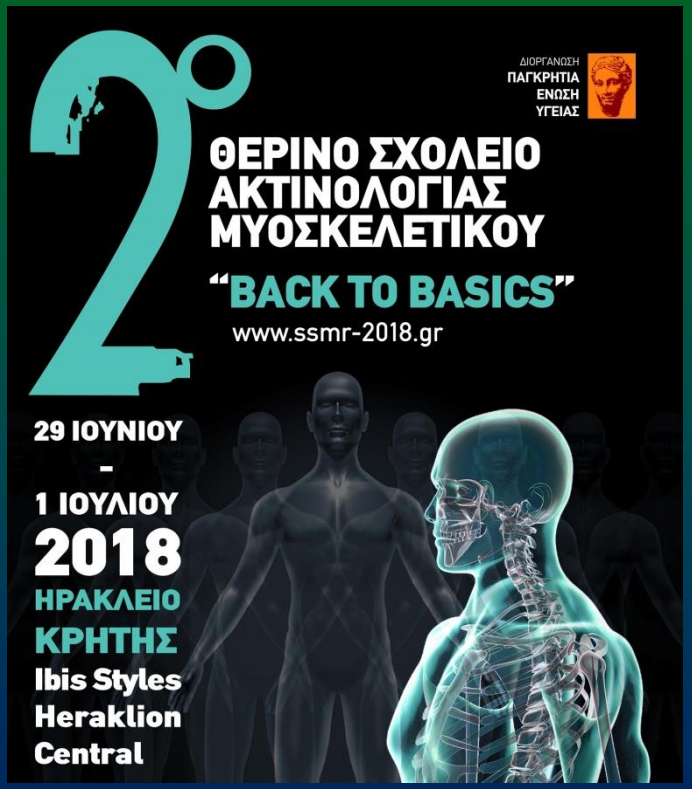
MRI for clinicians: ABC



Apostolos Karantanas

Professor of Radiology, University of Crete

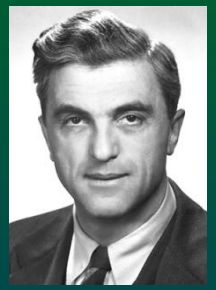
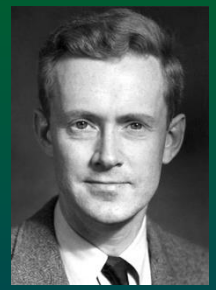
Chairman, Dpt of Medical Imaging, Heraklion University Hospital

Objectives

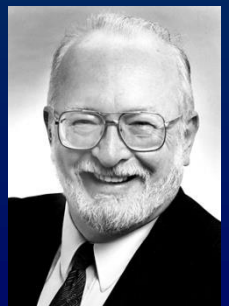
- Learn basic principles of MRI including sequences
- Learn how to recognize on MR images the spectrum of findings in aSpA / Inflammatory Joint Disease

Nobel Prizes for Magnetic Resonance

- 1944: **Rabi**
  Physics (Measured magnetic moment of nucleus)

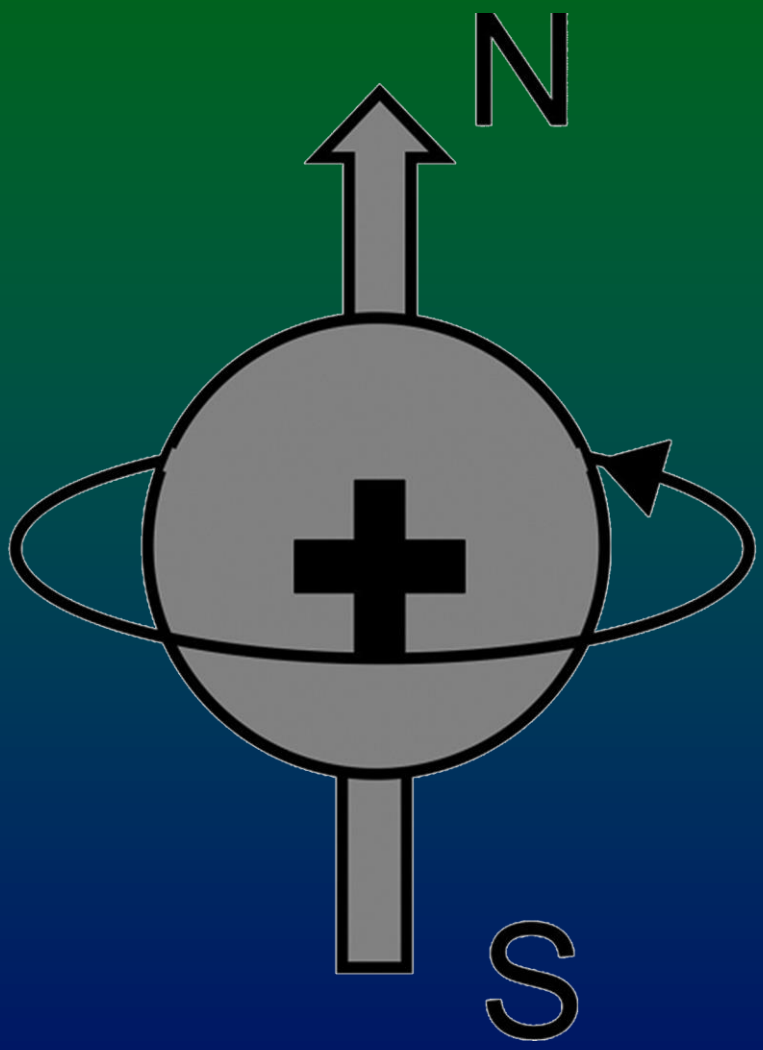



- 1952: Felix **Bloch** & Edward Mills **Purcell**
  Physics (Basic science of NMR phenomenon)
- 1991: Richard **Ernst**
  Chemistry (High-resolution pulsed FT-NMR)
- 2002: Kurt **Wüthrich**
  Chemistry (3D molecular structure in solution by NMR)



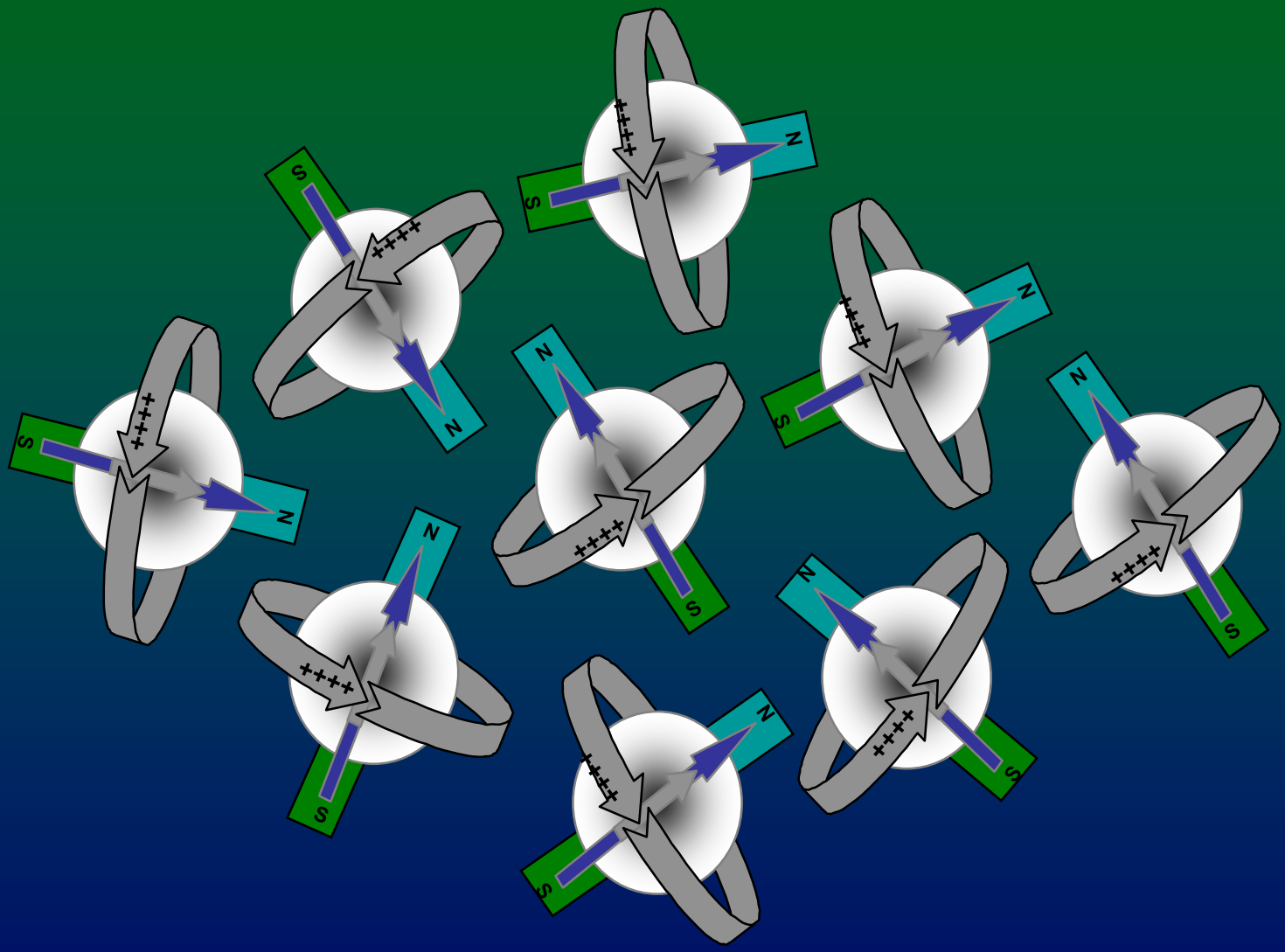

- 2003: Paul **Lauterbur** & Peter **Mansfield**
  Physiology or Medicine (MRI technology)

Hydrogen proton

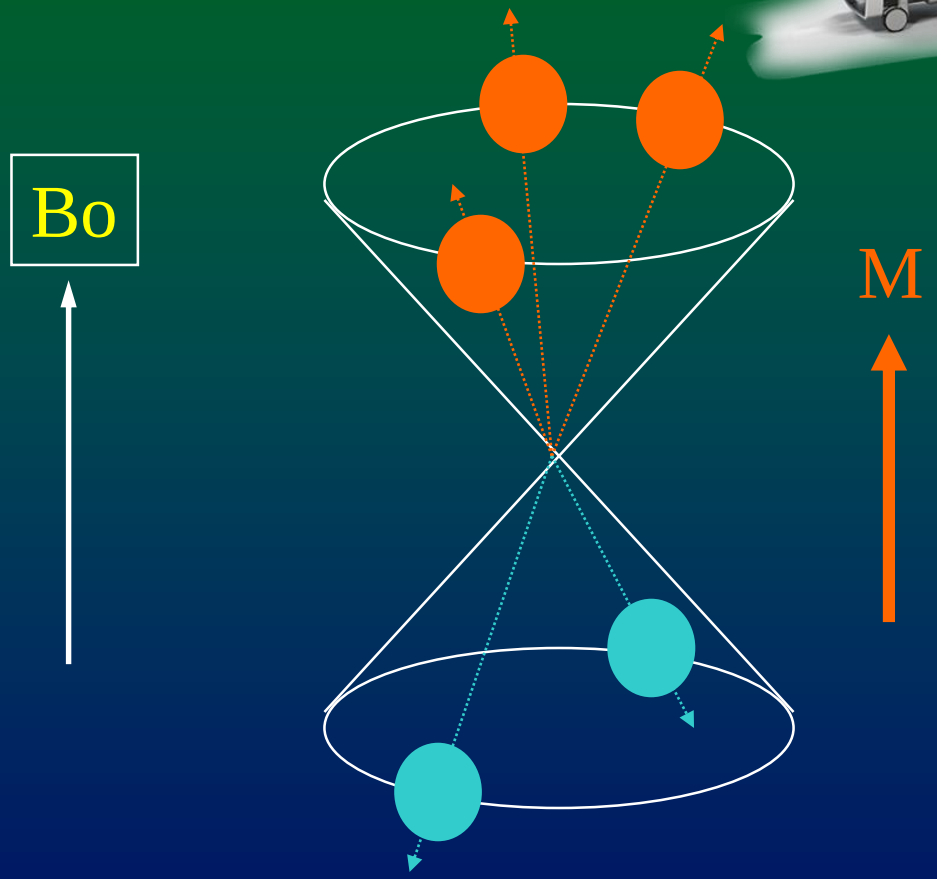


Pooley R A Radiographics 2005;25:1087-1099

Nuclei in free space

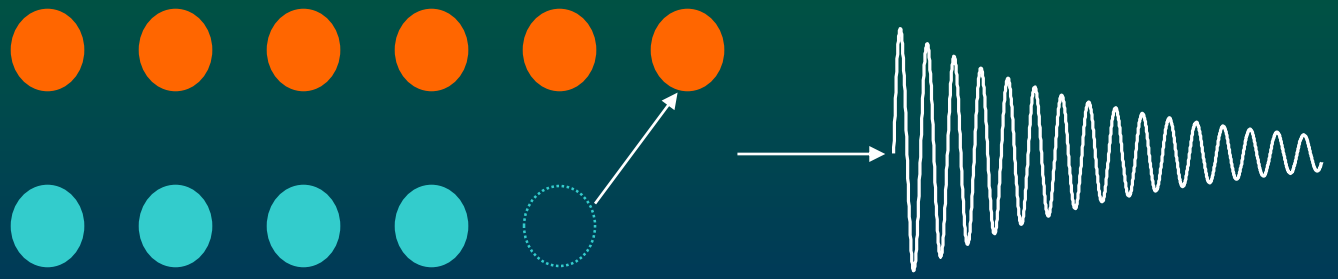


Net Magnetization

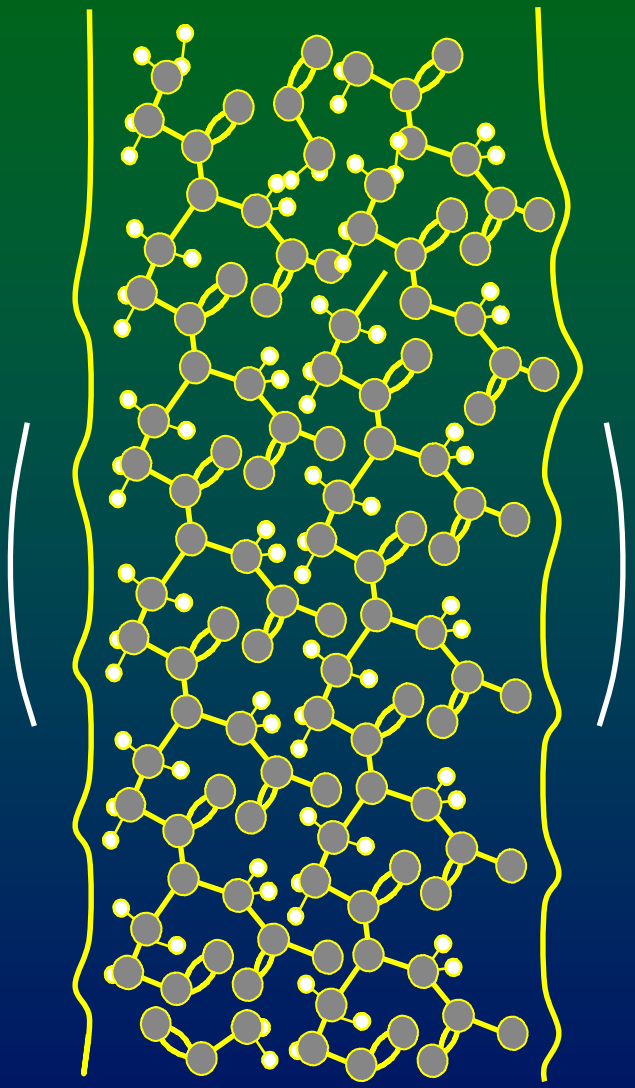


Only the excess nuclei in the lower-energy (spin-up) state generate the MR signal
4-6 / million proton nuclei at a magnetic-field strength of 1 tesla (T)

