Radiological diagnosis of injuries following Fall on outstretched hand (FOOSH)

Core Radiology Clerkship
Beth Israel Deaconess Medical Center

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HAND INJURIES ARE VERY COMMON IN ED, AND FALL IS ONE OF THE MOST IMPORTANT MECHANISMS

<table>
<thead>
<tr>
<th>Body surface area</th>
<th>Injuries presenting to ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Palm: 1% of TBSA</td>
<td>• Hands: ~4-8% of TBSA</td>
</tr>
<tr>
<td></td>
<td>• Hands: 29% of all injuries treated in ED (Dutch &amp; Danish surveillance data [1])</td>
</tr>
</tbody>
</table>

### Hand injuries: mechanisms (meta-analysis)*

<table>
<thead>
<tr>
<th>Location</th>
<th>AVG</th>
<th>Dk (2)</th>
<th>UK (3)</th>
<th>N Ir (4)</th>
<th>NL/Dk (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>535800</td>
<td>50272</td>
<td>2655</td>
<td>4873</td>
<td>478000</td>
</tr>
<tr>
<td>Cut/bite</td>
<td>31</td>
<td>46</td>
<td>28.7</td>
<td>17.3</td>
<td>31</td>
</tr>
<tr>
<td>Fall</td>
<td>22</td>
<td>23</td>
<td>29</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>Punch/assault</td>
<td>17</td>
<td>27</td>
<td>22</td>
<td>2.6</td>
<td>-</td>
</tr>
<tr>
<td>Sport</td>
<td>16</td>
<td>-</td>
<td>19</td>
<td>15</td>
<td>15</td>
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</table>

* Falls account for 22 percent of all visits to ED for hand injuries


BEFORE WE CONTINUE, A QUICK GLIMPSE OF WHAT WE’RE NOT COVERING: DISTAL INJURIES – A SELECTION OF BOSTON SEASONAL VARIANTS

<table>
<thead>
<tr>
<th>Summer: Foul ball at Fenway</th>
<th>Winter: Snowblowing the driveway</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Oblique fx of 4th DP</td>
<td>• Comminuted fx of R 2nd, 3rd, 4th MPs and DPs</td>
</tr>
<tr>
<td>• Volar displacement</td>
<td>• 3rd MP displaced radially</td>
</tr>
<tr>
<td></td>
<td>• Associated soft tissue defects</td>
</tr>
</tbody>
</table>

- Distal hand fractures most common site of injury in epidemiological studies
- Straightforward diagnosis and treatment… where’s the challenge?
- Let’s move on to wrist fractures
1. Differential diagnosis of wrist pain following FOOSH
   - Colles
   - Scaphoid fx
   - SL lig tear
   - Trangular fibrocartilage complex (TFCC) tear

2. Case presentations: radiological involvement in each diagnosis
   - Highlights of normal anatomy
   - What’s at stake: importance of early diagnosis and treatment
   - 1st line imaging and tricks
   - Backup imaging
1. Differential diagnosis of wrist pain following FOOSH
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ACCURATE AND TIMELY DIAGNOSIS AND TREATMENT CAN AVOID COMPLICATIONS OF HAND & WRIST FRACTURES

<table>
<thead>
<tr>
<th>Potential complications</th>
<th>1st line imaging modality</th>
<th>2nd line imaging modality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Distal radius fracture (Colles)</td>
<td>OA</td>
<td>Plain film</td>
</tr>
<tr>
<td></td>
<td>Strength deficit, instability</td>
<td></td>
</tr>
<tr>
<td>2. Scaphoid fracture</td>
<td>OA</td>
<td>Plain film</td>
</tr>
<tr>
<td></td>
<td>Avascular necrosis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malunion</td>
<td></td>
</tr>
<tr>
<td><strong>Soft tissue</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Scapholunate ligamentous tear</td>
<td>OA</td>
<td>Plain film</td>
</tr>
<tr>
<td></td>
<td>Wrist instability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scapholunate advanced collapse</td>
<td></td>
</tr>
<tr>
<td>4. Trangular fibro-cartilage complex (TFCC) tear</td>
<td>OA</td>
<td>Arthroscopy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arthrography</td>
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</table>

NORMAL HAND AND WRIST ANATOMY IS CONFUSING, AND CHARACTERISED BY UNHELPFUL MNEMONICS

- **Bones**
  - How can a mnemonic with eight letters have three T's?
    - TriQuetrum—Ulna
    - Trapeziun—near the thumb
  - Only Trapezoid is left
    - Thumb is missing a...

- **Ligaments**
  - Any permutation you can imagine
  - Strength ligaments volar

- **Arteries**
  - Ulnar
  - Radial

- **Nerves**
  - Median
  - Ulnar
  - Radial
OUTLINE

1. Differential diagnosis of wrist pain following FOOSH
   – Colles
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2. Case presentations: radiological involvement & imaging for each diagnosis
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PATIENT 1: FALL DOWN STAIRS

Patient 1

- 65F
- “Pain in my hand”
- Had ‘1/2 glass of wine’ and fell down stairs
- PMH: HTN
- Meds: ASA, HCTZ, black cohosh
- SHx: menopause
- FHx: n/c
- PE: tender prox to wrist

Distal radius fracture
Ulnar styloid avulsed

Normal comparison PA film
RELEVANT ANATOMY: DISTAL RADIUS AND RADIO-CARPAL JOINT HAS
SEVERAL INTERESTING BONY AND SOFT TISSUE FEATURES...

