

Imaging in Axial Spondyloarthritis (SpA) Xray, MR, and CT



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Objectives

- To review the radiographic and advanced imaging of axial SpA
- To outline the indications, advantages and disadvantages of radiographs, MR and CT in evaluation of axial SpA
- To review the current radiologic scoring systems in axial SpA

Advanced Imaging Rheumatology

Modality	MRI	CT/DECT	US	Arthro	Nuc Med
Utility	Diagnostic	Diagnostic Therap/Intervention	Diagnostic Therap/Intervention	Diagnostic Therap/Intervent +/- MR/CT	Bone Scan PET CT WBC, etc
Advantage	Hi Resolution Anatomic Detail Distinguish Tissue Types, Edema vs Tumor/Sup/Deep *STRUCTURE AND FUNCTION	Bone detail/Mineralization Cortical erosions DECT: Specific for Gout/ CPPD; Bone edema, metal	Easily Accessible Assess real time		Multifocal sites WBC specific for infection
Contrast	+/- Contrast -IV vs IA	+/- Contrast -IV vs IA DECT No Contrast		Contrast - IA	IV injectate
Ionizing Radiation	(-)	(+)	(-)	(+)	(+) injectables
Time	30-60 min	5-10 min	10-30 min	15 min arth +/-CT/MR	Hours to days (activity)
Cost	High	Medium	Low- Medium	Low - Medium	
Area of Coverage	Limited by surface coil area (covers joint)	No limitation	Difficult for deep structures (spine)	Joints	Whole body or region

MRI: Rheumatologic Indications

- Evaluation of Bone:** Bone Marrow Edema/Osteitis (BME), AVN/ infarct, erosion, sacral/vertebral abnormalities (ie) spondyloarthropathies
- Evaluation of Cartilage:** Erosion, thinning
- Soft Tissues:** Inflammation, synovitis, infection (and extent of disease)
- Associated Soft Tissue pathology:** Bursitis, enthesitis, effusion, ligament / tendon disease
- Tissue typing:** Mass or bodies
- Monitoring response to drug therapy**

Major Goals of MRI in Arthritides

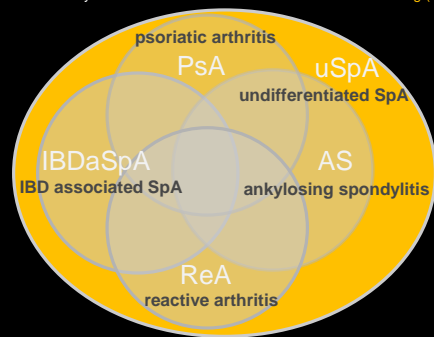
To identify precursor lesions before arthritis progresses to bone erosion and cartilage destruction.

Relevant points:

- Radiographs: relatively insensitive to small erosions, and even combined with clinical features cannot prognosticate the disease course.
- Enthesitis, Synovitis and Bone marrow changes often precede and predict later disease
- To institute treatment before bone or chondral destruction

SERONEGATIVE SPONDYLOARTHROPATHIES

Chronic inflammatory arthritides of *ENTHESIS ***Rheumatoid Factor Neg (NOT RA)



2009 ASAS axial SpA criteria

Ankylosing Spondylitis

IMAGING:

**SPINE
&
SACROILIAC JOINTS**

ENTHESIS

STAGES

1. Inflammation
2. Erosion
3. Fatty Post Inflamm Changes
4. Sclerosis
5. Ankylosis

Ankylosing Spondylitis Radiographic Manifestations

Progression

SI 1st
ascends to TL
then LS
then ML
UT to cervical

Ankylosing Spondylitis SI Joint Disease – “Entheses”

STAGES:

- *MRI 1. Subchondral Edema (*Early Inflammation*)
2. Erosions - iliac side first
3. Sclerosis - primarily iliac side
4. Ankylosis