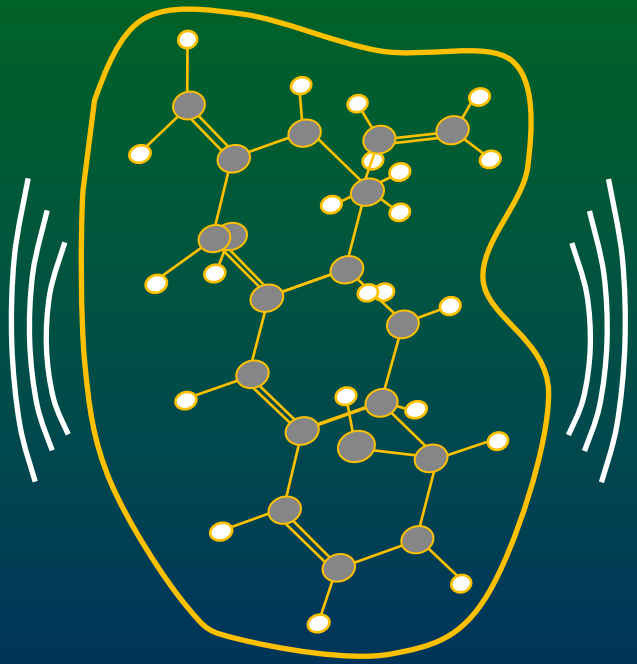
Spin System After Irradiation



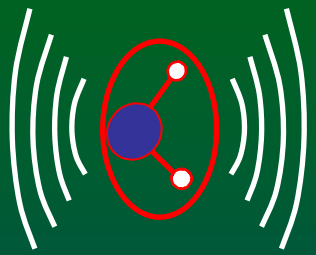
Magnetic relaxation and molecular motion