<table>
<thead>
<tr>
<th>Anatomical features</th>
<th>Pathological features following fracture</th>
</tr>
</thead>
</table>
| 1. Metaphyseal widening  
  • 2cm from joint: less cortical, more cancellous bone | 1. Less density is fracture set up  
  • Osteoporosis screening |
| 2. Radius longer than ulna  
  • Radius bears 80% of strain | 2. Shortened radius  
  • Ulnar loading, OA  
  • Muscle spasm |
| 3. Triangles  
  • Volar tilt (11°)  
  • Ulnar inclination: loads radius | 3. Triangles  
  • Dorsal angulation in Colles’ fx loads ulna |
| 4. TFCC cartilage  
  • Joins radius to ulnar styloid | 4. TFCC cartilage  
  • Frequent avulsion of ulnar styloid |

FOR COMPLEX INTRA-ARTICULAR FRACTURES OF DISTAL RADIUS, 2D CT RECONSTRUCTION CAN BE VALUABLE...

Companion case: CT slices
Left to right, top to down

Companion case: 2D CT reconstruction
Coronal

Coronal reconstruction shows clear scaphoid fracture...

Sagittal

...and sagittal shows small associated lunate fracture.
... AND 3D CT RECONSTRUCTION CAN SIGNIFICANTLY INCREASE DIAGNOSTIC ACCURACY, AND CHANGE SURGICAL DECISION-MAKING

Companion case: PA & lat films, 3DCT reconstruct’n

• Multiple intra-articular fractures

...leading to complex internal fixation

• Increases reliability and diagnostic accuracy
• Significantly changes surgical decision-making vs plain films (1)

PATIENT 2: FALL WHILE ‘HORSEPLAYING’

Patient 2

- 27M
- “Pain in my hand”
- Had ‘one beer,’ was discussing baseball with friend from NYC
- PMH: none
- Meds: none
- SHx: painter
- FHx: n/c
- PE: tender snuffbox

Images courtesy of Dr Jim Wu, BIDMC Radiology
PATIENT 2: CORRECT VIEWS EXPOSE…

• High degree of clinical suspicion required to diagnose occult fractures…
• …Correct views also required! (request scaphoid views, not wrist)
• If still unsure, can cast and re-image in 2 weeks, to avoid additional imaging

Images courtesy of Dr Jim Wu, BIDMC Radiology
SCAPHOID ANATOMY: ORIENTED OBLIQUELY, WITH VASCULAR SUPPLY EXEMPLIFYING LESS-THAN-INTELLIGENT DESIGN

1. Bony orientation of scaphoid
   - Not parallel to plane of palm
   - Radial side volar, ulnar side dorsal
   - Need oblique views!

2. Vasculature
   - 80% of supply from dorsal branches of radial artery, entering at scaphoid waist
   - 20% from palmar branches entering at distal pole
   - Negligible supply from SL ligament, SRL ligament
   - AVN risk increases with more proximal fracture location, approaching 100% with proximal pole fractures

Notes

Image reproduced from www.eorthopod.com
PATIENT 3: WRIST PAIN SEVERAL DAYS FOLLOWING FALL

Patient 3

- 42F
- “Pain in my hand”
- At a cocktail party, was ‘pushed by agent from competing real estate agency’
- PMH: none
- Meds: none
- SHx: smokes half pack x20y
- FHx: n/c
- PE: tender snuffbox

Patient 3’s PA hand film

Normal comparison

Images courtesy of Dr Jim Wu, BIDMC Radiology
Does Patient 3 have AVN? (PA film)

Patient 3’s MRI

- Fat subtraction shows blood filling distal to fracture, but filling defect proximal
- Diagnostic of avascular necrosis

Images courtesy of Dr Jim Wu, BIDMC Radiology
PATIENT 4: SPORTS INJURY

- **67M**
- “Pain in my hand”
- Bicyclist struck by car and thrown, used hand to break fall
- **PMH**: none
- **Meds**: MVI
- **SHx**: n/c
- **FHx**: mother, father with OA

**PE**: +Watson test (painful snap with volar scaphoid pressure, uln to rad dev)

**SCAPHOLUNATE LIGAMENT TEAR**
MR ARTHROGRAPHY CAN DIAGNOSE SUBTLE LIGAMENTOUS TEARS, THOUGH FALSE POSITIVES ARE COMMON

- Evaluation based on visualization of contrast in compartments of hand
- Indirect MR arthrography is not superior to traditional arthrography (1)
- However, difficult to differentiate clinically irrelevant pinhole communications vs real tear (2)

**Scapholunate ligament tear**

*MRI arthrograph with gadolinium injection*

- Radiocarpal gadolinium injection

**TFCC tear**

*MRI arthrograph with gadolinium injection*

- Gadolinium diffuses out of radiocarpal compartment
- Indicates ligamentous disruption

1. Radiology plays a critical role in establishing diagnosis of wrist pain following FOOSH, and directing treatment plan
   - Clinical differentiation among various etiologies nearly impossible given similarities of symptoms

2. Fractures of the distal radius are common, particularly in the elderly, and can have debilitating consequences
   - Osteoporosis screening
   - Associated injuries
   - 3D CT reconstruction is promising way to characterize complex intra-articular fractures

3. Scaphoid fractures are easy to miss— one of the most common causes of litigation vs radiologists – and can lead to avascular necrosis of the proximal pole
   - Correct views are essential
   - MR can aid in diagnosis of AVN

4. Ligamentous tears can be difficult to diagnose with non-invasive means, but early diagnosis and treatment can help to avoid late complications
THANK YOU

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