The Triangular Fibrocartilage Complex

Jeremy Grubin
06/02/2016
Outline

• Histoanatomy
• Function
• History and Physical
• Imaging
• Classification
• Treatment
Components of TFCC

- Fibrocartilaginous disc proper/articular disc/TFC/horizontal portion
- Meniscus homologue/meniscal homologue
- Dorsal and volar radioulnar ligaments
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament/ulnar joint capsule
Components of TFCC

- **Fibrocartilaginous disc proper**
  - Hammock-like concavity supporting carpus distally
  - Arises from radius as fibrocartilaginous extension of hyaline articular cartilage
  - Splits into two lamina ulnarly
    - Upper/proximal lamina attaches to styloid process and ulnar head
    - Lower/distal lamina extends beyond ulna and blends with sheath of extensor carpi ulnaris and ulnar collateral ligament
    - Triangular ligament – both laminae
  - Superficial radioulnar fibers surround disc and insert onto ulnar styloid
  - Deep radioulnar fibers called ligamentum subcruentum insert on to fovea and ulnar styloid base

- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament
Components of TFCC

- **Fibrocartilaginous disc proper**
  - Hammock-like concavity supporting carpus distally
  - Arises from radius as fibrocartilaginous extension of hyaline articular cartilage
  - Splits into two lamina ulnarly
    - Upper/proximal lamina attaches to styloid process and ulnar head
    - Lower/distal lamina extends beyond ulna and blends with sheath of extensor carpi ulnaris and ulnar collateral ligament
    - Triangular ligament – both laminae
  - Superficial radioulnar fibers surround disc and insert onto ulnar styloid
  - Deep radioulnar fibers called ligamentum subcruentum insert on to fovea and ulnar styloid base

- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament
Components of TFCC

- **Fibrocartilaginous disc proper**
  - Hammock-like concavity supporting carpus distally
  - Arises from radius as fibrocartilaginous extension of hyaline articular cartilage
  - Splits into two lamina ulnarly
    - Upper/proximal lamina attaches to styloid process and ulnar head
    - Lower/distal lamina extends beyond ulna and blends with sheath of extensor carpi ulnaris and ulnar collateral ligament
    - Triangular ligament – both laminae
  - Superficial radioulunar fibers surround disc and insert onto ulnar styloid
  - Deep radioulnar fibers called ligamentum subcruentum insert on to fovea and ulnar styloid base

- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament

Components of TFCC

- Fibrocartilaginous disc proper
- **Meniscus homologue**
  - Ulnar internal wall of radiocarpal joint
  - Similar to ropes supporting a hammock
  - Ill defined region of irregular, dense fibrous connective tissue
  - Integral part of lower lamina
  - Attaches to triquetrum
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament

Components of TFCC

- **Fibrocartilaginous disc proper**
- **Meniscus homologue**
  - Ulnar internal wall of radiocarpal joint
  - Similar to ropes supporting a hammock
  - Ill defined region of irregular, dense fibrous connective tissue
  - Integral part of lower lamina
  - Attaches to triquetrum
- **Radioulnar ligament**
- **Sheath of extensor carpi ulnaris**
- **Ulnolunate and ulnotriquetral ligaments**
- **Ulnar collateral ligament**

Meniscal Homologue

• Meniscal homologue and its end attach to triquetrum and fifth metacarpal

• 4 subtypes of meniscal homologue attachments to triquetrum
  – Group 1 (28%) – small, thin structure with focal attachment
  – Group 2 (39%) – small, thick structure with focal attachment
  – Group 3 (38%) – thick structure with broad attachment between 1/3-1/4 of triquetrum
  – Group 4 (5%) – broad attachment covering entire triquetrum

Meniscal Homologue

- Meniscal homologue and its end attach to triquetrum and fifth metacarpal
- 4 subtypes of meniscal homologue attachments to triquetrum
  - Group 1 (28%) – small, thin structure with focal attachment
  - Group 2 (39%) – small, thick structure with focal attachment
  - Group 3 (38%) – thick structure with broad attachment between 1/3-1/4 of triquetrum
  - Group 4 (5%) – broad attachment covering entire triquetrum

