Prevalence of Arthritis

- Arthritis is one of the most prevalent chronic health problems.
- The nation’s leading cause of disability.
- Costs US economy $128 billion annually.

Arthritis Foundation

Prevalence of Types of Arthritis

- OA: 27M (59% of all Arthritis)
- RA: 1.3M (3% of all arthritis)

Arthritis is Ancient:

- Gout: 2600BC (Egypt): Described in the great toe.
- 400BC (Greece): Hippocrates wrote about it.
- 1599 Shakespeare (Henry IV, Part 2) Falstaff: “A pox of this gout! or a gout of this paw! for the one or the other plays the rogue with my great toe.”
- 1799 James Gillray (British caricaturist):
Old Diseases = Old Names (misnomers)

- **“Reiter’s Disease”**
  - 1942: Hans Conrad Julius Reiter
  - Head of the Reich Health Office
  - Widely considered expert on vaccines
  - Involved in experimenting with typhus on Buchenwald concentration camp internees
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- **“Osteoarthritis”**
  - Osteo “Bone”... but it’s not disease of bone
  - Osteo “inflamed”... but it’s not inflammatory disease

- **“Rheumatoid Arthritis”**
  - Resembles Rheumatic Fever...
  - but it has nothing to do with rheumatic fever

- **“Gout” vs “Pseudo-gout”**
  - Radiographically, these look nothing like each other

PowerPoint Model: Joint

- Joint: 2 bones meet
- Bones flair out at ends
- Metaphysis
- Can see on radiographs:
  - Trabecular bone
  - Cortical bone
  - Joint space between bones
  - Black rectangle = Radiograph

PowerPoint Model: Bone

- stuff inside joints we can’t see on radiographs:
  - Cartilage
    - Articular
    - Hyaline
    - [Gr] “resembling glass”
  - Synovium
    - Normally very thin (1-3 cells)
    - Synovial fluid
      - Normally just wetting amount

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Joint Disease = Cartilage Damage

Imaging joint disease = "seeing cartilage"

- Radiographs
  - Can't see cartilage directly
  - We see it indirectly by looking at joint space width
- Arthrogram-CT
  - Inject contrast into joint, then do a CT scan
  - Multiplanar reformat

The 5 Most Common Arthropathies

Is it...

<table>
<thead>
<tr>
<th>Joint Disease</th>
<th>Features</th>
<th>Distribution</th>
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<tr>
<td>OA?</td>
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<tr>
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<tr>
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<tr>
<td>Psoriatic?</td>
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</tbody>
</table>

OA = 27M
(59% of all Arthritis)

Osteoarthritis (OA)

THE most common joint disease

- At least 60% of ALL arthritis is OA...
- In my experience it's more like 80-90%
- Primary OA
- Affects specific joints
- Secondary OA
- Can effect any joint

"Osteoarthritis"

ARTHRITIS&RHEUMATISM,2005,v58,n1,p26-35

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OA = Disease of Hyaline Cartilage

Articular hyaline cartilage is the diseased tissue
- Loss of hyaline cartilage
- Proximal & Distal articular surfaces
- Non-Uniform \( \rightarrow \) to OA
  - e.g. Knee: Medial > Lateral
  - Progressive – worsens with time
  - Non-Uniform joint narrowing \( \rightarrow \)
  - e.g. Dominant hand > other hand

OA = Bone Producing Disease

In OA, joints make bone
- Sub-cortical sclerosis
- Articular cortex thickens
- Stress response?
- OSTEOPHYTES! \( \rightarrow \) to OA
  - Bony spurs from joints
  - Can occur either after the joint is narrowed…
  - or before the joint narrows

Let's Talk about “Phyte Club”

Suffix phyte: “abnormal growth”

3 Types of phytes:
- Osteophytes @ Joints
- Enthesophytes @ Ligament/Tendon insertions
- Synsdesmophytes @ Disks (Annulus Fibrosis)

Enthesophytes are… nothing
- Bone spurs at ligament/tendon insertions
- Not osteophytes (which occur at joints)
- Not pathology
- Common in calcaneus
- “Heel spurs”
- Not plantar fasciitis