*Bilateral and Symmetric usually – like enteropathic

Other pelvic bone findings

- pubic symphysis - 16-23% erosions/ankylosis
- enthesitis - ilium and ischium

Axial Spondyloarthritis (SpA)

pre-radiographic

inflammatory back pain
MRI sacroiliitis

radiographic (AS)

inflammatory back pain
Xray sacroiliitis
syndesmophytes

time [years] →

1984 mNY criteria

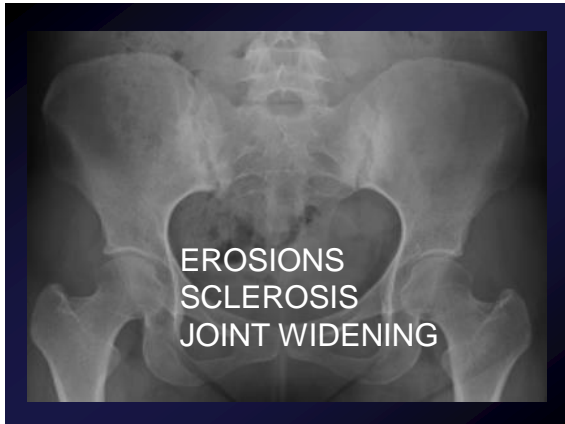
2009 ASAS axial SpA criteria

Rudwaleit Arthritis Rheum 2005, van der Linden Arthritis Rheum 1984, Rudwaleit Ann Rheum Dis 2009

SI joints

- Inferior 2/3 synovial (erosions Iliac>sacral)
- Cartilage thinner on iliac side
- Psoriatic & Reiter asym or unilateral
- AS & IBD symmetrical

Unilateral right sided sacroiliitis
Bilateral sacroiliitis



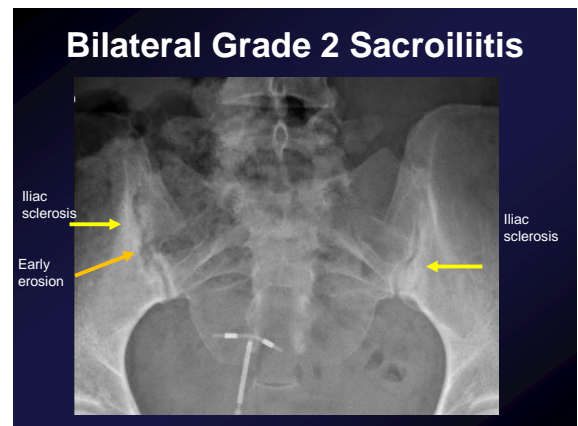
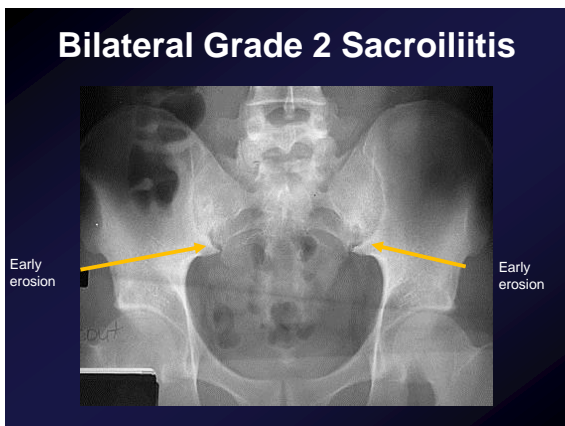
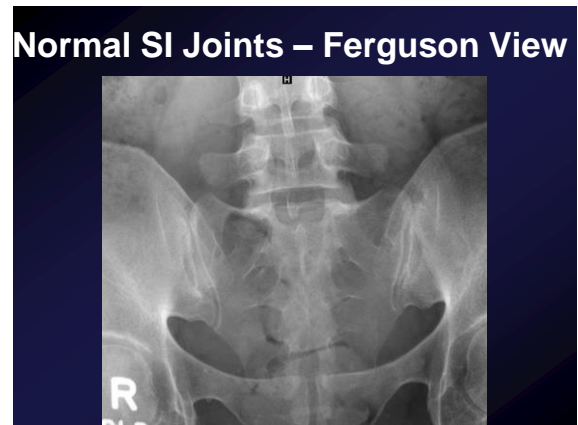
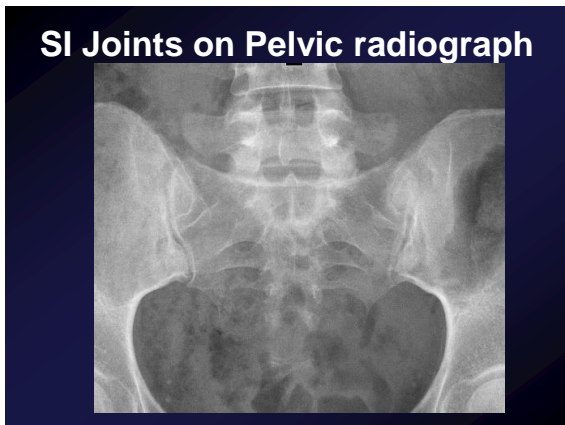
Modified New York Classification Criteria of AS SI

