MRI of the Wrist: Part 1 - everything but the tendons

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Educational Objectives
At the end of the presentation, each participant should be able to:

- discuss the basic MR techniques for obtaining high resolution images of the wrist including the roles of MR arthrography and intravenous contrast.
- describe the appearance of normal anatomic structures of the wrist (excluding tendons) on MR images.
- list the most common types of pathology affecting the wrist and the MR appearance of each.

Technique: Positioning

- Supine (arm at side)
- Prone (arm overhead)
- careful positioning
- extensive padding
- Surface Coil
- High resolution
  Thickness 1-3 mm
  Matrix 512x512
  FOV 10 cm
- Low vs. high field
  1.5T / 3T / low field?

Technique: Pulse Sequences

- T1 Anat overview
  - Marrow
- T2* (3D)
  - Ligaments Cartilage
- STIR
  - FS T2
  - Soft Tissues Cartilage

Technique: Arthrography?

- Direct MR Arthrography
  - dilute gadolinium
  - 0.1 cc in 10 cc saline/contrast
  - off label use
  - T1, T1-fat sat
  - T2-fat sat / GRE
- Value added?

Technique: Arthrography?

<table>
<thead>
<tr>
<th>SLL Complete Tears</th>
<th>Sens</th>
<th>Spec</th>
<th>Radiology</th>
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<tbody>
<tr>
<td>1999 Zuckin (42)</td>
<td>92</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>1997 Schneck (41)</td>
<td>52</td>
<td>34</td>
<td>100/80</td>
</tr>
<tr>
<td>1999 Schneck (29)</td>
<td>30</td>
<td>62</td>
<td>100/60</td>
</tr>
<tr>
<td>2001 Schadel-Hopfer (102)</td>
<td>.88</td>
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*MRI is not recommended for the diagnosis of SLL injury.*

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<td>2005 Mettler (128)</td>
<td>32</td>
<td>100</td>
<td>100/70</td>
</tr>
<tr>
<td>2007 Meier (125)</td>
<td>52</td>
<td>77</td>
<td>70/83</td>
</tr>
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Technique: *Intravenous Contrast?*

- **Infection**
  - abscess
  - sinus tract

- **Mass**
  - cystic vs. solid

- **Synovitis “screening”**
  - Pre Gad:
    - Cor T1, STIR
    - Ax T1
  - Post Gad:
    - Cor, Ax T1-FS

**Anatomy: coronal**

- Bones
- Intrinsic ligaments
- TFCC
- Cartilage

**Anatomy: axial**

- Tendons
- Median nerve
  (Carpal tunnel)
- Ulnar nerve
  (Guyon’s canal)

**Anatomy: sagittal**

- Carpal alignment
- Pisotriquetral joint
- Triangular fibrocartilage

Technique: *Protocol*

- Coronal STIR
- Coronal T1
- Coronal GRE (3-D)
- Axial T1
- Axial T2-FS
- Sagittal PD-FS

Outline: “Inside Out”

- Bones
- Intrinsic ligaments
  (SL, LTL)
- TFCC
- Tendons
- Nerves
- Masses
**Bones: Normal**
- Signal intensity
- Alignment
  - sagittal alignment
  - axial variance

**Bones: occult osseous injuries**
- Contusion
  - bone marrow edema
  - ↑ signal T2WI
- Fracture
  - edema + fx line

**Scaphoid Fracture**
- 16% not detected initially
- Complications
  - Nonunion
    - “humpback” deformity
  - AVN
    - blood supply
    - distal - proximal

**AVN: Scaphoid**
- Normal T1 = no AVN (?)
- ↓ T1 ↓ T2 = necrotic
- ↓ T1 ↑ T2 = ischemia vs. traumatic edema
- Contrast enhancement?
  - Unenhanced - 68% accurate
  - Enhanced - 80-90% accurate
  - Cerezal AJR, 2000

**AVN: Scaphoid**
*Degree of decreased signal intensity on T1 weighted images*

**AVN Lunate: MRI**
- Kienbock’s disease
- Ulna minus
- Abnormal marrow signal
  - ↓ T1 ↓ T2 = diagnostic
  - ↓ T1 ↑ T2 = earlier stage
  - more than 50% of lunate
Ulnolunate Impaction

- Ulna plus variance
- Degenerative changes
  - especially lunate
  - cartilage loss
- TFC tears

Other Impaction Syndromes

- Stylocarpal
  - elongated ulnar styloid
  - styloid deformity
  - impacts triquetrum
- Hamate-lunate
  - type II lunate
  - cartilage loss prox hamate

