



2^ο ΘΕΡΙΝΟ ΣΧΟΛΕΙΟ
ΑΚΤΙΝΟΛΟΓΙΑΣ
ΜΥΟΣΚΕΛΕΤΙΚΟΥ
“BACK TO BASICS”

29 ΙΟΥΝΙΟΥ
1 ΙΟΥΛΙΟΥ
2018
ΗΡΑΚΛΕΙΟ
ΚΡΗΤΗΣ
Ibis Styles
Heraklion
Central

Avascular necrosis and transient osteoporosis

Imaging investigation



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Outline

20 min

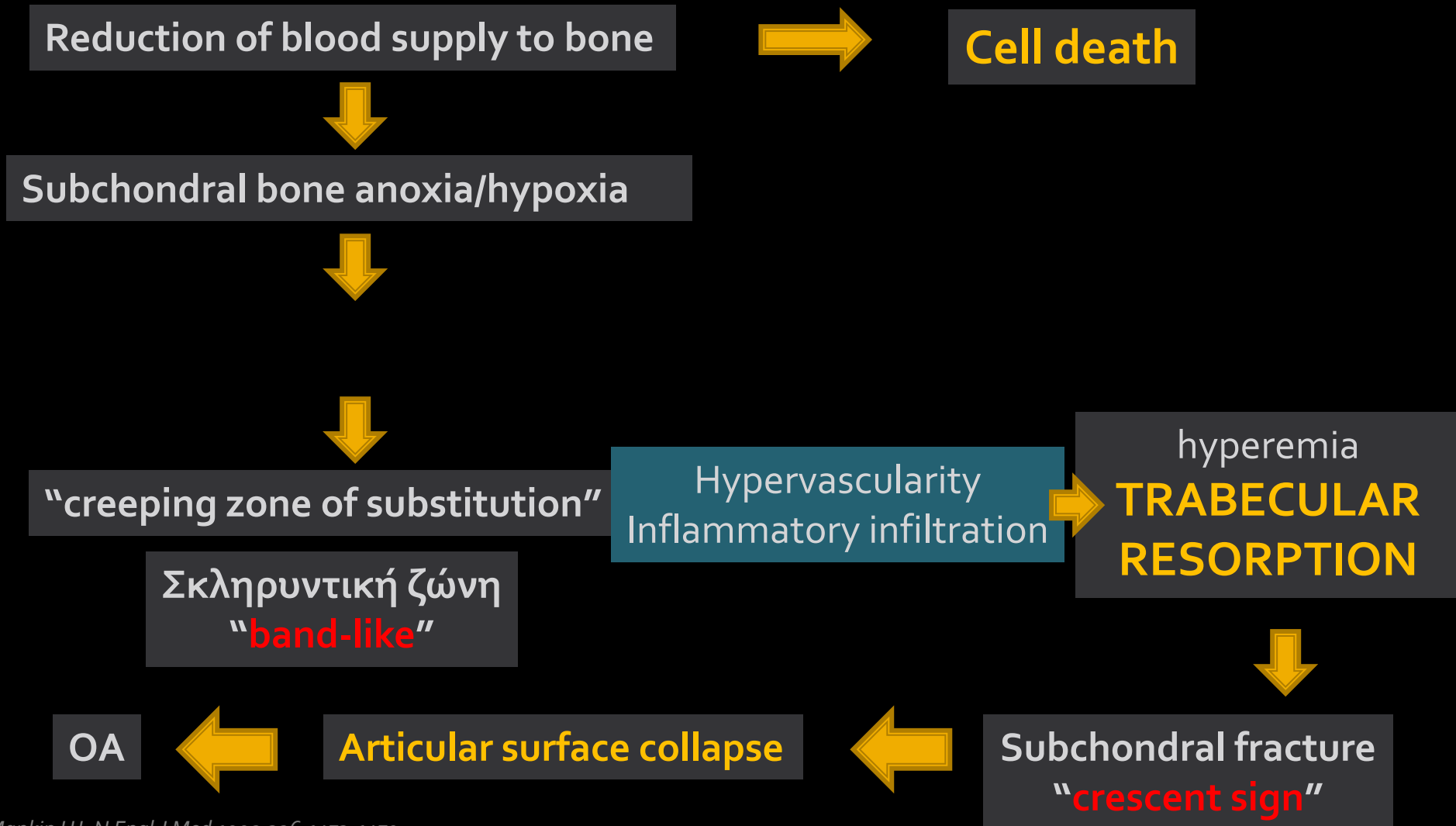


- **Osteonecrosis**
 - pathophysiology
 - epidemiology
 - imaging investigation
 - plain radiographs/CT
 - MRI
 - post-surgical

- **Transient osteoporosis**
 - pathophysiology
 - epidemiology
 - imaging investigation
 - plain radiographs
 - MRI

Osteonecrosis

Pathophysiology



Epidemiology

- United States: 10,000 - 20,000 patients/year
- Males > Females (4-8:1)
- 40-60 y
- Humeral head
- Bilateral 50% (trauma, idiopathic: unilateral)

Common

Trauma

Corticosteroids (exogenous and endogenous)

Idiopathic

Sickle cell anemia

Collagen vascular disease

Alcoholism

Uncommon

Pancreatitis

Renal transplantation

Drug therapy (immunosuppressive, cytotoxic therapy, bisphosphonates [jaw])

Pregnancy

Radiation therapy

Occlusive vascular disease (thromboembolic disease and arteriosclerosis)

Infection (including human immunodeficiency virus)

Leukemia/lymphoma

Vasculitis

Diabetes

Rare

Dysbaric conditions (caisson disease)

Hemophilia

Gout

Thermal injury (burn, frostbite)

Gaucher disease

Langerhans cell histiocytosis

Neuropathic arthropathy

Polycythemia vera

Multiple epiphyseal dysplasia

Imaging investigation

Plain radiographs / CT

- Low sensitivity at initial stages (I, II)
- Diagnosis/staging at late stages

MRI

- Method of choice (accuracy 97-100%)
 - Early diagnosis
 - Staging - prognosis
 - Follow-up