Radiological criteria:

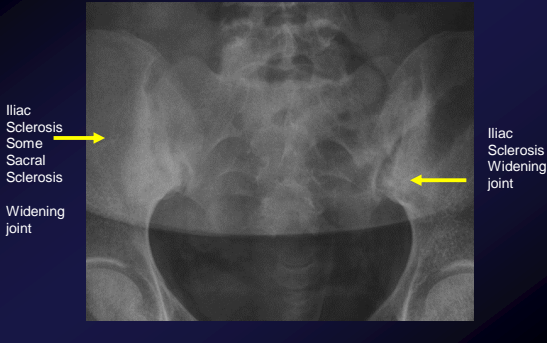
Bilateral sacroiliitis > grade 2

Unilateral sacroiliitis > grade 3 or 4

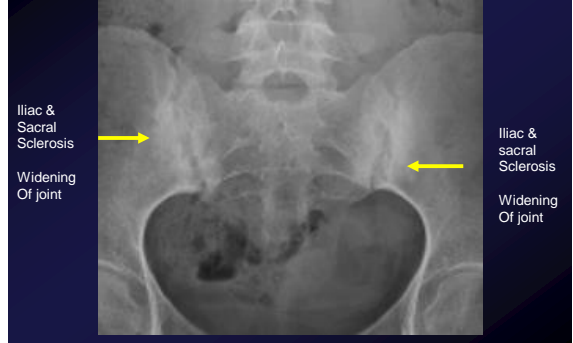
Grade 0	Normal (no change)
Grade 1	Suspicious changes
Grade 2	Minimal sclerosis or some erosions
Grade 3	Moderate/severe erosions WIDENING joint space, some ankylosis
Grade 4	Severe complete ankylosis



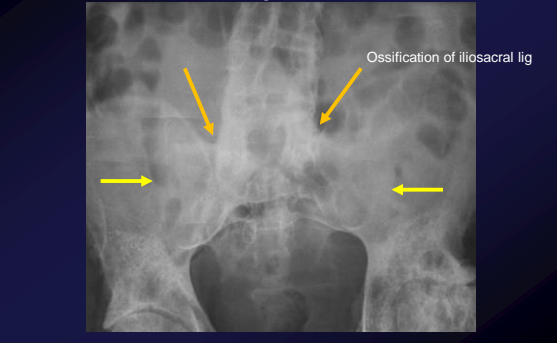
Bilateral Grade 3 Sacroiliitis



Bilateral Grade 3 Sacroiliitis



Bilateral Grade 4 Sacroiliitis Ankylosis



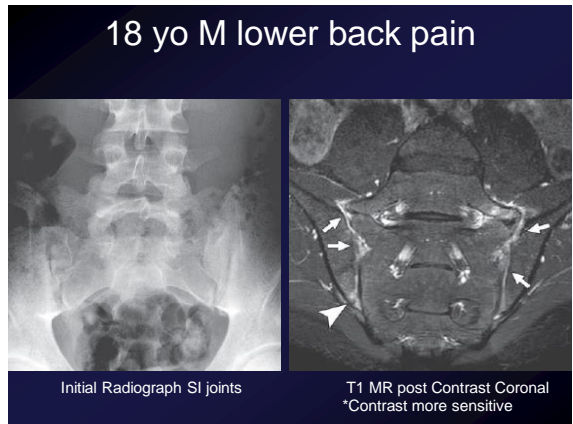
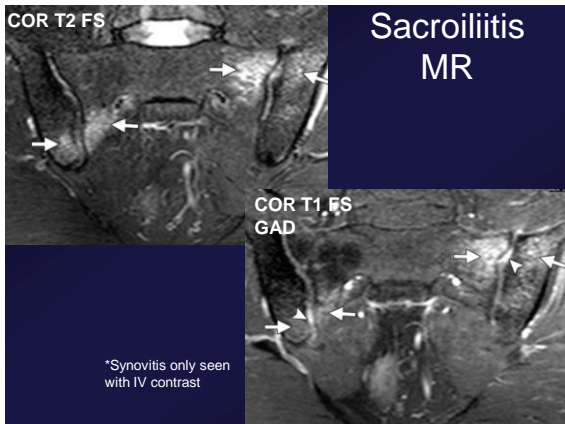
Ankylosing Spondylitis SI Joint Disease – “Entheses”

