"Non-traumatic hip bone marrow edema"

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Introduction

- **BM:** major hematopoietic organ (fatty marrow/red marrow)
- **BME**: increased water content
  - Increased blood perfusion
  - Hypervascularization
  - Vascular rupture

  } ⇧ **intraosseous pressure**
- Common MRI finding ⇔ pain
- ⇩T1-w, ⇧T2-w FS/PD FS/STIR, Gd, lack of sharp margins
- Non-specific finding
  - Distribution
  - Concomitant findings
  - Timing

Eustace S et al. Clin Radiol 2001; 56: 4–12
Andrews CL. Radiographics 2000;20:S27 – 42
Karantanas AH. Eur Radiol 2007;17:2225 – 2236

Imaging protocol

X-rays (low sensitivity)

MRI

- T1-w
- STIR or PD/T2-w FS TSE
- Cartilage-specific sequences (GRE - axial oblique)
- Gd:
  - Neoplasms
  - Inflammatory/infectious processes
  - ⇧ SNR ⇨ improved spatial resolution

Vassalou EE et al. Semin Musculoskelet Radiol. 2019;23:276-288
Karantanas AH et al. Semin Musculoskelet Radiol 2011;15:281-300

Osteonecrosis
Pathophysiology

Reduction of blood supply to bone → Cell death

↓

Subchondral bone anoxia/hypoxia

↓

↓

"creeping zone of substitution"

Σκληρυντική ζώνη
"band-like"

Hypervascularity
Inflammatory infiltration → hyperemia **TRABECULAR RESORPTION**

↓

Subchondral fracture
"crescent sign"

←

Articular surface collapse

←

OA

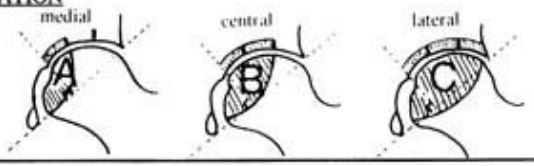
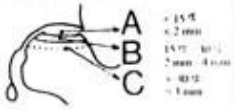
Mankin HJ. N Engl J Med 1992;326:1473-1479

Staging - ARCO

MRI

- Accuracy 97-100%
  - Early diagnosis
  - Staging
  - Prognosis

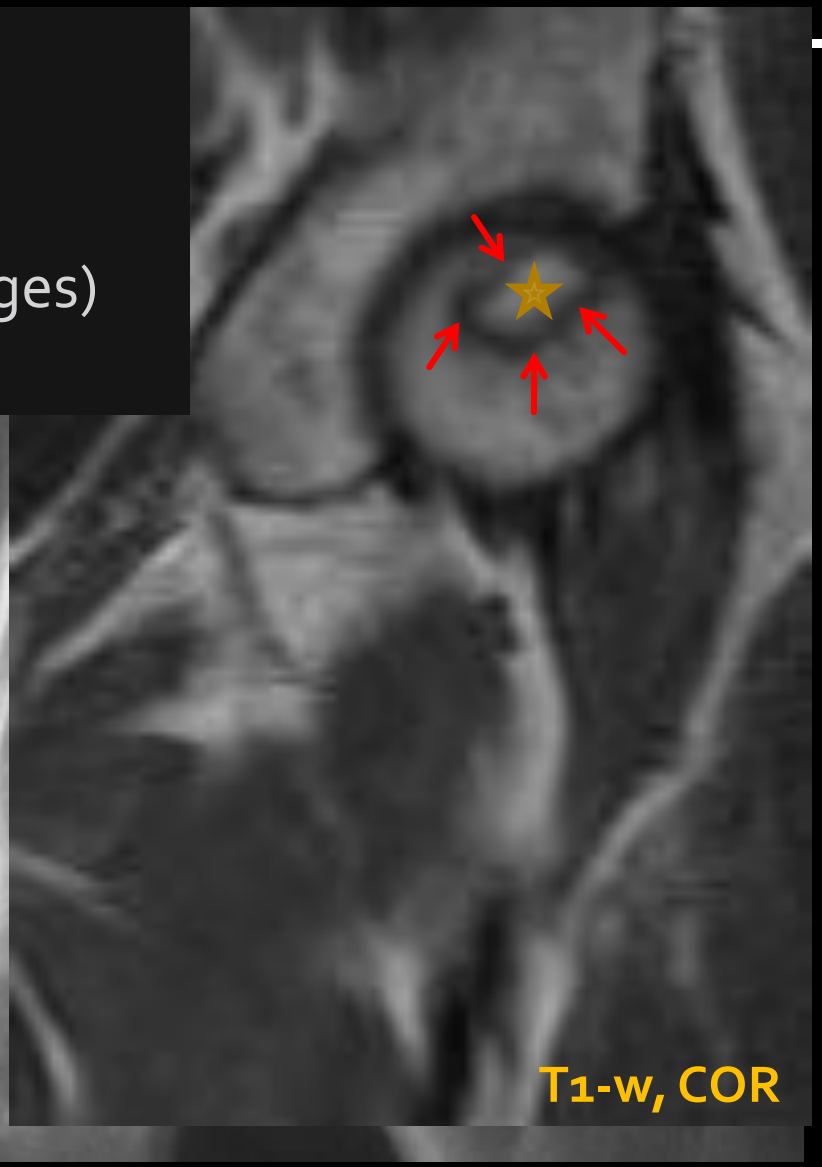
Glickstein MF et al. Radiology 1988;169:213-215

STAGE	0	1	2	3	4
FINDINGS	All present techniques normal or non-diagnostic	X-ray and CT are normal at least ONE of the below mentioned is positive	NO CRESCENT SIGN! X-RAY ABNORMAL: sclerosis, osteolysis, focal porosis	CRESCENT SIGN! on the X-ray and/or flattening of articular surface of femoral head	OSTEOARTHRITIS! joint space narrowing, acetabular changes, joint destruction
TECHNIQUES	X-ray, CT Scintigraph MRI	Scintigraph MRI *QUANTITATE on MRI	X-ray, CT Scintigraph MRI *QUANTITATE MRI & X-ray	X-ray, CT ONLY * QUANTITATE on X-ray	X-ray ONLY
SUBCLASSIFICATION	NO	LOCATION 			NO
QUANTITATION	NO	QUANTITATION % AREA INVOLVEMENT minimal A < 15 % moderate B 15 % - 30 % extensive C > 30 % LENGTH of CRESCENT A < 15 % B 15 % - 30 % C > 30 % 			NO

Imaging
ARCO I/II

"band-like" lesion

- 7d
- low signal intensity zone (T1-w)
- surrounds normal BM area (initial stages)
- anterosuperior location

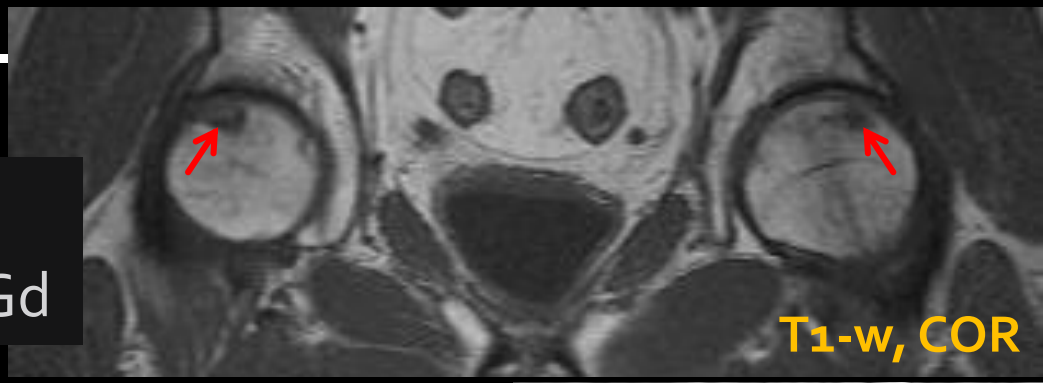


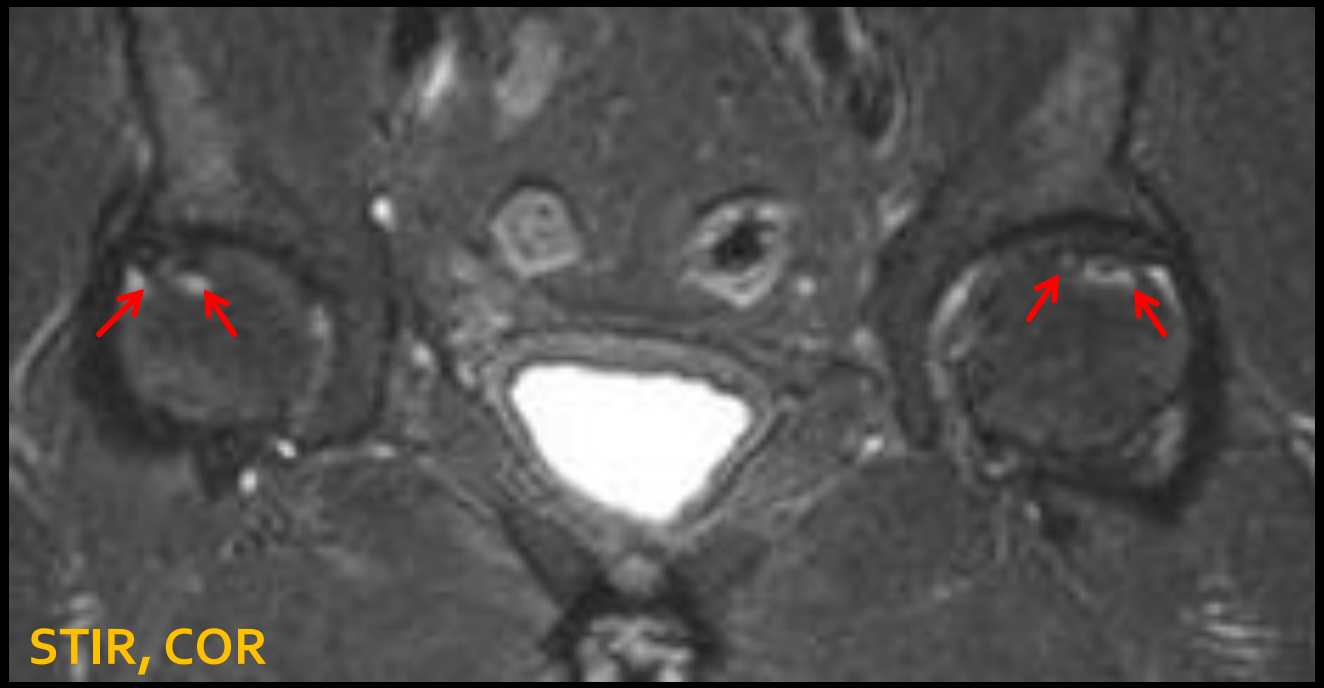
Mitchell DG et al. Radiology 1987;162:709-715