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Osteophytes

- Occur at Joints in DJD (Degenerative Joint Disease)
  - Extend from joint edges
- Occur at Disks in DDD (Degenerative Disk Disease)
  - Extend from vertebral bodies corners
  - In DDD disk bulges outward
  - Osteophytes extend out around bulging disk
  - Extend horizontally
  - Typically extend anteriorly

Osteophytes vs Syndesmophytes

While Osteophytes
- Extend horizontally from corners of vertebral body
- Syndesmophytes
- Extend vertically along Annulus Fibrosus
- Thin
- Cover multiple levels
- Thoracic
- Lumbar

Syndesmophytes Vertical

- Extend vertically along Annulus Fibrosus
- Thin
- Cover multiple levels
- Cervical
- Thoracic
- Lumbar

Ankylosing Spondylitis

- Bamboo Spine
- Fused SI Joints
- "Bamboo Spine"

Distribution

<table>
<thead>
<tr>
<th>Prevalence/Hx</th>
<th>Joint Anatomy</th>
<th>Ordered List</th>
<th>OA</th>
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<td>Non-uniform joint space narrowing Osteophytes!</td>
<td>Hips, Knees, 1st MTP, L4-5, C5-6</td>
<td>DIPs,PIP,Thumb base</td>
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</table>
Distribution: OA

Spine
- Lower Cervical Spine
- C5-C6
- Lower Lumbar Spine
- L4-L5

Lower Extremity
- Common in the Hip
- Common in the Knee
- Uncommon in the Ankle
- Not simply due to weightbearing
- Common 1st MTP Joint

OA: Hips
- Non-uniform narrowing \(\rightarrow\) to OA
  - Hip: Superior weightbearing surface
- Asymmetry \(\rightarrow\) to OA
- Progressive
- Worse over time
- Osteophytes? \(\rightarrow\) to OA
  - Often not seen on AP view
  - Best seen on frog-leg view

What's a frog-leg view?

Lying on x-ray table
- Not weight-bearing
- Unlike knees/feet which should be done standing

Cassette slides into “Bucky Grid”
- Minimize x-ray scatter
- Dr. Gustav Bucky (1853/1899-1963)
- 1913: Moving grid

Marty age 15

PowerPoint Model: Hip
- Acetabulum
- Femoral Head
- Symptomatic Side
- Asymmetry: \(\rightarrow\) to OA

Ordered List
- Spine
- Lower Extremity
- Joint Anatomy
- Prevalence/Hx

Osteophytes?
- Progressive
- Worse over time
- Often not seen on AP view
- Best seen on frog-leg view

Radiology of Joint Disease
My Practical Approach
Prevalence/Hx
Joint Anatomy
Ordered List
- OA
- Phytes
- RA
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- PA
- WOW

AP Pelvis
View of Femurs
Greater Trochanter
Lesser Trochanter
Head Neck
Joint width

Frog Leg Lateral
View of Femurs
Internally Rotated
Externally Rotated

Osteophytes: Hips
Superior narrowing
Asymmetry
Osteophytes?
None on AP

Sub-Cortical Sclerosis: Hips
Not sub-cortical sclerosis
Normal appearance of acetabular roof
Sourcil: "eyebrow"

Distribution: OA
Upper Extremity
Uncommon in the Shoulder
1st OA spares glenohumeral joint
2nd OA from trauma, rotator cuff tear

This is sub-cortical sclerosis!
This looks more like this guy's eyebrow...

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**Distribution: OA**

**Upper Extremity**
- Uncommon in the Shoulder
  - 1st OA spares glenohumeral joint
  - 2nd OA from trauma, rotator cuff tear
  - Very common acromioclavicular joint
- Uncommon in the Elbow
  - Common at the Thumb base
  - STT & CMC (Spares rest of wrist)
  - Common at the PIPs & DIPs
  - (Spares MCPs)

**OA: Hands**
- Narrows DIPs & PIPs
  - Non-uniform narrowing
  - Sub-cortical sclerosis
- Spares MCPs
- Narrows Thumb Base
  - Thumb CMC joint
  - Spares the other CMCs
  - Scaphoid-Trapezoid-Trapezium joint
  - Spares other intercarpal joints
  - Spares radiocarpal joint