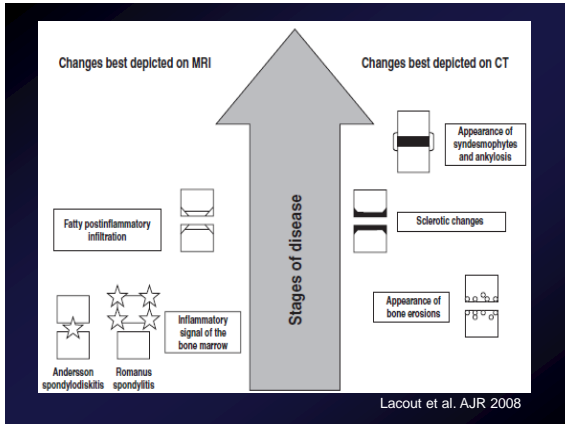
RADIOGRAPHS FIRST

HOWEVER...

MRI
MORE SENSITIVE FOR EARLY INFLAMMATION & MARROW EDEMA

CT
MORE SENSITIVE FOR EROSIONS, SCLEROSIS & ANKYLOSIS





CT and MRI

Both superior to conventional radiographs

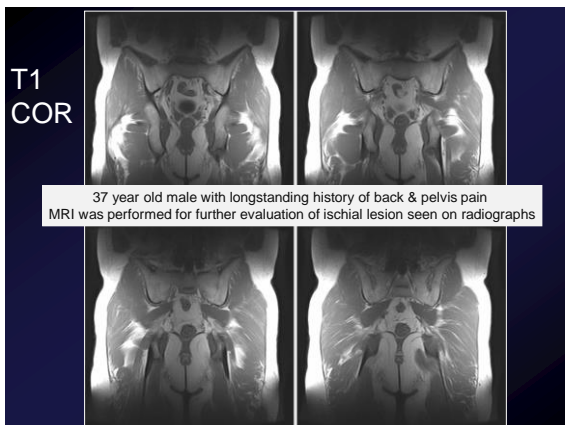
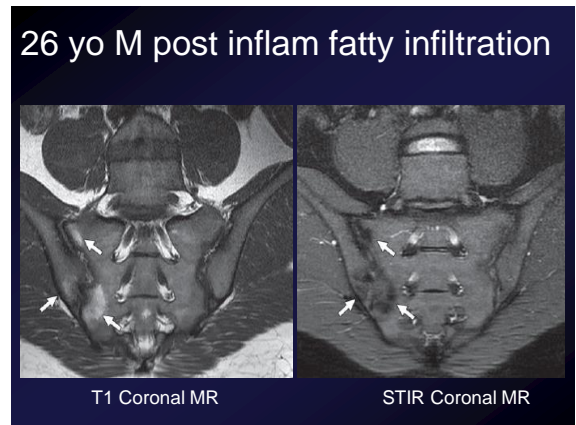
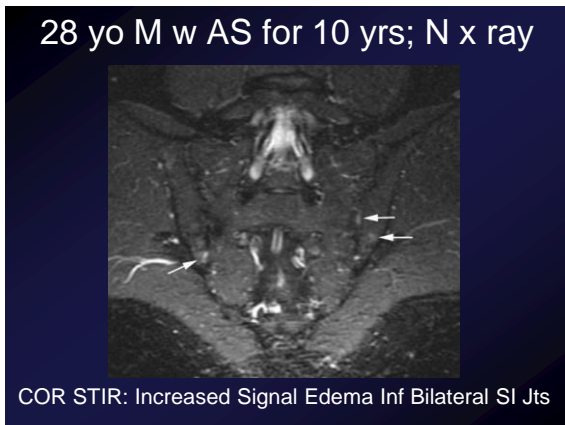
MRI: INFLAMMATION