Meniscal Homologue

• Meniscal homologue and its end attach to triquetrum and fifth metacarpal

• 4 subtypes of meniscal homologue attachments to triquetrum
  – Group 1 (28%) – small, thin structure with focal attachment
  – Group 2 (39%) – small, thick structure with focal attachment
  – Group 3 (38%) – thick structure with broad attachment between 1/3-1/4 of triquetrum
  – Group 4 (5%) – broad attachment covering entire triquetrum

Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- Radioulnar ligament
  - Attaches to ulna at fovea and basistyloid
  - Bifurcates volarly and dorsally to enclose and partially coalesce with disc
  - Inserts around distal rim of sigmoid notch of radius
  - Dorsal radioulnar ligament blends with sheath of extensor carpi ulnaris
    - Stabilizes distal radioulnar joint
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament

Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- Radioulnar ligament
  - Attaches to ulna at fovea and basistyloid
  - Bifurcates volarly and dorsally to enclose and partially coalesce with disc
  - Inserts around distal rim of sigmoid notch of radius
  - Dorsal radioulnar ligament blends with sheath of extensor carpi ulnaris
  - Stabilizes distal radioulnar joint
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament

Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- **Radioulnar ligament**
  - Attaches to ulna at fovea and basistyloid
  - Bifurcates volarly and dorsally to enclose and partially coalesce with disc
  - Inserts around distal rim of sigmoid notch of radius
  - Dorsal radioulnar ligament blends with sheath of extensor carpi ulnaris
  - Stabilizes distal radioulnar joint
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament
Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
  - Blends with lower lamina of disc and dorsal radioulnar ligament
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament

Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
  - Blends with lower lamina of disc and dorsal radioulnar ligament
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament

Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
  - Course from ulnar styloid to lunate and triquetrum
- Ulnar collateral ligament

Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
  - Course from ulnar styloid to lunate and triquetrum
- Ulnar collateral ligament

Components of TFCC

- Fibrocartilaginous disc proper
- Meniscus homologue
- Radioulnar ligament
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments
- Ulnar collateral ligament
  - Loose, poorly defined
  - Longitudinally oriented collagen fibers
  - Attaches to ulnar aspect of base of ulnar styloid

Additional Anatomic Considerations

• Blood supply
  – Terminal portions of the anterior and posterior interosseous arteries
  – Peripheral 10-40% vascularized, good healing potential
  – Central portion avascular, poor healing potential

• Innervation (study of 11 cadaveric specimens)
  – Volar and ulnar portions by dorsal cutaneous branch of ulnar nerve (100%), medial antebrachial cutaneous nerve (91%), volar branch of ulnar nerve (73%), anterior interosseous nerve (27%), posterior interosseous nerve (18%), palmar branch of median nerve (9%)
  – Central and radial portions devoid of nerve fascicles

• Ulnar variance
  – Negative – less wear
  – Positive – more wear
  – Studies show ulnar length reduction triggers repair and 50% of wrists show cartilage regeneration

Anatomy

Histology

• Inhomogeneous structure
  – Meniscus homologue more fibrous
  – Articular disc more fibrocartilaginous, particularly radially

• Disc contains aggregan, collagen and other molecules which may be a target of RA

Histology – Radial Insertion

- **Fibrocartilaginous disc**
  - Firmly inserts onto radius via Sharpey’s fibers, transitions from more fibrous to more cartilaginous, and coalesces into hyaline cartilage at sigmoid notch

- **Meniscus homologue**
- **Radioulnar ligament**
- **Sheath of extensor carpi ulnaris**
- **Ulnolunate and ulnotriquetral ligaments**

Histology – Ulnar Styloid Tip

• Fibrocartilaginous disc
• **Meniscus homologue**
  – Loose fibers extending from radial to ulnar and coalescing into distal ulnar side of disc
  – Confluent with fibers of ulnar joint capsule
• Radioulnar ligament
• Sheath of extensor carpi ulnaris
• Ulnolunate and ulnotriquetral ligaments

Histology - Dorsal

- Fibrocartilaginous disc
- Meniscus homologue
- Radioulnar ligament
  - Origin at fovea and base of the ulnar styloid contains loosely arranged collagen fibers dorsally
- Sheath of extensor carpi ulnaris
  - Ulnar to origin of radioulnar ligament
  - Contains collagen fibers, Sharpey’s fibers, and few chondrocytes with vertical orientation
- Ulnolunate and ulnotriquetral ligaments