MRI

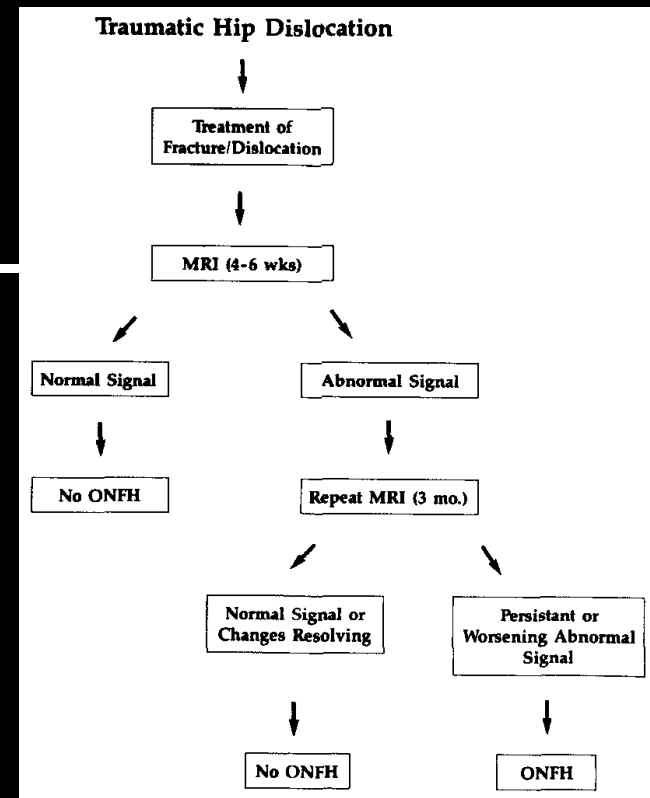
Imaging protocol

- T₁-w
- STIR or PD/T₂-w FSTSE
- Articular cartilage sequences
- Gd: Increased SNR

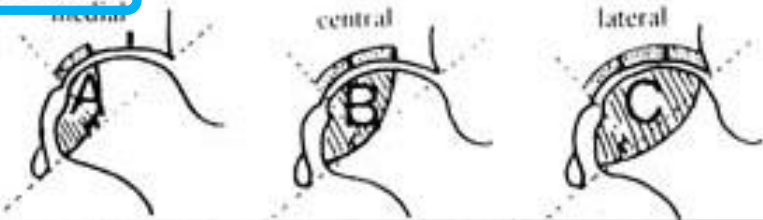
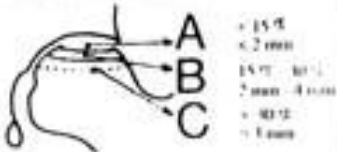
Improved spatial resolution

Trauma (hip dislocation)

- 6w: 60% => bone marrow changes
- 3m: 60% => resolution, 40% => osteonecrosis
 - MRI (4-6 w) => abnormal signal MRI (3 m)



Staging ARCO system

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	<p>LOCATION</p> 			NO
QUANTITATION	NO	<p>% AREA INVOLVEMENT</p> <p>minimal A < 15 % moderate B 15 % - 30 % extensive C > 30 %</p>	<p>LENGTH of CRESCENT</p> <p>A < 15 % B 15 % - 30 % C > 30 %</p>	<p>% SURFACE COLLAPSE & DOME DEPRESSION</p>  <p>A = 15 % ≤ 2 mm B 15 % - 30 % 2 mm - 4 mm C = 30 % ≥ 4 mm</p>	NO

Imaging

ARCO I/II

“band-like” lesion

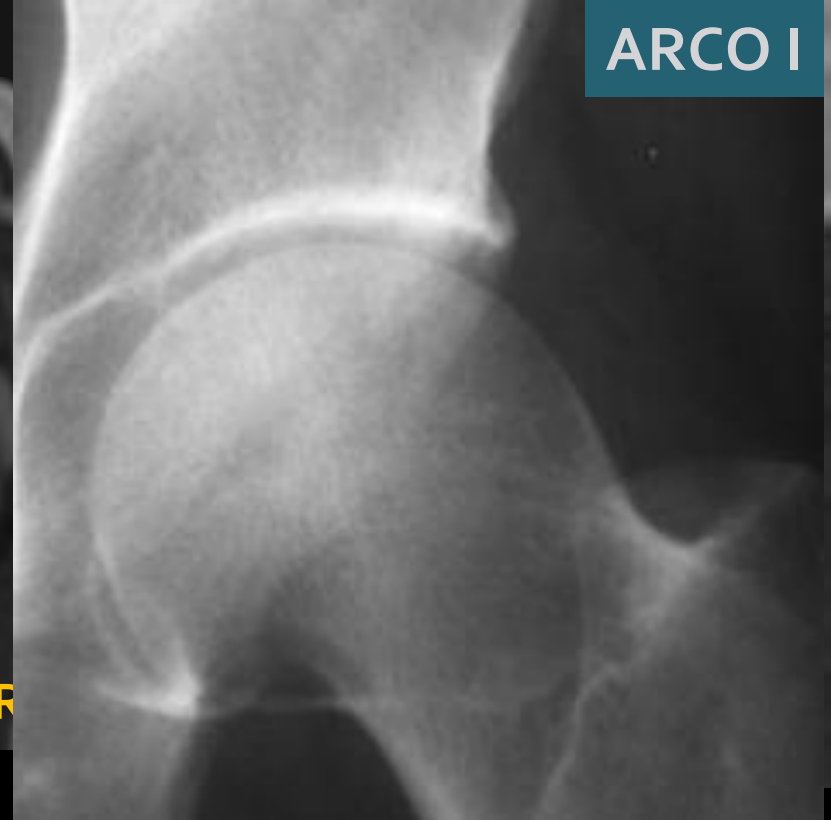
- 7d
- low signal intensity zone (T1-w)
- surrounds normal BM area (initial stages)
- anterosuperior location