Collagen



Cholesterol fat



Free Water

Basic pulse sequences

- T1-w
- T2-w
- PD/T2 fat suppressed
- STIR
- Fat suppressed Gd enhanced T1-w

Gd: only with T1

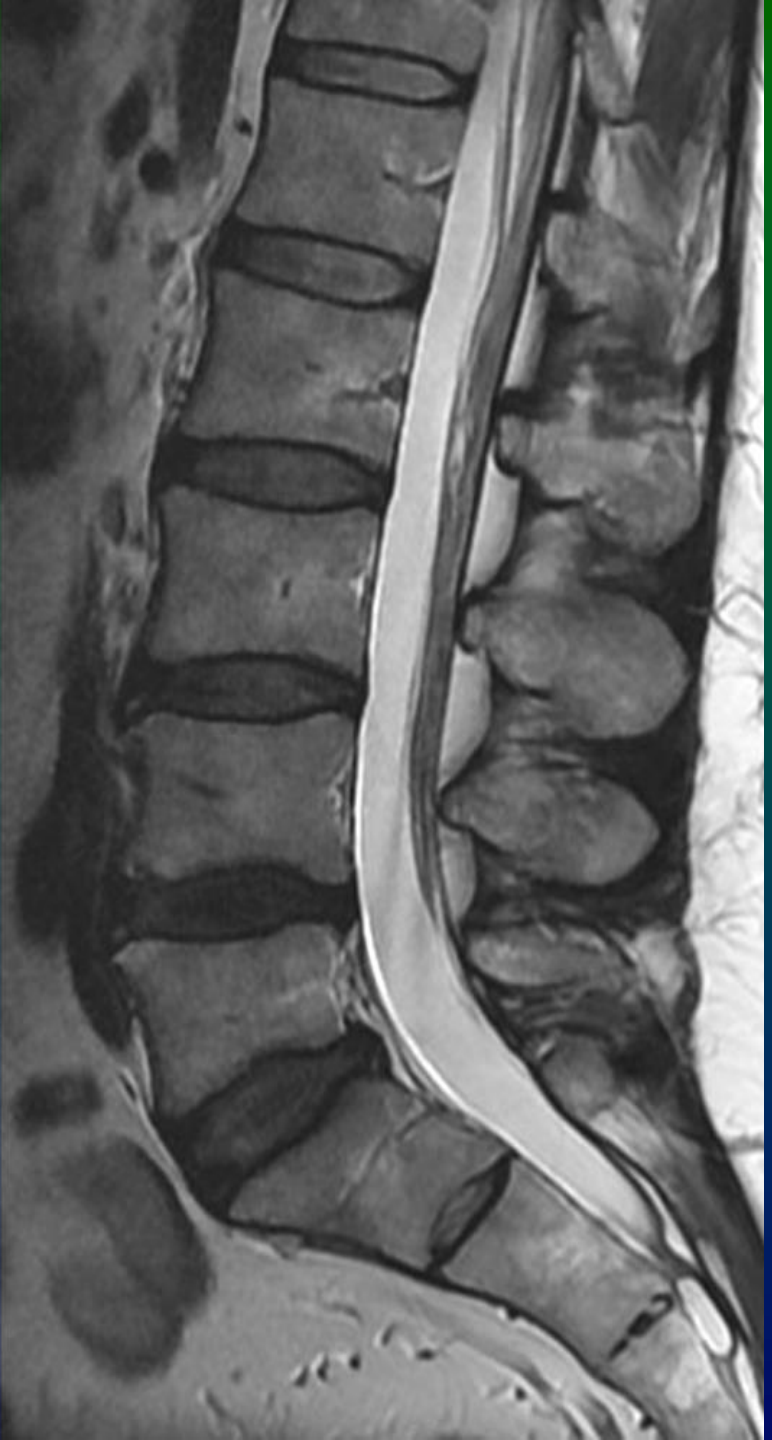
Fluid sensitive

T1-w

Water: dark

Fat: bright

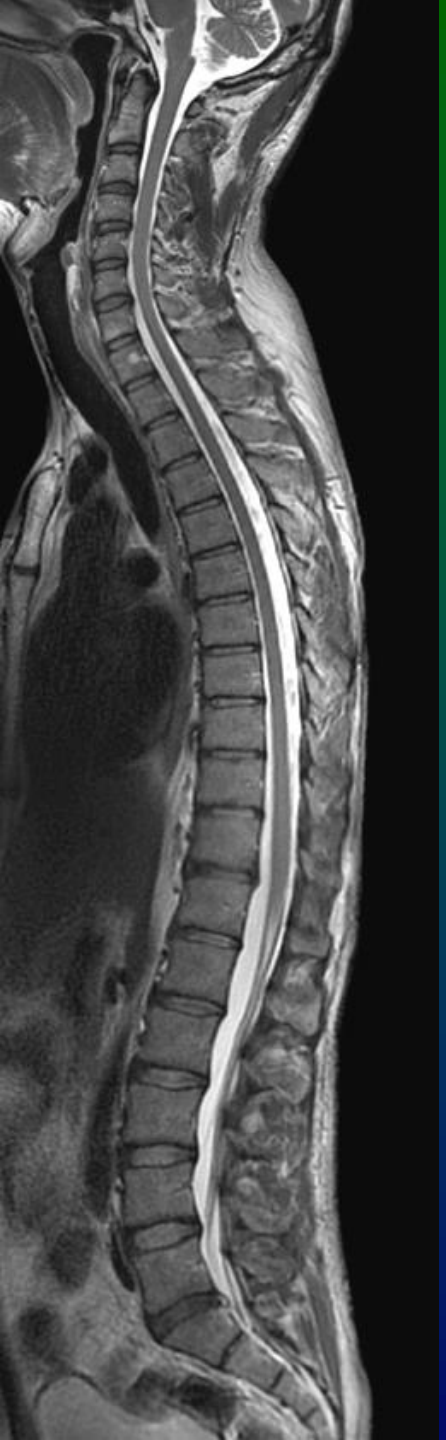
Bone marrow SI > discs



T2-w

Water: bright

Fat: variable



T2-w

mainly orthopaedic/neurosurgery use

Spinal cord, roots, discs

CSF: bright

Bone marrow: limited value

Fat suppression: bright on black

essential to detect edema

Fat suppressed PD/T2

Spectral presaturation with extra RF pulse

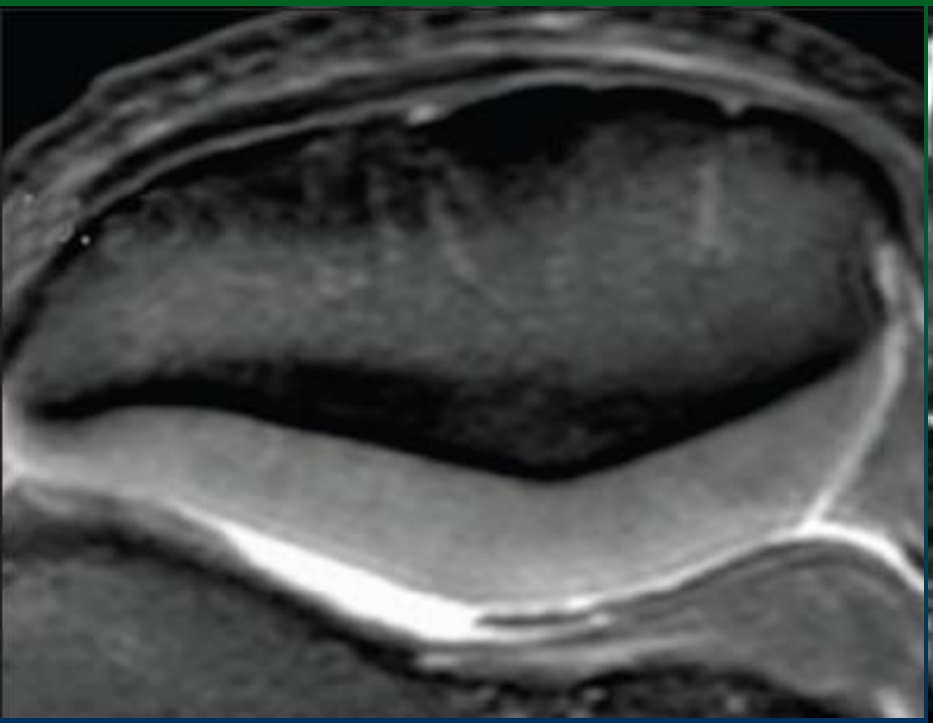
⇦STIR

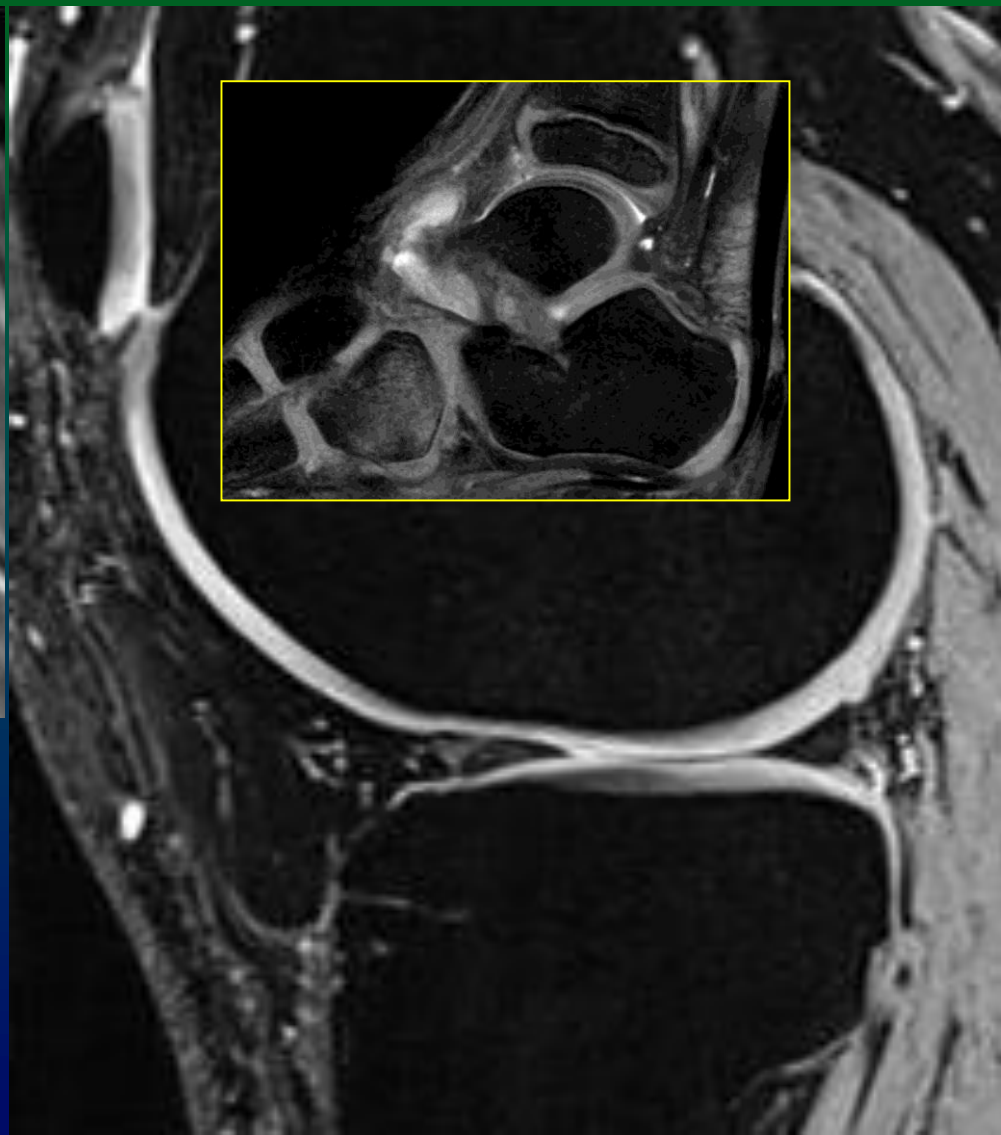
Inverted RF pulse

Gd-enhanced T1⇨

Spectral presaturation

Intermediate weighted - GRE



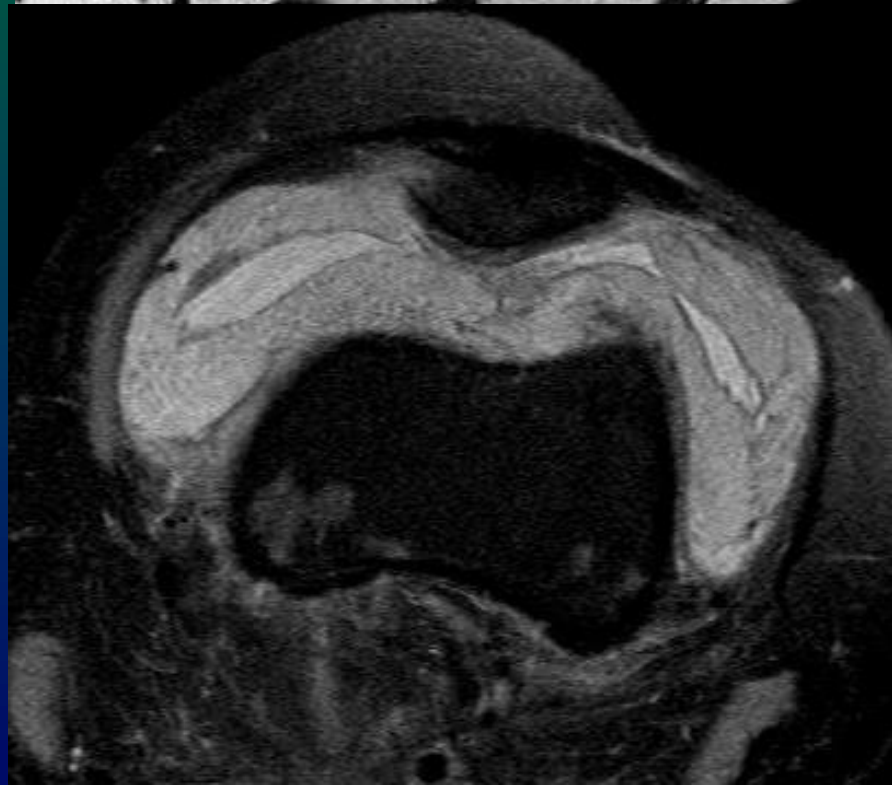


Basic terminology

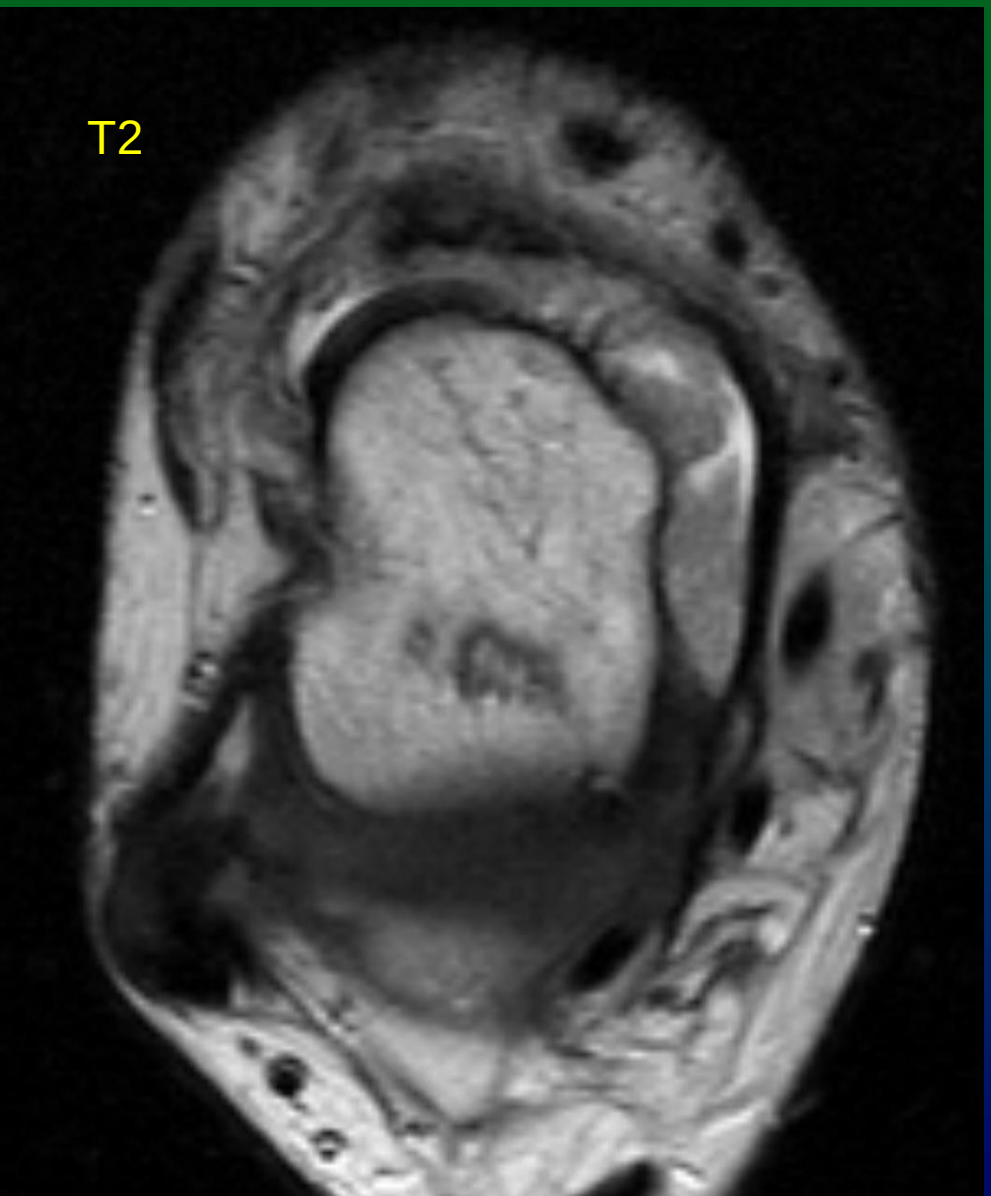
- Synovitis
- Bone marrow edema
- Enthesopathy
- Erosion
- Fat deposition
- Subarticular sclerosis
- Ankylosis

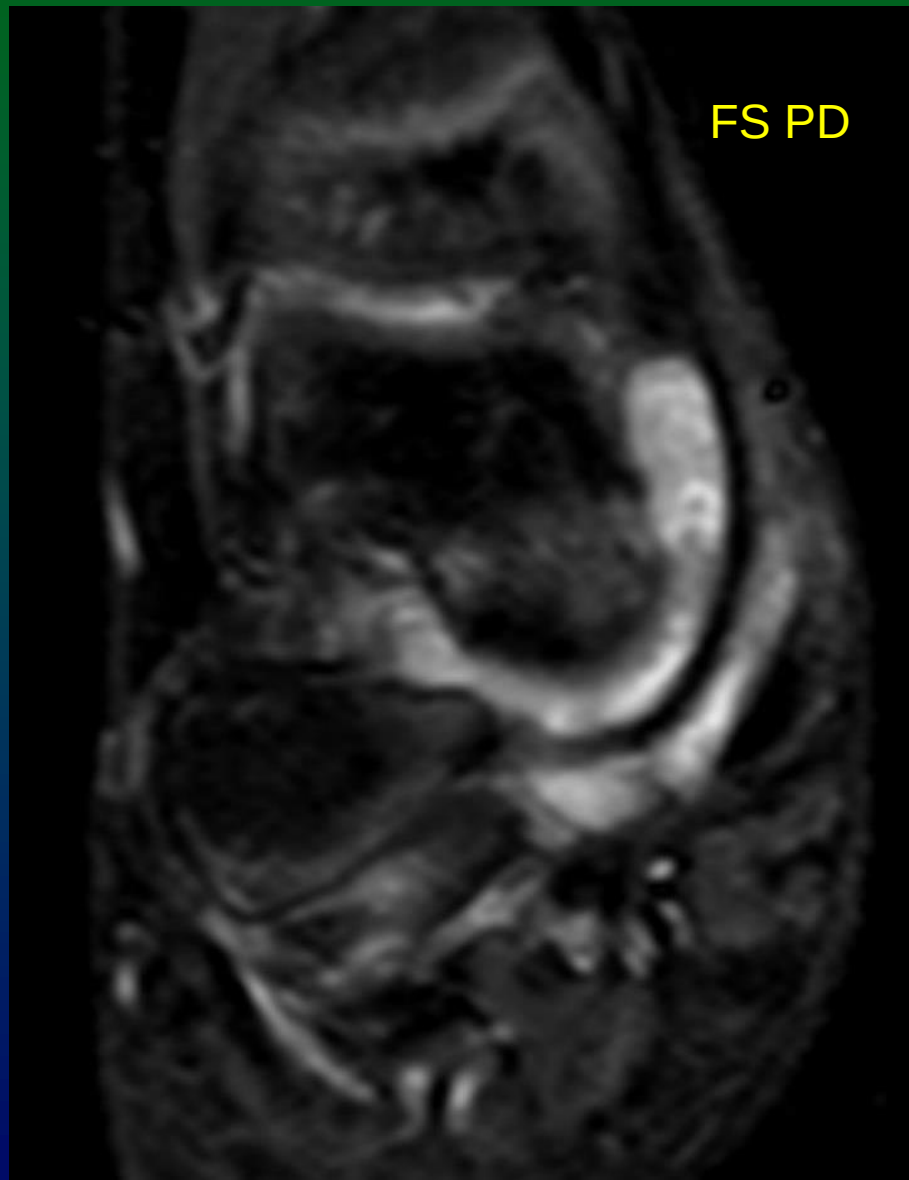
- **Synovitis**
- Bone marrow edema
- Enthesopathy
- Erosion
- Fat deposition
- Subarticular sclerosis
- Ankylosis

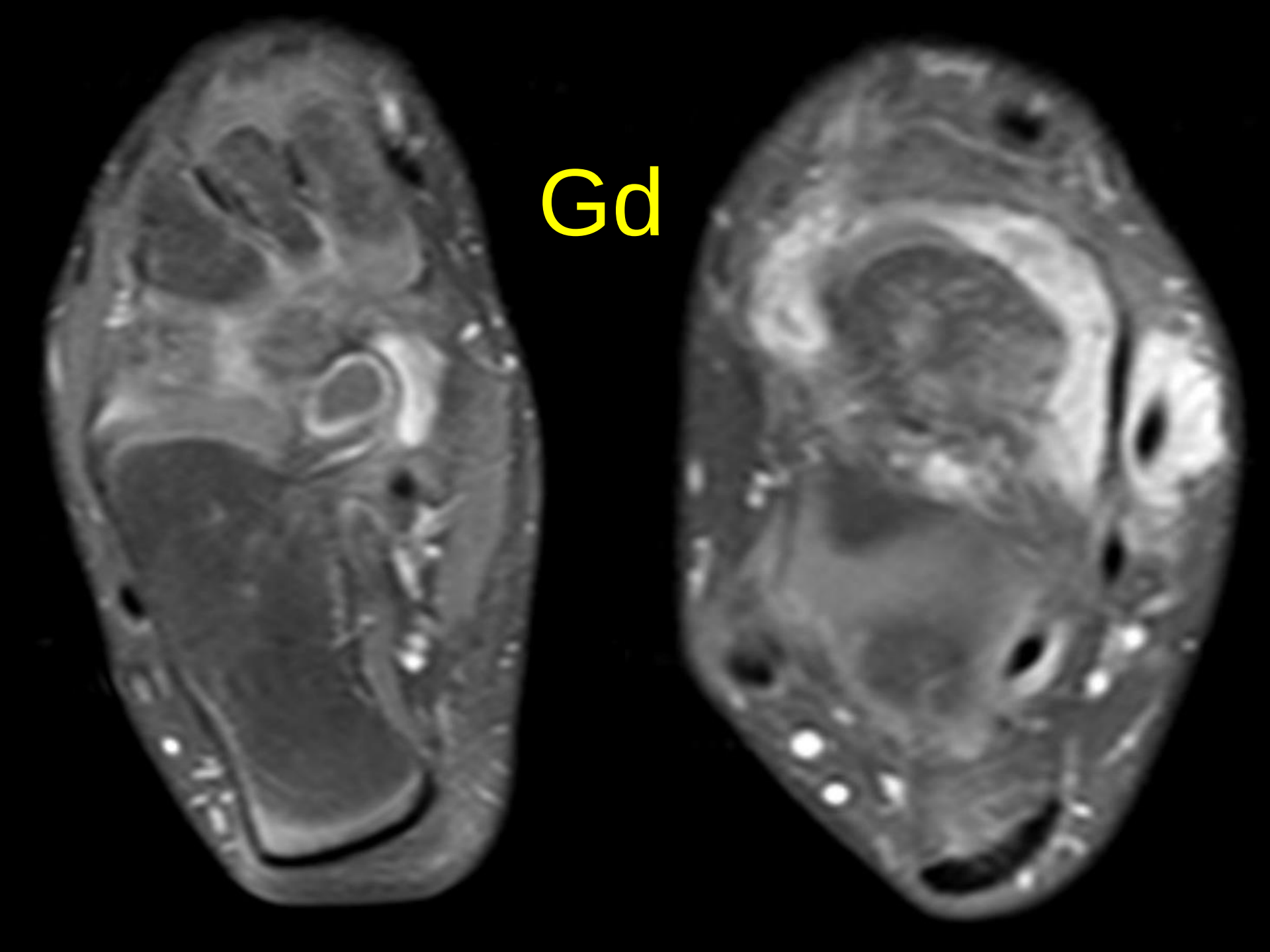
- “dirty” effusion
- Apparent thickening
- Synovial enhancement



5f, JIA

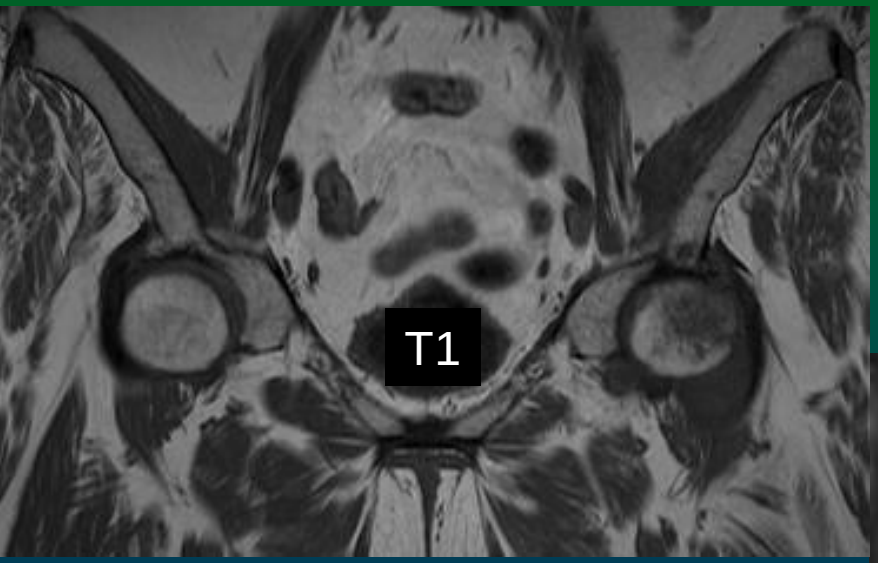





Gd

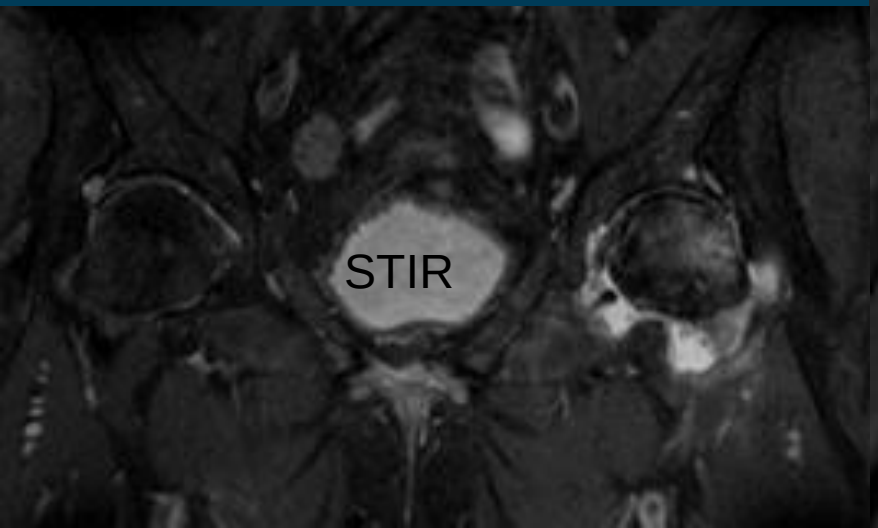
- Synovitis
- **Bone marrow edema**
- Enthesopathy
- Erosion
- Fat deposition
- Subarticular sclerosis
- Ankylosis

