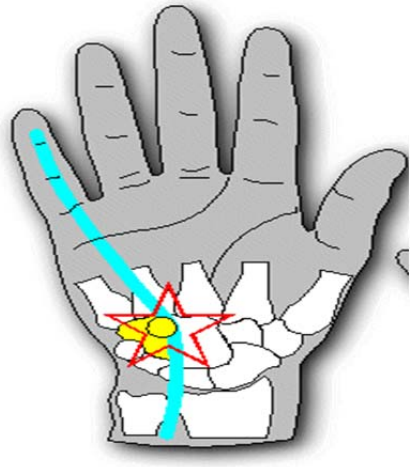

Figure 3-Hamulus redirecting flexor digiti minimi

Figure 4-Bony structure of Guyon's canal

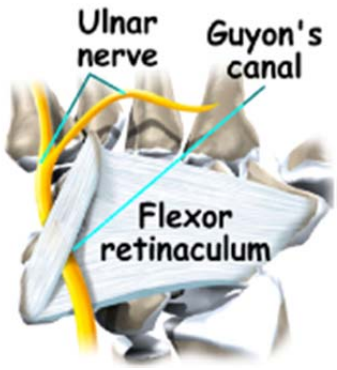

Figure 5-Guyon's canal with soft tissues

Mechanism

Hamulus injuries are most commonly caused by a direct blow to the hypothenar eminence base. This is frequent when the handle of a racquet, bat or club strikes the protuberant hamulus. Golf is the sport most commonly associated with this mechanism. (8,9) A direct blow to the hamulus is caused by the handle of a golf club when the club face strikes an immovable object. (2,3) (Figure 6)

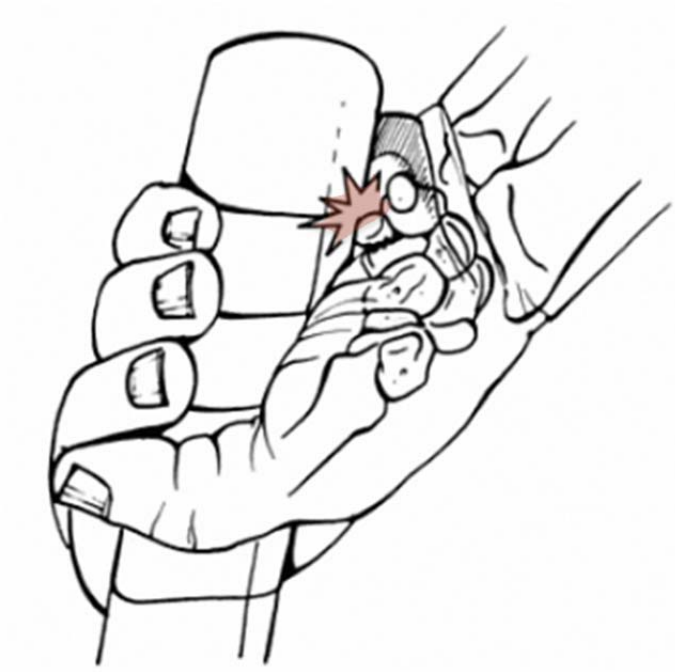

Figure 6

Other sports that involve racquet or bat use may injure the hamulus in the same way. (1,8,9)

Direct blows (crush injuries) are frequent mechanisms of injury of the hamulus. FOSH injuries also are associated with hamulus fractures in every series. The mechanism of fracture may be a direct blow to the hamulus during the fall, but it could also be an avulsion fracture from traction on the hamulus by the support structures that use the hamulus as an attachment site. (1,8,9)

One additional and interesting mechanism of hamulus injury is repeated minor trauma. This repetition results in a stress fracture. Thus, the patient presents with the same symptoms as a patient with a direct blow but without the obvious instigating injury. Stress fractures are described in racquet sports but can occur in other activities such as bouldering. (4) Though there are no large series and hamulus fracture is an unusual condition, golfers seem particularly prone to this stress injury in their nondominant hand (lead hand in the golf swing). (5)

Symptoms and Signs

The patient usually demonstrates the expected pain and tenderness in the base of the hypothenar eminence, pain with gripping, pain with dorsiulnar deviation of the wrist, and pain with flexion of finger 5 if the flexor digiti minimi is irritated by the fracture. (3) (Figure 7)

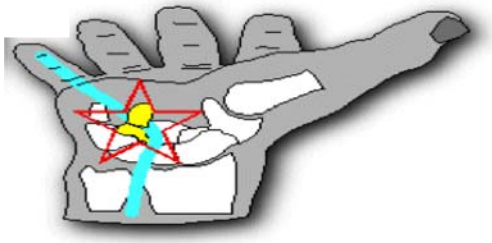

Figure 7-Flexor digiti minimi irritated by a fractured hamulus

Dorsal wrist pain is often felt over the body of the hamate, which is fairly superficial dorsally. Paresthesias along the ulnar nerve may result from impingement of the nerve in Guyon's canal. (Figure 8)

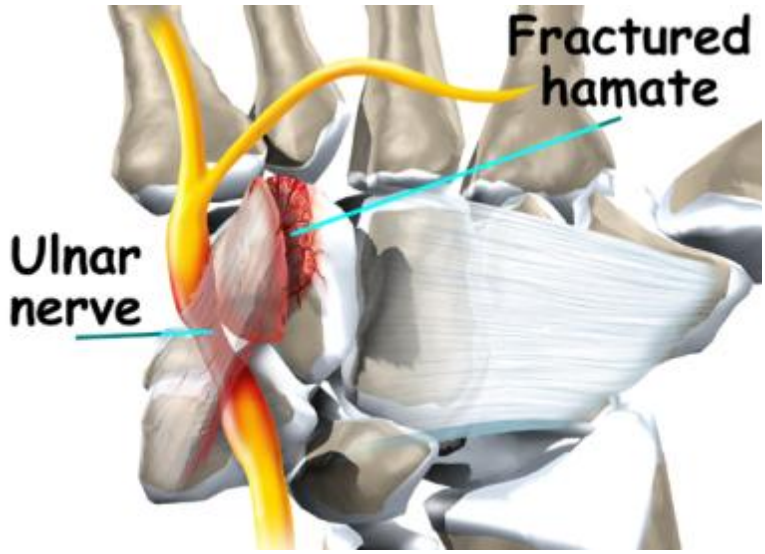

Figure 8-Impingement of the ulnar nerve in Guyon's canal

Chronic hamulus injuries often have mild carpal tunnel syndrome symptoms that are common but not specific. (3)

The Problem
Hamulus fractures do not show up well in plain wrist or hand films.

Standard wrist x-rays include AP, lateral and oblique views. This does not show the hamulus well or at all. The plain x-ray view most likely to delineate this fracture is the carpal tunnel view. How this x-ray is performed is demonstrated in Figure 9.