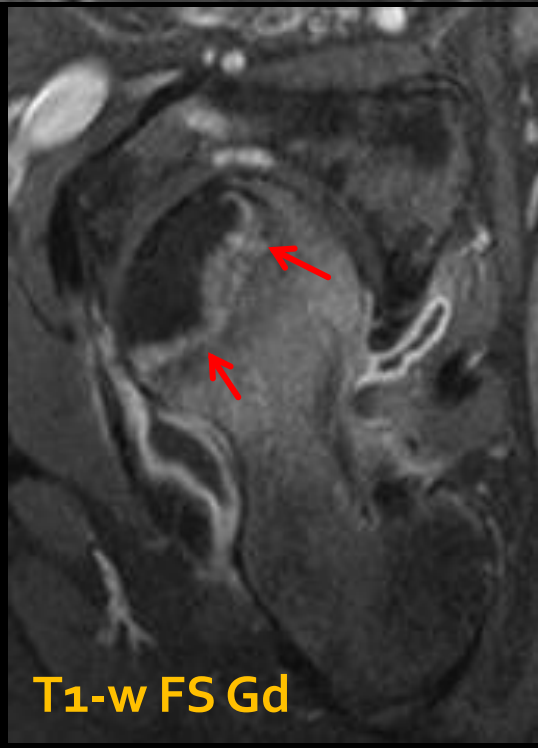
Imaging
ARCO I/II

"bright band-like" sign

- T2-w TSE FS, STIR, T1-w FS Gd

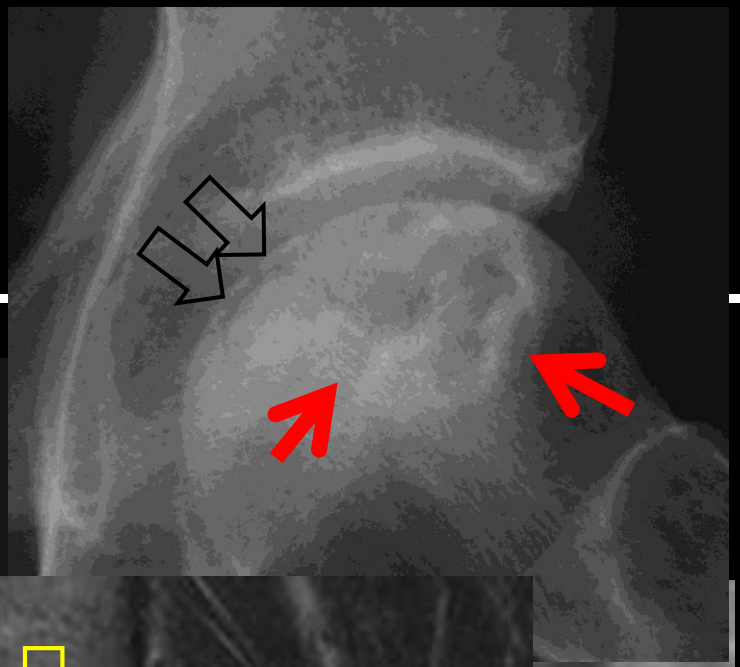




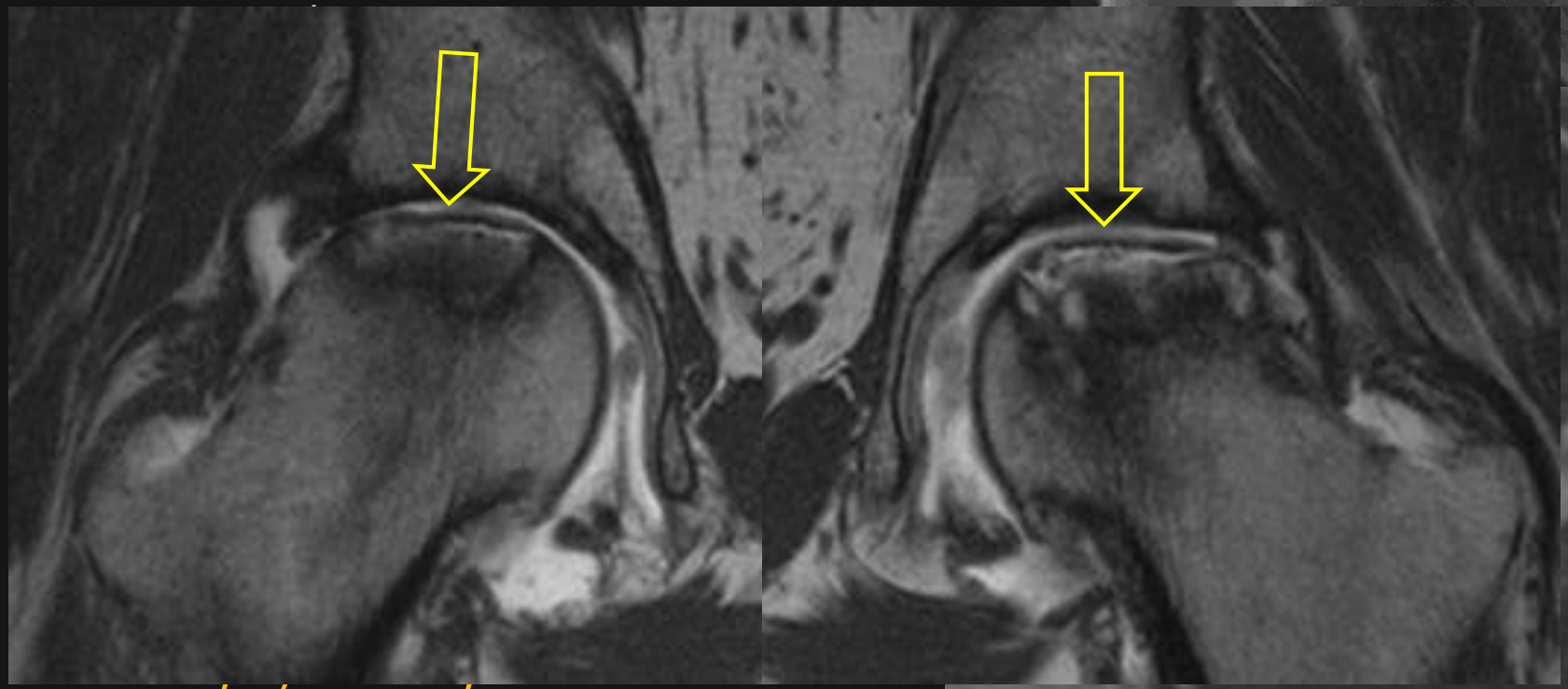


Malizos KN et al. Eur J Radiol 2007;63:16-28

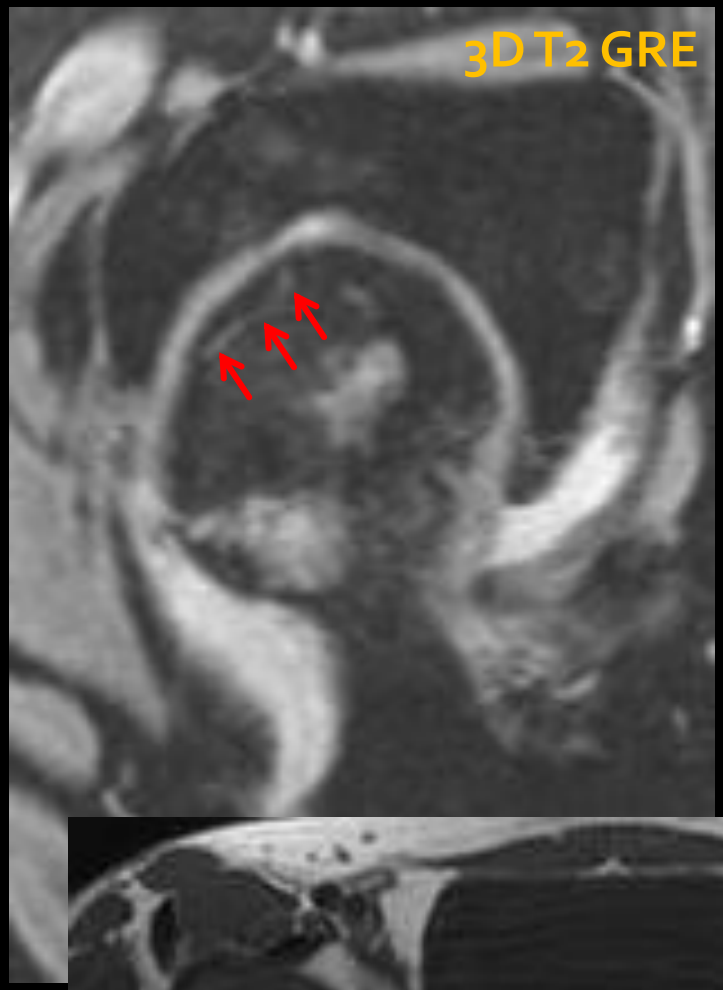
Imaging
ARCO III

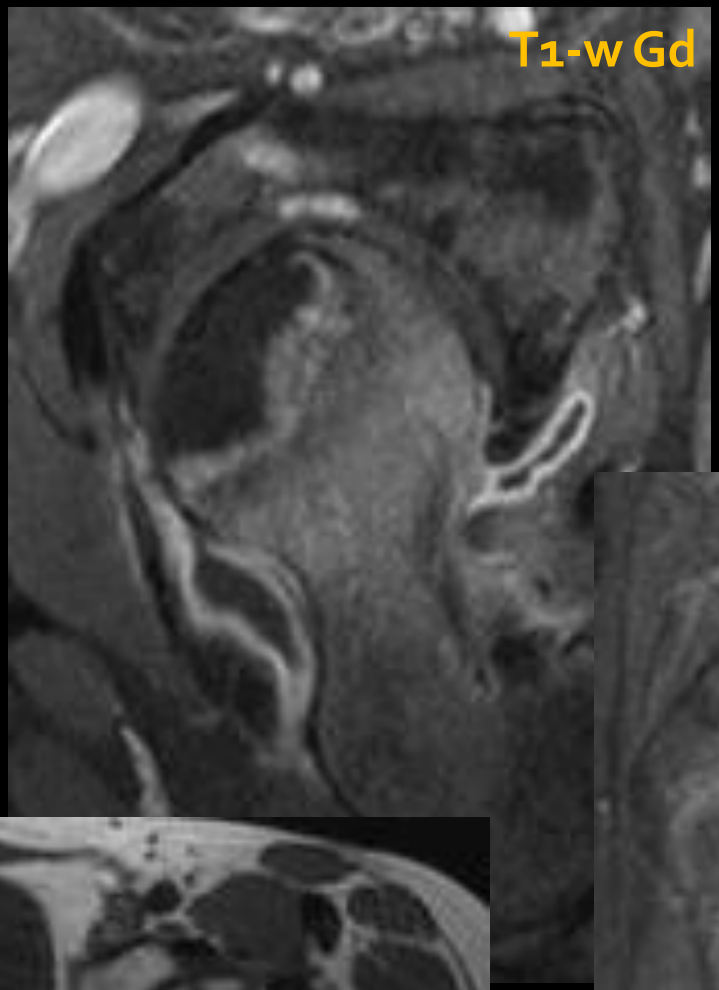


- **"crescent sign"** (subchondral fracture)
  - Low signal T1-w, variable T2-w

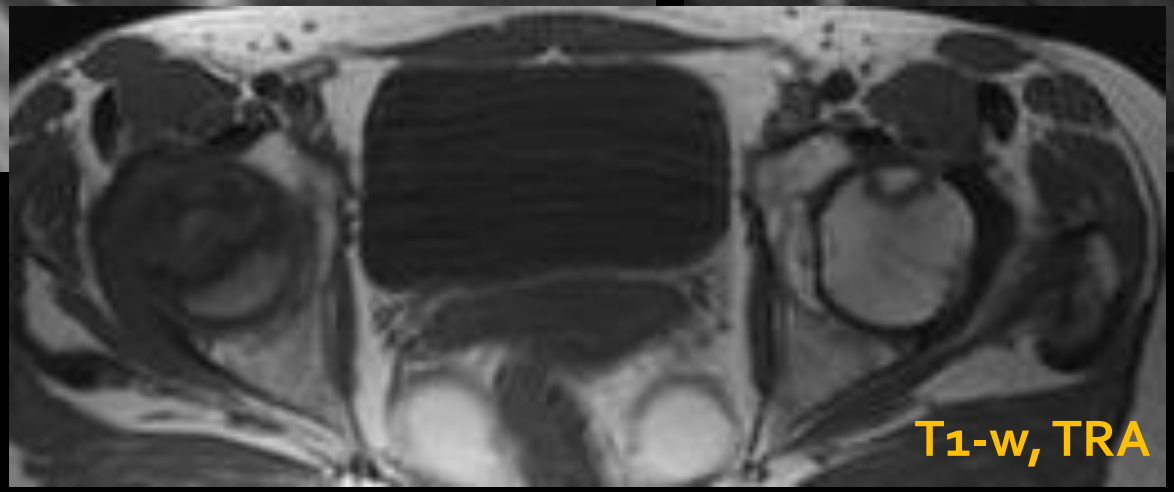


Vassalou EE et al. Semin Musculoskelet Radiol. 2019;23:276-288
Huang GS et al. AJR 2003;181:545–549
Meier R et al. Eur Radiol. 2014;24:2271–2278


3D T2 GRE


T1-w Gd


STIR, COR


T1-w, TRA

AVN & BME

- 30 - 50% of hips with AVN
- Advanced disease, **NO** early finding

BME
+
"band-like" lesion
+

1. Subchondral fracture - "crescent sign"
2. Articular surface collapse
3. OA