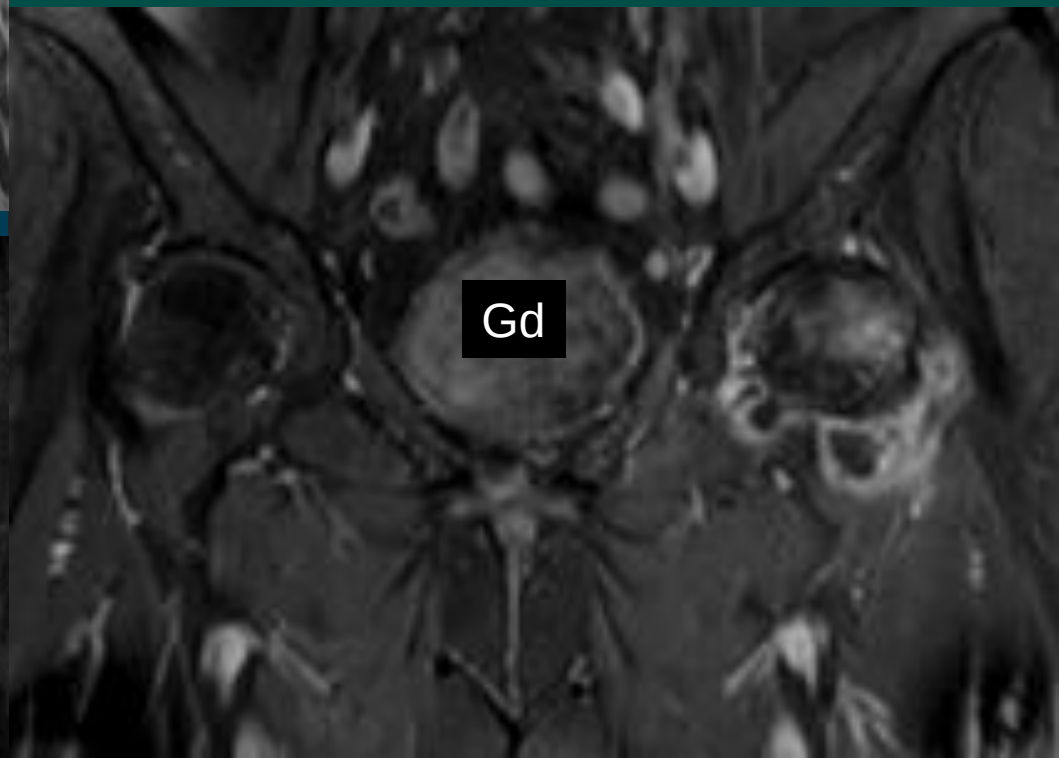
BME



66f,10y Seronegative RA

4m painful hips



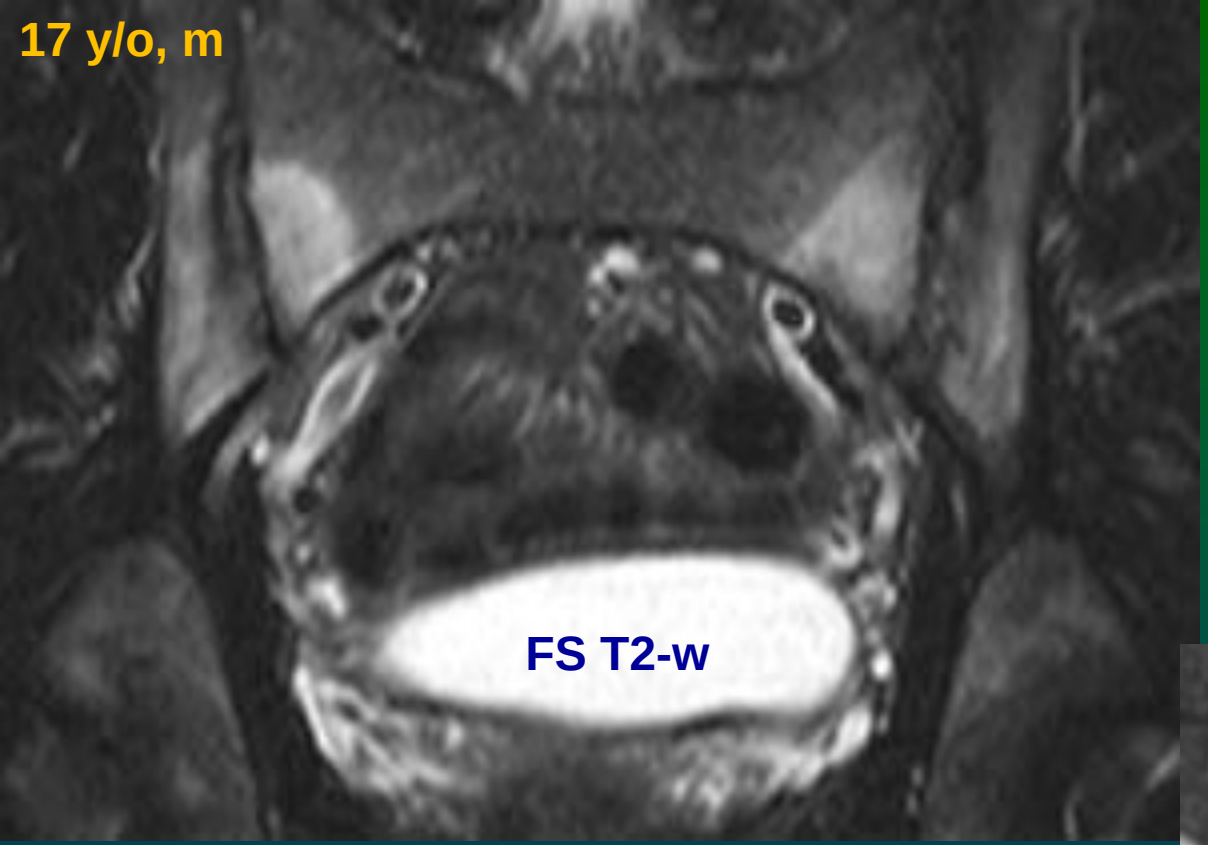


AS: Early disease

- **Sacroiliitis: hallmark of AS, especially in early stage**
- **Subchondral BME**
- **MRI: method of choice** (fat suppressed PD/T2-w, STIR) **Sens. >90%**

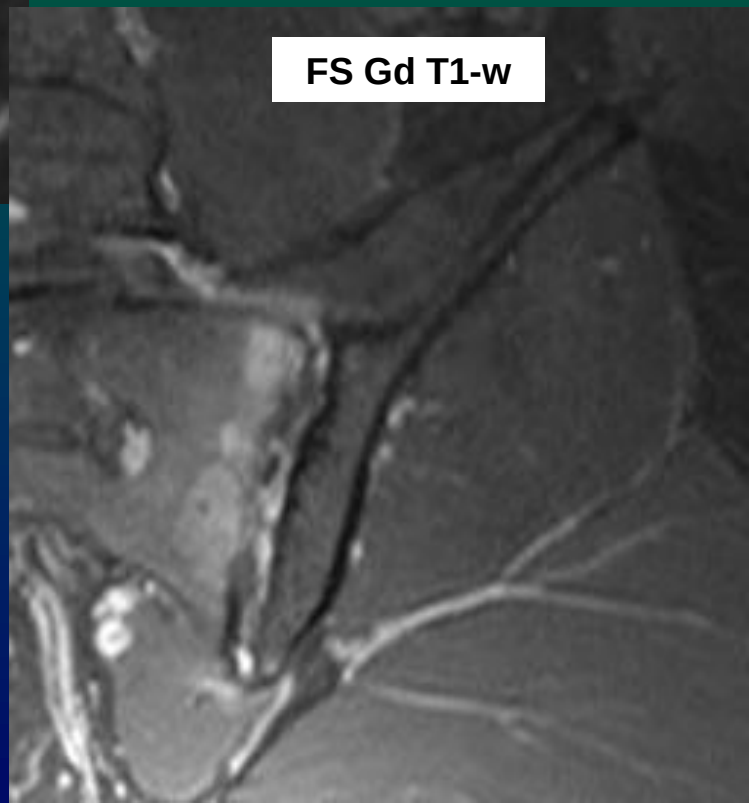
Jochling J, et al. 2010; Sieper J, et al. ASAS handbook. ; Ann Rheum Dis 2009; Braun J, Sieper J. Lancet 2007

17 y/o, m



High SI on fluid sens. Imagea

Gd: enhancement

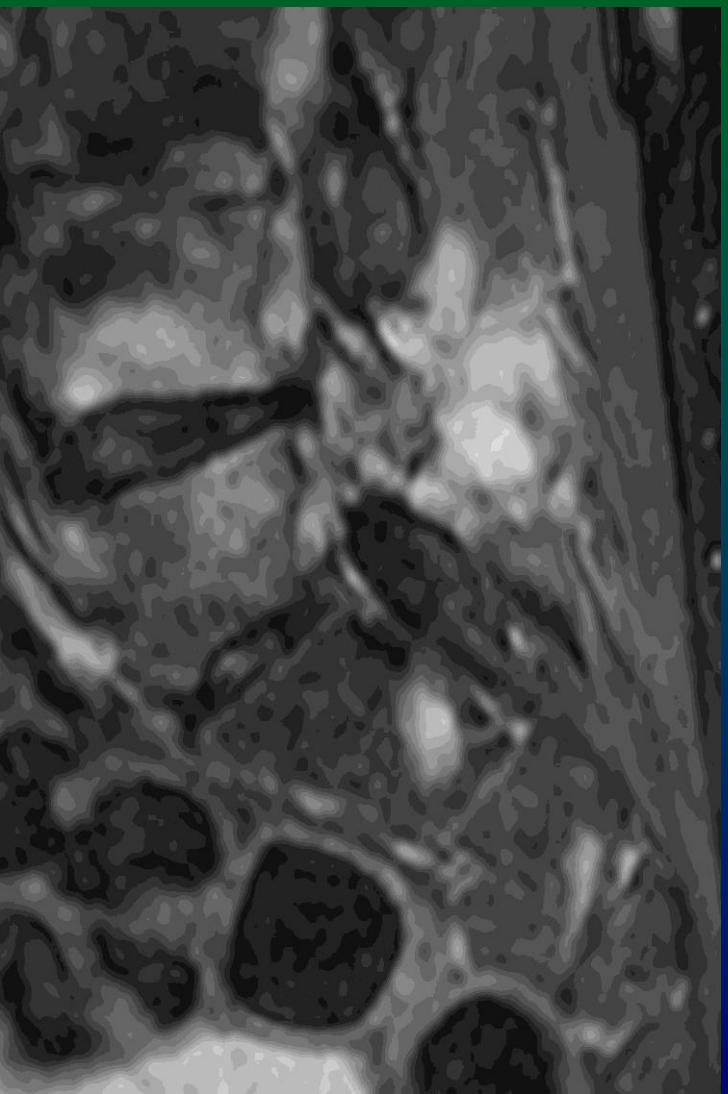


BME: observed within a few w of IBP presentation

Subchondral BME: osteitis

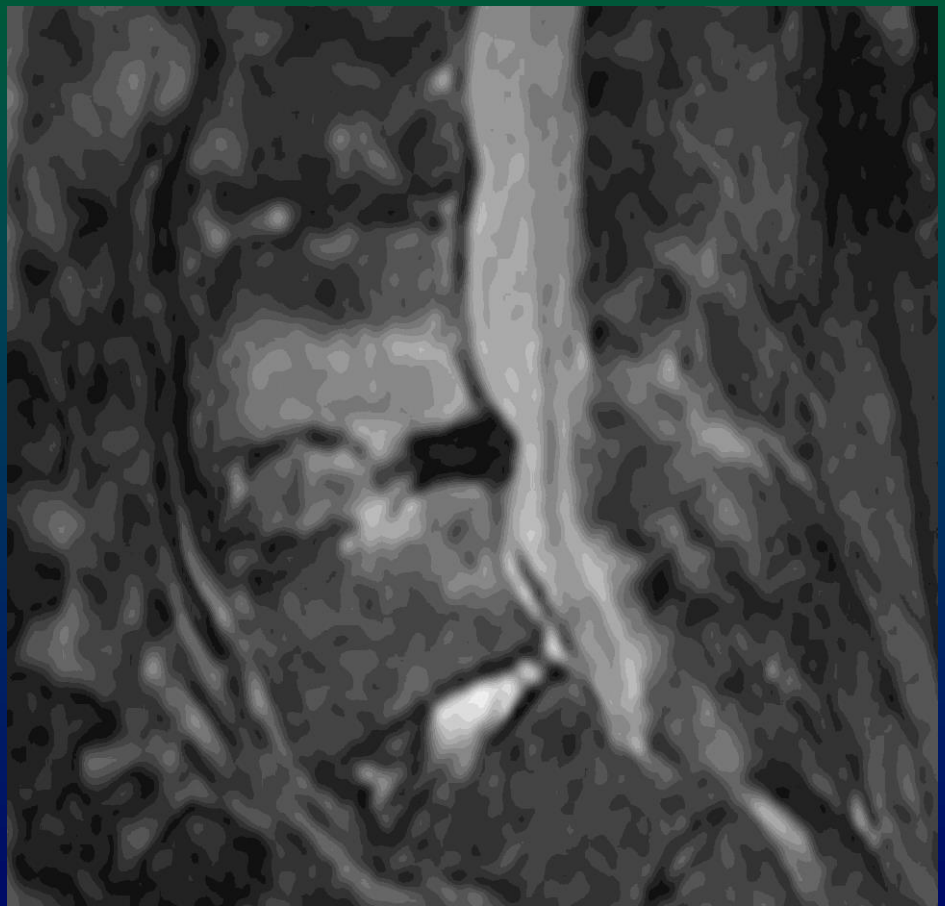
- Synovitis
- Bone marrow edema
- **Enthesopathy**
- Erosion
- Fat deposition
- Subarticular sclerosis
- Ankylosis