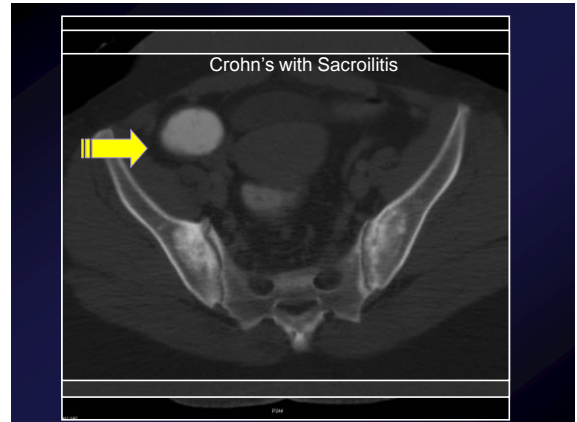
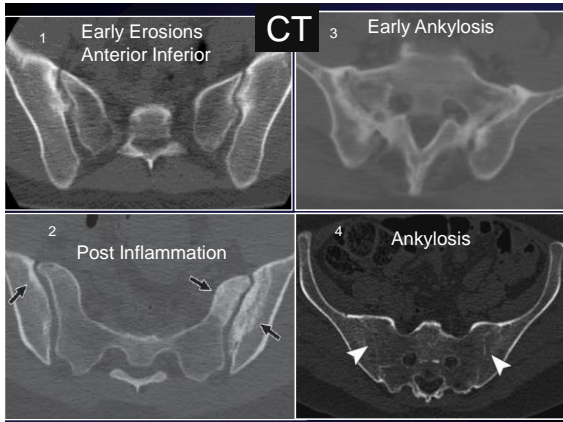
Most sensitive for early disease

Marrow edema, fluid

CT: STRUCTURAL DAMAGE

Sclerosis, Erosions, Ankylosis

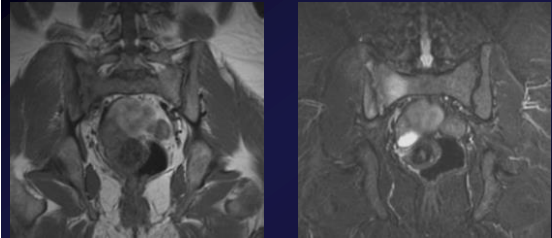




In Comparison to Enteropathic Arthropathy

- Ulcerative Colitis or Crohn's
- Peripheral arthritis more common here than in AS (50-70%)
- Spine involvement **NOT** related to activity of bowel disease
- Peripheral involvement **IS** related to activity of bowel disease (mono or oligo – knee usually)

Seronegative Spondyloarthropathy.