**OA: Distribution**
- Non-uniform joint space narrowing
- Gullwing Erosions

**OA: Features**
- Non-uniform joint space narrowing
- Gullwing Erosions

**OA: Distribution**
- Hip, Knee, 1st MTP
- L4-5, C5-6
- DIPs, PIP, Thumb base

**OA: Features**
- Glutewing Erosions
- DIPs (Symmetric)
- Women > 50yo

**OA: Order**
- Is it...
  - OA?
  - EOA?

**OA: Distribution**
- Hip, Knee, 1st MTP
- L4-5, C5-6
- DIPs, PIP, Thumb base

**OA: Features**
- Glutewing Erosions
- DIPs (Symmetric)
- Women > 50yo

**OA: Order**
- Is it...
  - OA?
  - EOA?
Erosive Osteoarthritis

**Prevalence/Hx**
- Erosive Osteoarthritis (EOA) occurs in women > 50.
- As does conventional OA
- Involves DIPs (PIP) in women > 50.

**Joint Anatomy**
- OA
- Phytes
- EOA
- RA
- Gout
- CPPD
- PA

**Ordered List**
- OA
- Phytes
- EOA
- RA
- Gout
- CPPD
- PA

**Features**
- Non-uniform joint space narrowing
- Osteophytes
- Gullwing Erosions
- Uniform narrowing
- Marginal erosions

**Distribution**
- Hips, knees, 1st MTP
- L4-5, C5-6
- DIPs, PIP, Thumb base
- MCPs, Carpus, C1-2
- Big joints (Symmetric)

**RA = Disease of Synovium**

**Normal synovium**
- Very thin
- 1-3 cells thick

**RA synovium hypertrophies**
- 8-10 cells thick
- Pannus
- Contains increased blood vessels
- Increased blood flow (hyperemia)
- Contains inflammatory cells
- Includes osteoclasts
- Causes erosions
- Cartilage
- Bone

**Synovial hyperemia causes**
- Bone resorption, bone loss
- Within the joint capsule
- “Peri-articular osteopenia”
- This is subtle on radiographs
- Radiographic technique dependent
- May not be present on patients treated with bisphosphonates to prevent loss of bone mass
- Cortical thinning causes bone bowing/deformity

**RA = Disease of Synovium**

**Inflamed pannus effects the articular cartilage uniformly**
- Uniform cartilage loss
- Uniform joint narrowing
- Synovial osteoclasts erode cortical bone
- Central erosions
- Marginal erosions ➔ to RA
- Pannus tends to heap up at margins of joint capsule

**Symmetry**
- T, M 64 yo F
- Left Hand PA view
- Right Hand PA view
Radiology of Joint Disease
My Practical Approach

Prevalence/Hx
Joint Anatomy
Ordered List

OA
Phytes
EOA
Gout
CPPD
PA
WOW

OA vs RA
Disease of Cartilage
Nonuniform Narrowing
Produces bone
Subchondral Sclerosis
Osteophytes

OA
Phytes
EOA
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OA vs RA
Disease of Synovium
Uniform Narrowing
Resorbs bone
Periarticular Osteopenia
Erosions

Prevalence/Hx
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Disease of Synovium
Uniform Narrowing
Resorbs bone
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OA    vs    RA
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Produces bone
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OA    vs    RA
Disease of Synovium
Uniform Narrowing
Resorbs bone
Periarticular Osteopenia
Erosions

H,A 51yoF
V,D 50yoF

Knee AP view

Knee AP view

RA: Marginal Erosions

RA: Erosions

Marginal Erosions

Central Erosions

Features
Nonuniform joint space narrowing
Osteophytes!
Gullwing Erosions
Uniform narrowing
Marginal Erosions!

Distribution: OA vs RA

Big Joints
Hips
Knees
Ankles
Shoulders
Elbows
Spine
C1-C2
Hands
All the MCP jts
Entire Wrist

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Also, since with RA there is bone loss/resorption, there can be thinning of medial acetabular wall…

The degree of bone loss in RA can be so great that the medial acetabular wall not only thins, it protrudes into the pelvis…