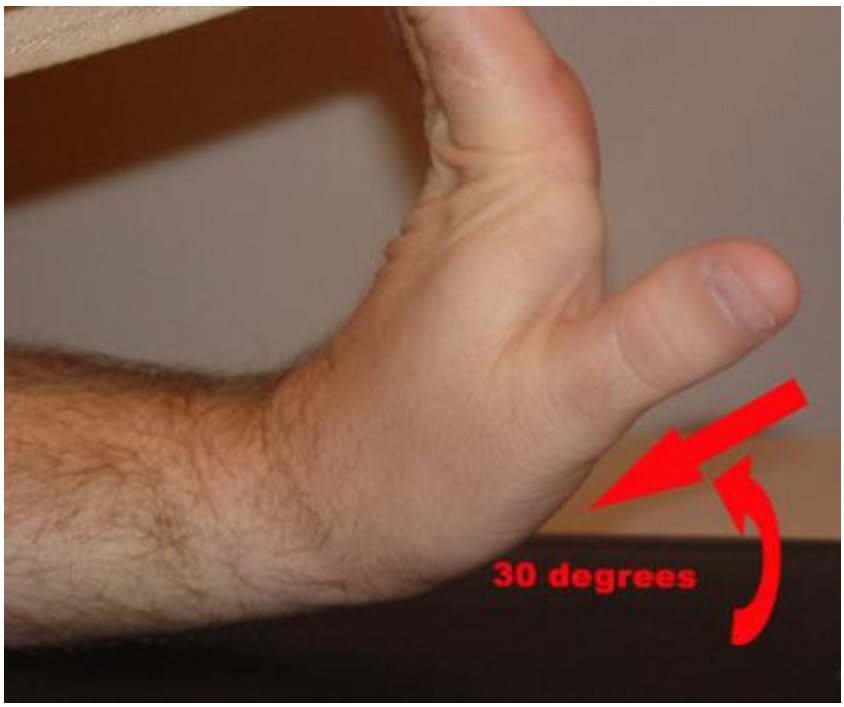

Figure 9-Wrist position for a carpal tunnel x-ray

The carpal tunnel view appears as shown in Figure 10.

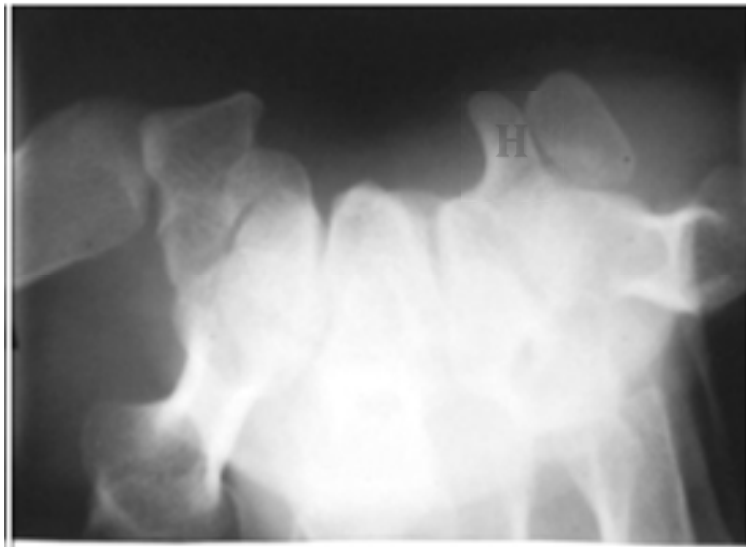

Figure 10-Carpal tunnel view (hamulus marked with H)

X-rays of hamulus fractures are shown in Figures 11a, 11b and 12.

