Introduction
Anatomy of the scaphoid

- Resembles a deformed peanut
- Articular cartilage covers 80% of the surface
- It rests in a plane 45 degrees to the longitudinal axis of the wrist
- Articulates with the distal radius proximally, the lunate medially, and with the capitate, trapezoid, and trapezium distally
Kinematics of the scaphoid

- The scaphoid moves with the proximal carpal row in flexion and extension.
- Also flexes during radial deviation of the wrist and extends during ulnar deviation of the wrist.
- The scaphoid is important in controlling wrist stability and is the main bony support between the proximal and distal carpal rows.
Vascularity of the scaphoid

- Supplied by branches of the radial artery at the distal end.
- The middle and distal pole of the scaphoid have a direct blood supply but the proximal pole receives no direct blood supply.
Mechanism of scaphoid fractures

- Most frequently fractured carpal bone (60-70% of carpal fractures)
- Second only to fractures of the distal radius
- Most common in young men (15-30)
- Results from a fall onto the outstretched hand with the wrist extended and in radial extension
Mechanism of scaphoid fractures cont.

- Distal radius is fractured when the hand is more relaxed (slight extension and some horizontal component to force)
- Striking an object with the heel of the hand may also produce a scaphoid fracture
Classification of scaphoid fractures

- Fracture direction can be horizontal oblique, transverse, or vertical oblique
- Fracture sites:
  - Tuberosity
  - Distal articular
  - Distal third
  - Middle third
  - Proximal third
Factors affecting healing

- Fractures of the proximal pole have a higher incidence of delayed union, nonunion, and avascular necrosis.
- Vertical and oblique fractures are potentially unstable and require prolonged immobilisation.
- Uncorrected displacement of more than 1mm on the lateral radiograph is likely to result in nonunion.
Factors affecting healing cont.

- Delayed diagnosis and inadequate immobilisation for longer than 4 weeks has a nonunion frequency as high as 88%.

- Healing time depends on the fracture site, e.g. uncomplicated fractures of the scaphoid tubercle may heal in 4 weeks, but a proximal pole fracture may take up to 20 weeks to heal.
Uncomplicated scaphoid fractures have a union rate of 95% when diagnosed early and immobilised, but complications of scaphoid fractures have a poor prognosis.

Complications require more aggressive treatment such as prosthetic replacement of the whole bone, bone grafting, or screw fixation.
Clinical evaluation

- Suspected scaphoid fractures present with wrist pain and tenderness at the anatomic snuffbox.

- Anatomic snuffbox pain is said to be only 40% specific for a scaphoid fracture. Scaphoid tubercle palpitation is considered more specific (57%).
Clinical evaluation cont.

- Resisted supination often exacerbates scaphoid fracture pain and is more reliable than pain from resisted pronation.
- Range of motion is reduced somewhat, with pain usually felt at the extremes of motion.
- Swelling or bruising is generally not present except in fracture-dislocations.
Any clinical findings suggesting a scaphoid fracture should be treated as such.
This is the first investigation following clinical suspicion of a scaphoid fracture. PA and lateral views of the wrist are sufficient for evaluating most wrist injuries, but special views greatly increase the sensitivity in detecting occult scaphoid injury. Special scaphoid views needed when clinical suspicion is high.
Routine scaphoid views include a PA in ulnar deviation, a PA oblique (also in ulnar deviation), an AP oblique, and a lateral projection.

Ulnar deviation is needed for the PA and PA oblique projections in order to bring the scaphoid more perpendicular to the x-ray beam.

An AP oblique projection is not useful (overlapping carpal bones).
The scaphoid view (k/a Ziter view) should also be included, where the scaphoid is further extended by extending the wrist. This can be achieved by:
- Taking the PA projection with the fist clenched
- Using a foam pad under the wrist
- Tilting the beam 30 degrees
Diagram of scaphoid view

Fig. 1 Angle of X-ray beam. (a) In conventional views the beam of X-rays is perpendicular to the long axis of the arm but not to the long axis of the scaphoid. (b) If the fingers are clenched as the hand rests on the X-ray cassette, the wrist is extended and the scaphoid becomes more horizontal. (c) Alternatively, the X-ray beam can be tilted so that it is perpendicular to the long axis of the scaphoid, not of the arm.
Value of radiographs

- Initial plain x-rays are frequently normal (up to 65% of scaphoid fractures are initially radiographically occult)
- Though it is standard practice to immobilise the wrist and take x-rays 10-14 days post trauma, a number of cases remain false-ve and it may take up to 6 weeks to see a scaphoid fracture on x-rays
Radiographic interpretation has a low interobserver agreement (>0.6 to be reliable).