Histology - Central

- Fibrocartilaginous disc
- Meniscus homologue
- Radioulnar ligament
  - Foveal fibers oriented vertically
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments

Histology - Central

- Fibrocartilaginous disc
- Meniscus homologue
- Radioulnar ligament
  - More volarly, collagen becomes denser
  - Foveal fibers oriented vertically
  - Styloid fibers oriented horizontally
  - Both sets of fibers curve and course towards radius
  - Some central fibers confluent with fibrocartilaginous disc
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments

**Histology - Volar**

- Fibrocartilaginous disc
- Meniscus homologue
- **Radioulnar ligament**
  - More volarly, collagen becomes denser
  - Foveal fibers oriented vertically
- Sheath of extensor carpi ulnaris
- Ulnolunate and ulnotriquetral ligaments

Functions of TFCC

• Unique to hominids
• Likely developed to isolate ulna from carpus and allow brachiation
• Supports the carpus
• Stabilizes ulnocarpal and distal radioulnar joints
  – Volar radioulnar ligament – major constraint to volar translation and supination of radius relative to ulna
  – Dorsal radioulnar ligament – major constraint of dorsal translation and pronation
• Distributes loads between carpus and ulna
• Permits complex movements of wrist
• Allows smooth motion of wrist
History and Physical

• Important to elicit if there was a single trauma
• Symptoms – ulnar sided pain with rotation or when lifting heavy objects
• Physical exam findings
  – Swelling along prestyloid recess or ECU tendon sheath
  – Grip weakness
  – Crepitus
  – Sense of instability
  – Tenderness to palpation
    • Ulnar snuff box (ulnovolar to ECU between triquetrum and ulnar head) – foveal disruption of TFCC, prestyloid recess synovitis, meniscus homologue pathology, ulnotriquetral ligament injury
    • Ulnar aspect of lunate, distal surface of ulnar head, proximal tip of hamate – ulnocarpal abutment
Functional testing

- **Fovea sign** – point tenderness over ulnar joint capsule just volar to extensor carpi ulnaris tendon
- **Screwdriver test** – ulnar sided pain with passive maximum ulnar deviation and active forearm rotation against resistance
- **GRIT test** – pain limited grip strength in supination versus pronation
- **Ulnocarpal stress test (TFC grind test)** – ulnar sided wrist pain with rotation from supination to pronation while an axial load is applied, the forearm is in vertical position, and the wrist is in maximum ulnar deviation
- **TFC shear test (pisiform boost test, ulno-menisco-triquetral dorsal glide test)** – pain when pisiform is pushed dorsally by thumb while index and middle fingers translate ulnar head volarly
- **Press test** – ulnocarpal pain when seated patient lifts body weight off chair using affected wrist
- **Ulnocarpal meniscoid test (waiter’s test)** – bringing wrist passively from extension to ulnar deviation and then flexing and applying axial load eliciting pain with supination

Functional testing of DRUJ

- Piano key sign – prominent ulnar head with hand lying flat, dislocates dorsally again after being reduced volarly
- Bilateral test for potential subluxation of the DRUJ – palpate both DRUJs with index and middle fingers to assess for relative movement between radius and ulna
- Ballotment test of distal ulna – radius held by examiner, distal ulna moved dorsally and volarly; compared to contralateral side

Imaging

• Radiography
  – First step in evaluation in trauma
  – Useful to assess for fractures, ulnar variance, arthritis
  – Neutral rotation PA, lateral, and oblique views

• Arthrography
  – Triple injection favored
  – High rate of false negatives, only detects 50% of tears

• MRI
  – Accurate for partial tears and central or radial TFCC lesions (91% sensitivity for central degenerative perforations, 86-100% sensitivity for radial tears)
  – Low sensitivity for peripheral ulnar insertion TFCC lesions (25-50% sensitivity for ulnar avulsions, 17% sensitivity for peripheral TFCC tears)

• MR arthrography
  – Sensitivity 97%, specificity 96%, accuracy 97%
Wrist Arthrography

• Triple compartment arthrography – previous gold standard imaging modality for TFCC assessment
• Study of 150 patients comparing arthrography to arthroscopy
  – 42% agreement
  – 58% discordance
  – 80% false negative rate with normal arthrography
• 2011 meta-analysis of 12 studies (6 single compartment, 6 triple compartment) looking at detection of full-thickness tears
  – Single compartment – 72.4% sensitivity, 92% specificity
  – Triple compartment – 82.5% sensitivity, 96% specificity
Wrist Arthrography