Enthesitis

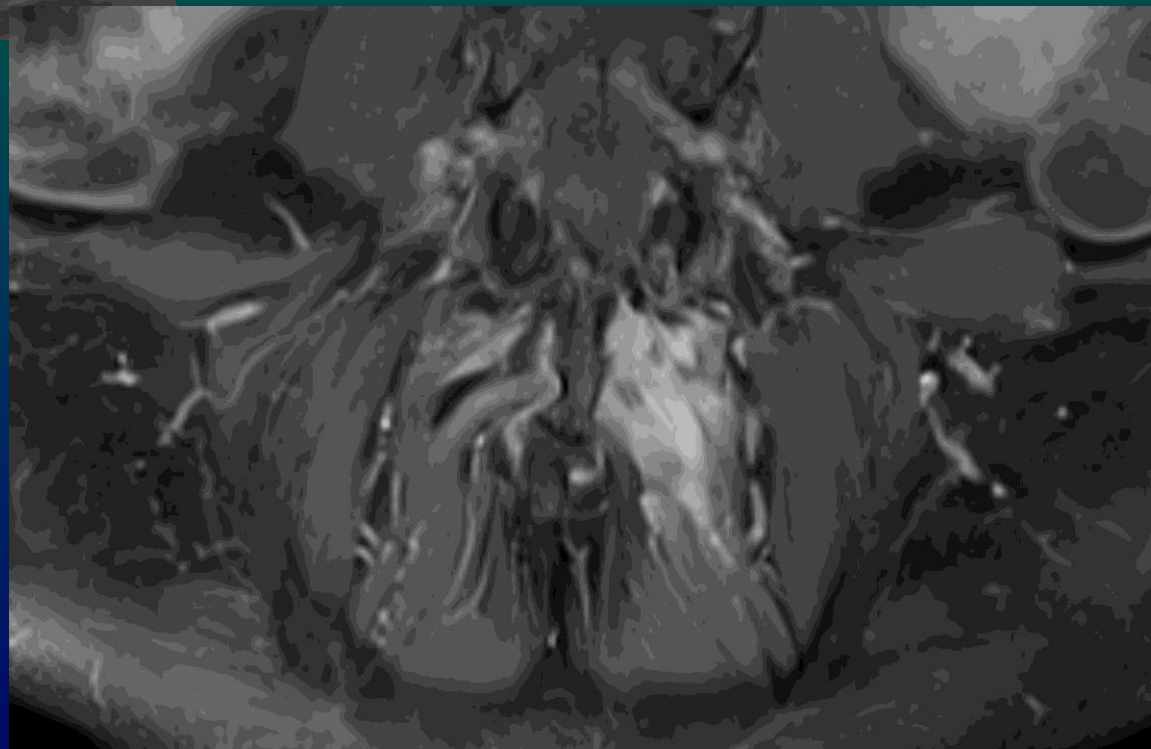


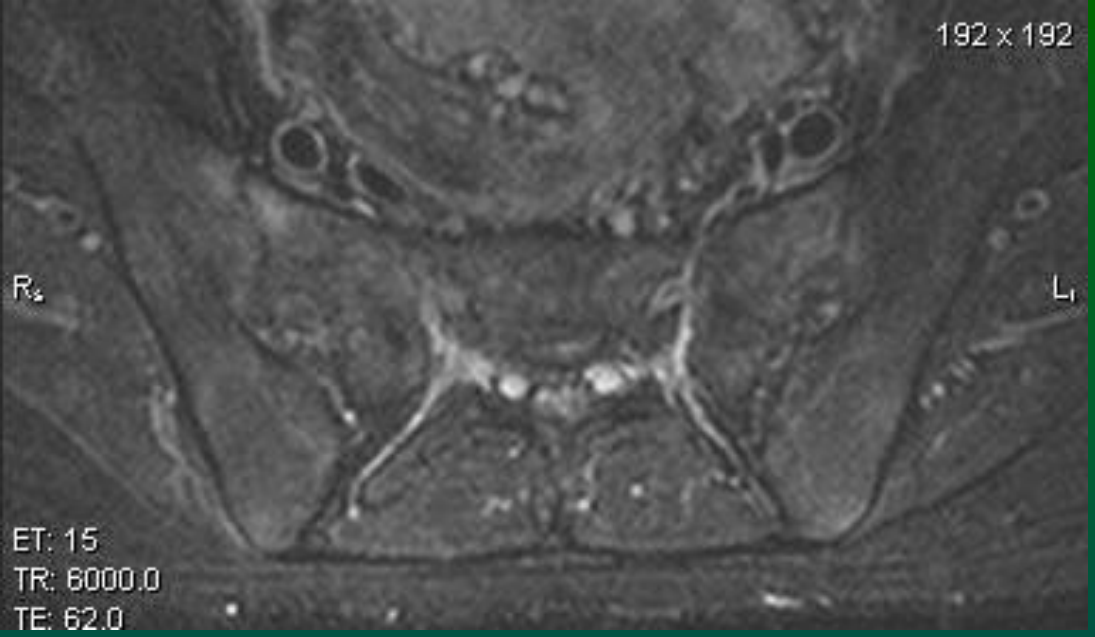
High SI at junctional areas

May extend to adjacent BM and surrounding ST

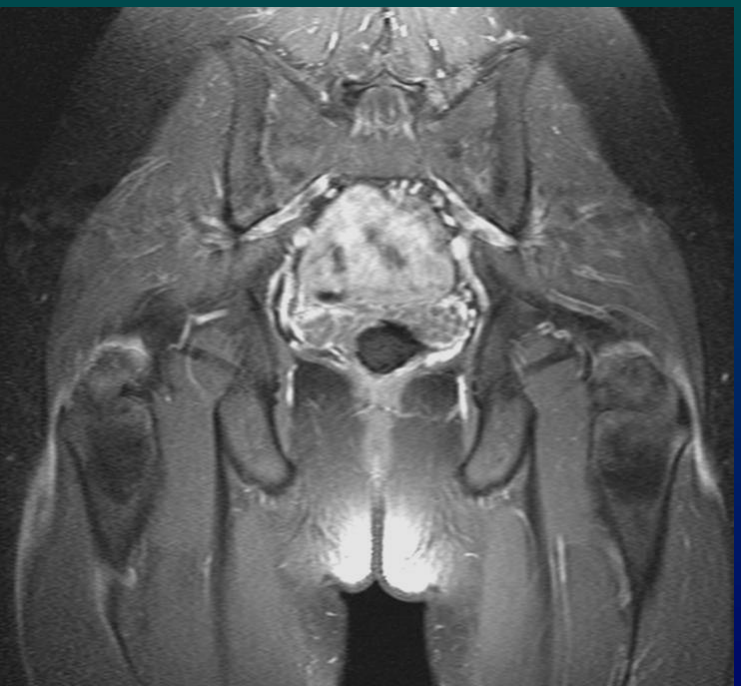


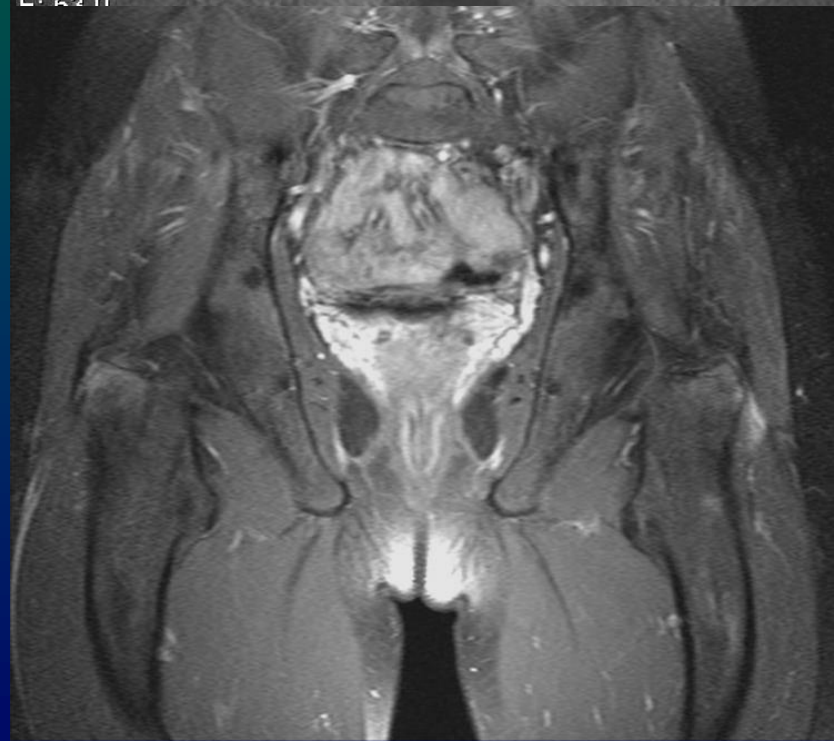
Gd

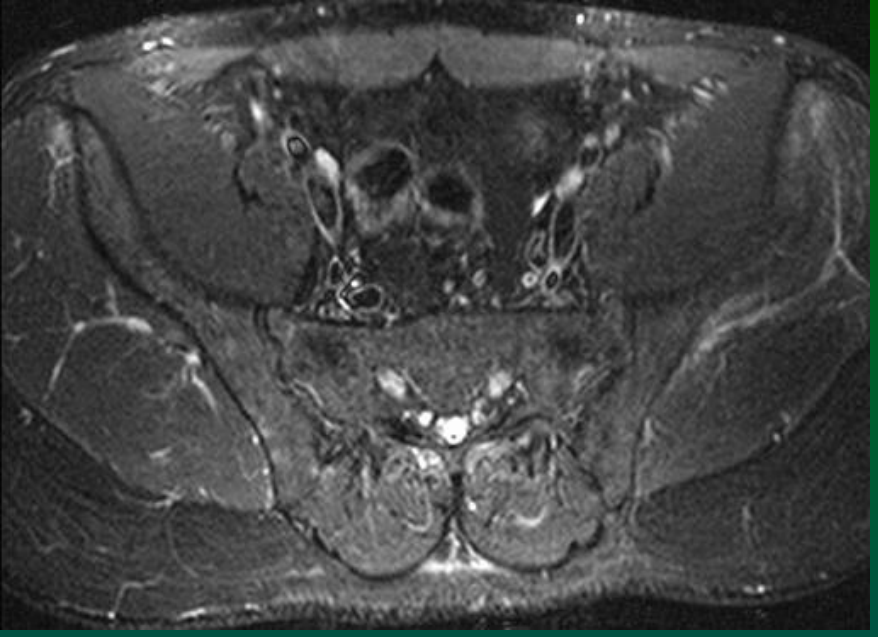


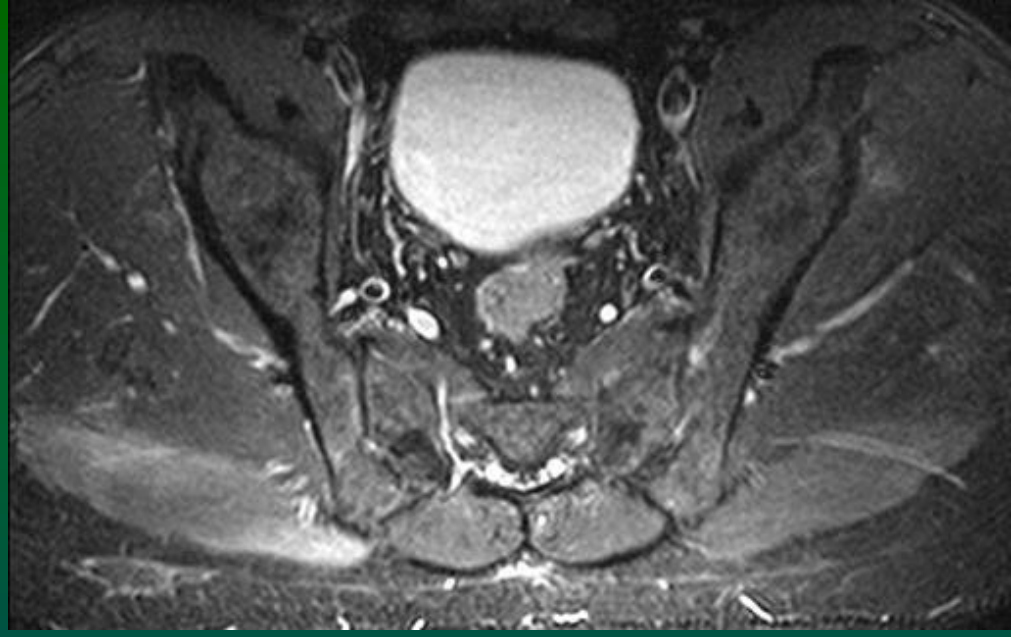


19 y/o, m Hip enthesitis + early SI



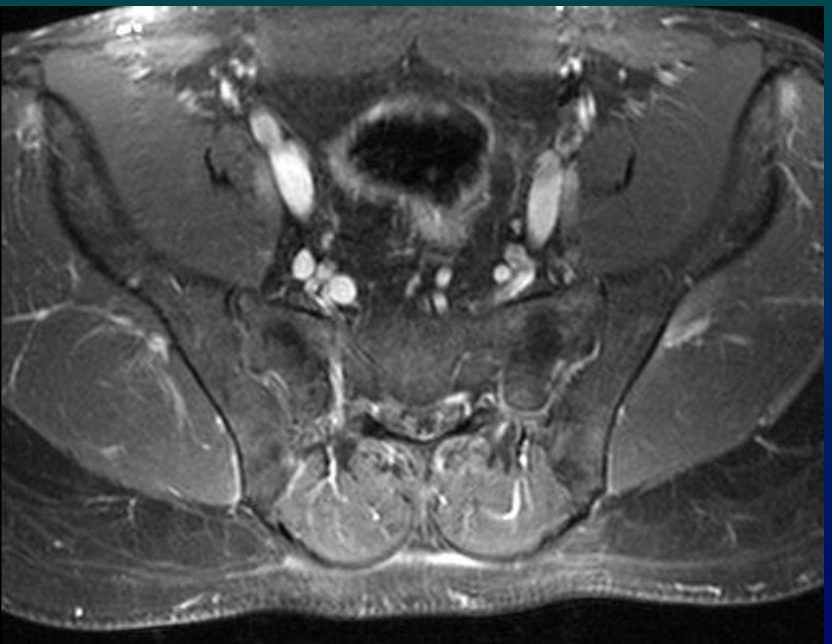






39 y/o, m

2 month pain



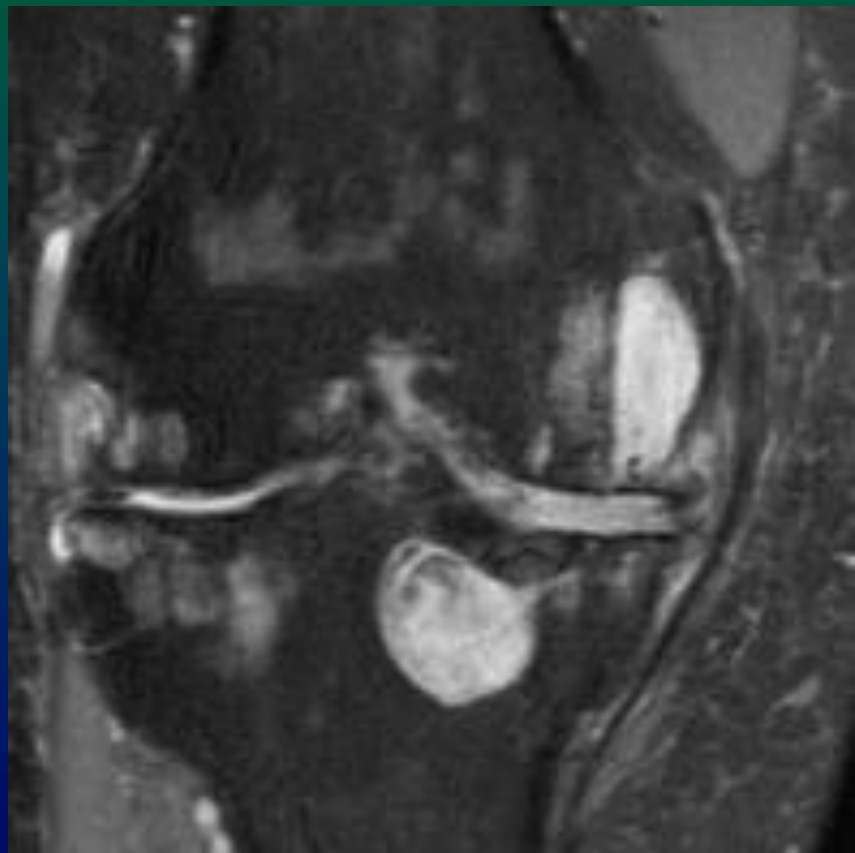
- Synovitis
- Bone marrow edema
- Enthesopathy

- **Erosions**

- Fat deposition
- Subarticular sclerosis
- Ankylosis

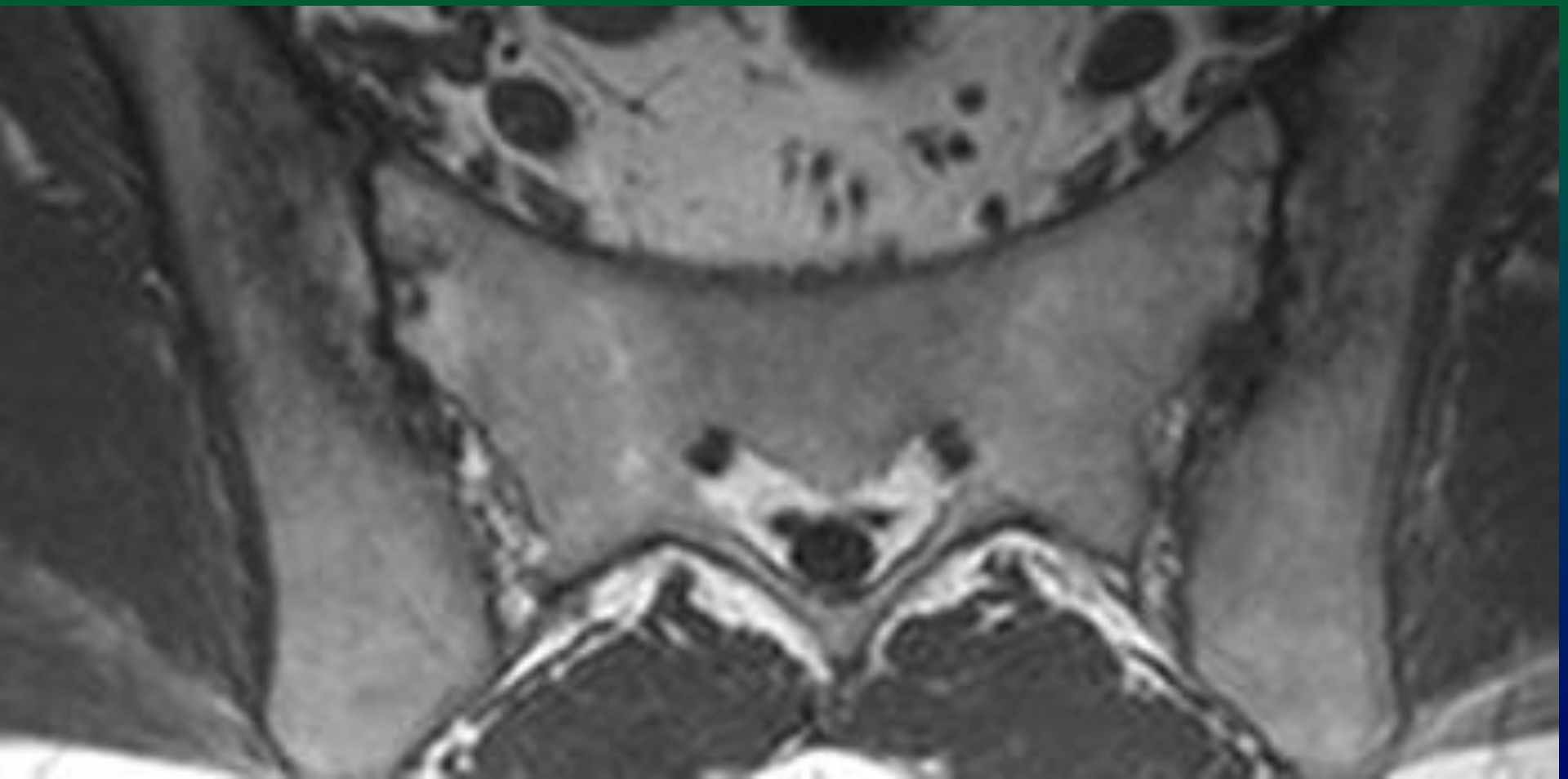
Bony defects at the joint surface
Low SI on T1-w

