**MRI and MR Arthography of Intrinsic Carpal Ligaments and Triangular Fibrocartilage Complex**

Fabio Becce  
Department of Diagnostic and Interventional Radiology  
Lausanne University Hospital

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**Joints**

- Distal radioulnar (DRUJ)
- Radiocarpal
- Midcarpal

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**Ligaments**

- Triangular fibrocartilage complex (TFCC)
- Intrinsic:
  - Interosseous
  - Capsular
- Extrinsic:
  - Palmar
  - Dorsal
  - Collateral

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**TFCC**

- TFC proper (articular disc)
- Radioulnar ligaments
- Ulnocarpal ligaments
- Ulnar collateral ligament
- Meniscus homologue
- Extensor carpi ulnaris tendon sheath

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**Intrinsic Ligaments**

- Intrinsic interosseous:
  - Scapholunate (SL)
  - Lunotriquetral (LT)
Intrinsic Ligaments

- Intrinsic capsular:
  - Palmar scaphotriquetral ("arcuate")
  - Dorsal intercarpal

Extrinsic Ligaments

- Extrinsic palmar:
  - Radioscaphocapitate
  - Radiolunotriquetral
  - Ulnolunate
  - Ulnotriquetral

Imaging

- Radiography
- Ultrasonography
- Computed tomography (CT), CT arthrography
- Magnetic resonance imaging (MRI), MR arthrography (direct, indirect)

MRI and MR Arthrography

- System (field strength)
- Coil
- Patient position
- Protocol (sequences)

Field Strength

- Advantages of 3-Tesla (T) imaging:
  - Increased signal-to-noise ratio (SNR)
    → Higher spatial resolution
    → Shorter image acquisition time
    → Higher contrast-to-noise ratio (CNR)

- Challenges at 3 T:
  - Specific absorption rate (SAR)
  - Artifacts
**Field Strength**

- **Advantages of 7-T MRI**

- **Challenges at 7 T**

**Patient Position**

- Prone, wrist over the head ("Superman")
- Supine, wrist at the side
**Patient Position**

- Wrist in radial or ulnar deviation

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**MRI Protocol**

- Axial and/or coronal T1-w TSE
- Coronal proton density (PD)-w with/without fat-suppression (FS)
- Axial T2-w TSE FS
- Sagittal PD-w with/without FS
- (Gd-enhanced iv. 3D T1-w GRE FS)

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**MRI Protocol**

- Axial oblique vs. true axial plane

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**MRI Protocol**

- Axial oblique vs. true axial plane

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**MRI Protocol**

- Axial oblique vs. true axial plane

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**MRI Protocol**

- Axial oblique vs. true axial plane

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**MRI Protocol**

- 3D FSE vs. 2D FSE sequence
**MRI Protocol**

- 3D FSE vs. 2D FSE sequence


**MRI**

- Criteria for TFCC tears:
  - Degeneration (asymptomatic): increased signal intensity on T1- or PD-w images
  - Defect/Tear (asymptomatic/symptomatic): increased signal intensity on fluid-sensitive FS images extending to surface, associated with DRUJ effusion
  - Acute (0-3 months), subacute (3-12 months), chronic (>1 year)


**MRI**

- TFCC tears: Palmer class 1 (traumatic)


**MRI**

- TFCC tears: Palmer class 2 (degenerative)
  - 2A: TFCC wear
  - 2B: 2A + lunate or ulnar chondromalacia
  - 2C: TFCC perforation, lunate or ulnar chondromalacia
  - 2D: 2C + LT ligament tear
  - 2E: 2D + ulnocarpal osteoarthritis


**TFCC Tears**

Pfirrmann et al. Variants, pitfalls and asymptomatic findings in wrist and hand imaging. Eur J Radiol. 2005

**Pitfalls**
MRI

Criteria for intrinsic interosseous ligament tears:
- Increased signal intensity on fluid-sensitive FS images
- Morphologic distortion or complete absence
- Secondary SL dissociation (>3 mm), carpal arch disruption, ganglion cyst formation


Intrinsic Ligament Tears

MRI

Criteria for extrinsic ligament injuries:
- Acute sprain (grade 1): periligamentous edema
- Partial tear (grade 2): thickening due to peri- and intraligamentous edema
- Complete tear (grade 3): complete disruption
- Traction-related avulsive cystic changes
- Soft-tissue ganglion cysts


Extrinsic Ligament Tears

Becce et al. Dorsal fractures of the triquetrum: MRI findings with an emphasis on dorsal carpal ligament injuries. Acta Radiologica. 2013
**Direct MR Arthrography**

- Exploits the natural advantages gained from joint effusion:
  - Distends the joint capsule
  - Outlines intra-articular structures
  - Leaks into abnormalities

**Indications**

- TFCC tears
- SL and/or LT ligament tears
- Articular cartilage lesions
- Intra-articular (“loose”) bodies

**Approaches**

- Dorsal:
  - Unicompartmental (radiocarpal) arthrography
  - Bicompartmental
  - Tricompartmental

**Guidance**

- Fluoroscopic
- Sonographic
- CT
- MR
- Clinical landmarks

Cerezal et al. Wrist MR arthrography: how, why, when. Radiol Clin NAm. 2005
Lunenfeld et al. Magnetic resonance arthrography of the upper extremity. Radiol Clin NAm. 2013

Cerezal et al. Wrist MR arthrography: how, why, when. Radiol Clin NAm. 2005

Blend

Andreisek et al. Direct MR arthrography at 1.5 and 3.0 T: signal dependence on gadolinium and saline concentrations - phantom study. Radiology. 2008

Timing


MR Arthrography Protocol

- Axial, coronal and sagittal T1-w TSE FS and/or 3D T1-w GRE FS
- Coronal PD-w FS
- Axial T2-w TSE FS

TFCC Tears

Intrinsic Ligament Tears

Diagnostic Performance


• TFCC tears

Ringler. MRI of wrist ligaments. J Hand Surg Am. 2013

Diagnostic Performance

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<th></th>
<th>1.5 T</th>
<th>3 T</th>
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<tr>
<td>Sensitivity</td>
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<tr>
<td>TFCC</td>
<td>0.82</td>
<td>0.90</td>
<td>0.493</td>
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<tr>
<td>SL</td>
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<tr>
<td>Specificity</td>
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<tr>
<td>TFCC</td>
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<tr>
<td>SL</td>
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<tr>
<td>LT</td>
<td>0.94</td>
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<td>0.898</td>
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</table>

Anderson et al. Diagnostic comparison of 1.5 Tesla and 3.0 Tesla preoperative MRI of the wrist in patients with unclassifiable wrist pain. J Hand Surg Am. 2008
Traction

Cerny et al. 3-T direct MRI arthrography of the wrist: value of finger trap distraction to assess intrinsic ligament and triangular fibrocartilage complex tears. *Eur J Radiol*. 2013

Leventhal et al. Conformational changes in the carpus during finger trap distraction. J Hand Surg Am. 2010