Stages III/IV

- Pain
- Deteriorated prognosis

Vassalou EE et al. Semin Musculoskelet Radiol. 2019;23:276-288
Fujioka M et al. Magn Reson Imaging 2001;19:985-991
Ito H et al. AJR2006;186:1761-1770
Karantanas AH et al. Semin Musculoskelet Radiol 2011;15:281-300

Transient osteoporosis (TOH)

1. Sudden onset pain
2. Conservative treatment
3. BME

aBMEs:

TOH, RMO

- Middle-aged males (m:f=3:1)
- Pregnancy (3° trimester)

Korompilias A V et al. J Am Acad Orthop Surg. 2008;16:480-9
Klontzas ME et al. Eur J Radiol 2015;84:431-6
Uzun M et al. Clin Rheumatol. 2013;32:919-23

TOH
Pathophysiology

Remains to be defined…

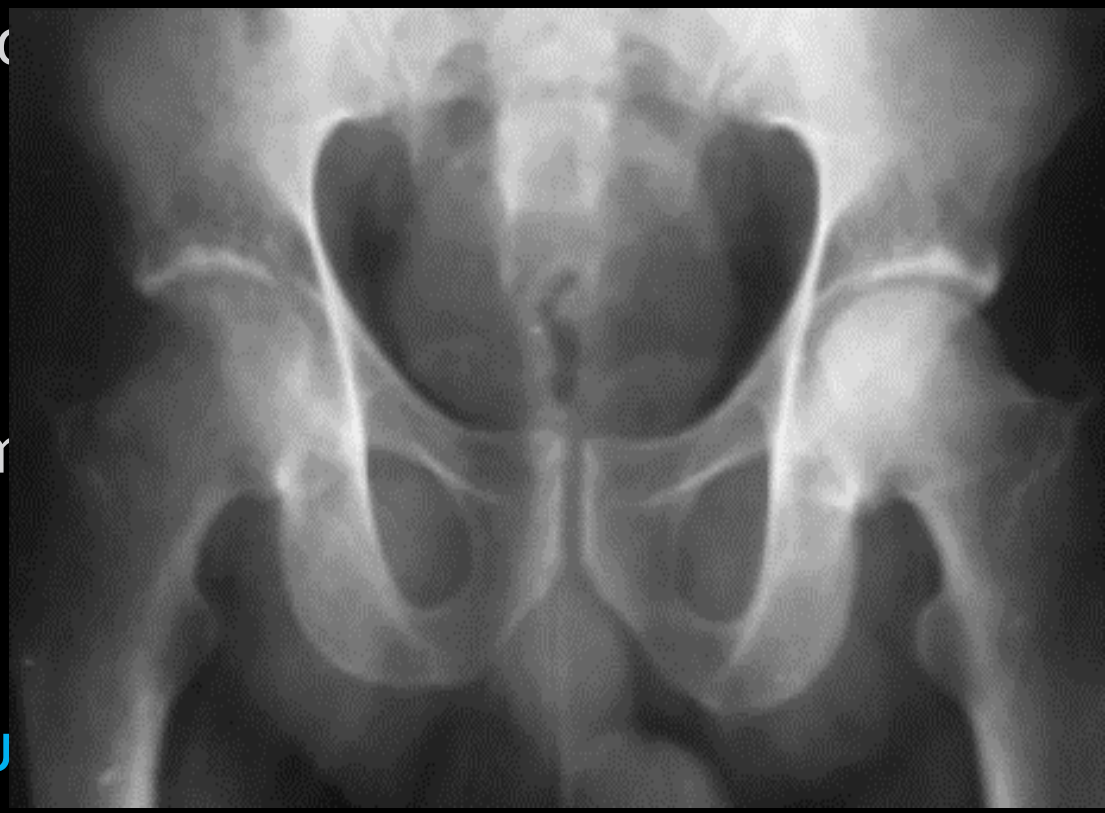
- **NO correlation with AVN**

- Compartment regional pain syndrome (CRPS)
- Transient ischemia
- Insufficiency fracture ⇔ osteopenia
  - 76/155 (48.7%): subchondral fracture
  - 30/31: osteopenia/osteoporosis