High SI on fluid sensitive sequences

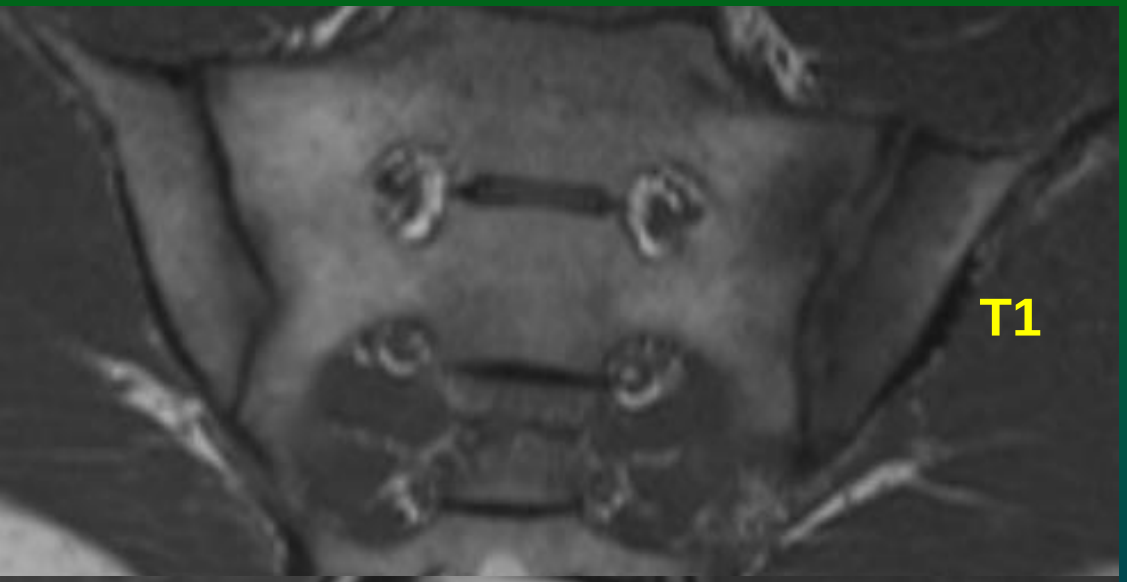


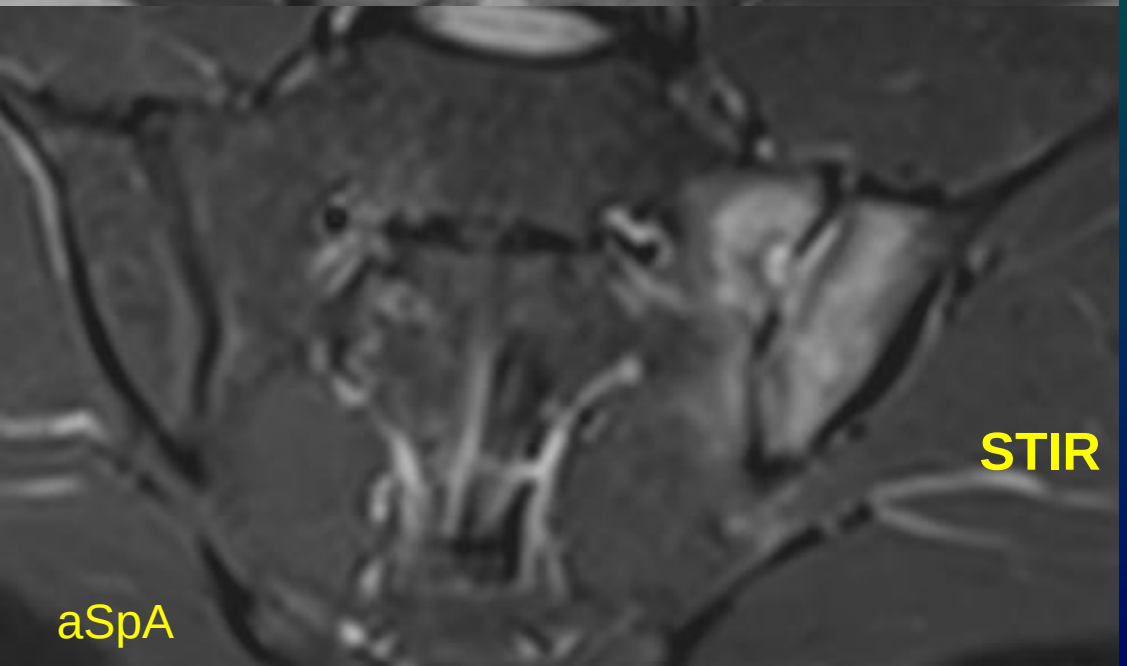
Erosions

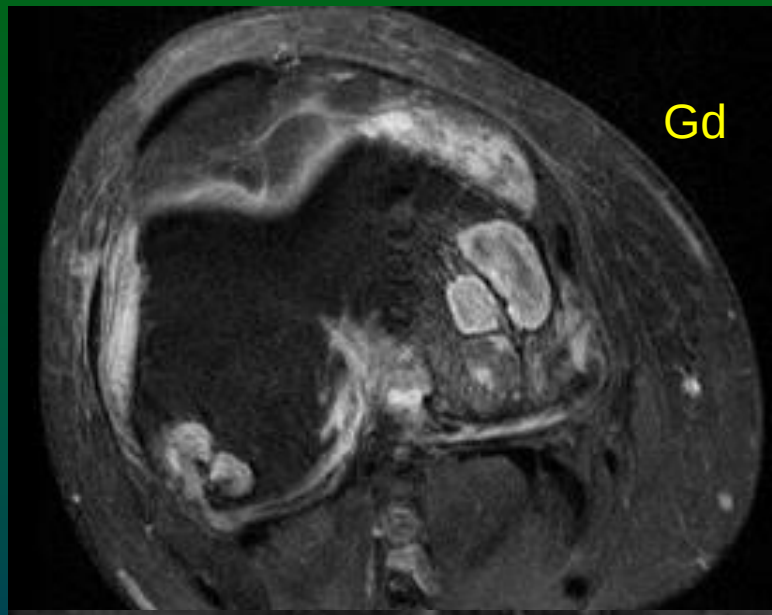
- **Confluent lesions cause a false widening**