• Radiocarpal joint - performed first
• Distal radioulnar joint - performed 3 hours later after contrast from radiocarpal injection resorbed
• Midcarpal compartment – performed 3 hours later after contrast from DRUJ injection resorbed

Wrist Arthrography

- 1991 study of 300 wrist arthrograms – 103 with TFCC abnormalities (32%)
  - 74 (72%) complete perforations – contrast leakage between RCJ and DRUJ
  - 15 (15%) incomplete perforations – irregular TFCC contour, no contrast leakage
  - 14 (14%) proximal perforations at attachment of TFCC to ulna
- MCJ injections important for lunotriquetral ligament tears – 76 in study (52%)
  - 22 (29%) after MCJ alone
  - 5 (7%) after RCJ alone
  - 49 (64%) after both

![Table 2: TFCC Abnormalities Seen Following Injections](image)

Wrist Arthrography

Wrist Arthrography

MRI Field Strength

• 3T has better SNR than 1.5 T

• 1.5T versus arthroscopy
  – 85% sensitivity
  – 75% specificity

• 3T versus arthroscopy
  – 94% sensitivity
  – 88% specificity

• High quality microscopy coil at 1.5T can be similar to a lesser coil at 3T
Coil Selection

- Study of 10 asymptomatic volunteers imaged at 1.5 T comparing conventional surface coil (80 mm) with microscopy coils (47 mm, 23 mm)
- Each patient had PD and T2*-weighted images
- Quantitative analysis - SNR of disc, lunate cartilage, and bone
- Qualitative analysis – visualization of disc, triangular ligament (lamina), meniscus homologue, ulnouunate ligament, ulnotriquetral ligament
- Results – better qualitative scores on microscopy coils for all structures except ulnolunate ligament, better SNR on microscopy coils

Coil Selection

- Study of 9 asymptomatic volunteers imaged at 3T comparing 3 inch surface coil and wrist volume coil
- Each patient had coronal 2D GRE and 3D-GRE weighted images on both coils
- Quantitative analysis - SNR of disc, lunate cartilage, and bone
- Qualitative analysis – visualization of disc, triangular ligament (lamina), ulnunate ligament, ulnotriquetral ligament, lunotriquetral and scapholunate ligaments
- Results – higher visualization with surface coil, particularly ulnotriquetral and ulnolunate ligaments

MRI versus MR Arthrography

- 3T MRI versus arthroscopy
  - 86% sensitivity
  - 100% specificity
- 3T MRA versus arthroscopy
  - Radiocarpal joint injection only
  - 100% sensitivity and specificity

---


---

### TABLE 1: MRI Compared with Arthroscopy

<table>
<thead>
<tr>
<th>Type of Tear</th>
<th>Tear on MRI</th>
<th>Tear on Arthroscopy</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFCC tear</td>
<td>19</td>
<td>22</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td>Scapholunate tear</td>
<td>16</td>
<td>18</td>
<td>89</td>
<td>100</td>
</tr>
<tr>
<td>Lunatrotiglietal tear</td>
<td>9</td>
<td>11</td>
<td>82</td>
<td>100</td>
</tr>
</tbody>
</table>

Note—TFCC = triangular fibrocartilage complex.

---

### TABLE 2: MR Arthrography Compared with Arthroscopy

<table>
<thead>
<tr>
<th>Type of Tear</th>
<th>Tear on MR Arthrography</th>
<th>Tear on Arthroscopy</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFCC tear</td>
<td>16</td>
<td>16</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Scapholunate tear</td>
<td>12</td>
<td>12</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Lunatrotiglietal tear</td>
<td>8</td>
<td>8</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Note—There were also three microperforations on MR arthrography in which no intrinsic ligament tear was seen. These were considered false-positive findings on MR arthrography. TFCC = triangular fibrocartilage complex.
MRI versus MR Arthrography

- Meta-analysis of 21 studies comparing MRI to MRA

MRI for Peripheral Tears

- Retrospective review of 85 wrists from 1993-1999 scanned on 1.5T MR
- Either unenhanced or indirect MRA
- 20 peripheral/ulnar tears found at arthroscopy

