Imaging Rheumatoid Arthritis

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Meet Ms. M

• 50-year old female
• 22-year history of seronegative rheumatoid arthritis (RA)
• Followed at BIDMC rheumatology department
• Films from 1981 - present in BIDMC Film Library
Ms. M’s RA at a Glance

• Age 28: trouble opening jars, episodic swelling of hands
• Principle sites: hands, wrists, feet
• Initially, rapid bony changes
• Developed osteoporosis
• Past DMARDs*: azathioprine, hydroxychloroquine, gold
• Present drugs: leflunomide, prednisone, piroxicam
• Disease now relatively stable
• Left wrist continues to give her most trouble

*DMARD = disease-modifying anti-rheumatic drug
Rheumatoid Arthritis: Definition

- **Chronic, inflammatory, systemic disease**
- **Etiology unknown**
- **Prominent characteristic = symmetric polyarthritis**
- **Extra-articular manifestations in 20% of patients**
- **Variable presentation at onset**
- **Variable clinical features**
Diarthrodial Joint Anatomy

Marginal areas—where synovium directly touches bone (without cartilage in between)—are designated with small black arrows.

Resnick & Niwayama, *Diagnosis of Bone and Joint Disorders*
Joint Pathology: Progressive Stages

- Synovitis $\rightarrow$ pannus* $\rightarrow$ joint destruction
- Pannus = granulation tissue

1. acute synovitis
2. continued synovitis, pannus formation, cartilage destruction, mild osteoporosis
3. fibrous ankylosis, subsidence of inflammation
4. bony ankylosis, advanced osteoporosis

Netter, *The Ciba Collection of Medical Illustrations*
American College of Rheumatology Criteria for RA

- 4 of the following 7:
  - Morning stiffness
  - Arthritis of > 3 joint areas
  - Arthritis of hand joints
  - Symmetric arthritis
  - Rheumatoid nodules
  - Serum rheumatoid factor
  - Radiographic changes

Rheumatoid Arthritis: Epidemiology

- 1.0% of Americans
- 2.5 female : 1 male
- Onset between ages 25-50
- Peak incidence between ages 40-50
- Associated with certain HLA-DR haplotypes
Agenda

• Broad overview of systemic manifestations
• Focus on Ms. M
• Focus on imaging hand pathology
  - conventional radiography
  - MRI
• Brief visit to Ms. T
Articular Manifestations

- Symmetrical involvement, listed from most → least commonly affected
- Hands, wrists
- Feet, ankles
- Knees
- Hips
- Cervical spine
- Shoulders
- Elbows

Areas of joint involvement

Hands & Wrists

- Almost always affected in RA
- MCPs, PIPs swollen and/or deformed
- DIPs spared
- Ulnar deviation at MCP
- Radial deviation at the carpals
- Swan-neck deformities
- Boutonnière deformities
- Neuropathy, e.g. carpal tunnel syndrome

Image from:
Eric A. Brandser on Virtual Hospital site, http://www.vh.org/Providers/Lectures/icmrad/skeletal/Parts/RAHands.html
Extra-Articular Manifestations

- Nodules
- Vasculitis
- Rheumatoid factor = anti-IgG antibodies
- Ocular: keratoconjunctivitis sicca, scleritis

Netter, The Ciba Collection of Medical Illustrations
Extra-articular manifestations

• Pulmonary: interstitial lung disease, pleural effusion
• Cardiac: pericardial effusion, pericarditis

• Subcutaneous nodules over knuckles
• 3rd phalange: swan-neck deformity
• Ulnar deviation
• Muscle atrophy
• Subcutaneous nodules in olecranon bursa and just distal to olecranon process
Imaging Modalities

- Conventional radiography
- Magnetic resonance imaging (MRI)
- Bone densitometry (DEXA)
  - Evaluate osteoporosis
- Ultrasound
  - Not often used for RA in US; more often in Europe
- Computed tomography
  - Only as adjunct; not as primary modality
- Bone scintigraphy
  - Confirm disease presence
  - Evaluate disease distribution & activity
Role of Imaging in RA

