Upper Extremity Trauma: Wrist

Scaphoid: [Gr] “boat” aka “Navicular of hand” (confusing Navicular in foot)

Scaphoid bridges the proximal and distal carpal rows

Lunate: [L] “moon” Should have opening up like a teacup folding tea

Lunate sits ½ over radius (lunate fossa), ½ over Triangular Fibro Cartilage (TFC)

Lunate is nearly surrounded by cartilage

Proximal Carpal Row: (SH+Tq+P)

Triquetrum (Tq): [L] “three-cornered”

Pisiform (P): [L] “pea”

Proximal pole sticks out anteriorly

Ulna: [L] “elbow” (related to “ell”, “cubit”)

Ulna major component of elbow, forearm Role at wrist is limited

Doesn’t even normally touch carpal bones

Forms the Distal Radioulnar Joint

Radius: [L] “ray” Arm: Radius originates around ulna distal bend

Wrist: Radius is the foundation upon which the carpal bones reside

Wrist: Normal anterior (volar) (pain) tilt of distal radius

Normal anterior (volar) tilt of radius

Perpendicular to long axis
Upper Extremity Trauma
Wrist

Anatomy
Radiographs
4 Views
Other Views
CT/MR
FOOSH
Colles
Torus
Barton
Scaphoid
Dislocations
VISI/DISI
WOW

Capitate: [L] "head"

Head-shaped round proximal end
sits inside open end of the lunate

Frontal view
Ulna side view

Capitate Lunate Radius form a straight stack

Colles
Torus
Barton
Scaphoid
Dislocations
VISI/DISI
WOW

Hamate: [L] "hook"

Hook-shaped process (H) sticks out anterior

Frontal view
Ulna side view

Trapezoid: [Gr] "table shaped"

2 parallel sides

Frontal view
Ulna side view

Metacarpals

Capitate articulates with Long finger MC
Hamate articulates with Ring & Small finger

Frontal view
Ulna side view

Trapezium: [Gr] "little table"

no parallel sides

Frontal view
Ulna side view

Trapezium articulates with the ThUMB

Trapezoid articulates with index finger MC

Carpal Tunnel

Walls of the carpal tunnel are made of the carpal bones that stick out anteriorly
Upper Extremity Trauma: Wrist

**Hand ≠ Wrist**

**Anatomy**
- Hand PA
- Hand Obl
- Hand Lat

**Radiographs**
- 4 Views

**CT/MR**
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations

**VISI/DISI**
- WOW

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**Upper Extremity Trauma**

**Hand ≠ Wrist**

**Anatomy**
- Hand PA
- Hand Obl
- Hand Lat

**Radiographs**
- 4 Views

**CT/MR**
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations

**VISI/DISI**
- WOW

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**Upper Extremity Trauma**

**Hand ≠ Wrist**

**Anatomy**
- Hand PA (next day)
- Hand Radiographs

**Radiographs**
- 4 Views

**CT/MR**
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations

**VISI/DISI**
- WOW

---

**Upper Extremity Trauma**

**Hand vs Wrist: X-ray Beam**

**Anatomy**
- Hand radiographs:
  - X-ray beam centered @ 3rd MC head

**Radiographs**
- 4 Views

**CT/MR**
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations

**VISI/DISI**
- WOW

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**Upper Extremity Trauma**

**Wrist: PA = Standard View**

**Anatomy**
- Elbow @ shoulder height
- Elbow @ 90°
- Low chair

**Radiographs**
- 4 Views

**CT/MR**
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations

**VISI/DISI**
- WOW

---

**Upper Extremity Trauma**

**Wrist: PA View**

**Anatomy**
- 4 Views

**CT/MR**
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations

**VISI/DISI**
- WOW

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Ulnar Variance

- Ulna shorter than Radius
  - "Negative Ulnar Variance"
  - Risk AVN Lunate (Kienböck)
- Ulna longer than Radius
  - "Positive Ulnar Variance"
  - Ulna can punch hole in TFC
  - Ulna can impact upon Lunate
    - "Ulna Abutment Syndrome"

Ulnar Variance

- Ulna is only slightly shorter than Radius
- AVN Lunate with collapse
  - Treated with ulna shortening osteotomy

Can see most carpal bones on Lateral

- Hard to see Ulna as it overlaps Radius on a good lateral view

Triquetral Fracture

Classically presents as a tiny avulsion fracture dorsal to the mid-carpus
- There are no normal ossicles dorsal to the carpal bones
- May be old, as these tiny fractures don’t always heal

Wrist: Lateral View

- Anterior Normal 6-20° volar

Wrist: Oblique View

- Best view of:
  - STT joint
  - Thumb C-MC joint
- Additional view of:
  - Carpals (scaphoid)
  - Metacarpals
  - Radius (styloid)
  - Sometimes a fracture is seen only on this view
Scaphoid (Ulnar Deviation) View

Patient holds wrist in ulnar deviation.