**TABLE 1** Results of MR Imaging When the Observer Interpreted Disruption of the Insertion as a Tear

<table>
<thead>
<tr>
<th>MR Imaging Observations</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All MR imaging examinations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>17</td>
<td>79</td>
<td>64</td>
</tr>
<tr>
<td>Observer 1</td>
<td>15</td>
<td>77</td>
<td>63</td>
</tr>
<tr>
<td>Observer 2</td>
<td>30</td>
<td>68</td>
<td>59</td>
</tr>
<tr>
<td>Observer 3</td>
<td>5</td>
<td>91</td>
<td>71</td>
</tr>
<tr>
<td>Indirect MR arthrography</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>12</td>
<td>81</td>
<td>74</td>
</tr>
<tr>
<td>Observer 1</td>
<td>9</td>
<td>83</td>
<td>63</td>
</tr>
<tr>
<td>Observer 2</td>
<td>18</td>
<td>70</td>
<td>56</td>
</tr>
<tr>
<td>Observer 3</td>
<td>9</td>
<td>90</td>
<td>68</td>
</tr>
<tr>
<td>Unenhanced MR imaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>18</td>
<td>77</td>
<td>68</td>
</tr>
<tr>
<td>Observer 1</td>
<td>11</td>
<td>72</td>
<td>68</td>
</tr>
<tr>
<td>Observer 2</td>
<td>44</td>
<td>67</td>
<td>62</td>
</tr>
<tr>
<td>Observer 3</td>
<td>0</td>
<td>92</td>
<td>73</td>
</tr>
</tbody>
</table>

**TABLE 2** Results of High Signal Intensity at Ulnar Insertion as Marker of Peripheral Triangular Fibrocartilage Tears

<table>
<thead>
<tr>
<th>MR Imaging Observations</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All MR imaging examinations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>42</td>
<td>63</td>
<td>55</td>
</tr>
<tr>
<td>Observer 1</td>
<td>35</td>
<td>70</td>
<td>53</td>
</tr>
<tr>
<td>Observer 2</td>
<td>50</td>
<td>56</td>
<td>55</td>
</tr>
<tr>
<td>Observer 3</td>
<td>40</td>
<td>64</td>
<td>58</td>
</tr>
<tr>
<td>Indirect MR arthrography</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>45</td>
<td>69</td>
<td>56</td>
</tr>
<tr>
<td>Observer 1</td>
<td>36</td>
<td>67</td>
<td>58</td>
</tr>
<tr>
<td>Observer 2</td>
<td>54</td>
<td>60</td>
<td>58</td>
</tr>
<tr>
<td>Observer 3</td>
<td>45</td>
<td>80</td>
<td>51</td>
</tr>
<tr>
<td>Unenhanced MR imaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>37</td>
<td>59</td>
<td>55</td>
</tr>
<tr>
<td>Observer 1</td>
<td>33</td>
<td>53</td>
<td>49</td>
</tr>
<tr>
<td>Observer 2</td>
<td>44</td>
<td>53</td>
<td>51</td>
</tr>
<tr>
<td>Observer 3</td>
<td>33</td>
<td>72</td>
<td>64</td>
</tr>
</tbody>
</table>

Traction Study

• Study of 40 consecutive MR wrist arthrograms
• 3 compartment arthrography was performed unless there were communications between compartments
• All patients had same sequences in 3 T MRI without and with a load applied (7 kg for M, 5 kg for F)
Traction Study

• Results
  – Markedly enhanced detection of scapholunate and lunotriquetral ligament tears
  – Markedly enhanced detection of TFCC tears

CT Arthrography

- Higher spatial resolution than MR arthrography
- Lower contrast resolution than MR arthrography
- Triple-injection
- Multiple studies of sensitivity, specificity, and accuracy for detection of TFCC tears
  - 92-94% in one series
  - 100% in one series
- Less accurate for peripheral TFCC tears
Cone-beam CTA versus Multidetector CTA

- Triple injection
- Equivalent for assessment of ligaments, TFCC, and cartilage
- Statistically significant radiation dose reduction with CBCT compared to MDCT

![CBCT vs MDCT images]

**Table 1** Sensitivity, specificity, and accuracy of cone-beam computed tomography (CB) and multidetector computed tomography (MD) for the detection of interosseous ligaments, triangular fibrocartilage complex (TFCC), and cartilage lesions