The bones drift in the ULNAR direction

“Ulnar deviation” of the MCPs

Normally, lunate sits ½ over radius and ½ over ulna

Ulnar translocation of the carpus

Particularly in the hand
- MCPs
- Wrist
  The bones drift in the ULNAR direction

Particularly in the hand
- MCPs
- Wrist
  The bones drift in the ULNAR direction

Distribution OA vs RA: Hands

OA: Ligamentous Laxity

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RA: Ligamentous Laxity

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Particularly in the hand
- MCPs
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OA vs RA: Hips

OA

Phytes

EOA

RA

Gout

CPPD

PA

Also, since with RA there is bone loss/resorption, there can be thinning of medial acetabular wall…

WOW

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OA vs RA: Hips

OA

Phytes

EOA

RA

Gout

CPPD

PA

Also, since with RA there is bone loss/resorption, there can be thinning of medial acetabular wall…

WOW

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RA: Hips

Medial Acetabular Wall

Mirror Image Symmetry

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Distribution OA vs RA: Hands

OA

DIPs

PIPs

Thumb base

CMC

STT

Spares

MCPs

Rest of the wrist

RA

MCPs

Entire wrist

DRUJ

Spares

DIPs

PIPs

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RA: Ligamentous Laxity

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- MCPs
- Wrist
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RA: Ligamentous Laxity

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Radiology of Joint Disease
My Practical Approach

**RA: Ligamentous Laxity**

- **Is it...**
  - OA?
  - RA?
  - Gout?
  - CPPD?

- **Features**
  - Non-uniform joint space narrowing
  - Osteophytes!
  - Marginal Erosions!
  - Sharp Erosions with overhanging edges

- **Distribution**
  - Hips, Knees, 1st MTP
  - MCPs, PIP, Thumb base
  - MCPs, Carpus, C1-C2
  - Unusual distribution for OA

- **OA**
- **RA**
- **Gout**
- **CPPD**

Erosions are sharply defined
Crystals erode cortex slowly
Marginal erosions
Calcified soft tissue tophi are rare

**Crystal Deposition Arthropathies**

- Three crystals can deposit in joints:
  - Hydroxyapatite: Usually in shoulders (calcific tendonitis/bursitis)
  - Uric acid (monosodium urate): “Gout”
  - Calcium pyrophosphate dihydrate: “Pseudogout”

**Gout**

- **Is it...**
  - OA?
  - RA?
  - EOA?

- **Features**
  - Non-uniform joint space narrowing
  - Osteophytes!
  - Marginal Erosions!

- **Distribution**
  - Hips, Knees, 1st MTP
  - MCPs, PIP, Thumb base

- **OA**
- **RA**
- **EOA**

OA has osteophytes
OA looks nothing like RA!
OA has erosions
Not everything with osteophytes is OA
Not everything with erosions is RA

**Joint Anatomy**

- **Is it...**
  - OA?
  - RA?
  - Gout?
  - CPPD?

- **Features**
  - Radiographically, Gout & CPPD look very different!

- **Distribution**
  - MCPs, Carpus, C1-C2
  - Big Joints (Symmetric)

OA has osteophytes
Not everything with osteophytes is OA
Not everything with erosions is RA

**Prevalence/Hx**

- **OA**
- **RA**
- **Gout**
- **CPPD**

- **Distribution**
  - MCPs, Carpus, C1-C2
  - Big Joints (Symmetric)

OA has osteophytes
Not everything with osteophytes is OA
Not everything with erosions is RA

**Past History**

- **OA**
- **RA**
- **Gout**
- **CPPD**

OA has osteophytes
Not everything with osteophytes is OA
Not everything with erosions is RA

**Clinical Symptoms**

- **OA**
- **RA**
- **Gout**
- **CPPD**

OA has osteophytes
Not everything with osteophytes is OA
Not everything with erosions is RA

**Imaging Features**

- **OA**
- **RA**
- **Gout**
- **CPPD**

OA has osteophytes
Not everything with osteophytes is OA
Not everything with erosions is RA

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My Practical Approach

Gout: Favors Toes (1st)

- Erosions can be quite small...
- ...or totally erode phalanges

Gout: Random Distribution

- Classic "rat-bite" erosion
- 1st toe
- Sharp margin
- Overhanging edges

Chondrocalcinosis

- Can be subtle...
- Sometimes obvious
- Common sites:
  - Knee
  - Pubic symphysis
  - Wrist
  - TFC (Triangular fibrocartilage)