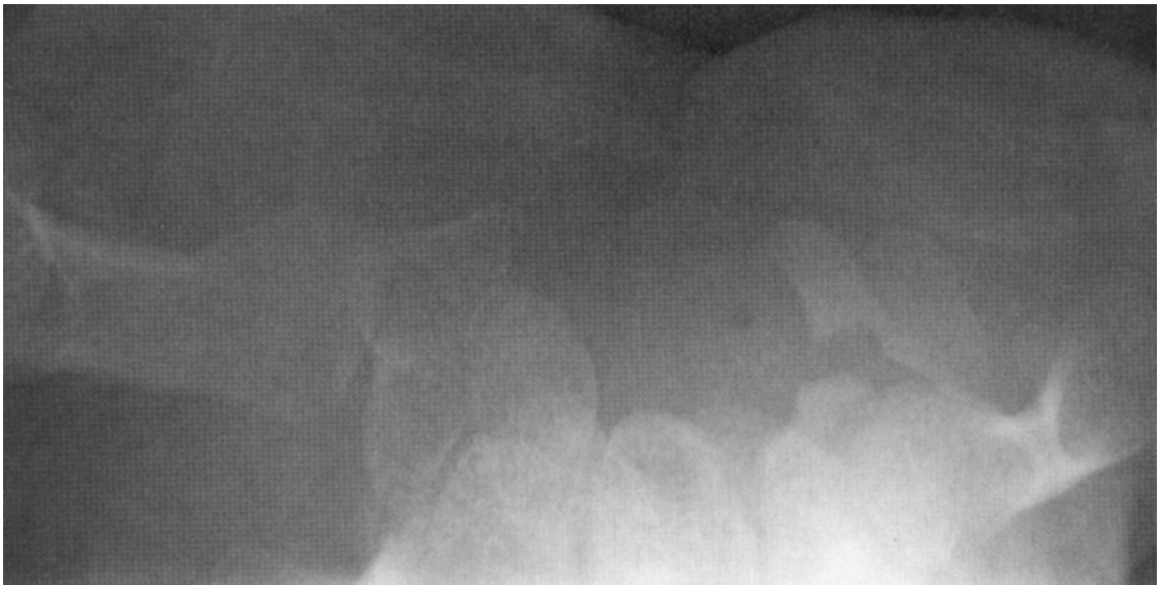

Figure 11a-Fracture of the hamulus

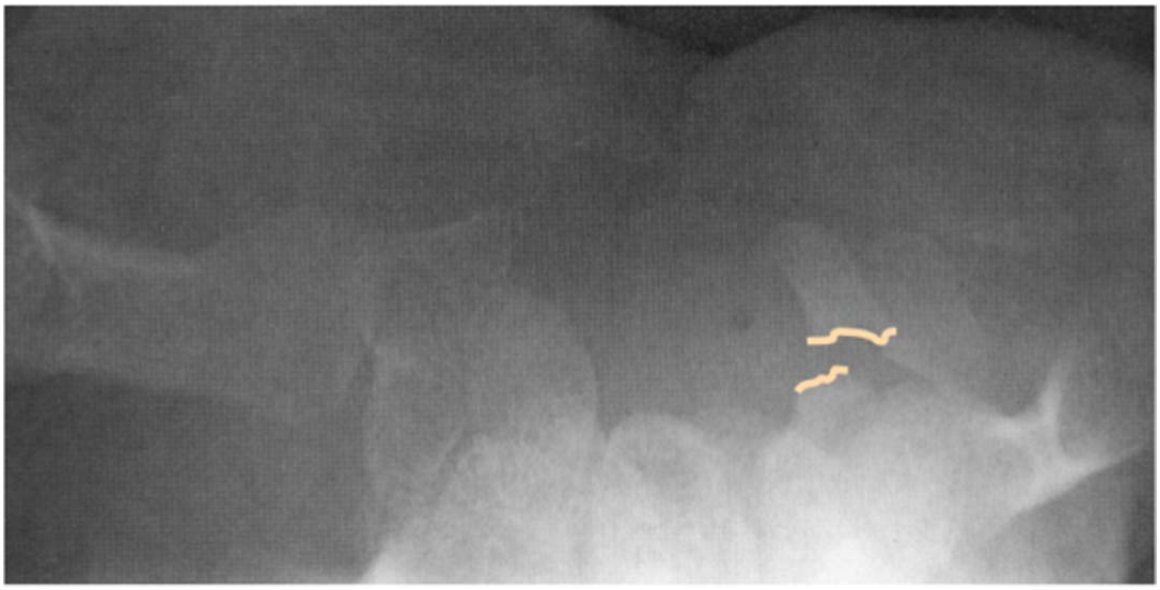

Figure 11b-Figure 11a with fracture marked by flesh colored lines

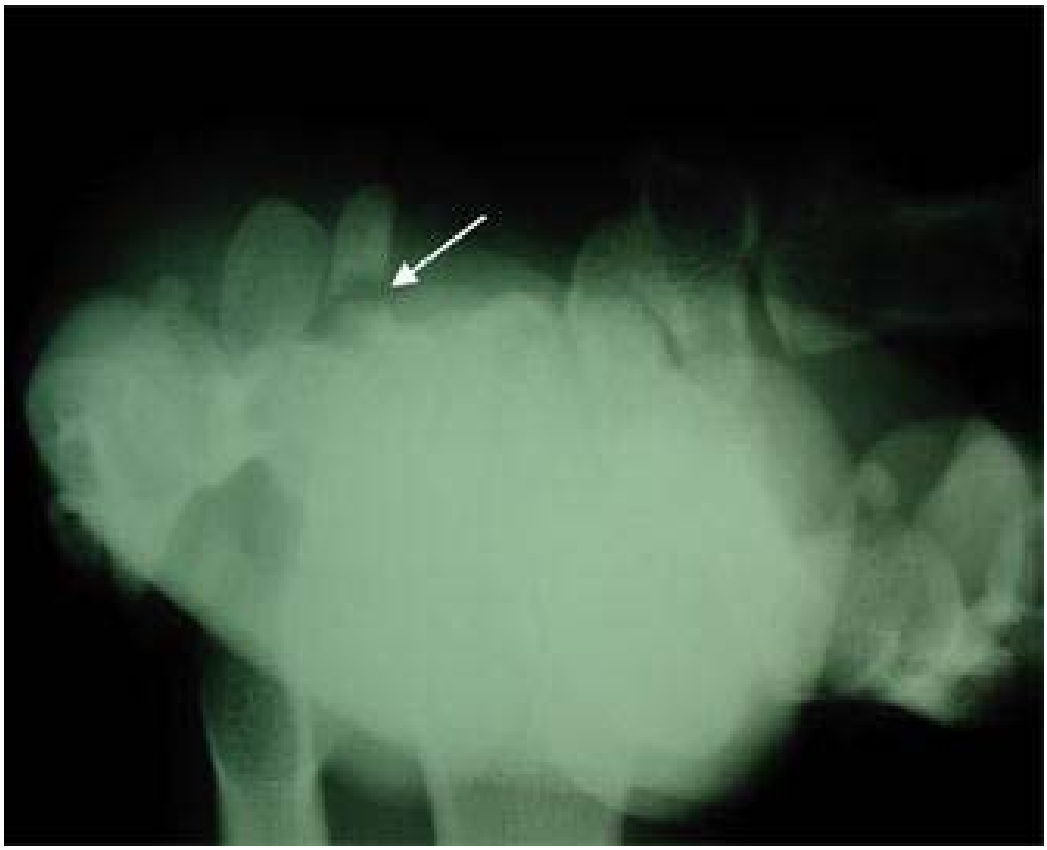

Figure 12-Hamulus fracture indicated by arrow

Plain films with carpal tunnel view had a sensitivity of finding a fracture of the hamulus of 70% and 53% in two small series each including 14 patients. (3,8)

Pain in an acute injury may prevent proper positioning of the wrist for the carpal tunnel view x-ray. If suspicion is high and adequate plain films cannot be obtained, CT of the wrist may be useful. (4,6) Some authors even say not to bother with special plain films and go directly to CT to make the diagnosis. (9) (Figures 13a, 13b, 14a, 14b, 15)

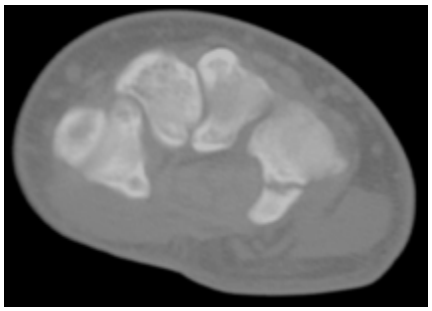

Figure 13a-Fracture hamulus on CT

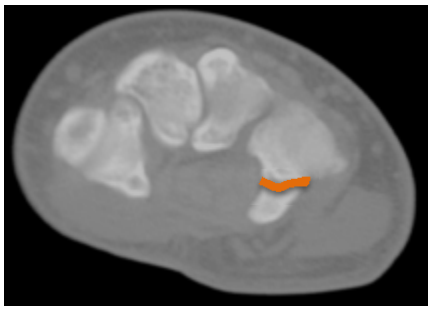

Figure 13b-Figure 13a with fracture outlined in orange

Figure 14a-Fracture hamulus on CT

Figure 14b-Figure 14a with fracture outlined in orange

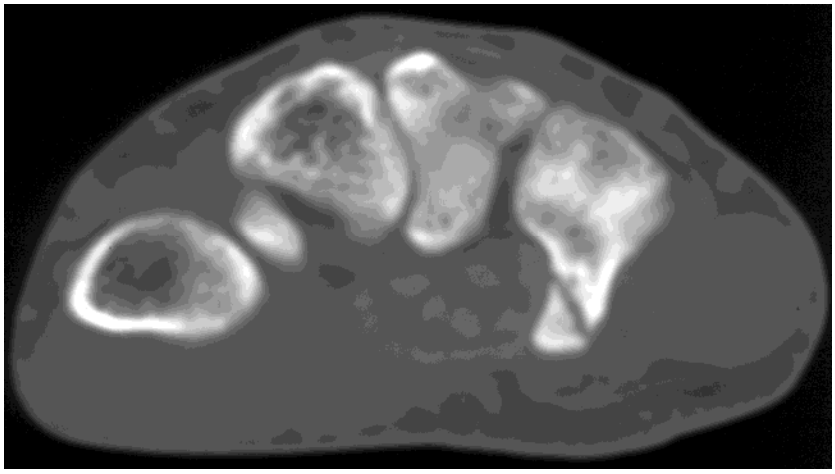

Figure 15-Hamulus tip fracture on CT

MRI is also a modality that may reveal a difficult hamulus fracture. (Figure 16a, 16b)

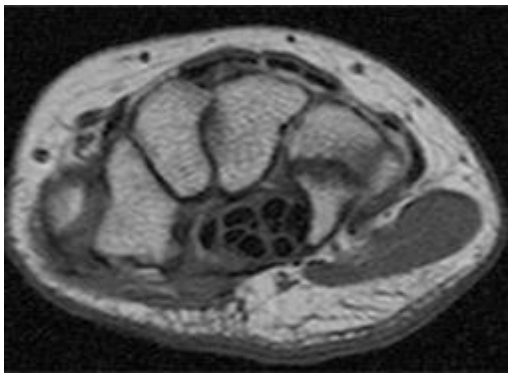

Figure 16a-Hamulus fracture on MRI

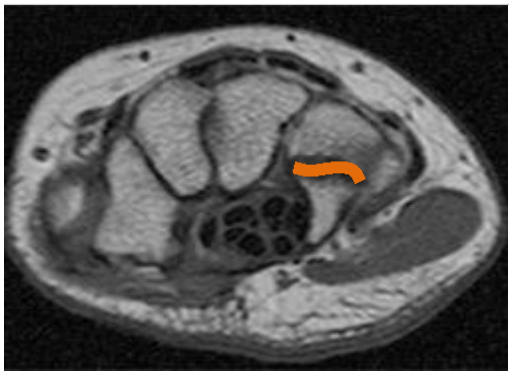

Figure 16b-Figure 16a with fracture outlined in orange

Treatment
Controversy surrounds the treatment of this injury. This stems from a plethora of problems: lack of any randomized controlled trials, small case series making up the bulk of the relevant information, and inclusion bias confounding these same series.