Korompilias A V et al. J Am Acad Orthop Surg. 2008;16:480-9
Klontzas ME et al. Eur J Radiol 2015;84:431-6
Uzun M et al. Clin Rheumatol. 2013;32:919-23

Imaging

X-rays: periarticular osteopenia (3-4w), normal joint space, +/- articular fluid



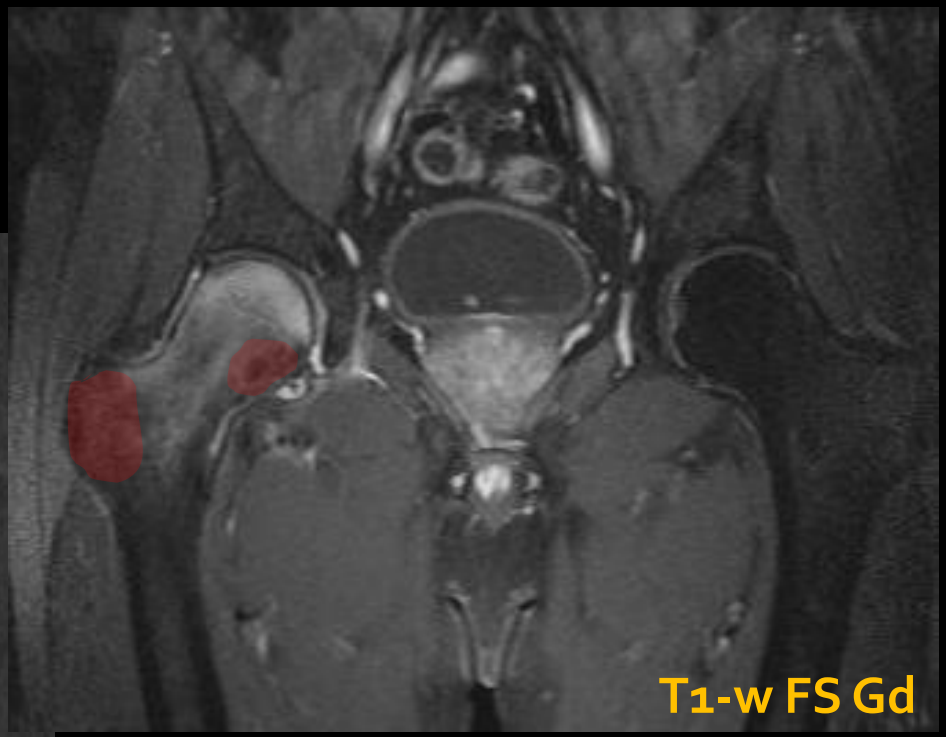
MRI

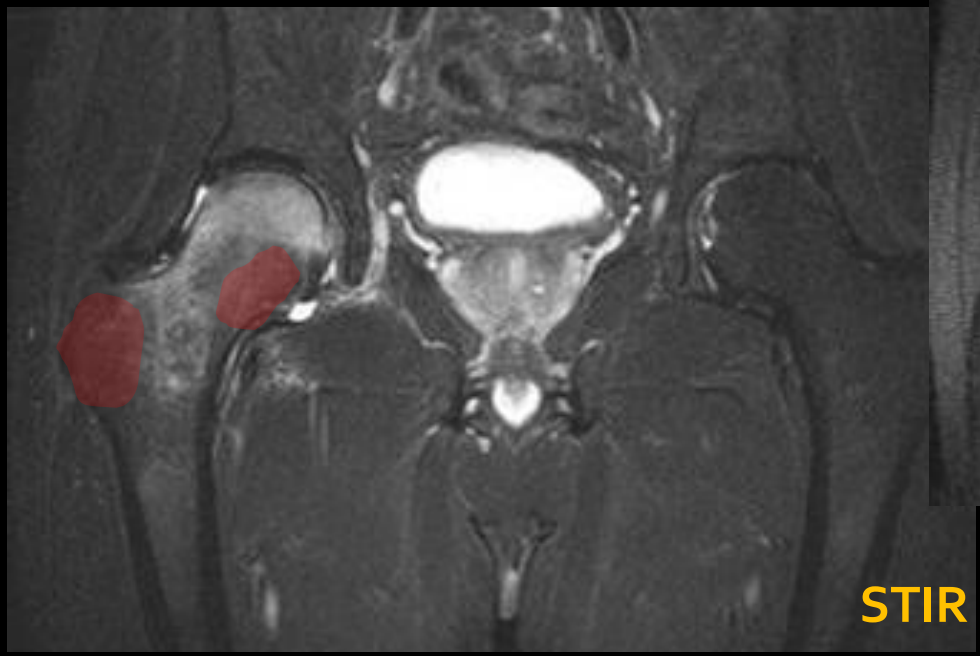
- BME
  - head, neck, proxim
  - "sparing sign"
- Articular effusion
- Subchondral fractu

Klontzas ME et al. Eur J Radiol 2015;84:431-6

Imaging
"sparing sign"

4-6w
Inferomedial location 87.7%
Greater trochanter 90%





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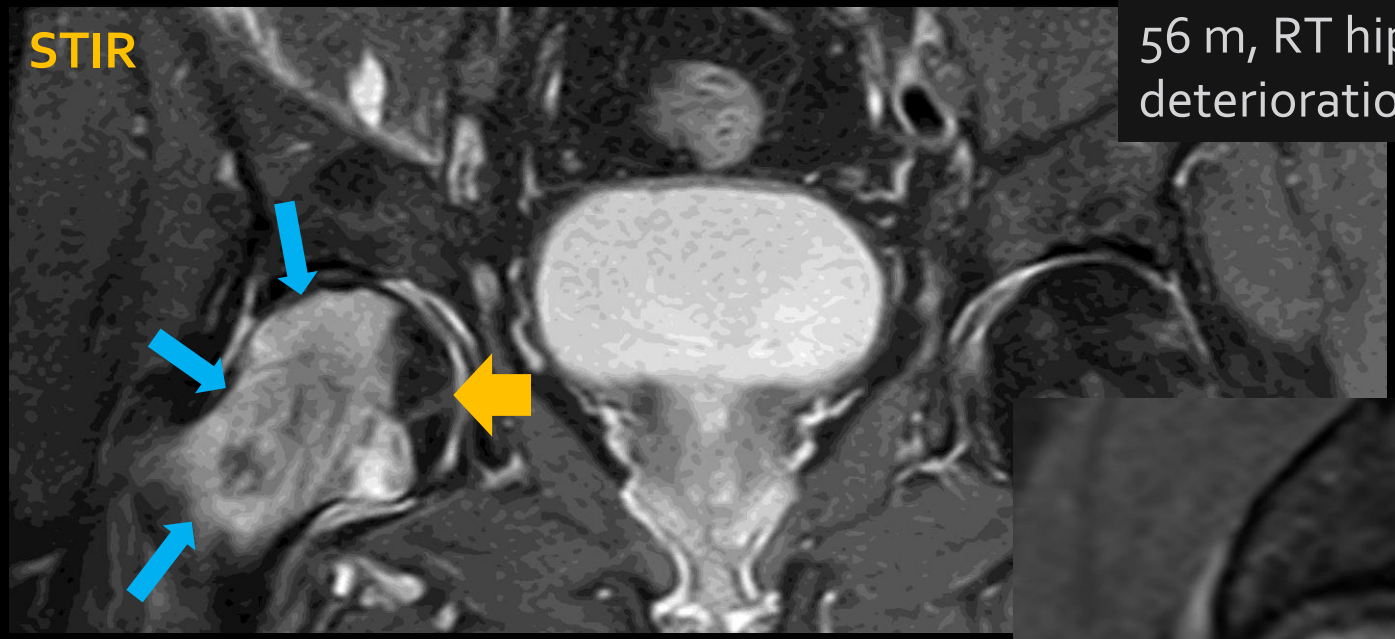
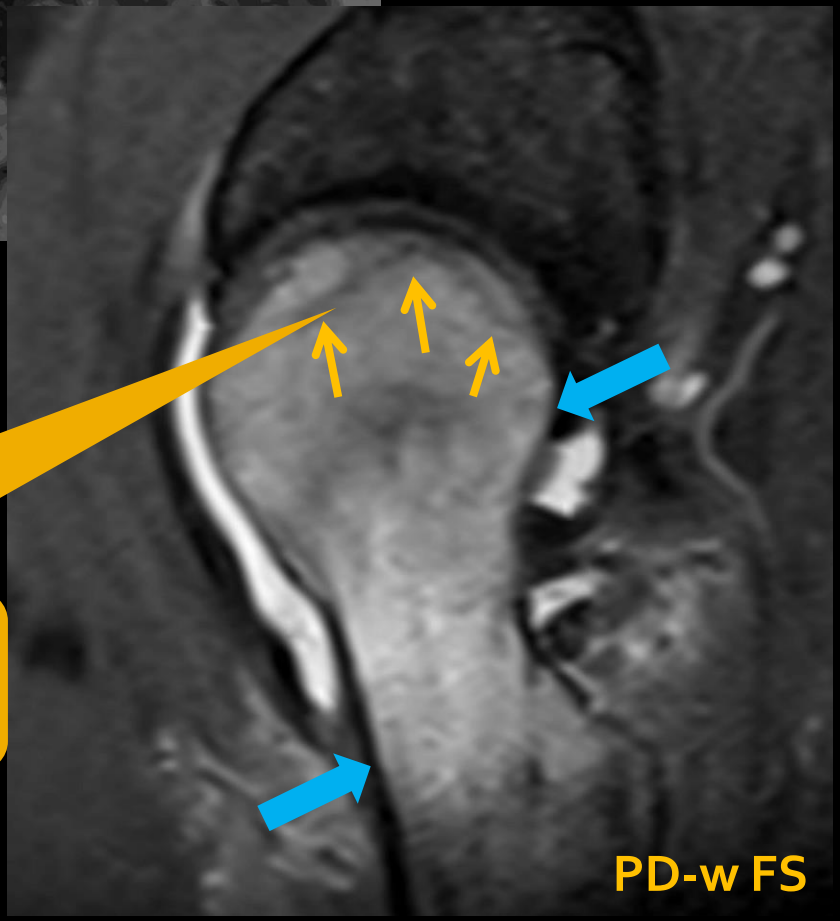
Klontzas ME et al. Eur J Radiol 2015;84:431-6