ARCO I



T1-w, TR

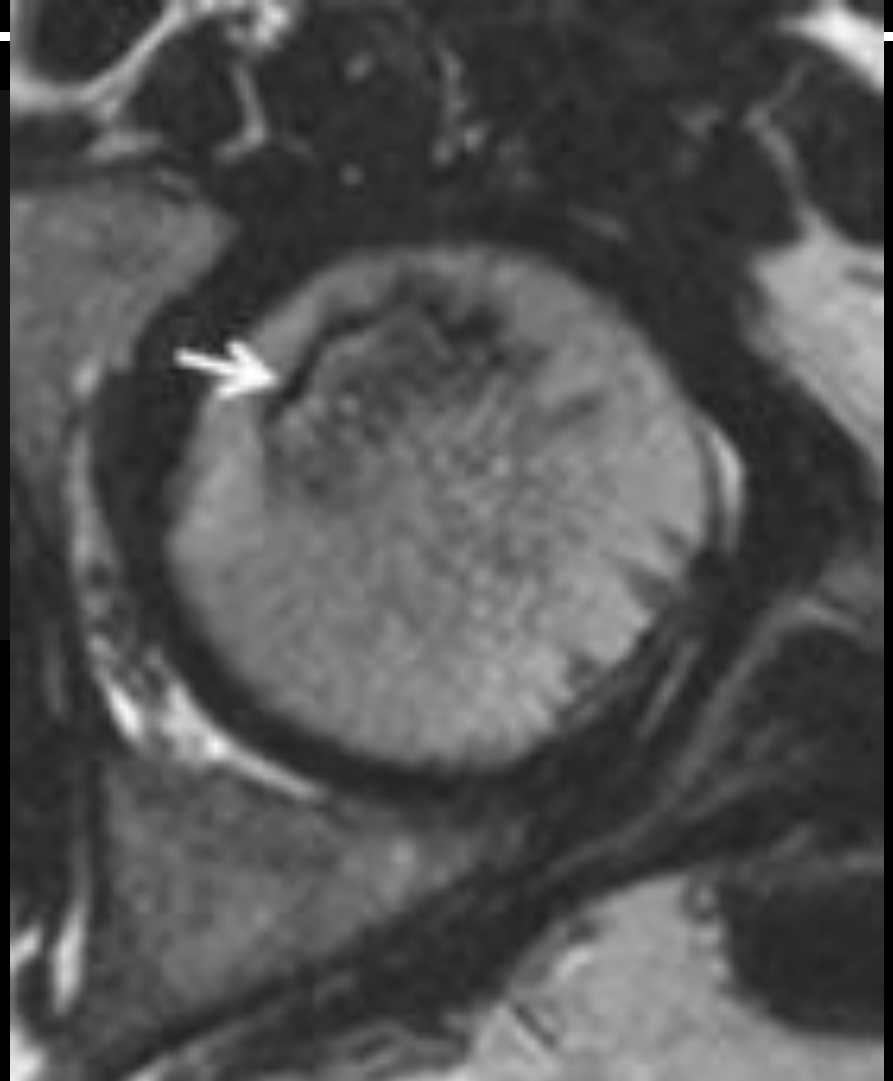


Imaging

ARCO I/II

“double-line” sign

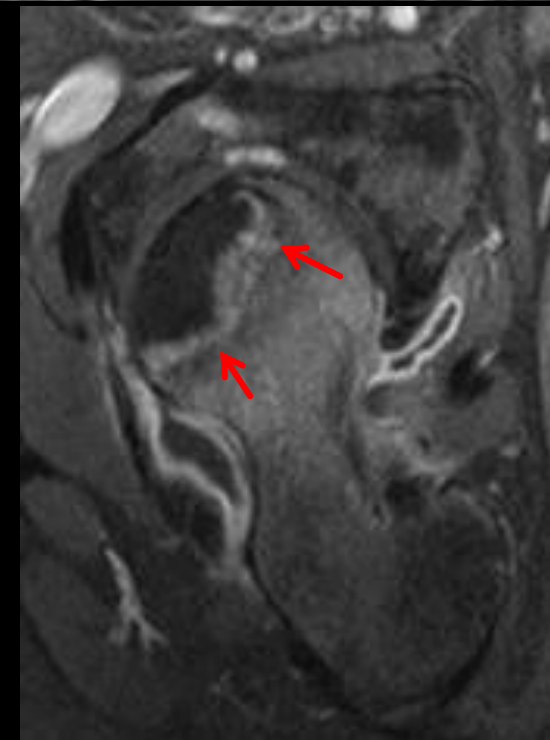
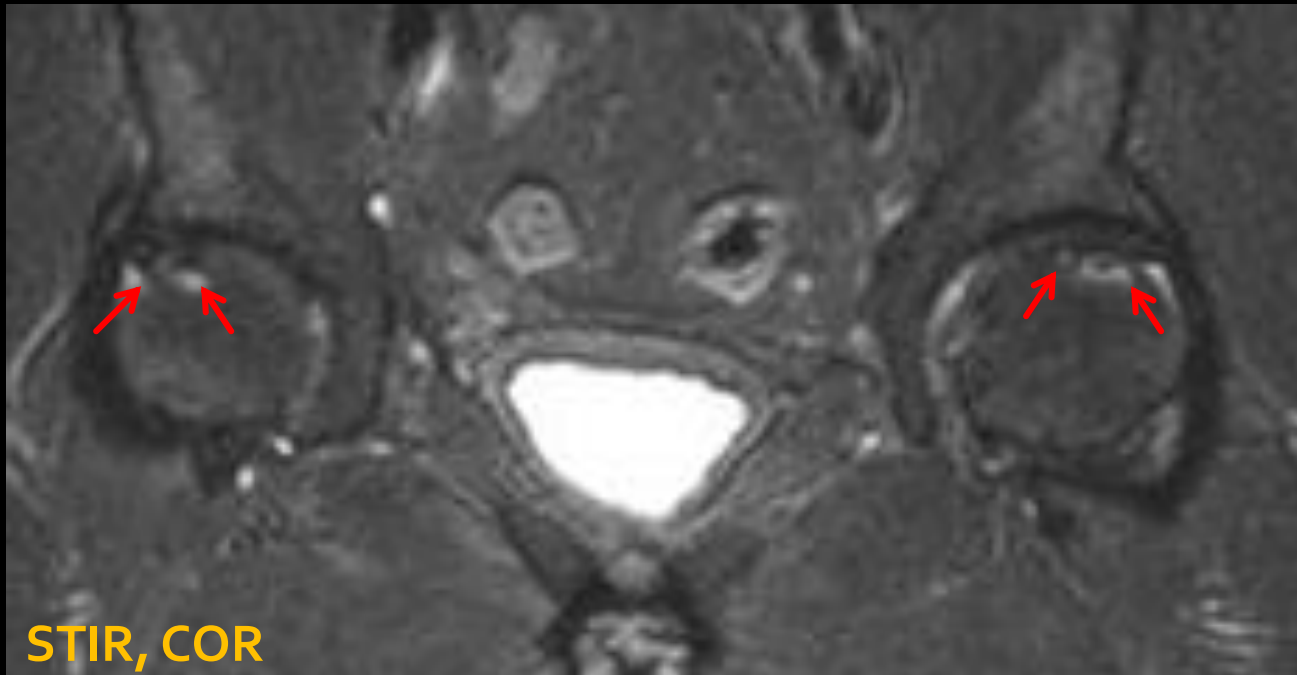
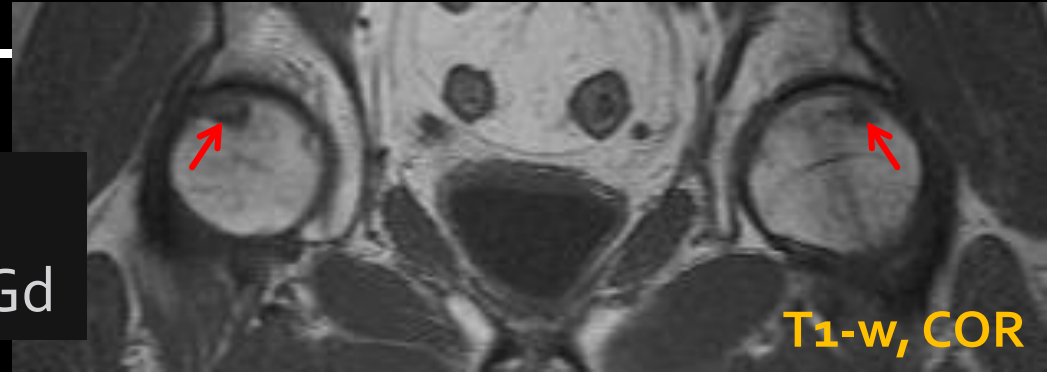
- T₂-w SE/TSE
- ✓ Pathologic correlation
 - sclerotic zone
 - “creeping zone of substitution”
- ✓ chemical-shift artifact