The initial injury of the hamulus is often ignored by the patients or undiagnosed by the physicians at their initial visit. The injury is usually diagnosed by an orthopedist when there is already chronic pain. (8,9) The patients in many case series have good results with removal of the hamulus. Therefore, several authors believe that excision is the treatment of choice. (7) Nevertheless, some authors feel ORIF is effective and preferable. (3) Fortunately, emergency physicians do not have to decide between these options.

On the other hand, there are some patients in these same small case series with acute fractures treated with short arm gauntlet splinting for 6-12 weeks that heal well. (10,8) Whalen, et al. had a series of 6 patients that all healed with casting. All but one of these patients was not diagnosed at the initial visit but each person was initially immobilized and follow-up arranged. It would seem that good results are attainable without surgery if the diagnosis is made during the initial visit. (3,7,8)

Since hamulus fractures are often initially ignored by the patient and easily missed by the unwary physician, it is possible that hamulus fractures are much more common than the reported 2% of carpal bones and may have a more benign course than the literature suggests. There is clearly an inclusion bias in case series that are reported by hand specialists that include only patients that are still having trouble weeks, months and years after the injury. It is quite possible that the natural history of the hamulus fracture is to heal well without any intervention at all. It is also possible that early discovery and immobilization will decrease the incidence of chronic problems. Perhaps, early diagnosis is where emergency physicians can make a difference.

The Solution
The emergency physician should be aware that injuries of the hypothenar eminence, **especially if *golf* related**, may be hamulus fractures. These patients should be imaged appropriately (carpal tunnel view, possibly CT scan). Short arm, ulnar, gauntlet immobilization and referral to hand surgery for follow up is likely to obtain the best results for the patient.

References (Hamulus fracture):

1) Guha AR, Marynissen H
Stress Fracture of the Hook of the Hamate
Br J Sports Med 2002;**36**:224-225

2) Evans MW
Hamate Hook Fracture in a 17-Year-old Golfer: Importance of Matching Symptoms to Clinical Evidence
Journal of Manipulative and Physiological Therapeutics 2003;27:516-518

3) Scheufler O, Andresen R, et al.
Hook of Hamate Fractures: Critical Evaluation of Different Therapeutic Procedures
Plastic and Reconstructive Surgery 2005;115:488-497

4) Williams G, Roche A
Stress fracture of the hook of the hamate as a result of intensive climbing
J Hand Surg 2009;34E:276-277

5) Aldridge JA, Mallon WJ
Hook of the Hamate Fractures in Competitive Golfers: Results of Treatment by Excision of the Fractured Hook of the Hamate
Orthopedics 2003;26:717-718

6) Gill NW, Rendeiro DG
Hook of the Hamate Fracture
J Ortho and Sports Phy Therapy 2010;40:45-47

7) Hirano K, Inoue G
Classification and Treatment of Hamate Fractures
Hand Surg 2005;10:151-157

8) Bishop AT, Beckenbaugh RD
Fracture of the Hamate Hook
J Hand Surg 1988;13A:135-139

9) Kato H, et al.
Diagnostic Imaging for Fracture of the Hook of the Hamate
Hand Surg 2000;5:19-24

10) Whalen JL, Bishop AT, Linscheid RL
Nonoperative treatment of acute hamate hook fractures
J Hand Surg 1992;17A:507-511

Punch Injuries

A 20-year-old man presents to your ED Sunday afternoon with right hand pain. He is not sure how he was injured. In fact, he is unsure of most of the previous night's activities.

Post pugilistic problems of the hand are common. Is boxer's fracture the whole story? Is there anything else to worry about?

The Problem
Some post fight hand injuries require special attention and some even do best with surgery. Which ones are they?

Boxer's fracture (Fifth metacarpal neck fracture)

A direct blow to the fifth metacarpal head while the metacarpophalangeal joint (MCP) is in flexion (as in a clenched fist) may fracture the relatively weak metacarpal neck. (Figure 1)

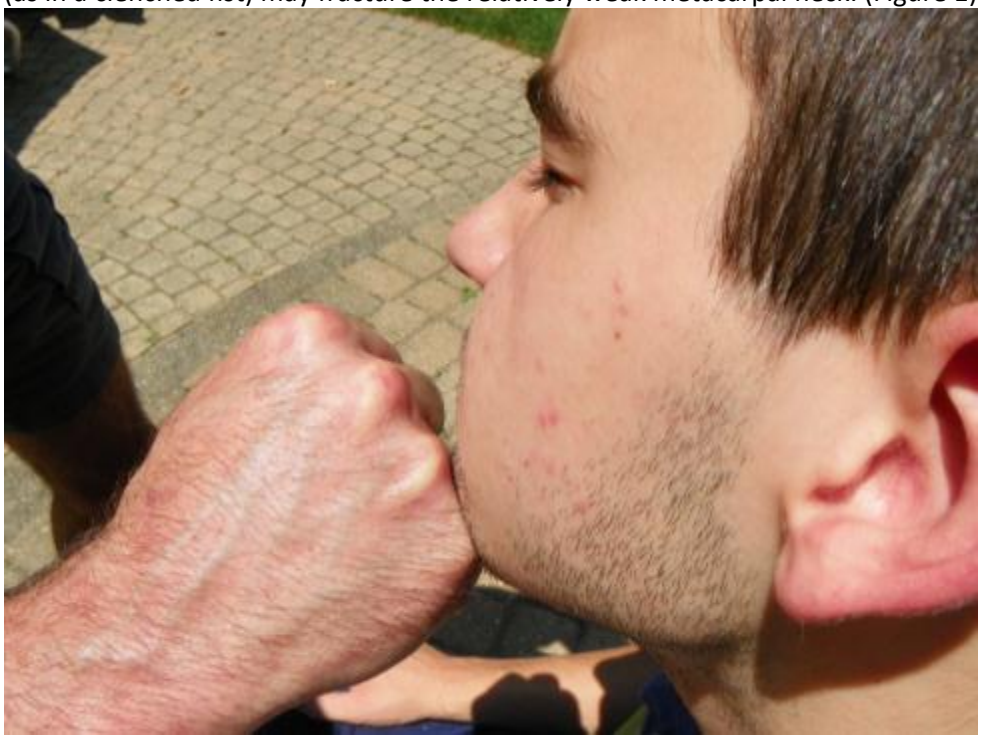

Figure 1

This is the most common hand injury accounting for up to 1/3 of all hand fractures (finger injury is a separate category). (1) Interestingly, this injury very rarely occurs in professional boxers. Rather, it is associated with amateur pugilistic incidents. A more apropos name for this injury has been suggested: 'brawler's fracture.' This is more mechanistically descriptive. (1) Unfortunately, this was never adopted and the moniker remains 'boxer's fracture.'

Diagnosis is not difficult since plain films clearly delineate the problem. (Figures 2a, 2b, 3)

Figure 2a-Fracture fifth metacarpal neck

Figure 2b-Figure 2a with fracture outlined in orange

Figure 3-Fracture distal fifth metacarpal

These fractures all have volar angulation. (Figure 4)

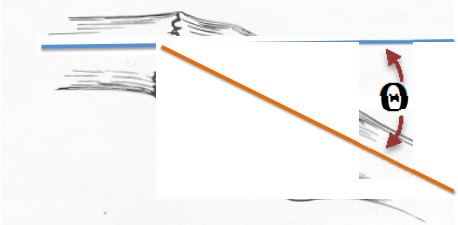

Figure 4-Volar angulation marked with Θ

How much volar angulation is acceptable in a healed metacarpal neck fracture? Some background helps answer this question.