56 m, RT hip pain since 1m, deterioration since 1 week



Deeper location than "crescent"

More **irregular** compared to "crescent"

Regional migratory osteoporosis (RMO)

- Progression of TOH

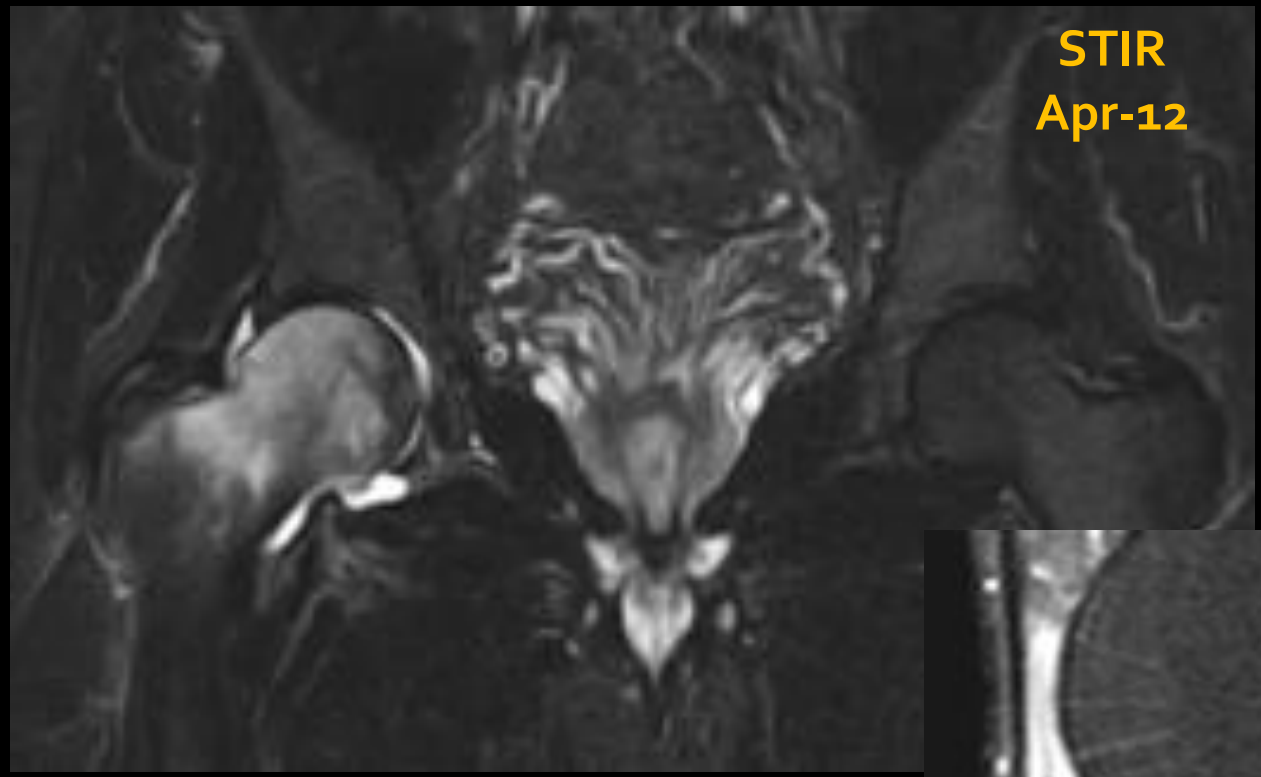
- Migratory arthralgia
- Weight-bearing joints of peripheral skeleton

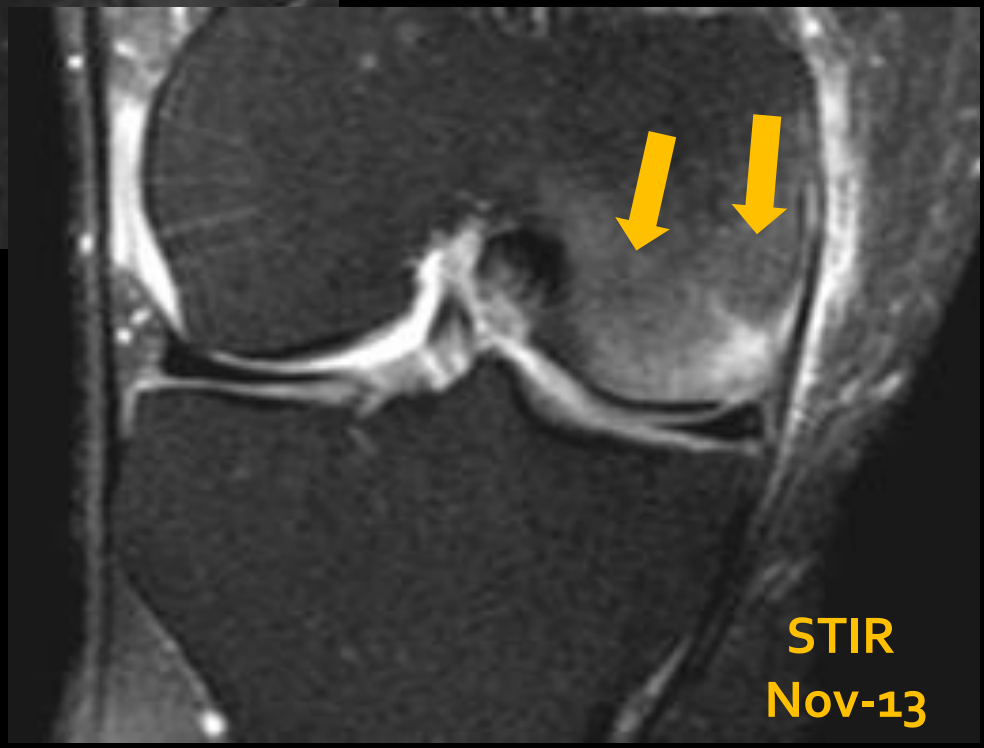
(4m – 1y)

- TOH (19,4-72% of patients) => BME
  - Contralateral hip
  - Knee
  - Ankle joint

Karantanas AH Et al. Eur J Radiol 2008;67:34-41
Klontzas ME et al. Eur J Radiol 2015;84:431-6
Cahir JG et al. Eur J Radiol. 2008;67:2-10

RMO





Stress Injuries

Continuing loading

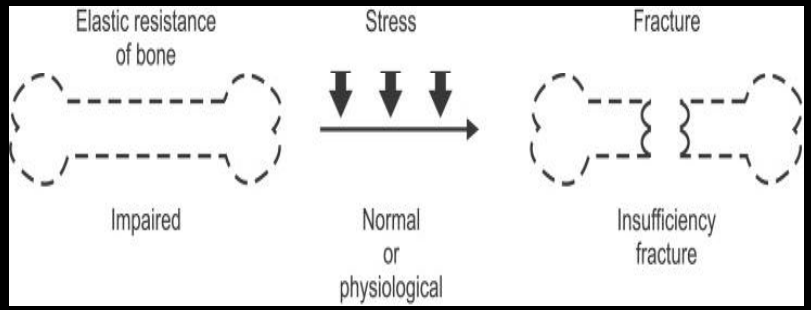
Bone resorption/remodeling imbalance

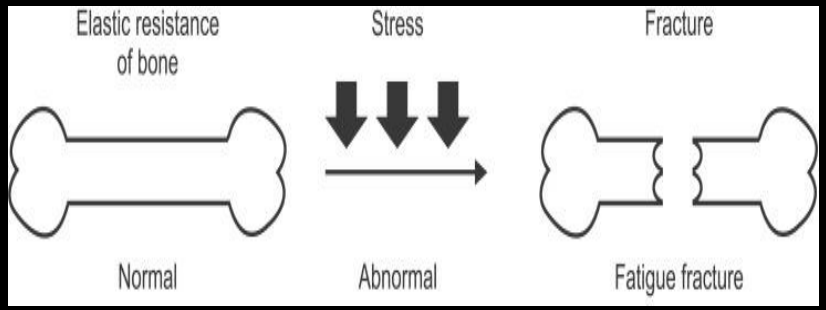
Microtrabecular fractures

"stress reactions"

"insufficiency fractures"

"fatigue fractures"