Imaging *ARCO I/II*

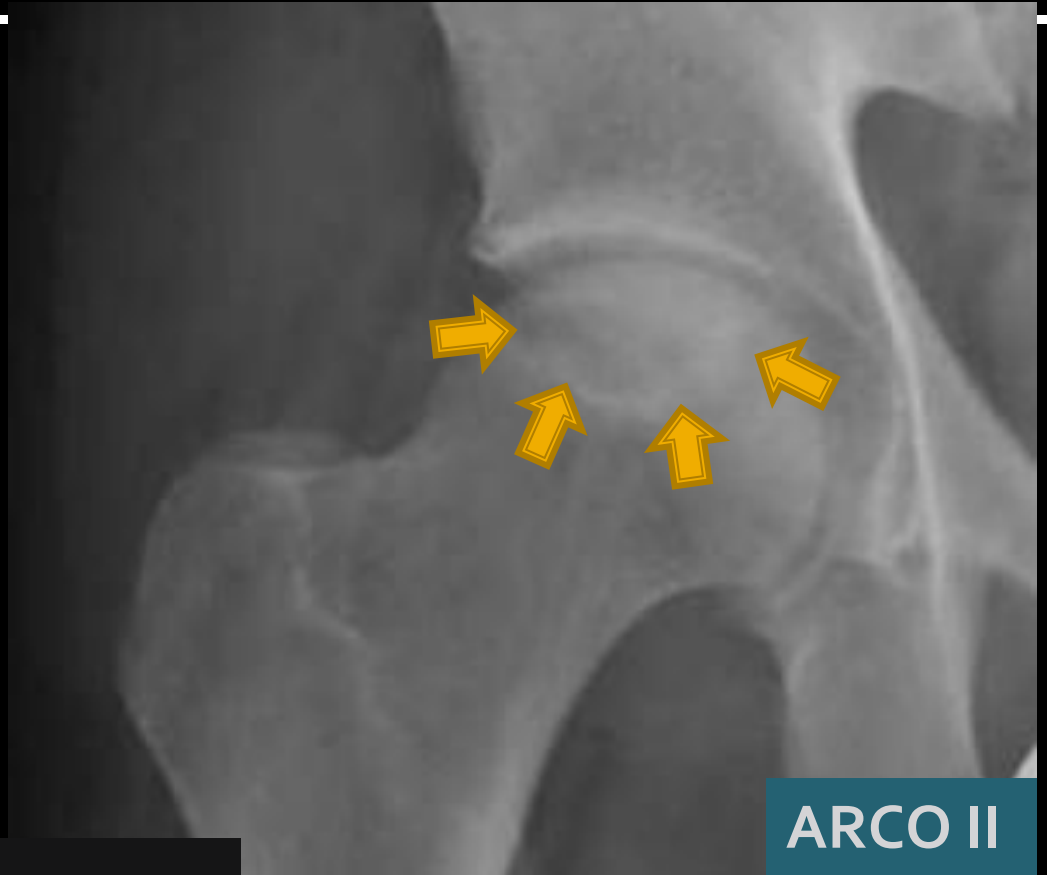
“bright band-like” sign

- T₂-w TSE FS, STIR, T₁-w FS Gd



Imaging

ARCO II

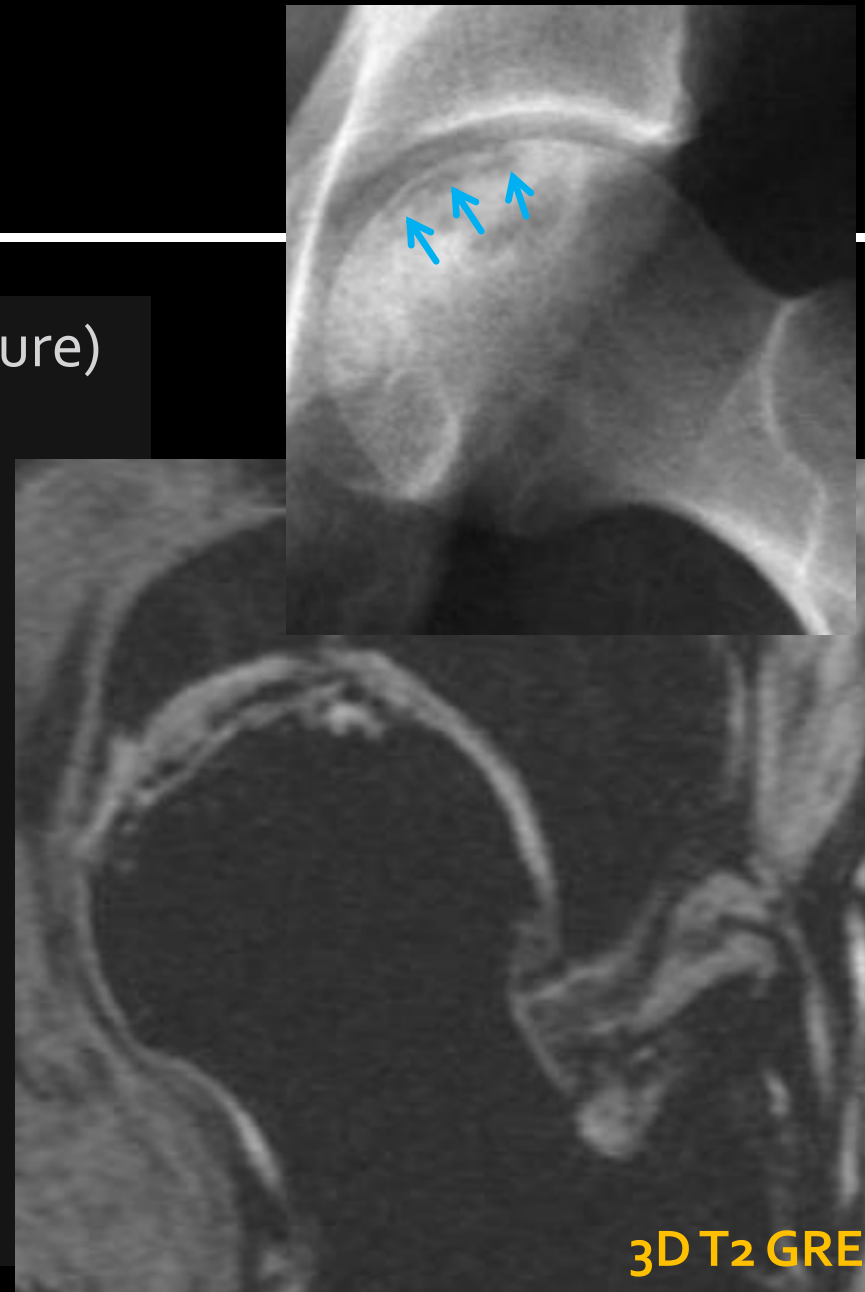


- Anterosuperior location
- Lytic area, surrounding sclerosis

Imaging

ARCO III

- **“crescent sign”** (subchondral fracture)
 - Low signal T1-w, variable T2-w
 - Smooth
 - Parallels articular surface
 - ✓ Articular collapse
 - MRA
- Synovitis, articular effusion
- BME