<table>
<thead>
<tr>
<th></th>
<th>CB</th>
<th>MD</th>
<th>CB</th>
<th>MD</th>
<th>CB</th>
<th>MD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ligaments</td>
<td></td>
<td></td>
<td>TFCC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>95 (81–100)</td>
<td>87 (73–100)</td>
<td>88 (73–100)</td>
<td>88 (73–100)</td>
<td>100</td>
<td>83 (72–100)</td>
</tr>
<tr>
<td>Specificity</td>
<td>82 (62–100)</td>
<td>82 (62–100)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Accuracy</td>
<td>90 (72–100)</td>
<td>83 (62–100)</td>
<td>90 (72–100)</td>
<td>90 (72–100)</td>
<td>100</td>
<td>90 (72–100)</td>
</tr>
</tbody>
</table>

Data are expressed as percentages with confidence intervals in parentheses.

CTA versus MRI versus MRA

• Study of 10 cadaveric wrists
• All had 3T MRI, then triple-injection arthrography, then CTA, then 3T MRA, then arthroscopy

Ultrasound

• Difficult to visualize internal structure of TFCC
• Useful for ligamentous injury
Normal MR Appearance

Burns et al. Pitfalls that may mimic injuries of the triangular fibrocartilage and proximal intrinsic wrist ligaments at MR imaging. Radiographics. 2011.
Burns et al. Pitfalls that may mimic injuries of the triangular fibrocartilage and proximal intrinsic wrist ligaments at MR imaging. Radiographics. 2011.
Palmer Classification

• Based on nature of injury

• Class 1
  – Traumatic – rotational or fall on pronated or hyperextended wrist
  – Subclassified based on location of injury

• Class 2
  – Degenerative wear and perforation
  – May be associated with chronic loading of ulnocarpal joint, ulnar impaction syndrome
  – Subclassified based on extent of degeneration
Palmer Class 1A

- Central tear through horizontal portion of TFCC
- Most common type of traumatic tear
- Not associated with instability
- Treatment – debridement, will not heal if not repaired

Palmer Class 1B

- Peripheral tear of TFCC from ulnar insertion
- May have bony avulsions
- +/- DRUJ instability
- Treatment - repair

Palmer Class 1B
Palmer Class 1C

- Peripheral tear with distal avulsion of ulnolunate and/or ulnotriquetral ligaments
- Rare, high-energy injury
- Often associated with DRUJ instability
- Leads to ulnar carpal instability
- Treatment – controversial, repair or reconstruction

Palmer Class 1D

- Radial avulsion of TFCC with or without sigmoid notch fracture
- Typically involve dorsal and volar radioulnar ligament insertions
- High risk for DRUJ instability
- Treatment – repair or debridement

Palmer Class 2A

- Wear of horizontal portion of TFCC without perforation
- Treatment – ulnar shortening

Palmer Class 2B

- 2A + chondromalacia of lunate and/or ulnar head
- Treatment – ulnar shortening

Palmer Class 2C

- Perforation of TFCC
- Usually in avascular portion of TFCC
- Ovoid configuration
- Treatment – debridement and wafer procedure or ulnar shortening

Palmer Class 2D

- 2C + rupture of lunotriquetral ligament
- Treatment – debridement of TFCC and lunotriquetral ligament, chondroplasty, possible reduction/fixation of lunotriquetral interval and/or ulnar shortening

Palmer Class 2E

- 2D + ulnocarpal arthritis
- Treatment – debridement of joint or open salvage

Atzei Classification

• Treatment-oriented classification for peripheral TFCC tears (Palmer Class 1B)
• Breaks up periphery of TFCC into 2 regions
  – Proximal component - triangular ligament and ligamentum subcruentum
  – Distal component - distal hammock structure (meniscus homologue) and ulnar collateral ligament

---

Atzei Class 1

- Repairable
- Distal tear with intact proximal TFCC component
- Treatment – arthroscopic suture

Atzei Class 2

- Repairable
- Complete tear through distal and proximal components of TFCC
- Treatment – foveal reattachment of TFCC

Atzei Class 3

- Repairable
- Proximal tear with intact distal TFCC component
- Treatment – foveal reattachment of TFCC