The carpometacarpal (CMC) joints of fingers 2 and 3 allow no motion since they form the center and fixed skeletal unit of the hand. (1,2) In contradistinction, CMC joint 4 has significant motion and CMC joint 5 a great deal more. This mobility is demonstrated by the amount of excursion of the metacarpal heads when clenching a fist. (Figures 5a, 5b, 6a, 6b)

Figure 5a-Fist

Figure 5b-Clenched fist

Figure 6a-Fist **Figure 6b-Clenched fist**

This increased motion of CMC joints 4 and 5, as well as the extraordinary mobility of the thumb CMC joint, permits opposition and the familiar hand dexterity. The increased mobility also permits more metacarpal angular deformity without functional compromise. (3, 4) Good functional results are thus possible despite significant volar angulation of some of the metacarpal heads. Figure 7 displays the generally acceptable angular deformity of the MCP joint (although there is some dispute about the optimum amounts). (3)

Figure 7-Degree of acceptable volar angulation of the metacarpal neck not requiring further reduction

Hence, the fifth MCP joint, which is the most mobile, also tolerates the most volar angulation. In fact, sometimes very large angulations (much in excess of that demonstrated above) are associated with a good outcome.

Treatment

Although angulation may be acceptable with boxer's fracture some reduction is often desirable. This is usually a closed reduction after a metacarpal block. The proximal phalanx is used as a lever arm to force the metacarpal head up. (Figure 8)

Figure 8-Reduction of fifth metacarpal neck fracture

A well-molded short arm, ulnar, gauntlet, gutter splint is applied. Surgery is very rarely necessary. Follow-up within a week with primary care or a hand/orthopedic specialist is appropriate depending on the local referral patterns.

Transverse Midshaft Metacarpal Fractures

Transverse, midshaft, metacarpal fractures typically occur from a blow to the metacarpal head (fight injury) (5) or a direct blow to the dorsal hand. (3)

X-ray will clearly show the dorsal tilt of the shaft and volar angulation of the metacarpal head. These fractures are easy to reduce but it is difficult to maintain the reduction in a cast. Why is that?

Recollection of pertinent anatomy answers the question elegantly. The interosseous muscles are attached proximally and distally in a way that tends to displace this fracture in the direction of its original injury. (Figures 1, 2, 3)

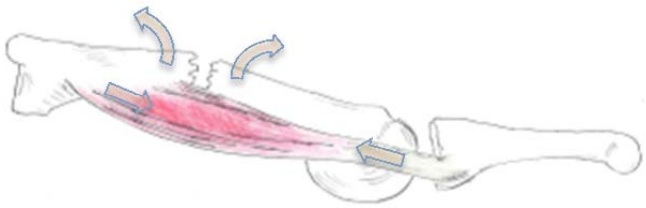

Figure 1-Transverse metacarpal fracture Figure 2-Forces acting to displace the transverse metacarpal

Figure 3

Dorsal angulation may lead to a persistent bony deformity and irritation of the extensor tendon as it passes nearby. This may contribute to tendon rupture. The acceptable volar angle is the same as that for MCP joints and is virtually none in fingers 2 and 3 with 20 degrees in finger 4 and 30 degrees in finger 5. (3)

Treatment

Gauntlet immobilization and referral to the hand/ortho specialist is appropriate. Definitive treatment usually involves surgery. (Figure 4)

Figure 4-Repair of transverse metacarpal fracture

Oblique Metacarpal Fractures

A rotational force with the finger acting as the long lever arm may cause an oblique metacarpal fracture. This spiral fracture has a tendency to shorten and rotate as time passes.

The oblique metacarpal fracture shortening is less pronounced in fingers 3 and 4 due to the tethering of the metacarpal heads as opposed to fingers 2 and 5, which are only tethered on one side. (Figure 1)

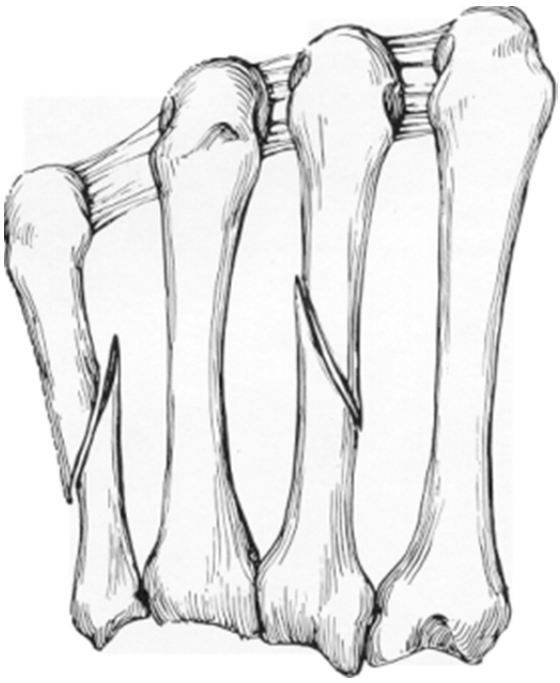

Figure 1-Tethering of the metacarpal heads

This shortening is significant for hand function in that 2 mm of shortening causes 7° less extension of the MCP joint. (3)

As much a problem as shortening of the metacarpal is, a more critical problem is rotational deformity. The fingers must come together in an organized fashion to permit grasping. In an uninjured state the partially closed hand will have all the fingers line up pointing at the medial radius. (Figure 2)

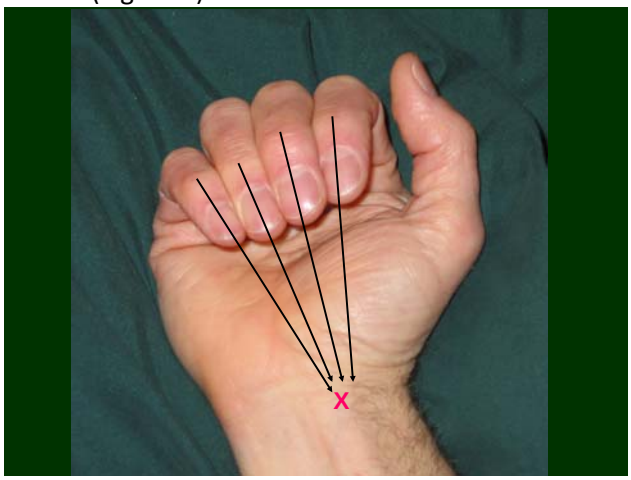

Figure 2-Alignment of the fingers in a normally closing hand

5 degrees of metacarpal shaft rotation results in 1.5 cm of digit overlap while making a fist. (3) Any rotation will manifest as overlap or finger scissoring and can be very debilitating. (3) (Figure 3)

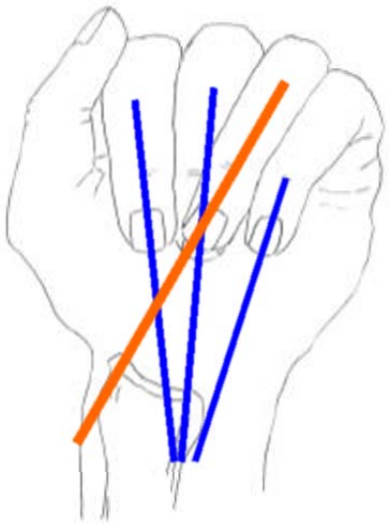

Figure 3-Rotational deformity of metacarpal causing finger overlap

Imaging

Oblique fractures may be obvious on routine hand x-rays. Nevertheless, occasionally an undisplaced oblique fracture is subtle, seen only in one image, and with difficulty. (Figures 4a, 4b, 5a, 5b, 5c, 5d, 6)