• Assist in diagnosis
  - Early & aggressive treatment is now the standard of care
• Track disease progression
• Evaluate response to treatment
• Classify disease severity for research/clinical trials
Characteristic Changes on Plain Film

- Individual findings are non-specific
  - since synovium reacts in limited # of ways
- But patterns and combinations of findings can suggest RA
Characteristic Changes on Plain Film

- Soft tissue changes
  - Early swelling
  - Later atrophy
  - Periarticular fat displacement (large joints)

- Cartilage changes
  - Joint space wide $\rightarrow$ narrow $\rightarrow$ wide
    - Secondary to inflammation, cartilage destruction, ligamentous laxity, respectively
Characteristic Changes on Plain Film

- **Bony changes**
  - Marginal bony erosion: periarticular “bare” areas
  - Subchondral cyst formation
  - Juxta-articular osteopenia → generalized osteopenia
  - Lack of bony response to overwhelming bone and joint destruction is characteristic of RA
  - Subluxation & dislocation
  - Flexion & extension contracture
  - Ankylosis
Hand Anatomy Review

Normal hand radiograph
Sesamoid bones = ovoid nodules embedded in tendons; # variable in between people

Wicke, Atlas of Radiologic Anatomy
Conventional Radiography of Hands

- “ABC’S”
  - Alignment
  - Bone mineralization
  - Cartilage
  - Soft tissue

- PA and oblique views
- low dose radiation for hands, therefore serial studies are relatively safe
Ms. M's Initial Presentation, Age 28

- 1981, age 28, episodic pain & swelling
- Right lateral oblique view ("Zither player position")
- Normal mineralization
- Normal joint space
- 4th digit, middle phalanx: small cystic changes & minimal soft tissue swelling, consistent with "post-traumatic cyst"
Ms. M’s Initial Presentation

- 1981, age 28
- Left lateral oblique
Ms. M, 1983, Age 30

- Right AP (dorsopalmar) view
- Changes since 1981
- Erosions: 2nd metacarpal, 3rd DIP, 4th PIP
- Soft tissue swelling
- Consistent with RA
Ms. M, 1983, Age 30

- Left AP view
- Erosions: 3rd & 5th PIPs
- Cyst: 1st IP
- Soft tissue swelling around PIPs, MCPs
Ms. M, 1986, Age 33

- Right lateral oblique
- Disease progression
- Erosions: 2\textsuperscript{nd} MCP, 3\textsuperscript{rd} & 4\textsuperscript{th} PIPs, 3\textsuperscript{rd} DIP, 1\textsuperscript{st} IP
- Decreased joint spaces
Ms. M’s RA Progresses, Right AP Views

- ↓ joint space, new erosions: 3rd MCP, 4th PIP, 5th PIP
- Note 1st IP fused by screw
- Erosions: 2nd-5th MCPs, 4th-5th PIPs, 4th-5th DIPs
- Carpal cysts

1988, Age 35

1995, Age 42
Ms. M, Left
Lateral Oblique, 1995, Age 42

• This view shows ulnar styloid erosion
• 2\textsuperscript{nd} MCP subluxation
Advantages of MRI

- Better than conventional radiography at imaging soft tissue, marrow, & cartilage
- Multiplanar
- Can assess complications
  - Tendon tear or rupture
  - Synovitis, tenosynovitis, bursitis
  - Erosions, cysts, fibrocartilage degeneration
- May show erosions earlier than plain film
- Up & coming!
Ms. M, 2002, Age 49

Anatomy Pointers

- **flexor retinaculum (Carpal tunnel)** contains tendons and median nerve
- Tendon sheath normally indistinct from tendon (low signal; dark in this view)
Ms. M, 2002, Age 49

Findings

- Tenosynovitis
  - Extensor carpi ulnaris tendon
  - Flexor carpi radialis tendon
- Synovial proliferation