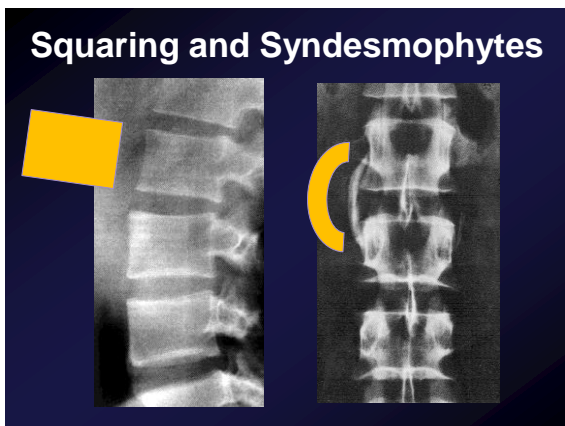
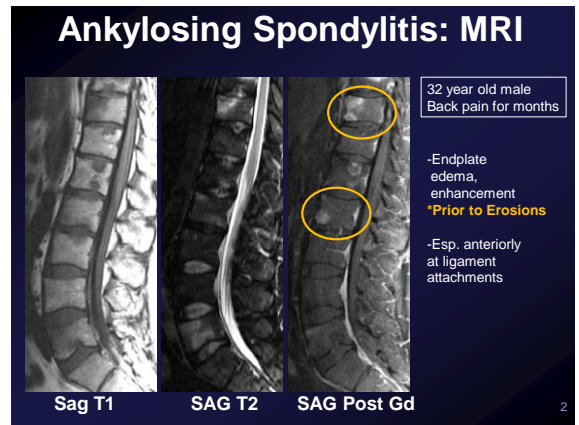
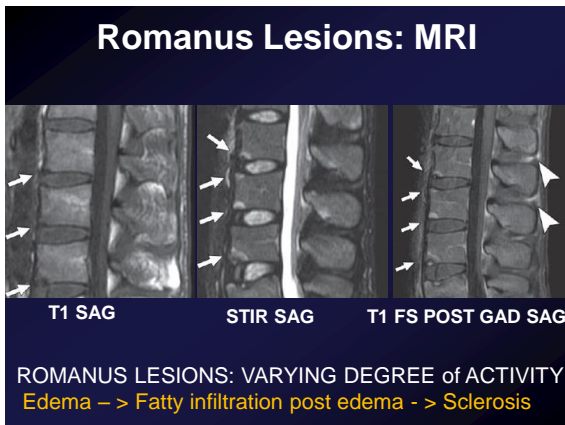
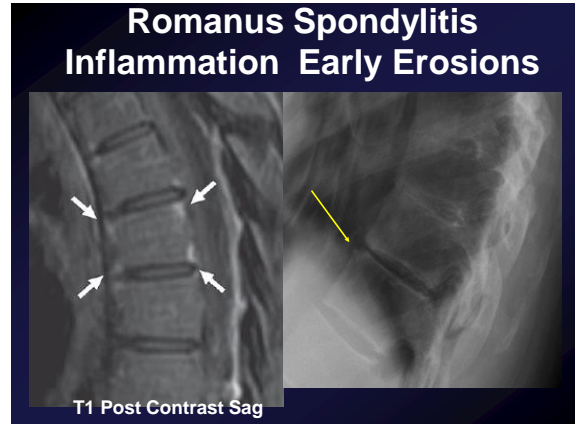
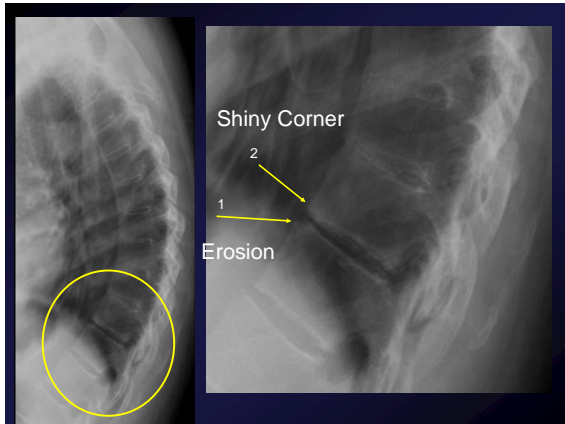
Bilateral asymmetric sacroiliitis
Dx: **Psoriasis**

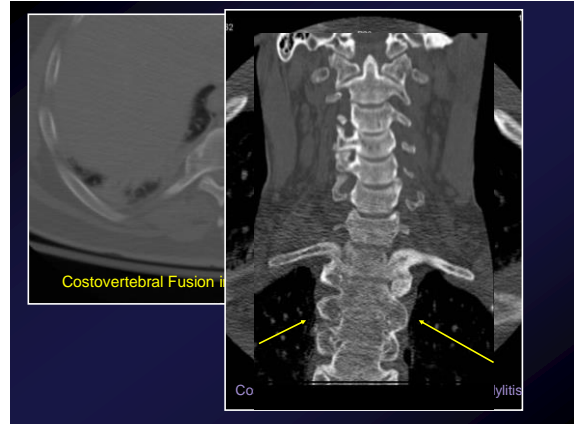
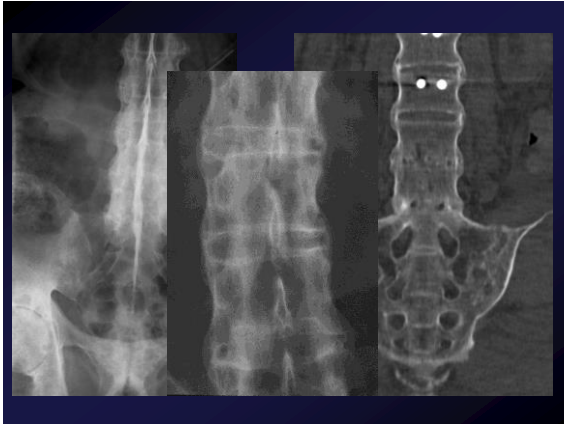
Ankylosing Spondylitis SPINE- Radiographic Manifestations