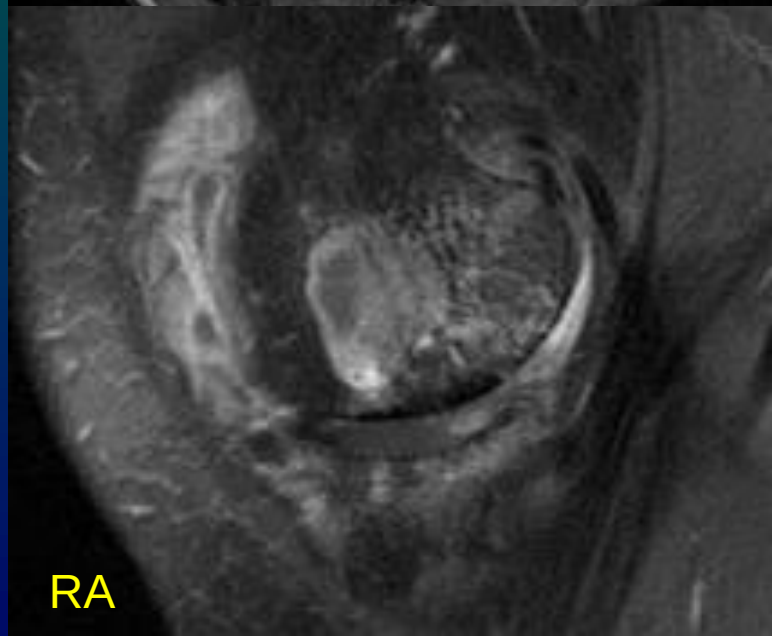


Acute on chronic



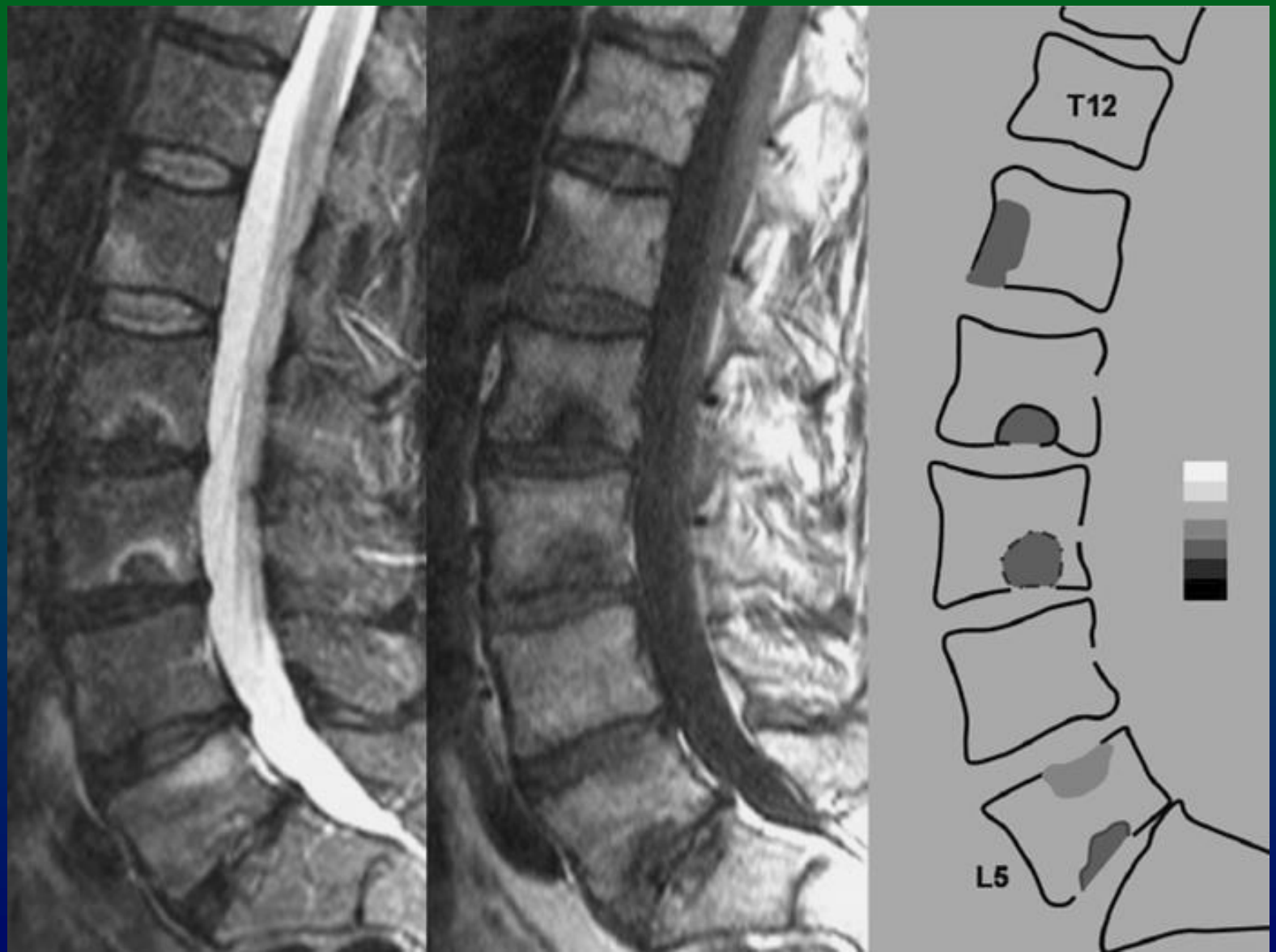






Erosions

Combined inflammatory lesions Romanus and Andersson

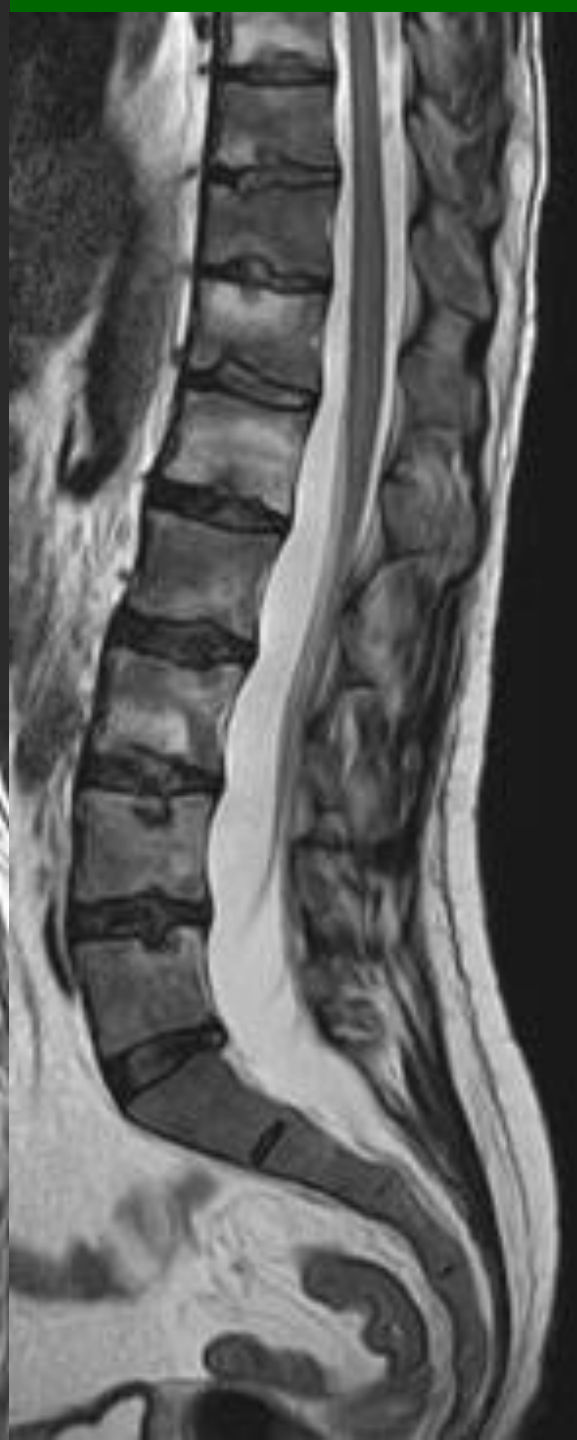


Andersson lesions:
Erosions within intervertebral spaces

2 adjacent levels is characteristic of AS

33% of pts with Spa

Specificity 59%

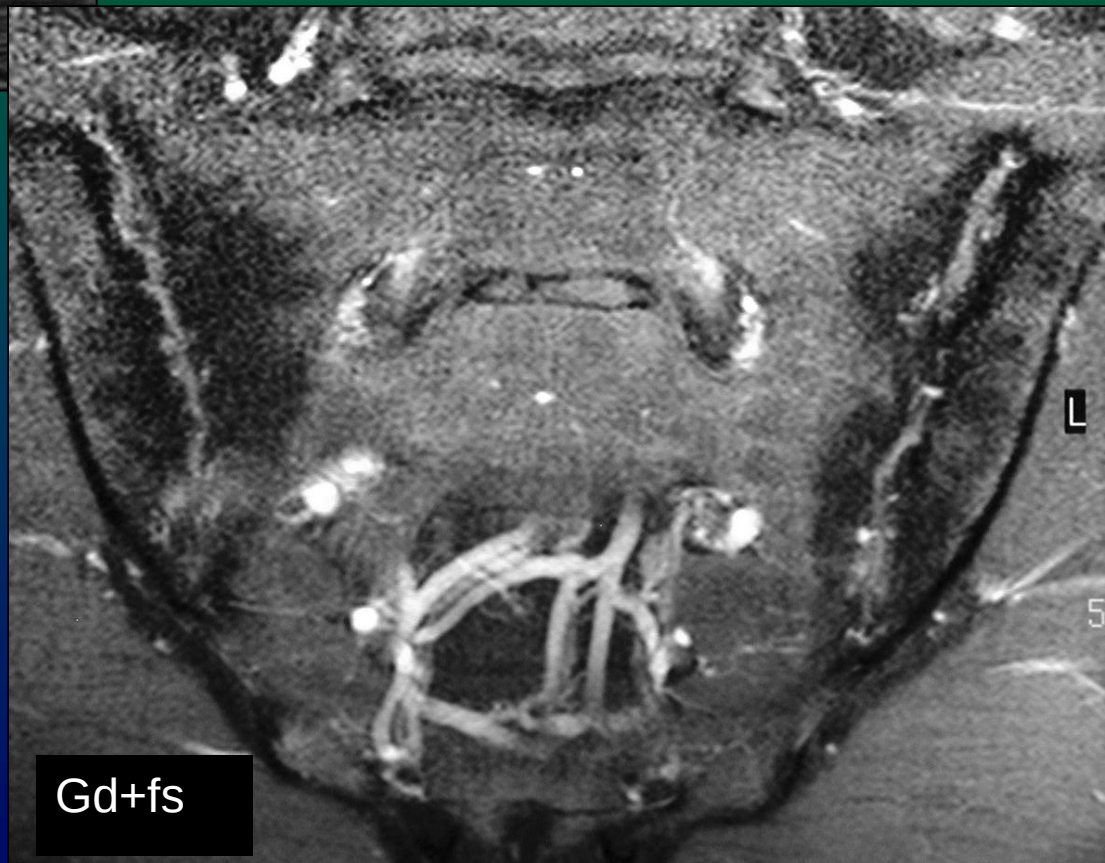


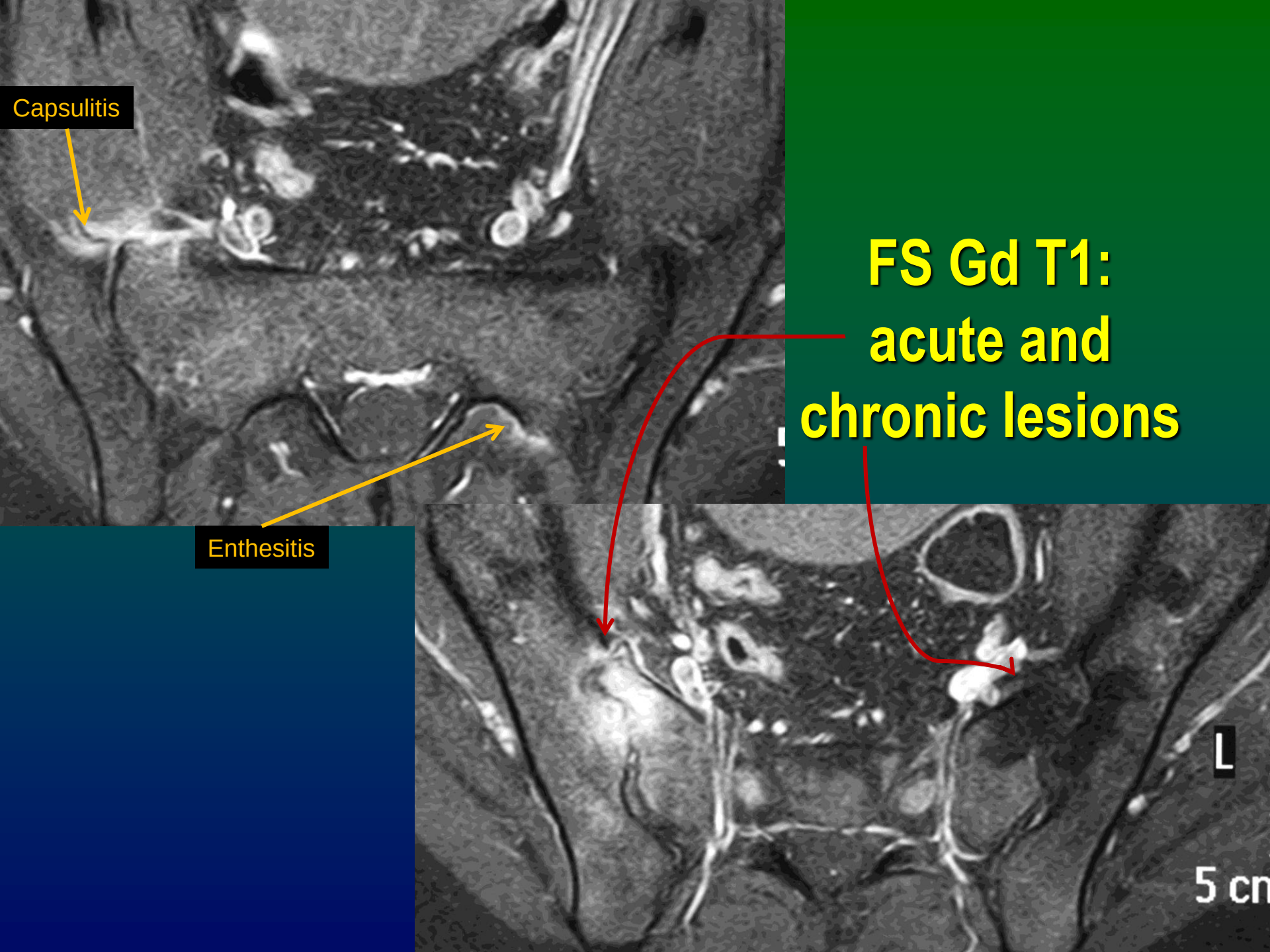
- Synovitis
- Bone marrow edema
- Enthesopathy
- Erosion

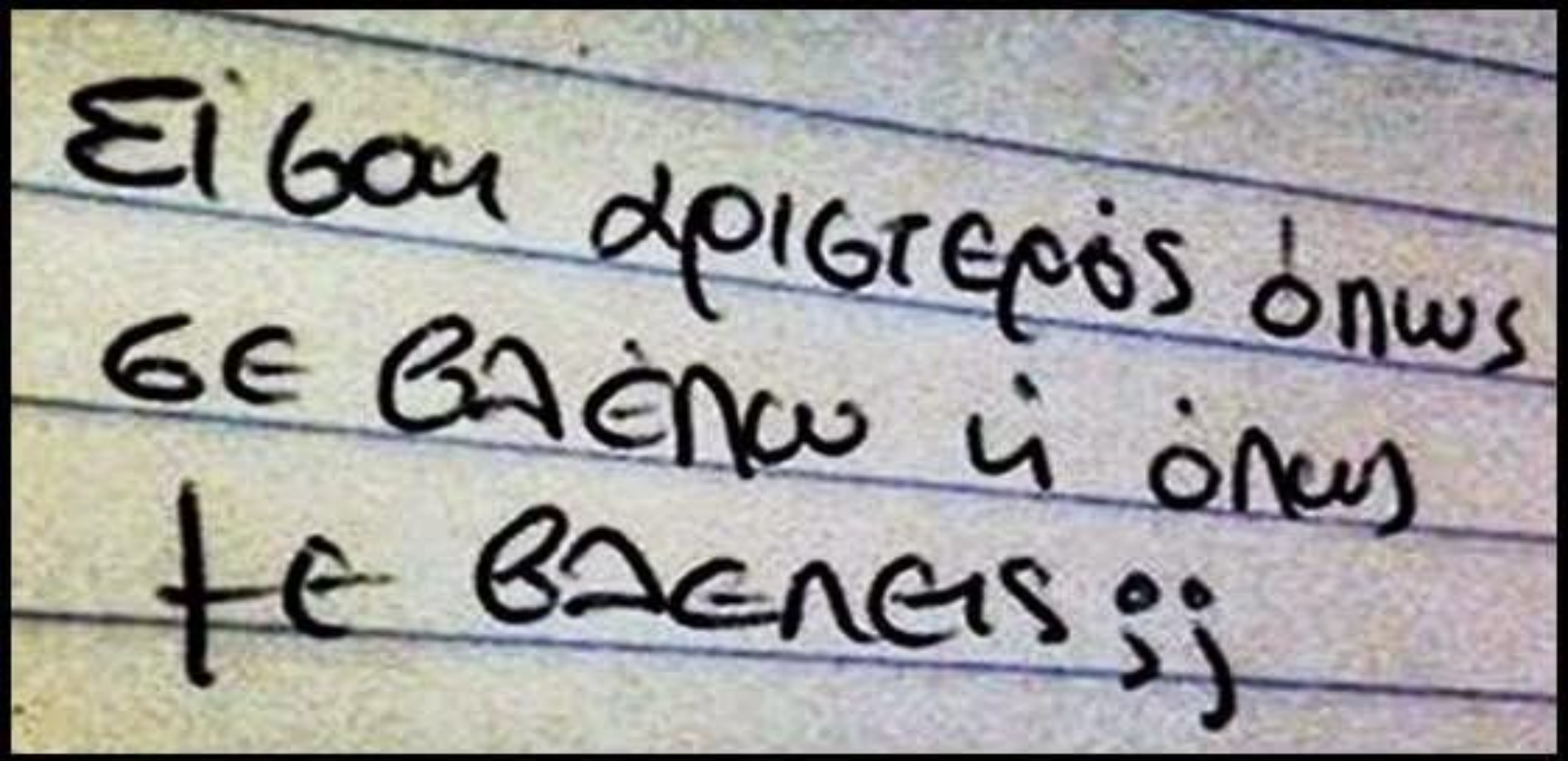
- **Fat deposition**

- Subarticular sclerosis
- Ankylosis

- Fatty infiltration: healed inflammation, inactive lesion
- High SI T1, low SI on fluid sensitive seuqences, no enhancement
- Indicates previous inflammation