Niva MH et al. Bone J Surg Br 2005;87:1385 -90
Kiuru MJ eta l. Am J Sport Med 2005;33:272 - 276
Karantanas AH. Injury 2014;45:923 -33

Insufficiency/fatigue fracture

- Fracture line
- BME
- Articular fluid/synovitis
- Soft tissue edema

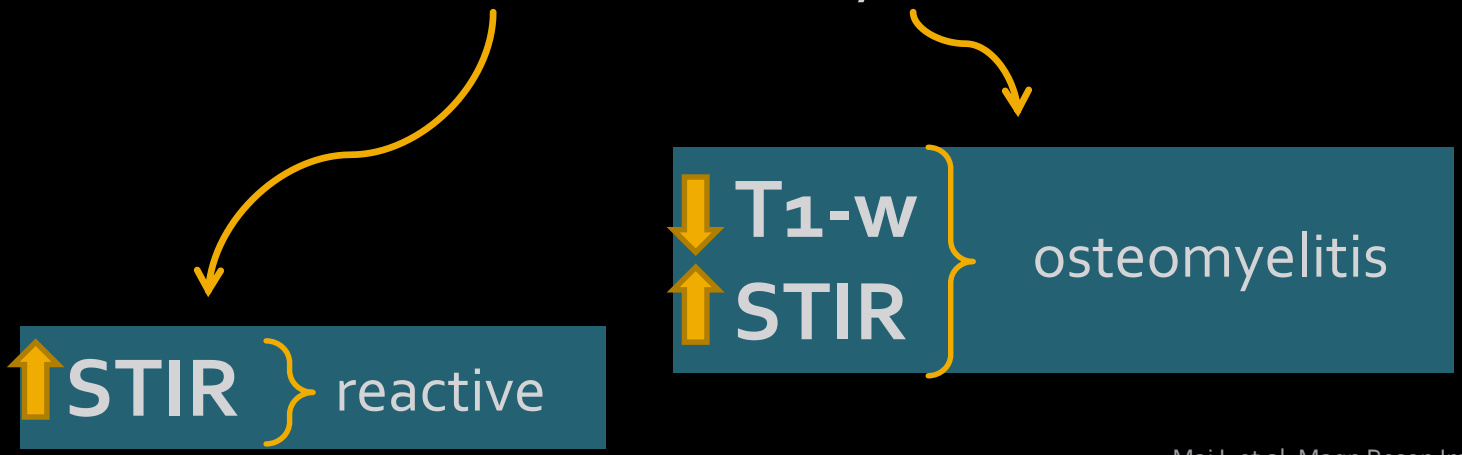
Slocum KA et al. AJR Am J Roentgenol 1997;168:1295 – 1299

Arthropathy
infectious, inflammatory, degenerative

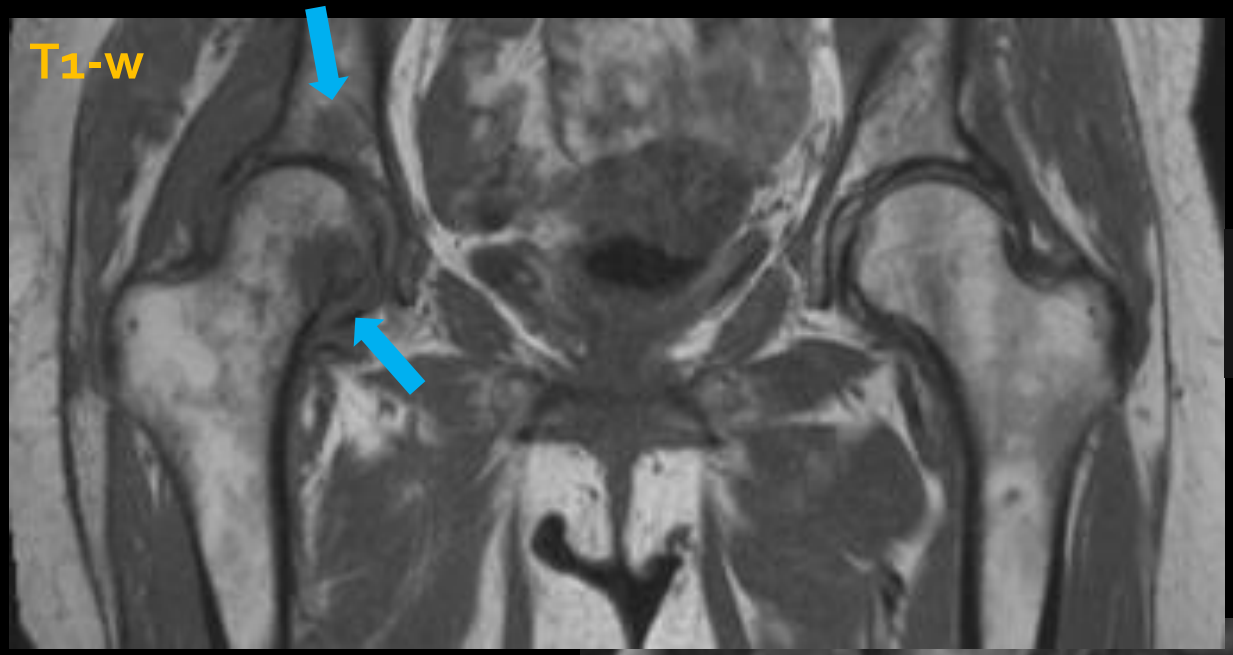
1. Septic arthritis/osteomyelitis

Increased age, children, diabetes, post-surgical

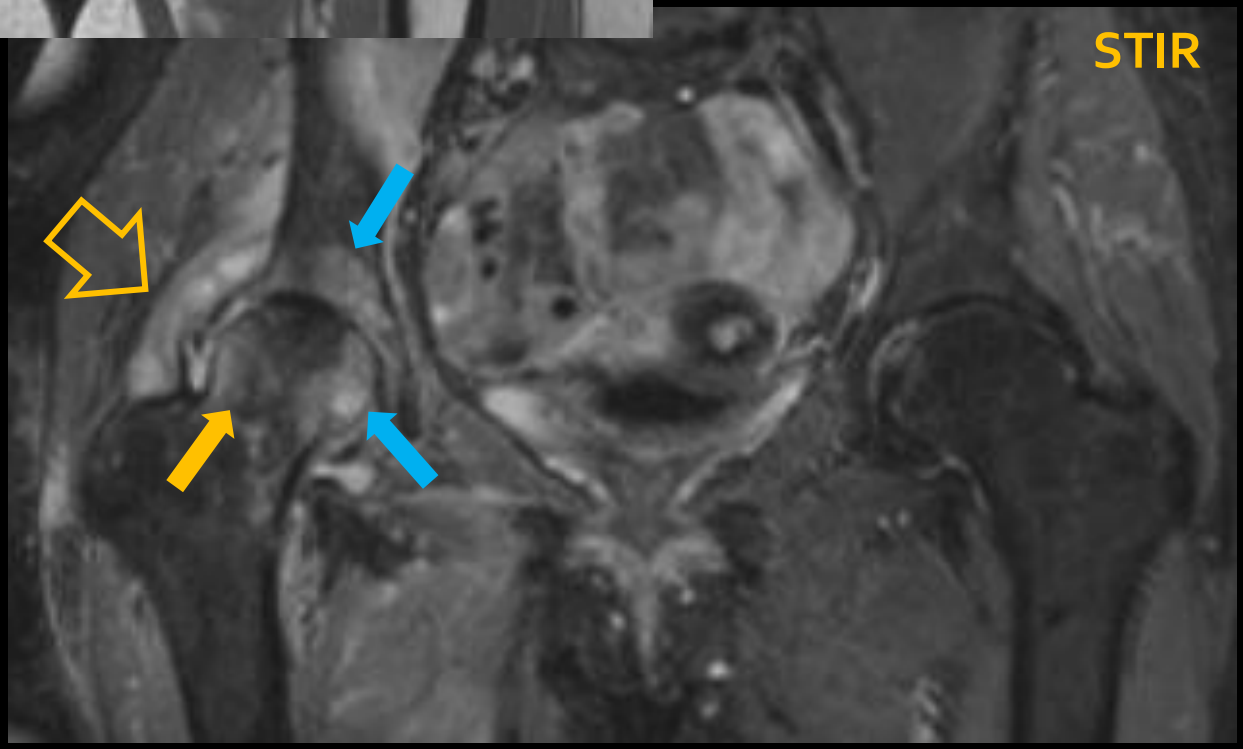
- Articular efussion/synovitis (culture => diagnosis)
- Erosions
- BME (reactive/osteomyelitis)



Maj L et al. Magn Reson Imaging Clin N Am 2013;21:127 – 39
Greenspan A et al. Radiol Clin North Am 2001;39:267 – 76



