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

Nodular episcleritis

Radiograph showing right lung nodule

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

Netter, The Ciba Collection of Medical Illustrations
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 → narrow → 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 $\rightarrow$ 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
Hand Anatomy Review

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

Wicke, Atlas of Radiologic Anatomy
Carpal Bones

- clavilunate
- triquetral
- pisiform
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
• 2nd 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 $\Rightarrow$ pain
Ms. M: TFC Tear & SL Tear

Gap > 2 mm indicates SL tear

↑ signal = TFC 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

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><strong>Ulnar deviation &amp; volar subluxation of proximal phalanges</strong></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 (&quot;punched-out&quot; 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
Acknowledgements

- Gillian Lieberman, MD, Radiology Course Director, BIDMC
- Pamela Lepkowski, Student Coordinator, BIDMC
- Daniel Saurborn, MD, Resident in Radiology, BIDMC
- Daniel Lim, MD, Radiology Staff, BIDMC
- Larry Barbaras and Cara Lyn D’amour, Webmasters, BIDMC