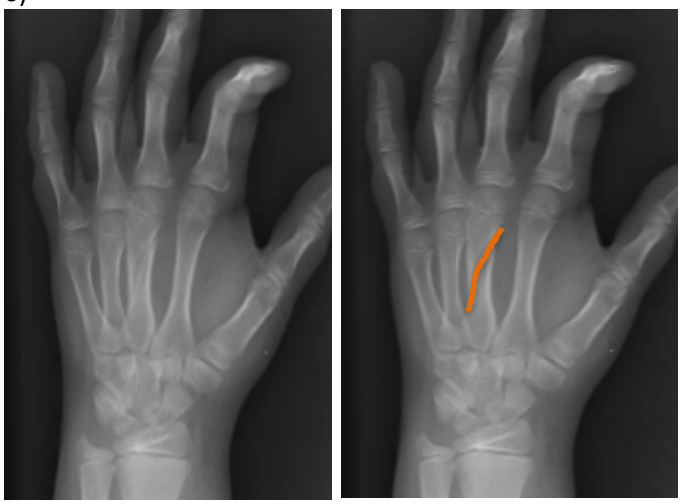

Figure 4a Figure 4b-Figure 4a with fracture in orange

Figure 5a

Figure 5b-Figure 5a with subtle fracture in orange

Figure 5c

Figure 5d-Figure 5c with fracture in orange

Figure 6-Oblique fracture proximal fifth metacarpal

Notice how much less displaced and more difficult it is to see the fracture in Figures 4 and 5 than in Figure 6. This is related to the tethering of the metacarpal heads. (Figure 1 and below)

Treatment

Oblique fractures tend to shorten and rotate with time-even in a cast. Consequently, definitive treatment is almost always operative.

Emergency treatment consists of gauntlet immobilization and referral to a hand/orthopedic specialist within a week.

References (Metacarpal fractures):

1) Gudmundsen TE, Borgen L
Fractures of the Fifth Metacarpal
Acta Radiologica 2009;3:296-300

2) Melone CP, et al.
Disabling Hand Injuries in Boxing: Boxer's Knuckle and Traumatic Carpal Boss
Clin Sports Med 2009;28:609-621

3) McNemar TB, et al.
Management of Metacarpal Fractures
J Hand Ther 2003;16:143-151

4) Singletary S, Freeland AE, Jarrett CA

Metacarpal Fractures in Athletes: Treatment, Rehabilitation and Safe Early Return to Play
J Hand Ther 2003;16:171-179

5) Soong M, Got C, Kararincic J
Ring and Little Finger Metacarpal Fractures: Mechanisms, Locations, and Radiographic Parameters
J Hand Surg 2010;35A:1256-1259

Bennett's Fracture

Fractures that have a surgeon's eponym are almost always associated with a problem injury. Bennett's fracture is not an exception. The mechanism of injury frequently involves an errant punch that delivers an axial load to the first metacarpal head. The force is transmitted to the base of the first metacarpal resulting in a fracture and usually a concomitant dislocation. (Figures 1, 2)

Figure 1

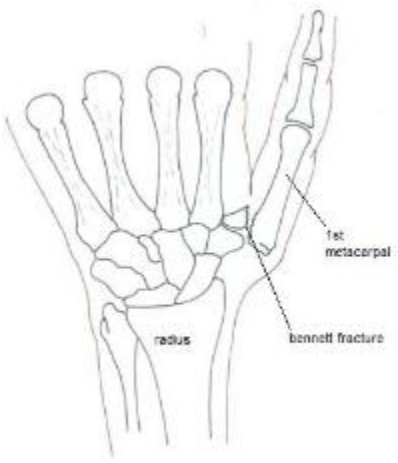

Figure 2

The following x-rays demonstrate a variety of presentations of this fracture. (Figures 3a, 3b, 4a, 4b, 5a, 5b, 6a, 6b)

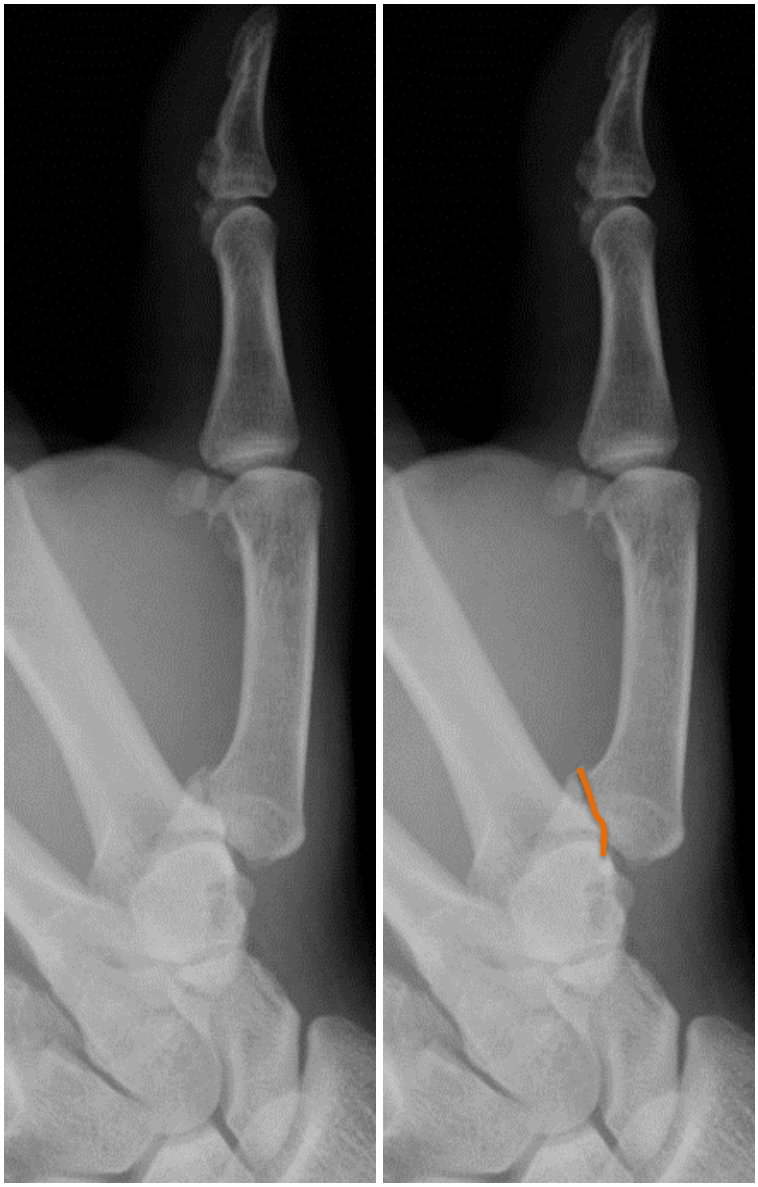

Figure 3a-Bennett's fracture Figure 3b-Figure 3a with fracture outlined in orange