59 m, septic arthritis,
Staph. Aureus



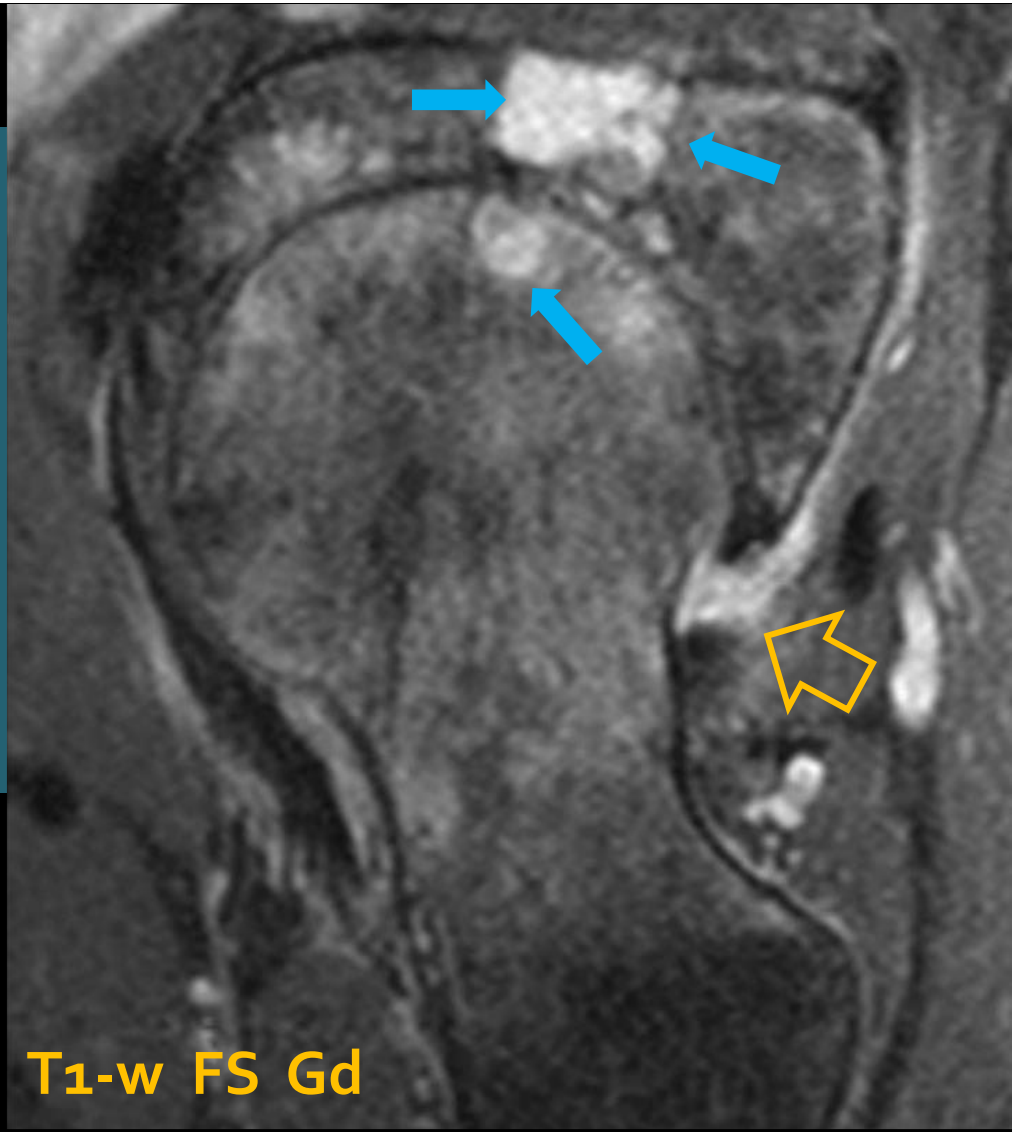
Arthropathy
infectious, inflammatory, degenerative

2a. RA

MRI

1. Erosions
2. Synovitis/effusion
3. BME
   - Early marker of inflammation
   - **Subchondral, diffuse**
   - **Surrounding erosions**

Smith HJ, et al. Radiology 1992; 185:229-234
McQueen F, et al. Ann Rheum Dis 1998; 57:350-356
Hetland ML, et al. Ann Rheum Dis 2009; 68:384-390



Arthropathy
infectious, inflammatory, degenerative

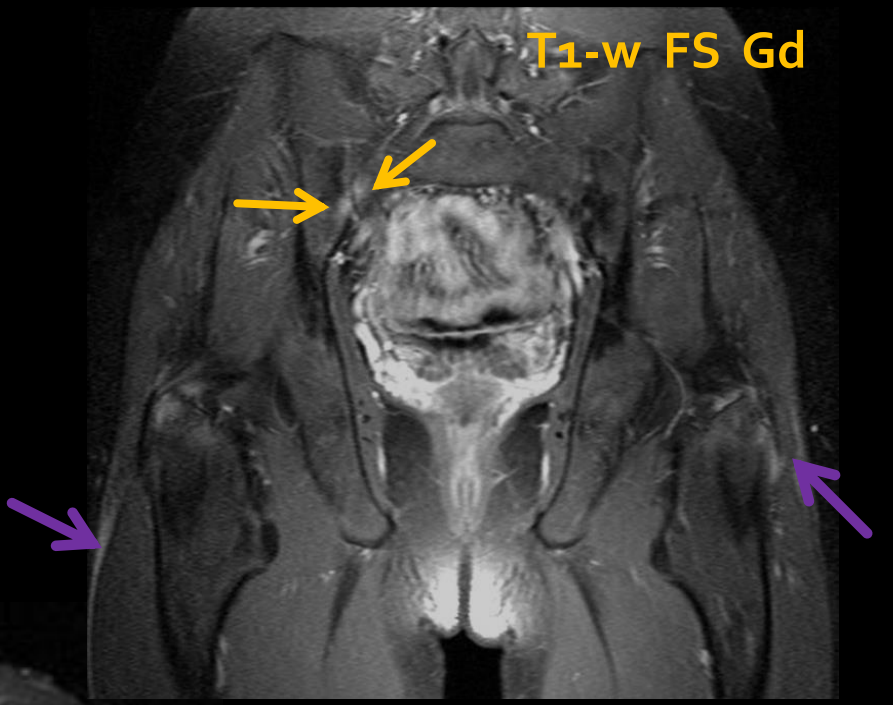
2b. Ankylosing spondylitis

Early involvement

MRI

1. **BME (osteitis)**
2. **Enthesitis**

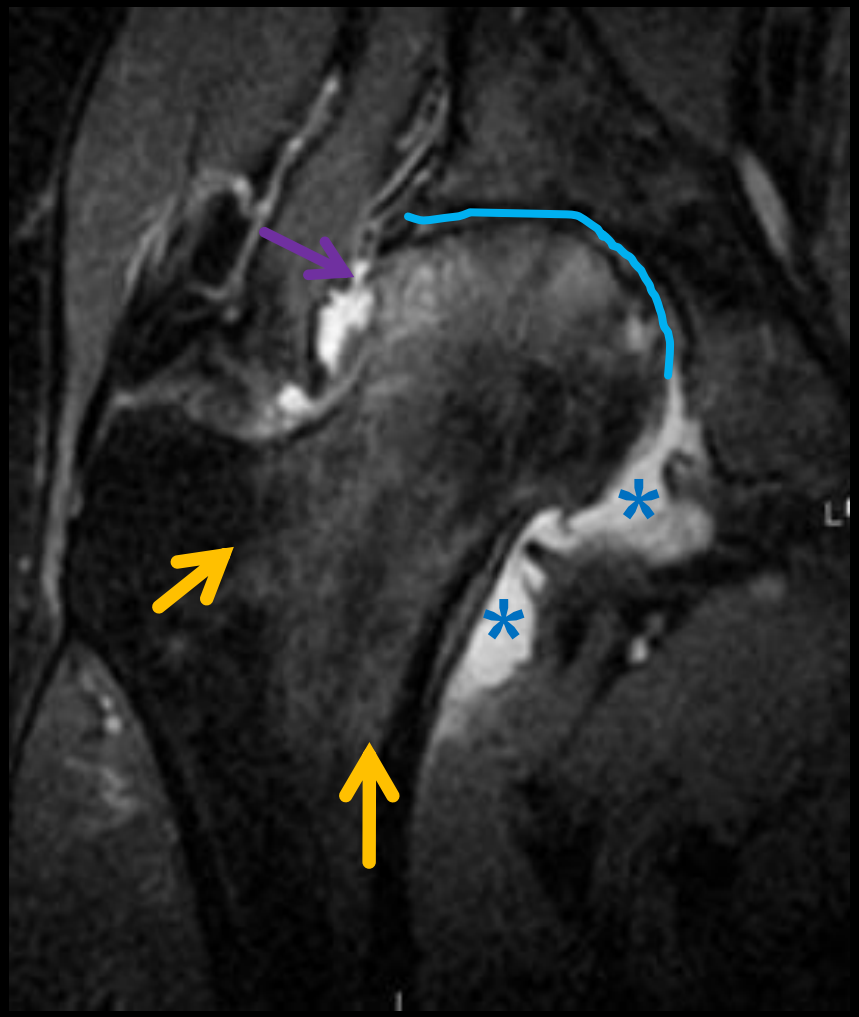
Vassalou EE et al. Semin Musculoskelet Radiol. 2019;23:276-288
Zhen-Guo J et al. Eur J Radiol 2013;82:1487 – 93