Clues to CPPD:
1) Chondrocalcinosis
2) Distribution unusual for OA

Not all chondrocalcinosis = CPPD

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Radiology of Joint Disease My Practical Approach

**Psoriasis**

Psoriasis is the most prevalent autoimmune disease in the US

- 7.5 million Americans (2% of population)
- 125 million worldwide (2.3% of population)
- Up to 30% develop psoriatic arthritis
- 15% the arthritis precedes the skin disease

Psoriatic Arthritis: 5 Types

- Symmetric arthritis
  - Like RA; milder, less deformity.
- Asymmetric arthritis
  - "Sausage digit". Usually mild.
  - DIP (5%)
  - Like OA; nail changes.
- Arthritis mutilans (5%)
  - Hands/feet.
- Spondylitis (5%)
  - Still spine, SIs, extremities.

Clue to PA:

- Pencil-in-Cup erosion

OA?

- Non-uniform joint space narrowing
  - Osteophytes!

RA?

- Uniform narrowing
  - Marginal Erosions!

Gout?

- Sharp Erosions with overhanging edges
  - MCPs, Carpus, C1-2

CPPD?

- Resembles OA
  - Chondrocalcinosis

Psoriatic?

- Pencil-in-Cup Sausage Digit
  - Hands, Feet, Spine
  - SI Joints (Asymmetric)

Radiology of Joint Disease My Practical Approach

**Psoriatic Arthritis: 5 Types**

- Symmetric arthritis
  - Like RA; milder, less deformity.
- Asymmetric arthritis
  - "Sausage digit". Usually mild.
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  - Chondrocalcinosis

Psoriatic?

- Pencil-in-Cup Sausage Digit
  - Hands, Feet, Spine
  - SI Joints (Asymmetric)
Radiology of Joint Disease

My Practical Approach

**4 Seronegative Spondyloarthropathies**

- OA
- EOA
- RA
- Gout
- CPPD
- PA

**Prevalence/Hx**

- "Seronegative": RF factor neg.
- "Spondylo": Effects spine

- All 4 cause sacroiliitis
  - Psoriatic arthritis & "reactive arthritis"
  - Unilateral, asymmetric
  - Ankylosing spondylitis & inflammatory bowel disease
  - Bilateral, symmetric
    -> fusion (ankylosis)

**Ordered List**

- OA
- EOA
- RA
- Gout
- CPPD
- PA

**WOW**

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**How Ordered List Helps Me**

- **Is this OA?**
  - No 1st MTP osteophytes

- **Is this RA?**
  - Not uniform narrowing
  - Not all MTP, no osteopenia

- **Is this Gout?**
  - Maybe… not 1st toe

- **Is this CPPD?**
  - No chondrocalcinosis

- **Could this be PA?**
  - Do we have SI images?

**SER**

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**What to Order When**

- Always start with radiographs
  - Least expensive imaging study
  - Well shows results of joint disease:
    - Narrowing & alignment
    - Osteophytes & erosions
  - Useful for following course of disease

**Radiographs: Disease Progression**

- "½ RA"
  - Run eyes around wrist: No Narrowing
  - Run eyes along MCPs: Only 1 MCP is narrowed
  - Disease progression, now with 4 MCPs narrowed
  - Radiograph 1 year later
  - Further disease progression, now with ulnar deviation MCPs
  - Radiograph 2 years later

**Advanced Imaging Studies**

- MRI with IV contrast
  - Well shows hypervascular pannus
  - Normal synovium does not enhance
  - Useful for diagnosing early RA

**Dual-Energy CT**

(coming soon…)

- Specific for uric acid crystals in gout

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Advanced Imaging Studies

Fluoroscopic guided joint injections

- Useful to prove which joint is symptomatic
- With steroids can yield long-term relief
- Can inject any joint:
  - Hips, Knees, Shoulders
  - Facets, AC, SI
  - Pubic symphysis
  - Ankle, Subtalar joint

Any Final Questions?

WOW

Final Exam

Is this OA?
- No. Erosions, not phytes.

Is this RA?
- Does involve MTPs...
- Has marginal erosions...

Is this Gout?
- Not random enough.

Is this CPPD?
- No chondrocalcinosis.

Could this be PA?
- Pencil-in-cup erosion!

Thank you!