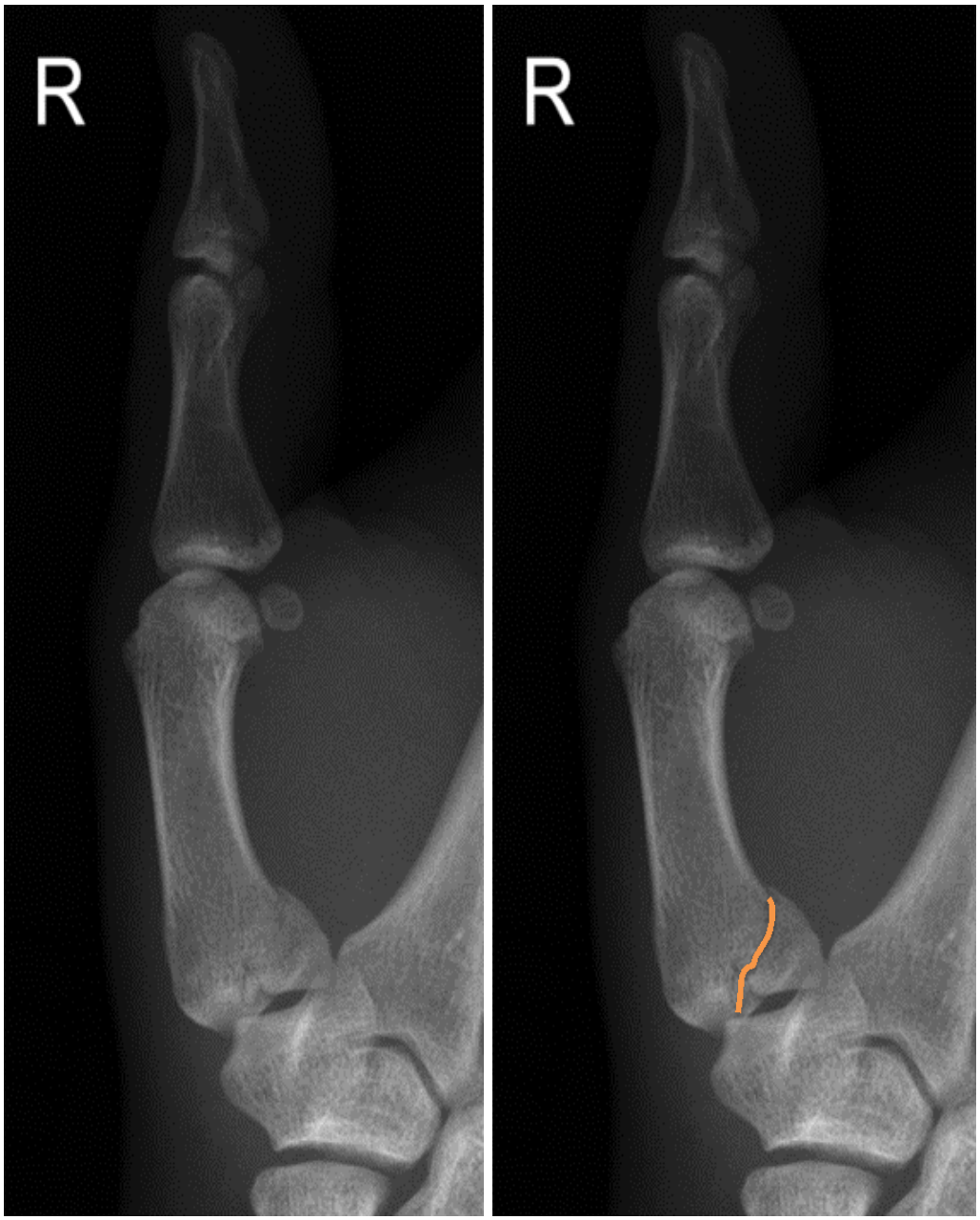

Figure 4a-Bennett's fracture **Figure 4b-Figure 4a with fracture outlined in orange**

Figure 5a-Bennett's fracture **Figure 5b-Figure 5a with fracture outlined in orange**

Figure 6a-Displaced Bennett's fracture Figure 6b-Figure 6a with fracture fragment colored orange

The problem with this fracture is that the powerful muscle abductor pollucis longus is attached to the proximal end of the dislocated piece of metacarpal continuing to displace it. To make matters worse the adductor hallucis it attached to the distal end of the same piece of metacarpal also contributing to its displacement. (Figure 7)

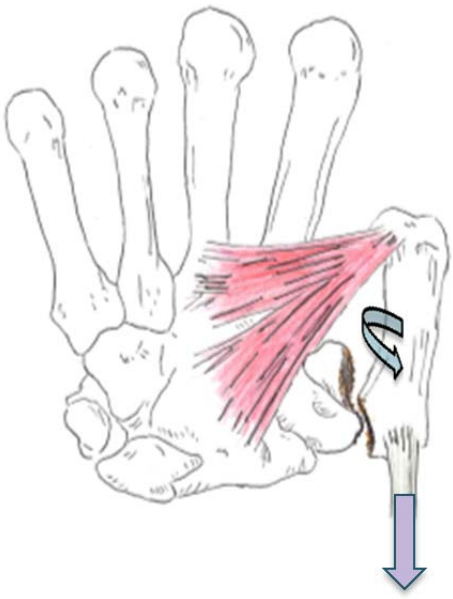

Figure 7-Forces acting on Bennett's fracture

Treatment

The highly mobile first CMC joint usually heals with significant arthritis if the bone isn't accurately reduced. The distracting forces of adductor hallucis and abductor pollicis longus prevent a closed reduction from being maintained in a cast. Thus, it does not stay reduced without surgery and invariably gets it.

Emergency physicians should apply thumb spica immobilization and refer to hand/orthopedic specialist for outpatient surgery. (1,2)

References (Bennett's fracture):
1) Huang JI, Fernandez DL

Fractures of the Base of the Thumb Metacarpal

AAOS Instructional Course Lectures 2010;59:343-356

2) Carlesen BT, Moran SL

Thumb Trauma: Bennett Fractures, Rolando Fractures, and Ulnar Collateral Ligament Injuries

J Hand Surg 2009;34A:945-952

FOR A FEW FRACTURES MORE

Fights may lead to additional fractures and dislocations. Some of these can be subtle and easily overlooked. Among these are metacarpal base fractures, metacarpal head fractures, and dislocations of the CMC joints. The canny physician should be aware of these injuries when examining a pugilist.

Metacapal Base Fractures

Metacarpal base fractures are caused by a stong axial load along the metacarpal and may result from pugilisitic activities. (1) (Figures 1a, 1b, 2a, 2b, 2c)