AVN & BME

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

BME

+

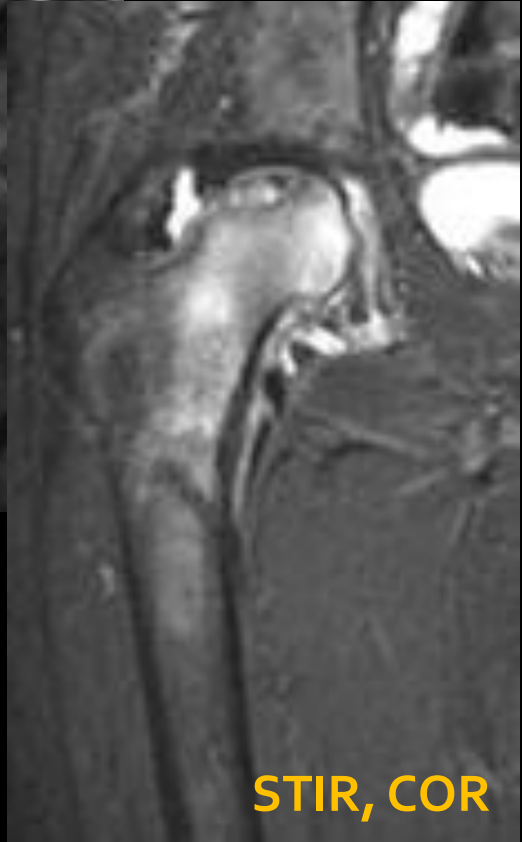
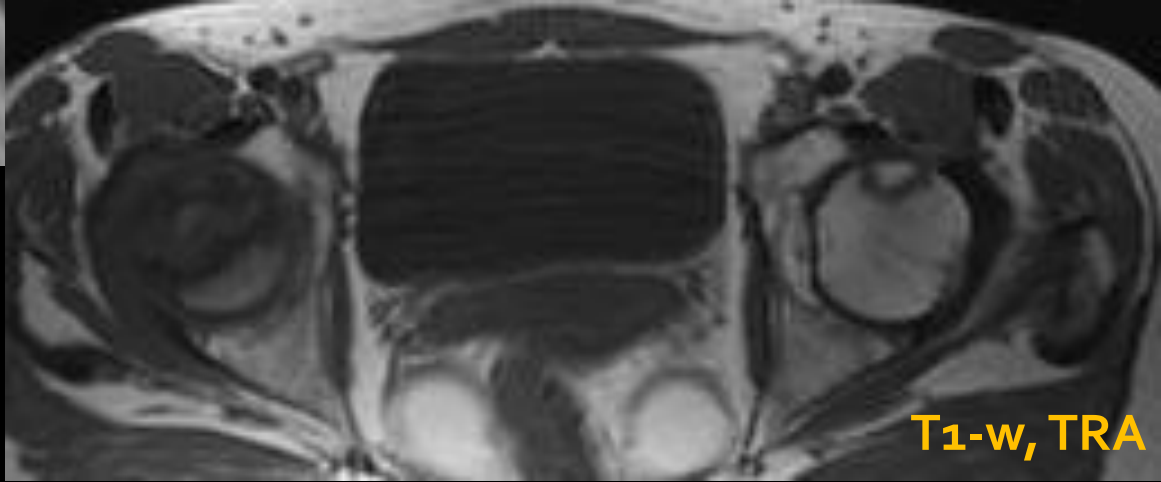
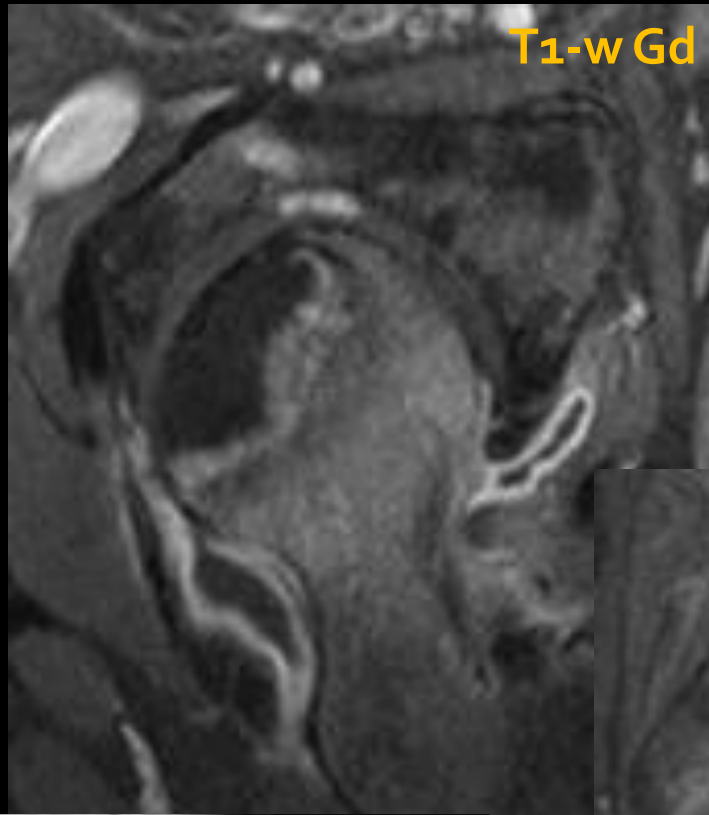
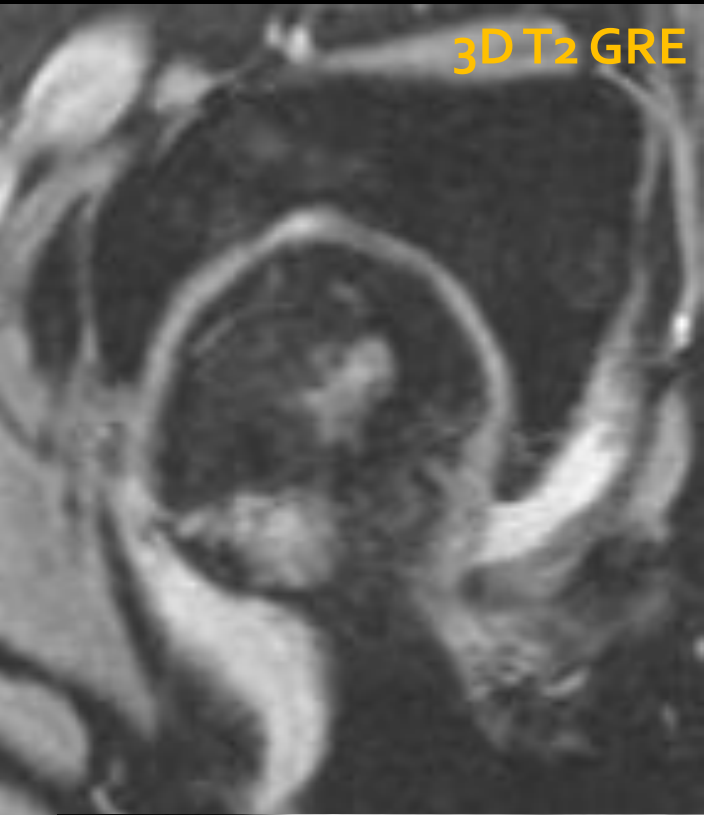
“band-like” lesion