Atzei Class 4

- Non-repairable
- Complete tear through distal and proximal components of TFCC
- Severe DRUJ instability
- Treatment – tendon graft reconstruction

Atzei Class 5

- TFCC tear with DRUJ arthritis
- Treatment – arthroplasty, joint replacement

Incidental Findings

- Cadaveric studies - 50% of people over age 60 have degenerative TFCC tears
- Arthrography of 52 healthy volunteers – 12% had abnormal communication across TFCC
- Arthrography of 56 patients with symptoms in CONTRALATERAL wrist – 73% had TFCC defects
- MRIs of asymptomatic wrists
  - 64/103 normal
  - 39/103 abnormal
    - Tears in 26, full thickness in 23/26
    - Abnormal signal centrally in 13
    - Findings most frequently involved articular disc

MRI Pitfalls

• Degenerative changes
  – High signal intensity within the disc without extension to an articular surface

• Proximal lamina
• Ulnar styloid tip
• Sigmoid notch of the radius
• Prestyloid recess
MRI Pitfalls

- Degenerative changes
- Proximal lamina
  - Highly vascular loose connective tissue with collagen fibers
  - High signal intensity
- Ulnar styloid tip
- Sigmoid notch of the radius
- Prestyloid recess

Burns et al. Pitfalls that may mimic injuries of the triangular fibrocartilage and proximal intrinsic wrist ligaments at MR imaging. Radiographics. 2011.
MRI Pitfalls

• Degenerative changes
• Proximal lamina
• **Ulnar styloid tip**
  – Has intermediate signal intensity hyaline cartilage
  – Should not be interpreted as a tear of the distal lamina
• Sigmoid notch of the radius
• Prestyloid recess

*Burns et al. Pitfalls that may mimic injuries of the triangular fibrocartilage and proximal intrinsic wrist ligaments at MR imaging. Radiographics. 2011.*
MRI Pitfalls

- Degenerative changes
- Proximal lamina
- Ulnar styloid tip
- **Sigmoid notch of the radius**
  - TFCC attaches directly to bone at marginal locations
  - Transitions from fibrocartilage to hyaline cartilage more centrally
  - Cartilage is intermediate signal intensity
- Prestyloid recess

*Burns et al. Pitfalls that may mimic injuries of the triangular fibrocartilage and proximal intrinsic wrist ligaments at MR imaging. Radiographics. 2011.*
MRI Pitfalls

• Degenerative changes
• Proximal lamina
• Ulnar styloid tip
• Sigmoid notch of the radius
• Prestyloid recess
  – Can be tubular or conical
  – Can mimic a tear

Burns et al. Pitfalls that may mimic injuries of the triangular fibrocartilage and proximal intrinsic wrist ligaments at MR imaging. Radiographics. 2011.
Treatment

• Non-operative
  – Activity modification
  – Splinting or casting
  – NSAIDs
  – Corticosteroid injections
  – Occupational therapy

• Operative
  – Open or arthroscopic
  – Debridement
  – Repair
  – Ulnar unloading procedures
Open versus Arthroscopic Repair

- Study of 75 patients with TFCC repair between 1997-2006
- 37 arthroscopic, 39 open
- No significant differences in clinical outcomes between two groups
- Slightly better flexion/extension in arthroscopy group
- Higher risk of nerve injury in open group
Debridement

- Palmer Class 1A tears often create unstable flap of tissue
- Goal – remove all loose flap components, establish stable rim of TFCC
- Up to 80% of disc can be resected without creating instability
- 66-87% success rate for arthroscopic debridement of Palmer Class 1A tears
- Higher failure rates in ulnar positive wrists – would also involve ulnar shortening
- Ulnar shortening increases overall success rate of Class 1A debridement from 87% to 99%

Repair

- Ulnar sided peripheral tears (Palmer 1B)
- Distract wrist, insert scope, debride area, and suture tear
- Good to excellent results in 61-91% of patients
- Some literature reports good results for Class 1C and 1D tears

Wafer Procedure

- Degenerative perforation of TFC (Palmer 2C)
- Debridement of perforation
- Debridement of underlying ulnar head cartilage and subchondral bone to correct positive ulnar variance

Summary

• Complex structure with multiple components
• Components have different histology and MR appearance
• Knowledge of histoanatomy allows for accurate description and characterization of MR findings

References


References


References