Tiel-Van Buul et al. (1992) found that <0.4, thus scaphoid x-rays are not reliable for diagnosis or exclusion of fractures, regardless of technique and irrespective of training/experience of the observer.
Dias et al. (1990) found that errors made on 2-3 week radiographs were comparable to those made on initial x-rays. Reliability does not improve when both sets are viewed together. Intraobserver agreement was also low.

Up to 20% of normal x-rays are diagnosed as fractured. Overcome by taking a view of the other side.
Some scaphoid x-rays

Initial x-rays

8 weeks later
Complications on x-rays

- Proximal #s are associated with delayed union/nonunion and avascular necrosis
3-phase bone scan

- Rarely performed in acute bone trauma, reserved for difficult cases.
- Cannot be used as a gold standard, but allows bony disease to be ruled out when normal.
- Tc-99m methylene diphosphonate (MDP) is used locally. Increased osteocyte activity due to trauma will show as a focal hot spot.
3-phase bone scan cont.

Movement of the tracer:
Phase I  – blood flow (1-2mins)
Phase II  – soft-tissue (5-10mins)
Phase III – bone (2-3hrs)

Fractures are seen in around 95% of nonosteoporotic patients under 65 within 24hrs. Over 65, scan will be abnormal in 95% of cases within 48-72hrs.
3-phase bone images
Murphy et al. (1995) found that a 3-phase bone scan at 4 days post-trauma had:
sensitivity = 100%
specificity = 92%
+ve predictive value = 65%
-negative predictive value = 100%
accuracy = 93%
Tiel-Van Buul et al. (1992) found that:

- sensitivity = 100%
- specificity = 98%
- high intra/interobserver agreement = 0.88

Negative bone scan rules out a fracture, however the value of a positive scan is less clear.
Tiel-Van Buul et al. (1993) found that around 25% of +ve scans are never radiographically confirmed.

Waizenegger et al. (1994) found similar results with 12 out of 19 patients continuing to have -ve x-rays despite +ve scans.

Thus, +ve scans may lead to overdiagnosis and overtreatment.
MRI of the scaphoid

MRI was traditionally used in the diagnosis of complications of scaphoid fractures such as avascular necrosis and delayed union.

More recently, MRI has been shown to be the most reliable imaging modality for the diagnosis of suspected scaphoid fractures.
MRI of the scaphoid cont.

Though the cortex gives no signal, MRI is very sensitive to bone marrow abnormalities so even undisplaced fractures are obvious.

MRI gives precise information about the type and location of the fracture, as well as allowing soft-tissue injuries and ligamentous injury to be diagnosed at an early stage.
MRI of the scaphoid cont. (2)

- MRI scanning sequence is:
  - T1-weighted SE
  - STIR (short tau inversion recovery)
  - T2*-weighted GRE

- A fracture is considered to be present if there is or more of the following signs:
  - cortical/trabecular # line or a diffuse bone marrow abnormality
MRI value

- STIR – sensitivity = 100%
  specificity = 100%
- T1 SE – sensitivity = 95%
  specificity = 100%
  \( = 0.953 \) (compared to \( = 0.88 \) for 3-phase scan & \( > 0.4 \) for x-rays)

Main problem of MRI is long scanning times and limited availability
Scaphoid fractures on MRI
Scaphoid fractures on MRI cont.
CT of the scaphoid

- Performed only as a follow-up investigation if 3-phase bone scan is positive and MRI is unavailable or contraindicated.
- The scan can be performed in less than a minute from which multiplanar and 3-D reconstructions are possible.
U/S of the scaphoid

High spatial resolution U/S has been considered as an alternative investigation for suspected scaphoid fractures. This imaging modality is still being evaluated for the detection of occult scaphoid fractures before being performed on a routine basis.
Conclusion

For early diagnosis of scaphoid fractures, initial radiography followed by MRI within 7 days of trauma (if x-rays are –ve) should ideally be performed.

3-phase bone scans can be used as an alternative, but only if MRI cannot be performed.

CT is only used for follow-up of cases.
THANK YOU FOR YOUR ATTENTION