Yields an elongated view of the scaphoid. Helps when looking for fractures.

4 View Series for Scaphoid Fracture

Lateral View

Dorsal swelling?

Doesn't show scaphoid well

Negative

Oblique View

Scaphoid View

Negative?

Positive!

scaphoid waist fx.
Upper Extremity Trauma: Wrist

**Wrist: Standard 4 View Series**

1. **PA View**
   - Shows alignment of all bones & joints
2. **Lateral View**
   - Important for Radius fractures
   - Important for Carpal alignment/dislocations
3. **Oblique View**
   - Shows STT joint (OA, Scaphoid fractures)
4. **Scaphoid (Ulnar Deviation) View**
   - Elongates Scaphoid (helps to find fractures)

**Additional Views**

- **Reverse Oblique (Piso-Triquetral View)**
  - Shows Piso-Tq joint
- **Carpal Tunnel (Hook of Hamate) View**
  - We rarely do this view
  - CT better to show Hook of Hamate fractures
- **Clenched Fist AP View**
  - Looking for Scapho-Lunate widening (diastasis)

**Chest: PA ≠ AP**

- Chest: PA is standard
- Anterior → Posterior = "AP"
- Portable Chest = AP

**Wrist: PA ≠ AP**

- PA view often doesn't profile SL
- SL joint appears WIDER than other joints on AP

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Upper Extremity Trauma: Wrist

**Wrist: AP Clenched Fist View**

To look for an abnormally wide SL joint (diastasis)
- SL joint always appears wide on AP view
- c/w standard PA
- Clenched fist forces Capitate down between S & L
- Further widening
- Need to compare with other side

**Scapho-Lunate Diastasis**

PA view: Post-operative

Proximal pole dislocation of scaphoid fossa

Suture anchors repair SL ligament

**Wrist Imaging**

Radiographs:
- Trauma
- Pain (Arthritis)
CT:
- Surgical planning known fractures
MR:
- Occult fractures (scaphoid)
- Synovitis (w/Gd) (Usually includes MCPs ± IPs)

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Upper Extremity Trauma: Wrist

**Wrist: CT**
- Good for complex fractures
- Aid in surgical planning
- Good to assess fracture healing
- Even in the presence of metal

**Wrist: Positioning**
- We scan patients with their wrist over the head
  - In a wrist coil
  - Functions best in the center of the magnetic field

**Wrist: MR**
- Good for occult fractures
  - We don't miss fractures with MR!
- Good for synovitis, infection
  - Needs IV contrast to show pannus, abscess
- Good for masses, tumors, cysts, ...
  - Needs IV contrast to show vascularity
- Tears? (SL/LT ligaments, TFCC)
  - Arthrogram-MR: Intra-articular contrast
  - I find tears better seen on the arthrogram

**Wrist: Arthrogram-MR**
- Fluoroscopy
- SL Intact
- TFC Tear
- Manipulation under fluoroscopy
- MR after arthrogram: Coronal T2fs
Fall On Out-Stretched Hand (FOOSH)

Most injuries to the wrist are due to one common mechanism
Perhaps THE most common injury

- 1 in 6 ER fractures occur in the distal radius*
- Humans are a clumsy species
  - We walk upright
  - We’re top heavy
  - When falling, we instinctively protect our head, by
    - Extending our arm
    - Striking the ground with our hand

This mechanism of injury is perhaps UNIQUE to humans

* orthopedics.about.com

**FOOSH**

Hyperextension of wrist

- Hyperextensive forces on:
  - Radius
    - Colles fracture
    - Torus fracture (children)
  - Carpal bones
    - Barton fracture
    - Scaphoid fracture
    - Lunate/perilunate dislocations

Transverse Fracture: Dorsal Angulation is Bad

To measure angle:
- Draw line along distal radius
  - From front corner
  - To back corner
- Draw line along shaft of radius
  - Perpendicular to the
- Measure this angle
  - Normal is VOLAR
  - 2-20°

There are no ligaments to support carpal bones on a dorsal sloped radius

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Upper Extremity Trauma: Wrist

**Upper Extremity Trauma**

**Wrist**

**Must reduce angle to heal right**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT
- MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DIST
- WOW

ER lateral view: Marked dorsal angulation

Following reduction & casting in ER: Volar angulation

6 weeks later: Healing, normal volar angulation

**Colles fractures very common**

- In children
  - Fall a lot
  - Torus fracture
- In women
  - Osteopenia
  - 2 women in my life...
- In the media...