Arthropathy
infectious, inflammatory, degenerative

3. OA

- JSN - erosions
- Joint effusion
- Osteophytes
- BME
  - Poor prognostic factor



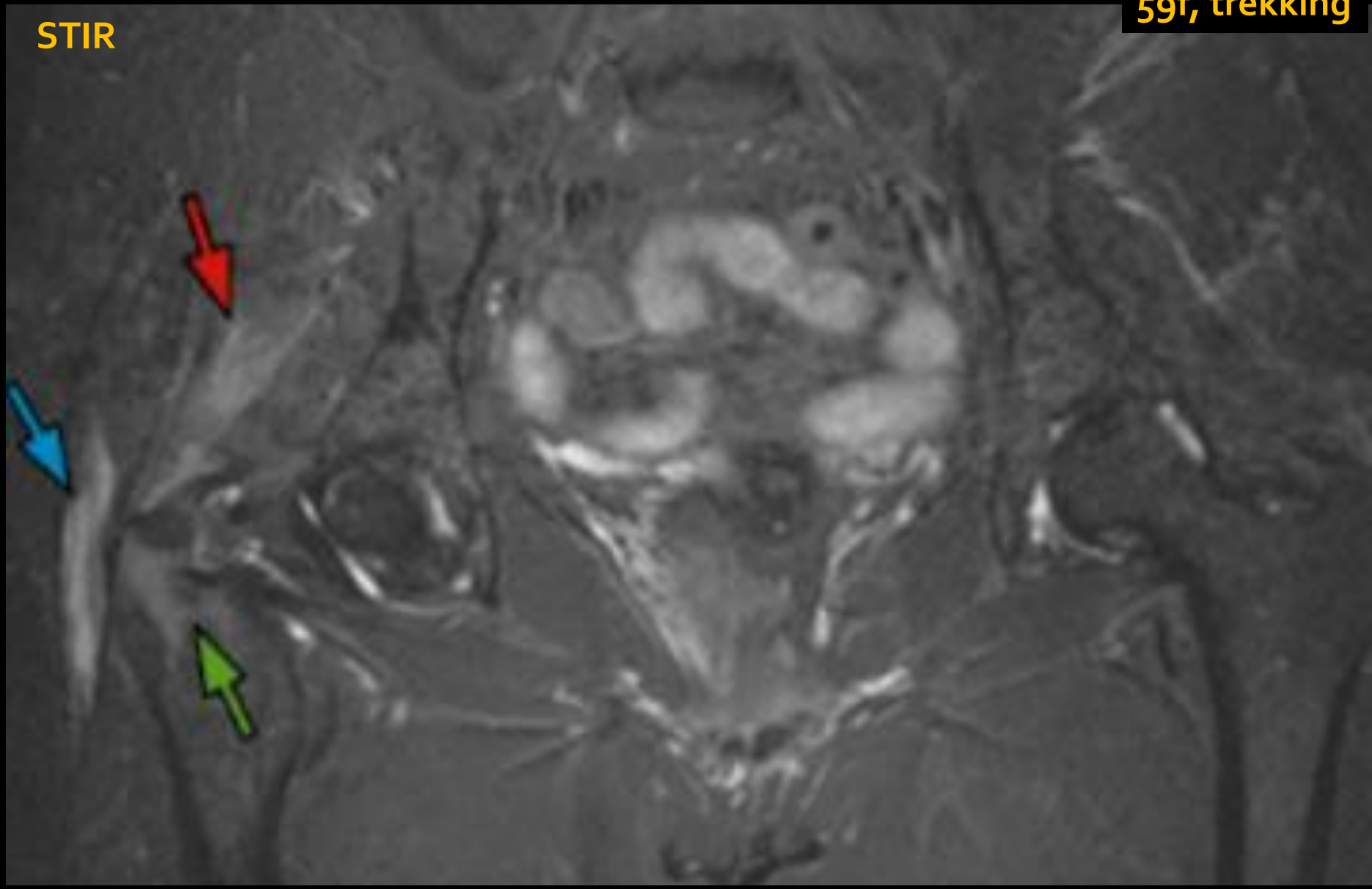
Greater trochanter pain syndrome

- Snapping hip syndrome
- Trochanteric bursitis
- HADD, gluteal tendinopathy
- Enthesopathy

Tibor LM et al. Arthroscopy 2008;24:1407 – 21

- *BME: uncommon*
  - Friction, hypervascularization

Dwek J et al. Magn Reson Imaging Clin N Am 2005:691 – 704



Klontzas ME et al. Hip Int. 2017;27:329-335

Neoplasms

- X-ray, MDCT diagnosis
- MRI: staging, matrix
  - BME: extend overestimation

Bancroft LW et al. Magn Reson Imaging Clin N Am 2005;13:757 - 74

Tumors + BME

- osteoid osteoma
- chondroblastoma

benign

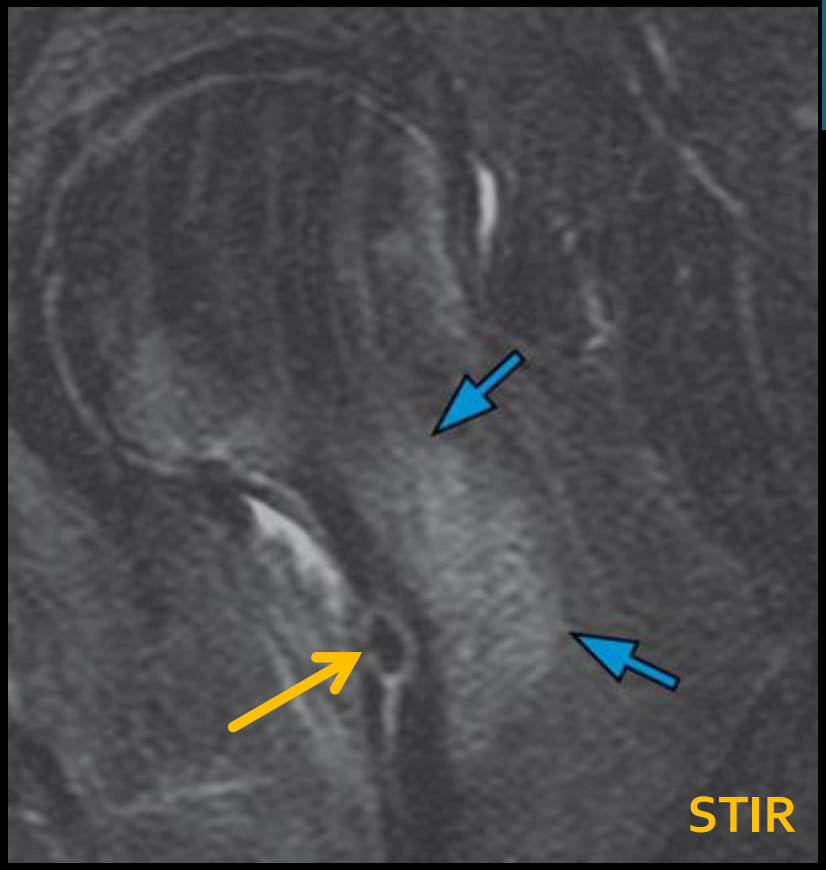
- osteosarcoma
- Ewing's sarcoma
- chondrosarcoma
- mets

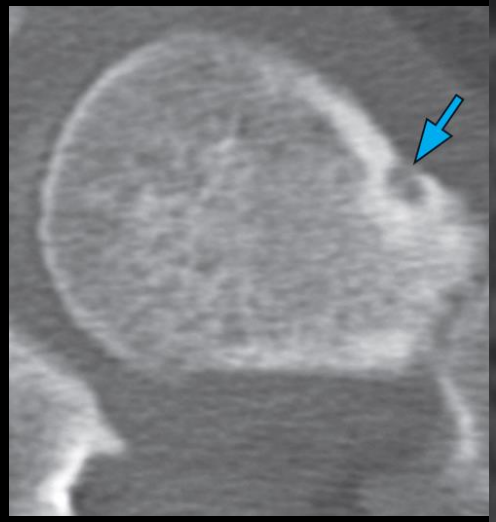
malignant

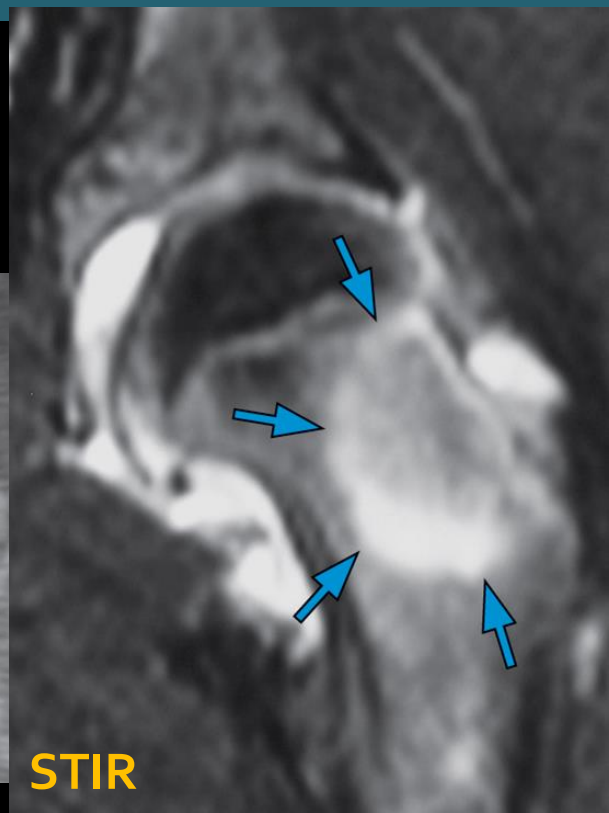
Osteoid osteoma

- **MDCT**: gold standard
- MRI
  - BME ("Half moon sign")

    Klontzas ME et al. AJR Am J Roentgenol 2015
  - Soft tissue edema
  - Articular effusion







Take home

BME: increased water content within BM

Non-traumatic hip BME

- AVN
- TOH
- Insuff. fractures
- Arthropathies
- GTPS
- Tumors

MRI: method of choice

Non-specific finding

- **Distribution**
- **Concomitant findings**
- **Timing**

Thank you!

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