*Tenosynovitis* = tendon sheath inflammation, seen in RA or repetitive trauma. In contrast, *tendonitis* = tendon inflammation, signal would be *within* tendon; seen with overuse
More proximally, flexor carpi radialis appears normal
Extensor carpi ulnaris

http://www.rad.washington.edu/atlas/extensorcarpiulnaris.html
Flexor carpi radialis

http://www.rad.washington.edu/atlas/flexorcarpiradialis.html
MR Normal Wrist, Coronal View

3 important areas:

- triangular fibrocartilage (TFC)
- scapholunate ligament (SL)
- lunotriquetra ligament (LT)

- These areas confer stability
- Commonly injured → pain
Ms. M: TFC Tear & SL Tear

↑ signal = TFC tear

Gap > 2 mm indicates SL tear

* SL tear nickname is “David Letterman sign” reminiscent of the talk show host’s gap teeth.

T2-weighted gradient echo. BIDMC Film Library
Ms. M: Erosions on MRI

T2-weighted gradient echo. BIDMC Film Library
Sagittal View of Normal TFC

Notice ample joint space between ulna and triquetral bones

T1 MRI, left wrist. BIDMC Film Library
Ms. M: TFC Tear

ulna and triquetral bones touch

Carpal tunnel

T1 MRI, left wrist. BIDMC Film Library
What is This Bulge on Ms. M?

No, it is not her thumb...

...It is a vitamin E tablet to mark the area of her pain!

T2 MRI, left wrist. BIDMC Film Library
Now Meet Ms. T

62yo woman, h/o RA and 50 lb weight loss, right leg shorter than left, inability to ambulate. Please evaluate...

Acetabuli protrusio into ilium

- hips involved in 50% RA patients
- ↓ cartilage allows femoral head to migrate superomedially within acetabulum
- more severe with time
Normal shoulder
Ms. T’s Shoulder

• Findings on Ms. T: erosions, fusions, superior subluxation
• Shoulders involved in 50% RA patients
• Narrowing of all compartments of shoulder
  - glenohumeral
  - acromiohumeral
  - acromioclavicular
• humeral head migrates proximally & superiorly
Arthritides

monoarticular
• trauma
• infection
• gout
• pseudogout
  • RA
  • SLE
  • scleroderma
  • DM

polyarticular
• inflammatory
  • rheumatoid types
    • RA
    • SLE
    • scleroderma
    • DM
• degenerative
  • rheumatoid variants
    • OA
    • ankylosing spondylitis
    • Reiter’s syndrome
    • psoriatic arthritis
    • IBD
• metabolic deposition
  • Gout
  • Amyloidosis
Arthritides

- Radiographic findings rarely pathognomonic for arthritides
- Must use radiographic findings in conjunction with clinical presentation
### Differential Diagnoses

<table>
<thead>
<tr>
<th>Feature</th>
<th>Also seen in</th>
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<tbody>
<tr>
<td>Carpal erosions</td>
<td>Gout</td>
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<tr>
<td>Ulnar deviation &amp; volar subluxation of proximal phalanges</td>
<td>SLE, Jaccoud’s syndrome 2° to rheumatic fever</td>
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<tr>
<td>Narrow joint space</td>
<td>Osteoarthritis</td>
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<tr>
<td>Bony destruction (“punched-out” lesion)</td>
<td>Sarcoid</td>
</tr>
<tr>
<td>Swell, erode, cyst</td>
<td>Psoriatic arthritis</td>
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RA: Distinguishing Features

- Diffuse (vs. limited to juxta-articular) osteoporosis
- Lack of new bone formation
Summary: Key Points

• Conventional radiography and MRI are especially useful in imaging RA
• Chronic, progressive changes are evident in the hands and wrists
• Characteristic changes on plain film include bony erosions, joint space narrowing, & osteoporosis
• On MRI: tenosynovitis, synovial proliferation, cartilage tear, tendon rupture
References

- American College of Radiology Film Library
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