**Colles vs Smith Fracture**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT
- MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DIST
- WOW

Colles:
- Hyperextension
- DORSAL angulation

Smith:
- Hyperflexion
- VOLAR angulation

**Mechanisms: Colles vs Smith**

- FOOSH → Hyperextension → Colles

**Smith Fracture = Reverse Colles**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT
- MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DIST
- WOW

Smith:
- Hyperextension
- VOLAR angulation

Reduction & cast: Normal volar angulation

**Mechanisms: Colles vs Smith**

- FOOSH → Hyperextension → Colles

whether fall *Forwards* or *Backwards*
Mechanisms: Colles vs Smith

- Fall onto back of hand
- Hyperextension - Smith Fracture
- Volar angulation

- Colles:
  - Hyperextension
  - Dorsal angulation

Smith fracture is much less common than Colles.

Abraham Colles (1773-1843)

"The injury to which I wish to direct the attention of surgeons, had not, as far as I know, been described by any author."

Robert William Smith (1807-1873)

"The injury of which I wish to direct the attention of surgeons, had not, as far as I know, been described by any author."

Robert William Smith (1807-1873)
Upper Extremity Trauma: Wrist

Fractures in Children

- Wrist Anatomy
- Radiographs
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- CT/MR

FOOSH Fractures in Children

- Adult bones: Brittle
  - Snap under force
- Child bones: Soft
  - Bend under force

Torus Fractures: Lateral View

- Cortex buckles IN
  - FOOSH (Colles)
  - Dorsal cortex
  - Fall on back of wrist (Smith)
  - Volar cortex
- Nature does not make angles...
- Nature makes smooth curves
  - If you see cortex angulation in a child that should be smooth, it's likely a torus fracture!

Torus Fractures: PA View

- Cortex buckles OUTWARD
- FOOSH

Torus Fractures: Common... Subtle

- Run eyes along cortex
  - Focus on metaphysis
  - PA view
  - Buckles outward
  - Not sure?
  - Compare to normal side
  - Use other views!

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**Upper Extremity Trauma: Wrist**

**Rhinoceros**

[L]: "swelling, protuberance, bulge"

[Architecture]: A large convex molding, semicircular in cross section, at base of a classical column.

**Fall On Out-Stretched Hand (FOOSH)**

Hyperextension of wrist → Hyperextensive forces on:
- Radius
  - Colles fracture
  - Torus fracture (children)
- Carpal bones
  - (Proximal carpal row)
  - Barton fracture

**Barton Fracture**

Hyperextension of wrist → Impaction of carpal bones on radius dorsal rim → Fracture radius rim
- Intra-articular fracture
  - Potentially more serious than Colles (extra-articular fracture)
  - May require surgical fixation
  - Surgeon may order CT for planning

**Dorsal Barton Fracture**

Due to FOOSH is much more common than Volar Barton

Due to blow to back of wrist (Just as Colles is much more common than Smith fracture)

**Volar Barton Fracture**

**John Rhea Barton (1794-1871)**

It was said that Barton was ambidextrous and that once he had positioned himself for an operation, he did not move about.

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Upper Extremity Trauma: Wrist

**Fall On Out-Stretched Hand (FOOSH)**

- Hyperextension of wrist
- Hyperextensive forces on
  - Radius
  - Colles fracture
  - Torus fracture (children)
  - Carpals
    - Colles (distal carpal row)
    - Barton fracture
    - Colles fracture

**Scaphoid Fractures**

- Scaphoid THE most common carpal bone to be fractured.
- 71% of all carpal fxs
- Scaphoid bridges the carpal rows
- Traumatic shear forces
- Shearing fracture

**Scaphoid Fractures Locations**

- **Scaphoid Waist**
  - 20% occur at scaphoid proximal pole
  - Increased risk of non-union

- **Scaphoid Proximal Pole**
  - 10% occur at distal pole
  - Rare, usually uncomplicated.
  - If nonunion, usually asymptomatic.

**Scaphoid & Radius Fractures**

- Same common mechanism (FOOSH)
  - Distal Radius Fracture
  - Scaphoid Fracture
  - BOTH!