+

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

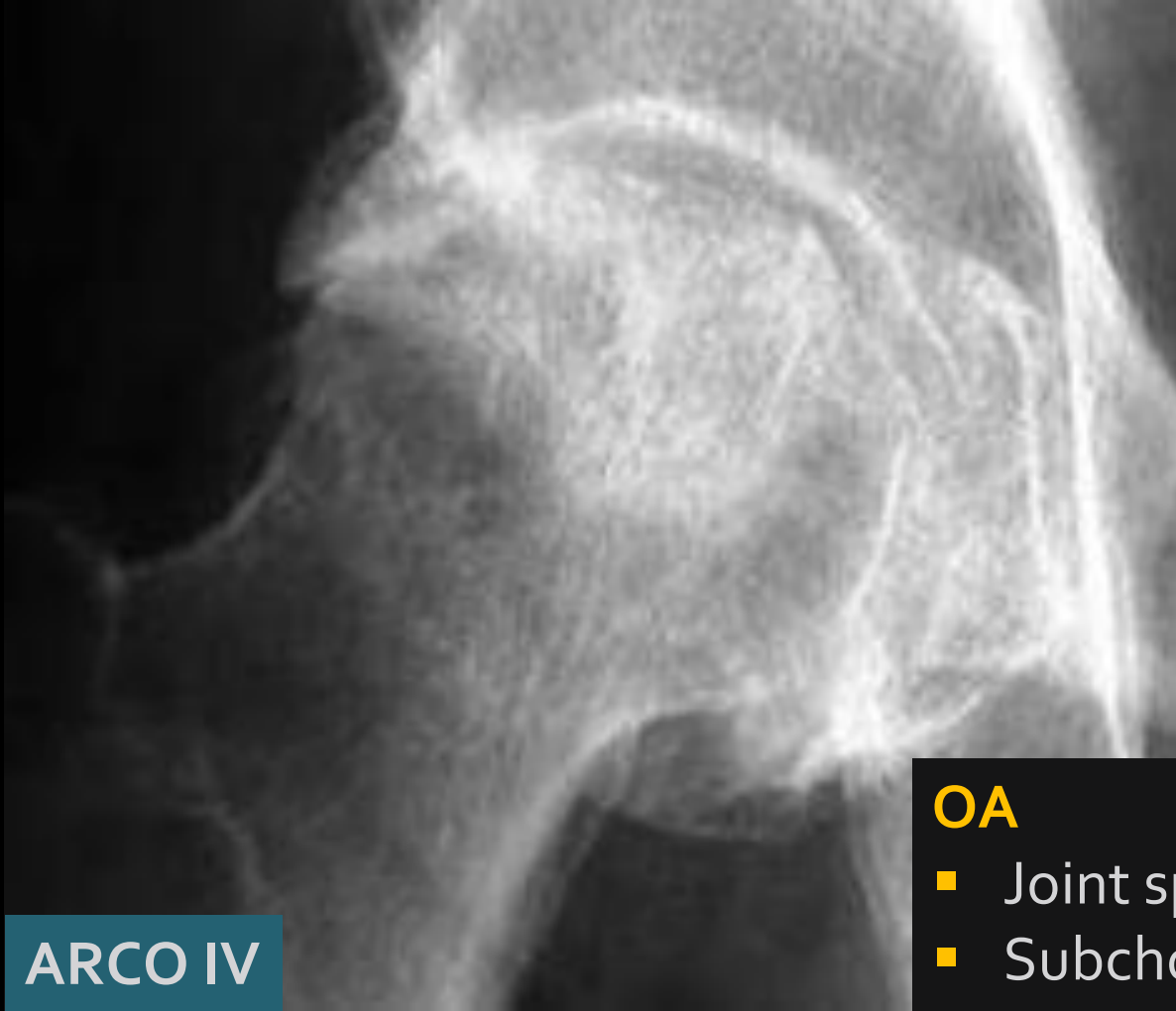
Stages III/IV

- Pain
- Extend of necrotic area



Imaging

ARCO IV



ARCO IV


OA

- Joint space narrowing
- Subchondral sclerosis
- Osteophytes

Imaging

Post surgical follow-up

Conventional MRI

- 
- enhancement along graft
 - reduced BME
 - reduced extend and increased enhancement of necrotic area

- 
- increased BME
 - low signal intensity of the graft

Perfusion

- till 1 m => minimal vascularization
- 1-7 m => neovascularization



Transient osteoporosis (TOH)

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

aBMEs:

TOH, RMO

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

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

Imaging

Plain radiographs

- Osteopenia (3-4 w)
 - Periarticular (proximal femur - acetabulum)
- Normal joint space
- +/- articular fluid