Capsulitis
Enthesitis
FS Gd T1:
acute and
chronic lesions
L
5 cm

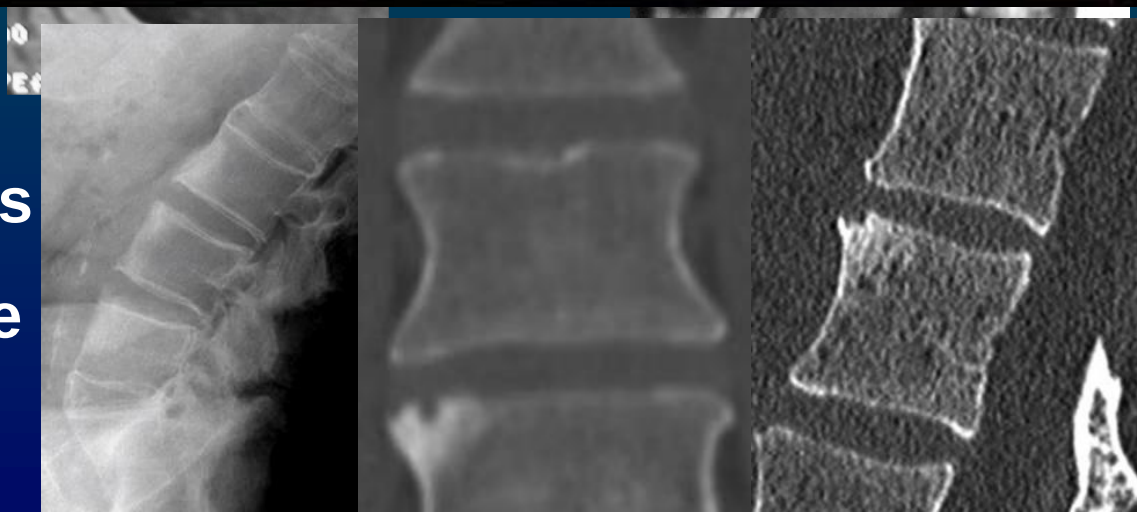


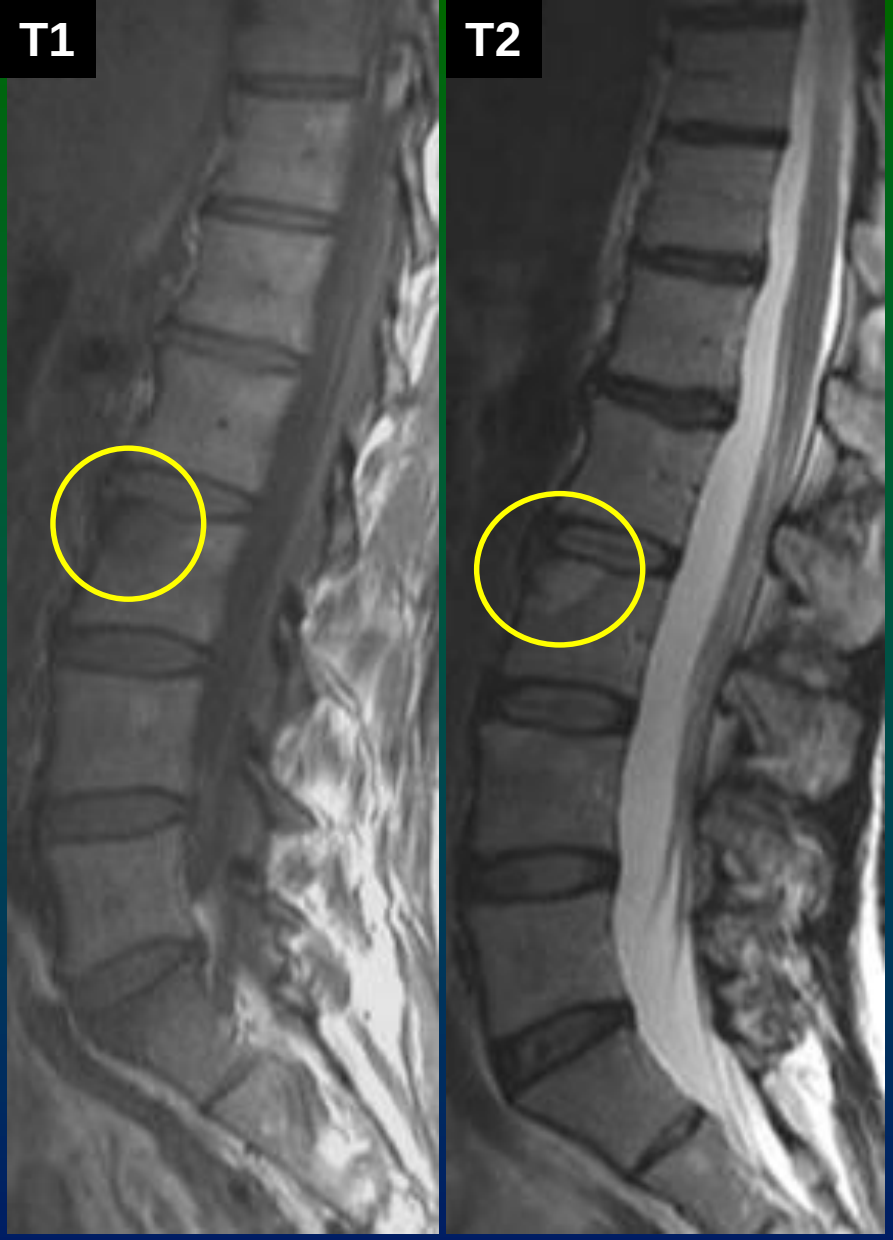
Shiny corners

MRI edema: active lesions

MRI fat/sclerosis: inactive

XR/CT sclerotic: chronic





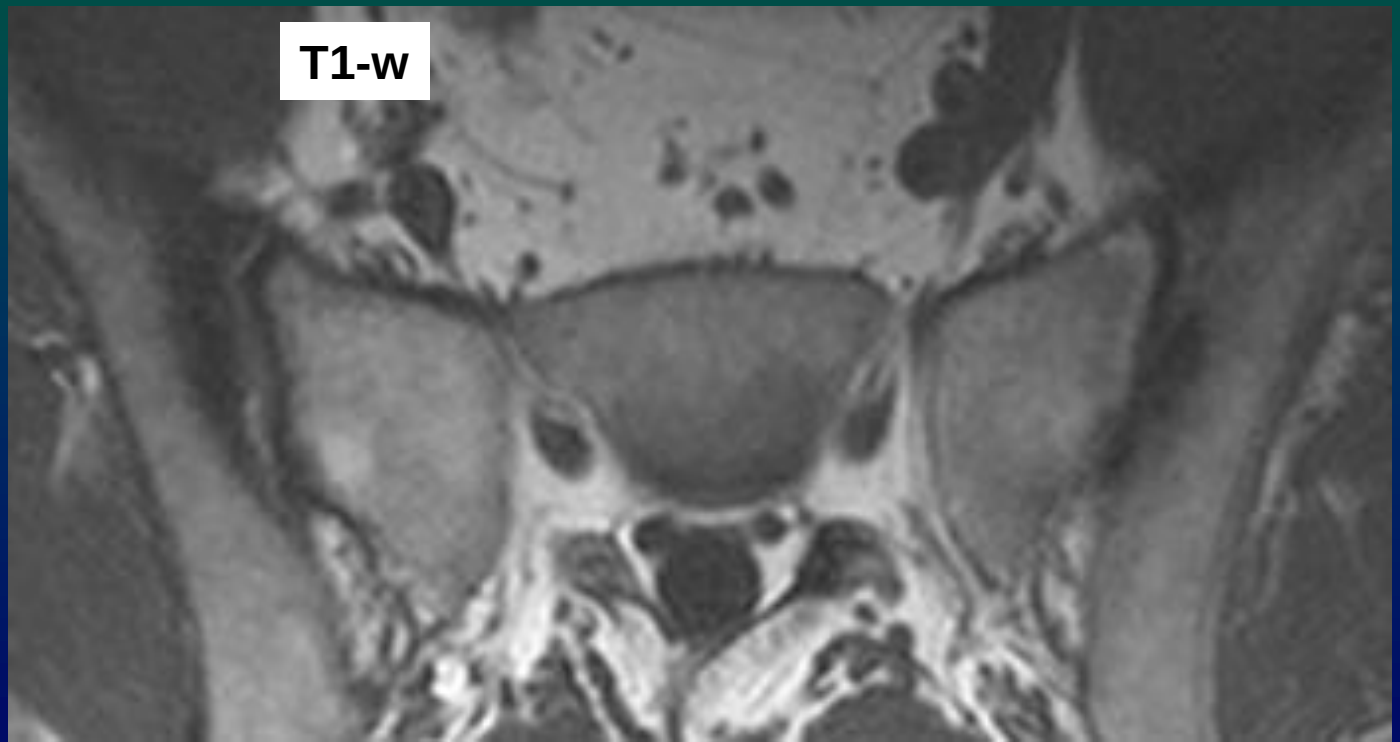
Fat deposition

Romanus lesion

67% of pts with SPa

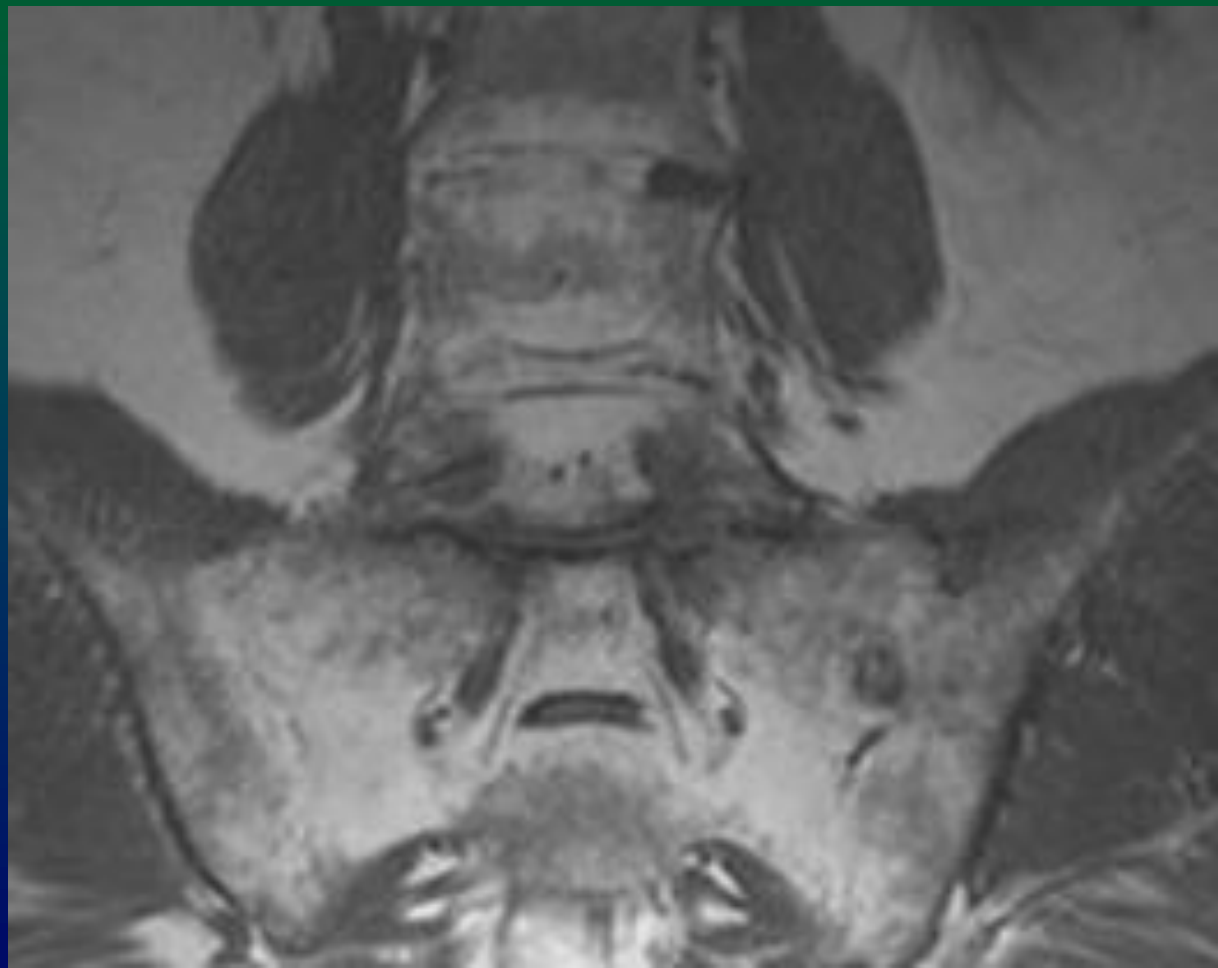
- Synovitis
- Bone marrow edema
- Enthesopathy
- Erosion
- Fat deposition
- **Subarticular sclerosis**
- Ankylosis

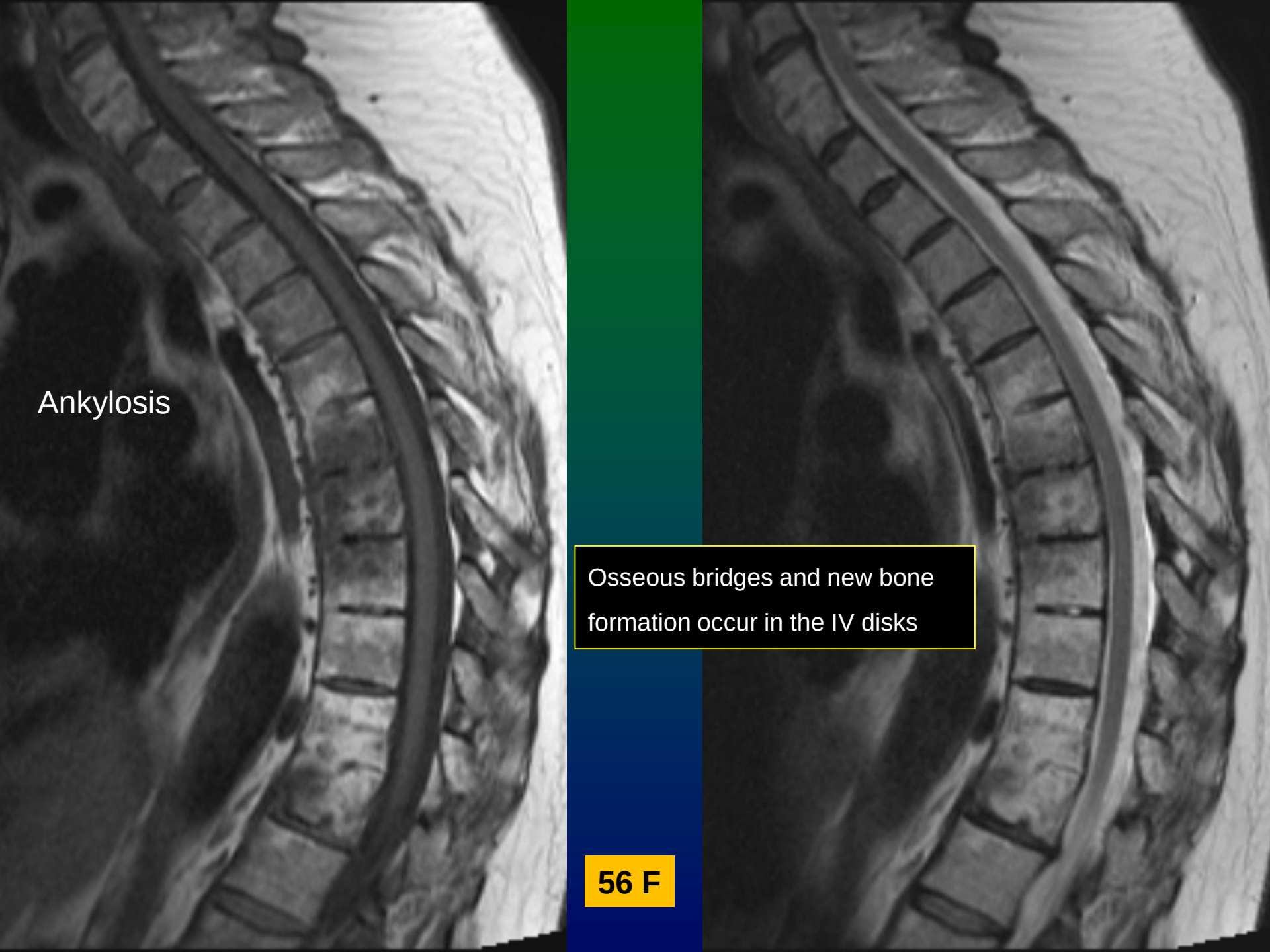
- Low SI on T1-w/STIR, not enhancing
- Typically extends >5mm from the joint surface



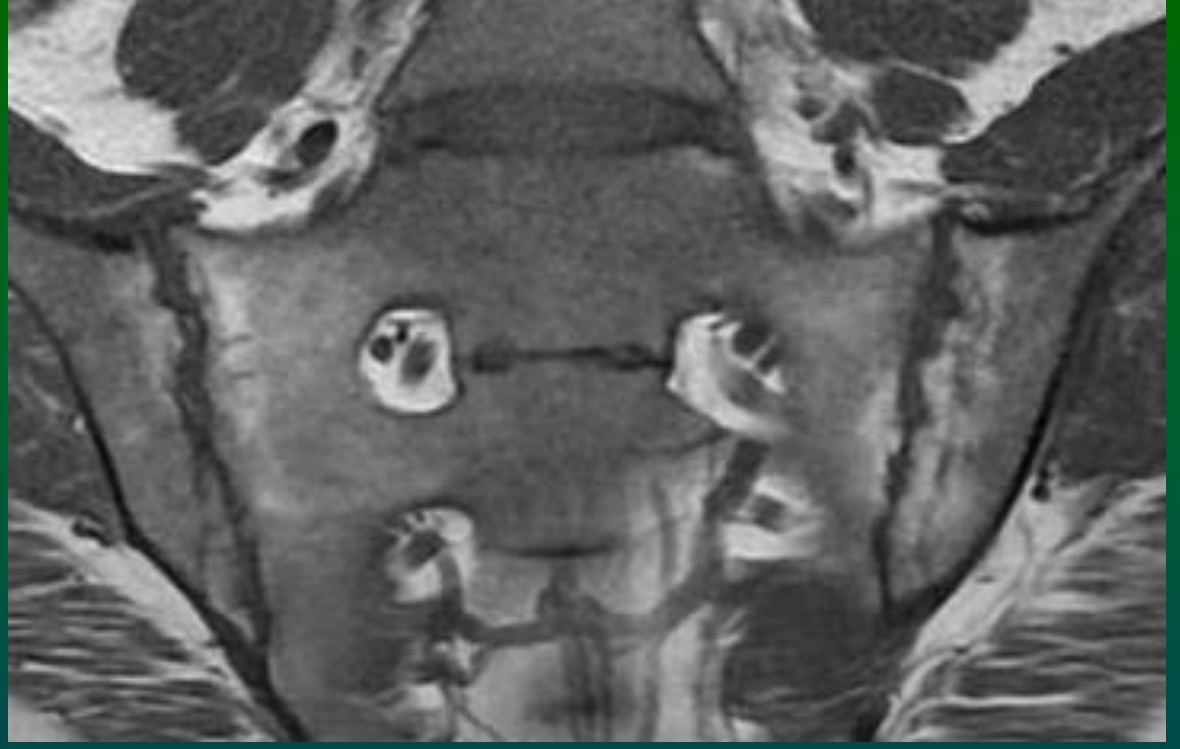
- Synovitis
- Bone marrow edema
- Enthesopathy
- Erosion
- Fat deposition
- Subarticular sclerosis
- **Ankylosis**

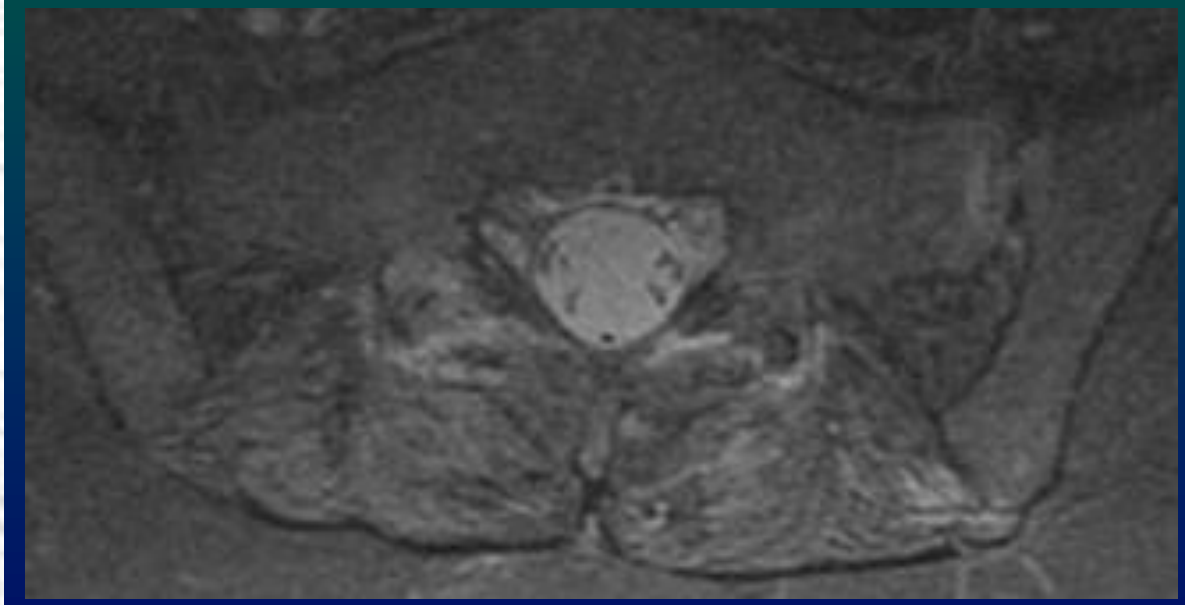
- Fusion of bone surfaces via osseous bridges across the joint




Ankylosis
Osseous bridges and new bone formation occur in the IV disks
56 F


Ankylosis





- Synovitis
- Bone marrow edema
- Enthesopathy
- Erosion
- Fat deposition
- Subarticular sclerosis
- **Ankylosis**

Disc paradox

Early ankylosis

Early changes

- **MRI>>Scintigraphy>CT>>X Rays**
- **Soft tissue changes**
- **Bone marrow edema**

Ευχαριστώ