  - **Watch out for “satisfaction of search”**
    - “Aha, I found the fracture… I’d done looking”
  - Old Radiology Axiom:
    - The hardest fracture to find is the 2nd fracture.

**Scaphoid with Radius Fracture**

- Screw fixes scaphoid fracture
- Plate fixes Colles fracture
Upper Extremity Trauma: Wrist

Scaphoid doesn’t heal as well as other bones

Anatomy
Radiographs
4 Views
Other Views
CT/ MR
FOOSH
Colles
Torus
Barton
Scaphoid
Dislocations
VISI/DISI
WOW

Upper Extremity Trauma: Wrist

Scaphoid doesn’t heal as well as other bones

Anatomy
Radiographs
4 Views
Other Views
CT/ MR
FOOSH
Colles
Torus
Barton
Scaphoid
Dislocations
VISI/DISI
WOW

Scaphoid has a tenuous blood supply

Anatomy
Radiographs
4 Views
Other Views
CT/ MR
FOOSH
Colles
Torus
Barton
Scaphoid
Dislocations
VISI/DISI
WOW

Scaphoid Non-Union → AVN

Anatomy
Radiographs
4 Views
Other Views
CT/ MR
FOOSH
Colles
Torus
Barton
Scaphoid
Dislocations
VISI/DISI
WOW

Proximal Row Carpectomy

Anatomy
Radiographs
4 Views
Other Views
CT/ MR
FOOSH
Colles
Torus
Barton
Scaphoid
Dislocations
VISI/DISI
WOW

To avoid non-union → AVN → PRC

All scaphoid fxs require early treatment!

- Probably with a screw if displaced
- At least with a splint or cast if non-displaced

But non-displaced fractures are hard to see because they are non-displaced

So how do we know if a patient has a non-displaced scaphoid fracture?

SNUFFBOX TENDERNESS = PRESUMED SCAPHOID FRACTURE

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Anatomical Snuffbox

Snuffbox Tenderness

Resorption of Fracture Margins?

Anatomical Snuffbox
Upper Extremity Trauma: Wrist

**Normal Carpal Alignment**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT/MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DISI
- WOW

3D CT
Lateral View
PowerPoint Model

Capitate sits on/in cupped Lunate
Lunate sits on/in cupped Radius

**FOOSH \rightarrow Carpal Dislocation**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT/MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DISI
- WOW

Hyperextend Wrist

**Dorsal Dislocation of the Carpus**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT/MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DISI
- WOW

20 yo Male
Riding ATV
Breaks locked
Flew over handlebars

Very rare injury
(I've seen this twice in 20 years)

**Perilunate Dislocation**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT/MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DISI
- WOW

Lunate NOT dislocated.
Carpal bones around lunate (perilunate bones) dislocated.
CAPITATE DISLOCATES

**Perilunate Dislocation becomes...**

- Anatomy
- Radiographs
- 4 Views
- Other Views
- CT/MR
- FOOSH
- Colles
- Torus
- Barton
- Scaphoid
- Dislocations
- VISI/DISI
- WOW

Sometimes the perilunate bones will relocate... showing the Lunate volar.

This is how a perilunate dislocation becomes a Lunate Dislocation
Upper Extremity Trauma: Wrist

**Lunate Dislocation**
- Lunate IS dislocated
- Capitate NOT dislocated

**Occasionally Lunate VERY Dislocated**
- Lunate dislocated beyond volar radial line
- Capitate dislocated beyond dorsal radial line

**Lunate vs Perilunate Dislocations**
- Lunate dislocated beyond volar radial line
- Capitate dislocated beyond dorsal radial line

**Mid-Carpal Dislocation**
- Easy to detect on Lateral view
- Alignment of L & C to R
- Hard to detect on PA view
- Orientation of Lunate
  - Tipped (Pie-shaped)
  - Lack of Parallelism

**Continuance of Same Injury**
- Mid-Carpal Dislocation
- Perilunate Dislocation

**Mid-Carpal Dislocation**
- Hard to appreciate these dislocations on the PA views

**Dislocations: Lateral vs PA Views**
- Easy to detect on Lateral view
- Alignment of L & C to R
- Harder to detect on PA view
- Orientation of Lunate
  - Tipped (Pie-shaped)
  - Lack of Parallelism
The Importance of the Lateral View

Lunate Dislocations

Comprise ~10% of all wrist injuries
- "Because the subtlety of wrist injuries often is not appreciated fully, many believe that perilunate injuries in general are underdiagnosed."
- "I maintain they shouldn't be underdiagnosed if we recognize the importance of the lateral view!"
- 61% also have scaphoid fractures
  - SCAPHOID BRIDGES CARPAL ROWS!
  - "Trans-Scaphoid Perilunate Fracture Dislocation"
  - Anytime we see one of these carpal dislocations, need to look for the accompanying scaphoid fx!