TRIAD:
INFLAMMATION-EROSION-BONE FORMATION

ANKYLOSING SPONDYLITIS SPINE: Radiographic Manifestations

- Discovertebral Junction:
 - **Erosion: Romanus Lesion** earliest x ray change anterior body edge destruction
 - **Osteitis: "Shiny corner Sign"** healing reactive bone formation at former Romanus lesions
 - **Squaring** of anterior vertebral body
 - **Syndesmophyte** formation – ossification of the annulus fibrosus > Bamboo spine
- Trolley Track and Dagger signs
- **Andersson lesions** – destructive discovertebral jn
- Pseudoarthrosis, discal calcification, balloon discs
- Enthesopathy





Ankylosing Spondylitis: Balloon Disks/Brittle Bone

"shiny corners"

Squaring of vertebral bodies

- inflammation of enthesial attachments
- early edema (MRI)
- late ossification (Xray)

Andersson Lesions - Aseptic

Andersson Lesions - Aseptic Spondylodiskitis

Post Zygoiphyseal Joints - Arthritic Edema

STIR MR SAG

Andersson Lesion MRI over time

SAG T1

Andersson Lesion MRI over time

SAG T1

SAG STIR

SAG T1

Radiographic damage and reactive bone formation are some of the core outcomes in axial SpA

How can we formally assess?

Radiographic Scoring Methods

- Modified Stoke Ankylosing Spondylitis Spine Score (**mSASSS**)
- Bath Ankylosing Spondylitis Radiology Index (**BASRI**)

Spinal Changes: Scoring Systems

- **mSASS**
 - Lateral cervical spine
 - Lateral lumbar spine
- **BASRI**
 - Lateral cervical spine
 - AP and lateral lumbar spine

mSASSS

- Lateral lumbar Spine view only (No AP)
- Each vertebral body level scored 0-3

- 0 Normal (no change)
- 1 Squaring, Sclerosis, Erosion
- 2 Syndesmophyte
- 3 Bridging syndesmophyte/ankylosis

* Shown to reliably track disease progression over time (48 weeks). Creemers et al. Annals of Rheumatic Disease 2005, 64,127–129.

mSASSS

Patient ID _____		Film Date _____		Date Read _____		Reader _____	
Lateral Lumbar Spine:							
T12	Score:	Erosion	Sclerosis	Squaring			
L1 upper							
L2 upper							
L3 upper							
L4 upper							
L5 upper							
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Lumbar Spine and Cervical Spine Scoring Criteria:

- Lateral Lumbar Spine and Lateral Cervical Spine:
- 0 = No abnormality
- 1 = Erosion, Sclerosis, or Squaring *
- 2 = Syndesmophyte
- 3 = Total bony bridging at each site
- NV = Not Visualized

* Squaring is defined as present if a line, actively drawn with a transparent ruler, from the upper and lower border of each vertebral body overlaid 50% or more with the surface of the vertebra, starting at either the upper or lower border, or if the surface of the vertebra was concave, approaching Talbot's method.

Scoring the Lumbar Spine
The scoring system is applied to the lower border of the 12th thoracic vertebra, all five lumbar vertebrae, and the upper border of the sacrum. Sites that have radiological abnormalities or that are not clearly visible are not scored. A total score is obtained by multiplying the mean score of all scored sites by 12 (highest possible score is 36).

BASRI

SI Joint Scoring Criteria:

* Please score the lower SI joints

- AP Pelvis X-Ray:
- 0-Normal = No change
- 1-Suspicious = Suspicious change
- 2-Minimal = Small localized areas with erosions or sclerosis or sclerosis without alteration in joint width
- 3-Moderate = Moderate or advanced sacroiliitis with erosions, evidence of sclerosis, widening, narrowing, or partial ankylosis
- 4-Severe = Severe abnormality with total ankylosis

Hips Scoring Criteria:

- AP Pelvis X-Ray:
- 0-Normal
- 1-Mild to Moderate disease
 - Suspicious: Possible focal joint space narrowing or early enthesiophytes
 - Minimal: Definite narrowing, but leaving circumferential joint space of > 2mm
- 2-Moderate: Narrowing with circumferential joint space <= 2 mm or bone on bone apposition of < 1 cm
- 3-Severe disease
- 4-Fused
- 5-Replaced