Figure 1-Metacarpal base fracture

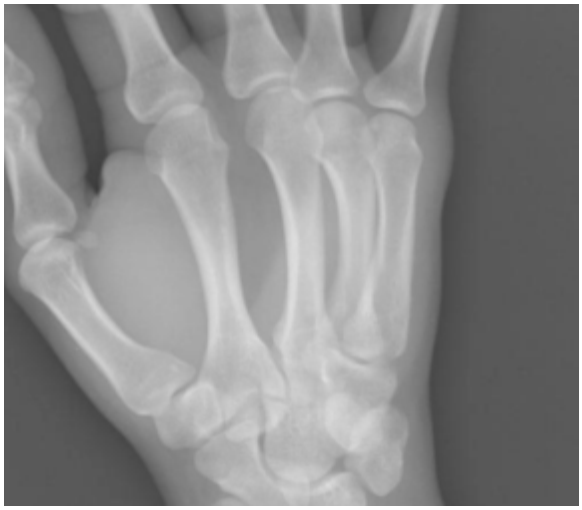

Figure 2a-Fracture base of fifth metacarpal

Figure 2b-Figure 2a enlarged

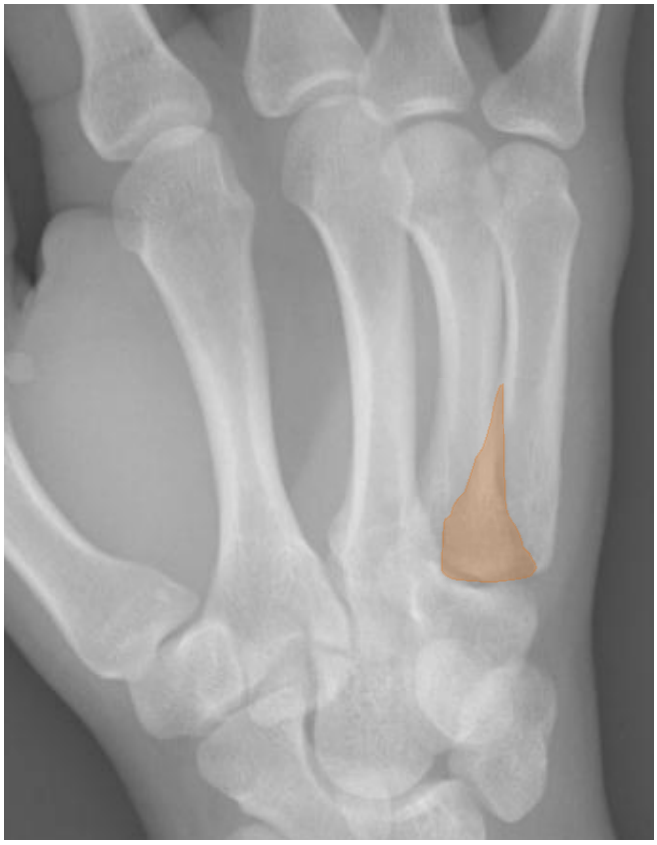

Figure 2c-Figure 2b with the fracture fragment colored orange

Figure 2 demonstrates how subtle these fractures may be. Look carefully for these fractures when circumstances warrant.

Treatment
Intraarticular metacarpal base fractures usually require surgery for best results. The ED treatment is a gauntlet immobilization and referral to hand/orthopedic specialist for definitive care.

Carpometacarpal (CMC) Dislocation

Occasionally a blow to the metacarpal head causes a dislocation of the carpometacarpal (CMC) joint. These injuries will be associated with pain, deformity and tenderness in the dorsal proximal hand. Examination of this area usually suggests the CMC dislocation.

Standard hand films will show the injury but it can be subtle if the physician is not cognizant of the possibility. (Figure 3a, 3b)

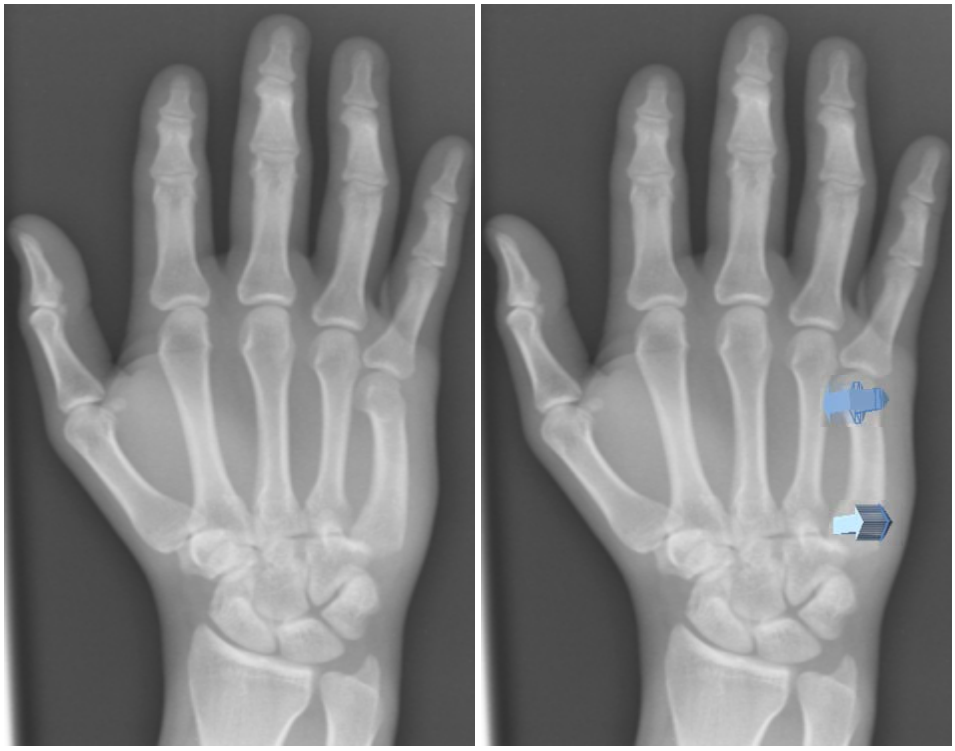

Figure 3a-Dislocated fifth CMC joint **Figure 3b-Figure 3a Direction of fifth metacarpal**

This injury is somewhat subtle and best seen in the lateral view of the same patient. (Figures 3c, 3d)

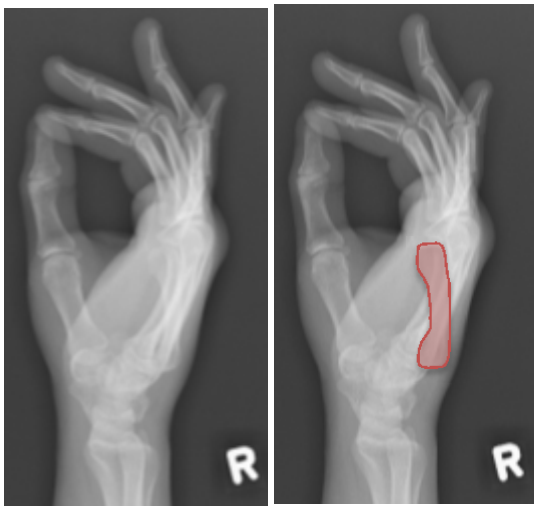

Figure 3c **Figure 3d-Figure 3c with dislocated fifth CMC colored red**

In the long run a CMC joint instability may lead to chronic pain, metacarpal boss deformity (2) and require arthrodesis. Consequently, surgery is usually required for optimum outcome. (Figure 3e)

Figure 3e-Surgical correction of CMC dislocation in 3a

Treatment

Emergency treatment consists of gauntlet immobilization and referral to hand/orthopedic specialist within a week for definitive care.

Metacarpal Head Fractures

Metacarpal head fractures are usually associated with open fractures. They occur in fights and by a direct blow to the MCP joint. (1) (Figure 1a, 1b)

Figure 2a-Third metacarpal head fracture **Figure 5b-Figure 5a Fractured head in blue**

Treatment

Treatment for an open metacarpal head fracture begins with thorough cleansing which is often performed in the operating room. If the fracture is not open, gauntlet immobilization is the initial treatment. Referral to a hand/ortho specialist is appropriate since many of these fractures require surgery.

References (FOR A FEW FRACTURES MORE):
1) McNemar TB, Howell JW, Chang E
Management of Metacarpal Fractures
J Hand Ther 2003;16:143-151

2) Malone CP, et al.
Disabling Hand Injuries in Boxing: Boxer's Knuckle and Traumatic Carpal Boss
Clin Sports Med 2009;28:609-621

The Solution

The following fractures usually need referral to a hand/orthopedic specialist:

- Significantly angulated fifth and fourth metacarpal neck fractures
- More than 10 degrees angulation of metacarpal 2 and 3 necks
- Oblique fractures of the metacarpal shaft

Transverse fractures of the metacarpal shaft
Metacarpal head fractures
Base of the thumb fractures
Dislocations of the CMC joints
Intraarticular CMC fractures
Still others not discussed

In general, most hand fractures need immobilization and referral to a hand specialist. Our job isn't all that hard: know the possibilities, find the fractures, immobilize, and properly refer them.