Imaging

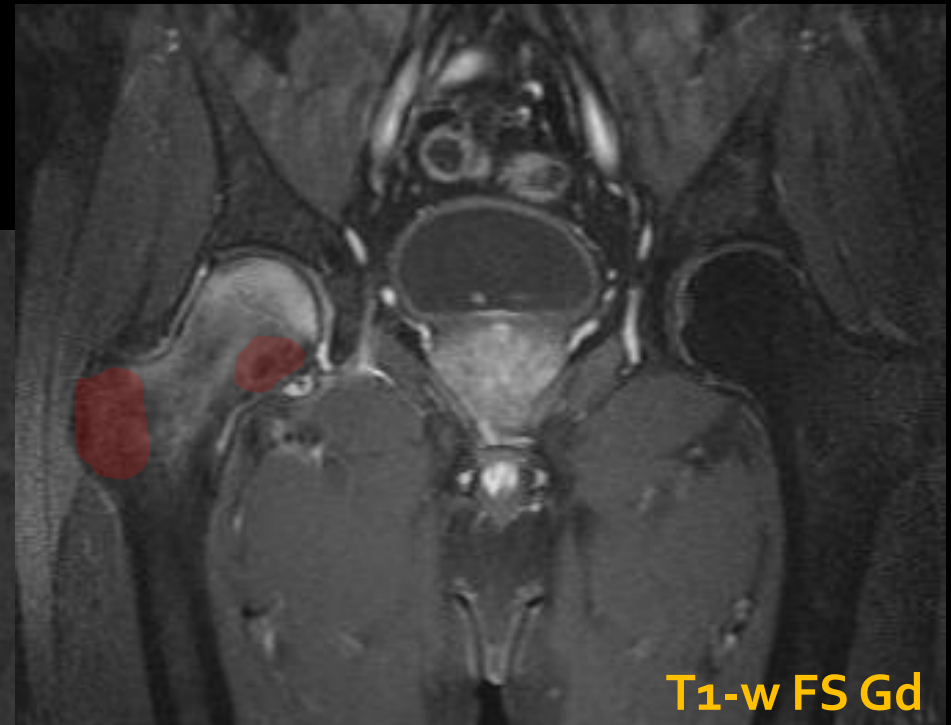
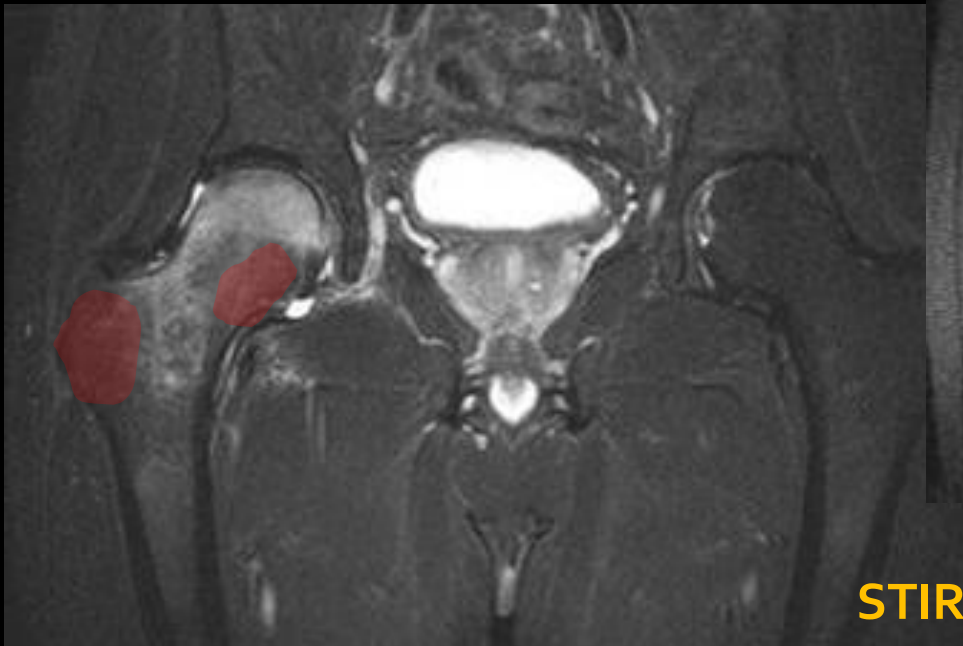
MRI

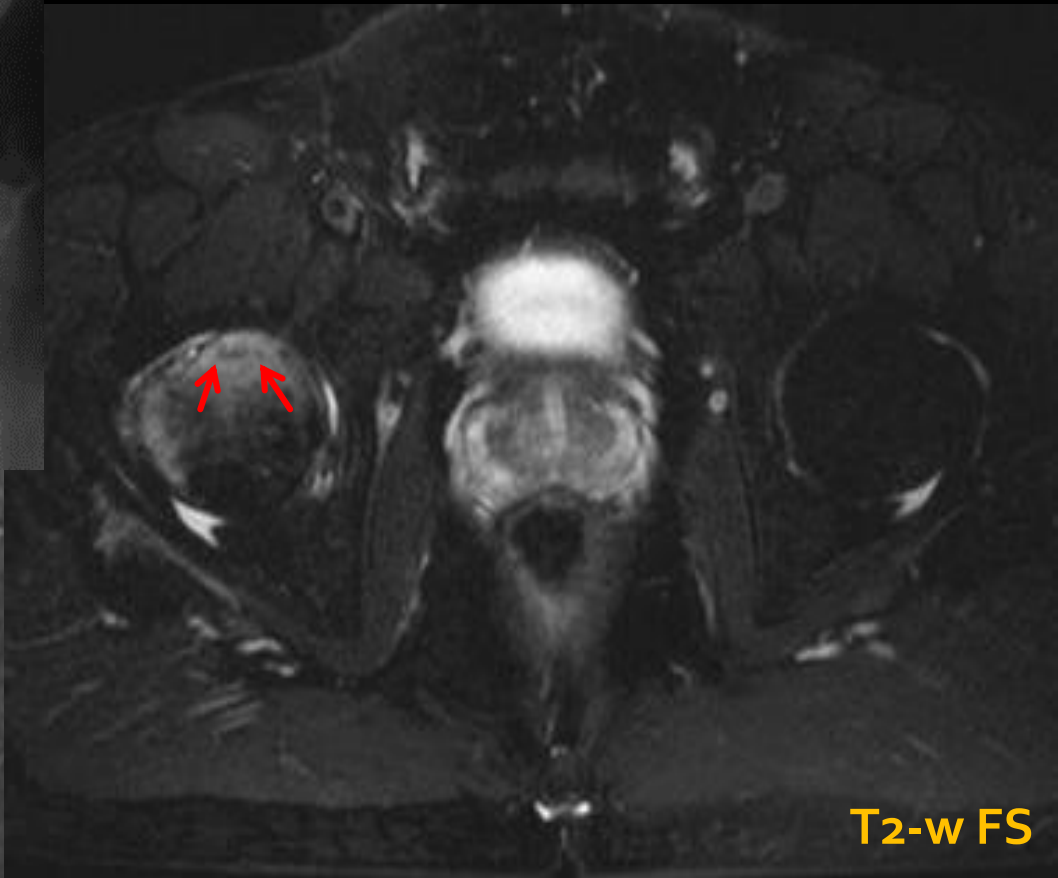
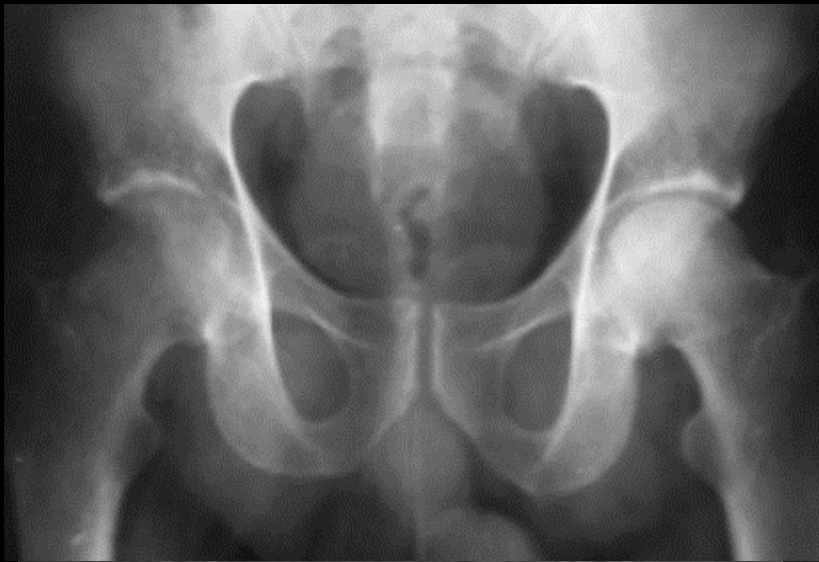
- BME
 - head, neck, proximal diaphysis
 - “sparing sign”
- Articular effusion
- Subchondral fracture
 - deeper location than AVN (“crescent”)
 - irregular
 - “benign”