Ligaments

- Intrinsic (intercarpal)
  - Scapholunate
  - Lunotriquetral
- Extrinsic (radius/ulna)
  - Volar
  - Dorsal

Intrinsic Ligaments

- Scapholunate
  - Volar
  - Oblique collagen fibers
  - Middle
  - Thin fibrocartilage
  - Dorsal
  - Strong tns bundles
- Lunotriquetral

Intrinsic Ligaments

- Scapholunate
  - Volar
  - Trapezoidal
  - Middle
  - Triangular
  - Dorsal
  - Band-like
- Lunotriquetral
  - Smaller (2mm)
  - Strongest fibers - volar
  - Close to TFC

Intrinsic Ligaments

- Pitfalls
  - Intermediate signal
  - Attach to bone or articular cartilage
  - Fluid signal across ligament
  - Asymptomatic perforations (> 50 yrs)
Ligament Pathology

- 1st Degree: Interstitial injury normal?
- 2nd Degree: Elongation / partial tear focal fluid signal / distorted
- 3rd Degree: Disruption absence / fluid across ligament

Injury may lead to carpal instability

Carpal Stability

Scaphoid ↔ Lunate ↔ Triquetrum

S-L Instability: SLAC Wrist

- Scapho
- Lunate
- Advanced
- Collapse
  DISI Arthropathy
  - radioscaphoid
  - capitolunate

Scapholunate Dissociation

- Tear or stretching of SLL
  - dorsal fibers
  - scaphoid palmar flexes
  - "signet ring" deformity
  - lunate dorsiflexes
  - S-L angle > 60°

- DISI deformity
  - can result from scaphoid fx
  - "humpback" deformity

Triangular Fibrocartilage Complex

- Triangular fibrocartilage
- Radiolunar ligs
- Meniscus homologue
- UCL and unocarpal ligs
- ECU tendon sheath

TFC: Normal Anatomy

- Fibrocartilage
- "Bow tie"
- Ulnar styloid — dist radius
- Attaches to radial cartilage
- Central portion / periphery
  - peripheral 20% vascularized
**TFC: Pathology**

- **Tear / Perforation**
  - 95% accuracy
  - partial vs. full thickness
  - central (avascular)
  - peripheral (vascular)
  - radial
  - ulnar (less accurate)

**Radioulnar Ligaments**

- **Volar / Dorsal margins of TFC**
  - Attach directly to bone

**Extensor Carpi Ulnaris Sheath**

- Ulnar-sided support
- Injury leads to
  - subluxation
  - tenosynovitis
  - tears

**Carpal Tunnel**

- Floor - carpal bones
- Roof - flexor retinaculum
- Contents
  - Flexor tendons
  - Median nerve
  - volar / radial position
  - stable to decreasing size
  - bifid ~4-5%
  - variable position

**Carpal Tunnel Syndrome**

- Compressive neuropathy
- Pain, paresthesias
  - thumb, index, long, radial 1/2 ring
- Worse at night

**Carpal Tunnel: Post-op**

- Retinaculum
  - free edges
  - non-visualization
- Volar displacement
  - tendons/nerve

**Dx:** Clinical exam, nerve conduction
**CT: Post-op Complications**
- Incomplete retinacular release
- Proximal swelling of median nerve
- Scarring around nerve
- Mass lesion in carpal tunnel
- Median nerve neuroma

**Guyon’s Canal**
- “Ulnar Tunnel”
- Ulnar nerve, artery, vein
- Boundaries
  - floor - flexor retinaculum
  - roof - fascia
  - lat. to pisiform and hook of hamate

**Ulnar Tunnel Syndrome**
- Ulnar neuropathy
- Ganglion cyst or other mass
- Fracture (hook of hamate)
- Repetitive trauma

**Masses: Ganglion Cyst**
- Well circumscribed
  - dorsal - scapholunate
  - volar - radial styloid
- MRI
  - T1: low signal intensity
  - T2: homogeneous high signal
  - fine, low signal septations
  - peripheral/septal enhancement

**Masses: Anomalous Muscles**
- Intermediate SI mass
- Isointense to muscle on all sequences

**Summary**
- **Bones:** marrow edema, fx line  
  STIR, Fat sat T2, T1
- **Ligaments:** SLU, LTL  
  Fat sat T2, GRE; thin cor images
  Fluid signal into or across ligament
- **TFCC:** TFC, Radioulnar ligs, ECU  
  STIR, Fat Sat T2, GRE; cor, axial
- **Nerves:** median, ulnar  
  STIR, Fat Sat T2; axial
  Carpal tunnel; Guyon’s canal
- **Masses:** ganglia, access muscles  
  STIR, Fat Sat T2; axial; +/- Gd