Trans-Scaphoid Perilunate Fracture Dislocation

Volar Perilunate Dislocation

Most Perilunate dislocations are dorsal
- Blow to the back of the wrist (like from a night-stick)
- Can result in a VOLAR Perilunate dislocation

Volar Perilunate Dislocation

C-MC Dislocations

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Lunate Tilting (Volar/Dorsal)

Volar Interdigital Segmental Instability
Dorsal Interdigital Segmental Instability

Lunate tipped forward
Lunate tipped backward

Lunate Tiling (Volar/Dorsal)

Volar Interdigital Segmental Instability
Dorsal Interdigital Segmental Instability

Lunate tipped forward
Lunate tipped backward

VISI & DISI

Intercalated:
[V] Interposed, inserted
Applied to the proximal carpal row...
the Lunate is the intercalated segment (IS) between the Scaphoid and Triquetrum.

VISI = Lunate tipped forward
DISI = Lunate tipped backward

Measuring VISI/DISI

Lateral View
Draw 3 Lines
- Lunate long axis
- Scaphoid long axis
- Capitate long axis

Measure 2 Angles
- Capito-Lunate angle
  Normally between 0-30°
- Scapho-Lunate angle
  Normally between 30-60°

Lateral View
Draw 3 Lines
- Lunate long axis
  First draw SHORT axis, between
  - Dorsal distal corner
  - Volar distal corner
- Long axis perpendicular to short
  On our PACS, I use the Cobb angle to draw these lines

Measuring VISI/DISI

Lateral View
Draw 3 Lines
- Lunate long axis
- Scaphoid long axis
  Between
  - Volar proximal edge
  - Volar distal edge

Measuring VISI/DISI

Lateral View
Draw 3 Lines
- Lunate long axis
- Scaphoid long axis
- Capitate long axis
  Just eyeball it
Measuring VISI/DISI

**Wrist**

### True Lateral View
- **Draw 3 Lines**
  - Lunate long axis
  - Scaphoid long axis
  - Capitate long axis
- **Measure 2 Angles**
  - Capito-Lunate angle
  - Scapho-Lunate angle
  - Normally between 0-30°
  - Scapho-Lunate angle
  - Normally between 30-60°

**S-P-C Lateral**

Pisiform should be between Capitate and distal pole of Scaphoid

**Visi (Lunate Tipped Forward)**

Lunate Tipped (Pie-shaped)

**Disi (Lunate Tipped Backward)**

Lunate Tipped Backward
Wrist: What to Order When (WOW)

Wrist Radiographs (95%)
- 3-view wrist series
  - PA (not AP)
  - Lateral
  - Oblique
- If snuffbox tenderness, add 4th view
  - Scaphoid (ulnar deviation)
- If snuffbox tenderness + negative radiographs
  - TREAT AS PRESUMED SCAPHOID FRACTURE
- Cast/splint, follow-up in 2 weeks
- If still has snuffbox tenderness, keep treating

Wrist CT
- Predominantly used for surgical planning of known radius/carpal bone fractures
- Ordered by Orthopedics from ER or clinic
- Assess healing of known scaphoid fracture
  - With or without prior screw fixation
  - Small screws cause virtually no CT artifacts
- We always reformat in 3 orthogonal planes
  - For scaphoid, we add oblique sagittal
- We have a specialized protocol for DRUJ instability
- All protocols at: www.radiology.wisc.edu

Wrist MR
- Occult fractures (scaphoid)
  - Persistent symptoms despite negative radiographs
- Synovitis (RA)
  - Needs IV contrast
  - Normal synovium does not enhance
  - Vascularized pannus greatly enhances
  - Ordering provider should specify area of concern
  - Just intercarpal joints
  - Also Metacarpal-phalangeal joints
  - Also Interphalangeal joints
  - Field of View = Resolution

Wrist Charges
- Wrist Radiographs
  - 3 views = 4 views = $137
  - It costs nothing to add the scaphoid view to a 3 view series
  - 1 view = 2 views = $128
  - Going from 2 views to 4 views adds only $9 (7%)
- Wrist CT
  - (without contrast) = $1,460
- Wrist MR
  - (without contrast) = $2,921
  - (with contrast) = $3,377

That's all we have on wrists...