Patient ID _____

Film Date _____

Date Read _____

Reader _____

SI Joints: _____

Hips: _____

Right _____ Right _____

Left _____ Left _____

L-Spine: _____

C-Spine: _____

***Gross measurements Score 0-4 Diff to quantitate change Maxes out easily**

Lumbar Spine and Cervical Spine Scoring Criteria:

- AP and Lateral Lumbar Spine and Lateral Cervical Spine:
- 0-Normal = No change
- 1-Suspicious = Suspicious but no definite change
- 2-Minimal = Any number of erosions, squaring, sclerosis or syndesmophytes on 2 vertebrae
- 3-Moderate = Syndesmophytes on 2-3 vertebrae or fusion involving 2 vertebrae (1 level)
- 4-Severe = Fusion involving 2-3 vertebrae (2 levels; does not have to be contiguous)

Syndesmophytes and Ankylosis

BASRI 4/4

mSASS 36/36



Syndesmophytes

BASRI 4/4

mSASS 28/36



*from T. Leach

BASRI 4/4

mSASS 4/36



Recent Advances: Computerized CT quantification of bone formation

Goal: identify early bone formation on CT before Radiographs/reproducible

Compared to 2 readers over time

Computerized algorithm
Lumbar spine CT:
Volume & height:

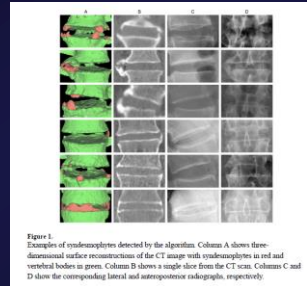


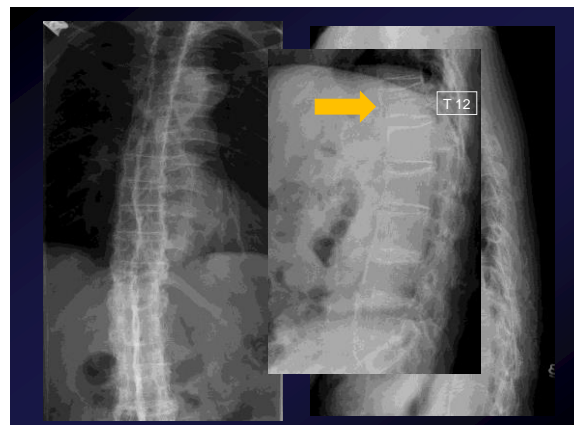
Figure 1. Examples of syndesmophytes detected by the algorithm. Column A shows three-dimensional surface reconstructions of the CT image with syndesmophytes in red and vertebral bodies in green. Column B shows a single slice from the CT scan. Columns C and D show the corresponding lateral and anteroposterior radiographs, respectively.

Tan et al. Quantitative measurement of syndesmophytes volume and height in ankylosing spondylitis using CT. Ann Rheum Disease 2014 March;73(3):544-550

Ankylosing Spondylitis Complications

- Pseudoarthrosis
- Vertebral fracture (MOST SERIOUS)
 - hyperextension injuries
 - horizontal fracture plane
- Atlantoaxial subluxation
- Hip disease (RA and osteoarthritis)

- Cauda equina syndrome (low back pain, sciatica, leg weakness, loss of bladder and bowel function, saddle anesthesia)
- Saccular dilation of dural sac - MRI





SpA SUMMARY (AS)

- SACROILITIS (symmetry) & SPONDYLITIS
- TRIAD: Inflammation – Erosion – Ankylosis
- MR useful in early disease
- ROMANUS/ SHINY CORNER/ANDERSSON
- Complications of disease (FRACTURE #1)
- Look at Clinical symptoms AND Imaging Findings (Radiographs first then other modalities usually)
- Look for peripheral involvement to differentiate from AS: (Psoriasis vs Reiters, Enteropathic or just RA)

CONCLUSIONS

- **RADIOGRAPHS** useful but limited in early disease. Inexpensive method for follow up/monitoring
- **MR BEST MODALITY (Inflammation)** for early identification of disease and fatty change progression
 - Enthesitis, marrow edema, spondylodiskitis
- **CT USEFUL FOR BONE** destruction/formation/ankylosis
 - More commonly performed, can help differentiate from enteropathic or other
- **BASRI** and **mSASS** useful for research/clinical with new grading systems on the horizon.



THANK YOU!

Questions?

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