Imaging "sparing sign"

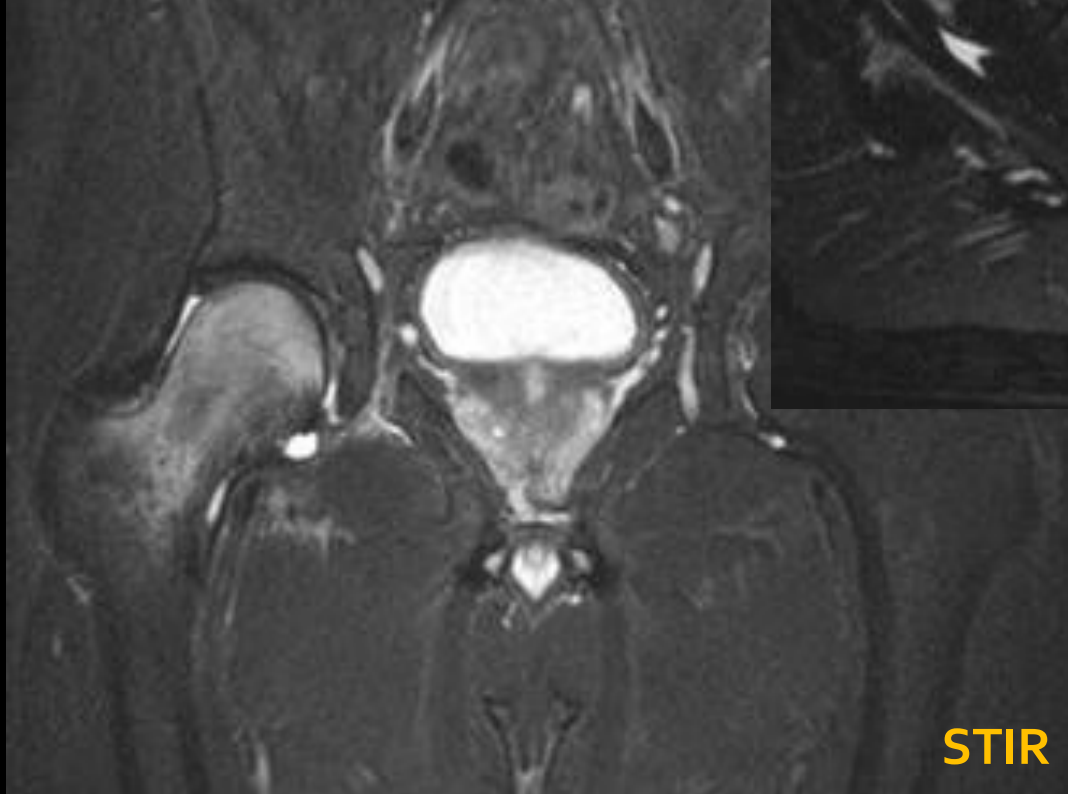


4-6w
Inferomedial location 87.7%
Greater trochanter 90%





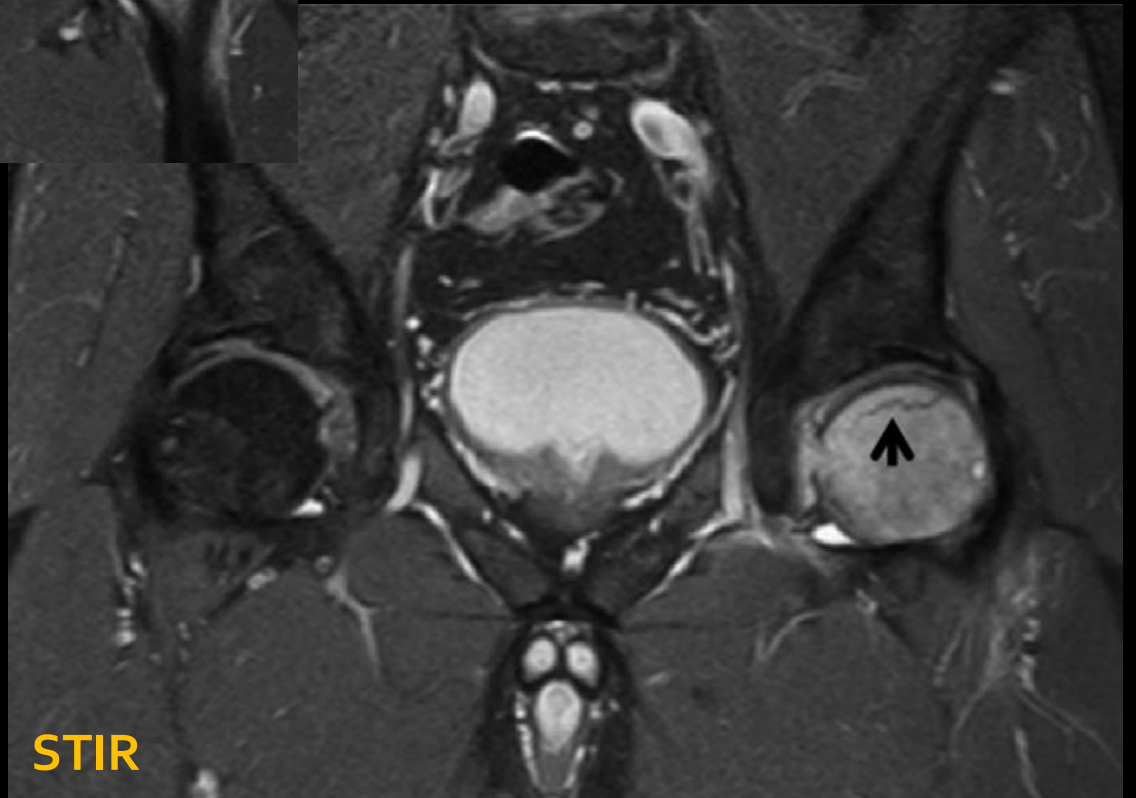
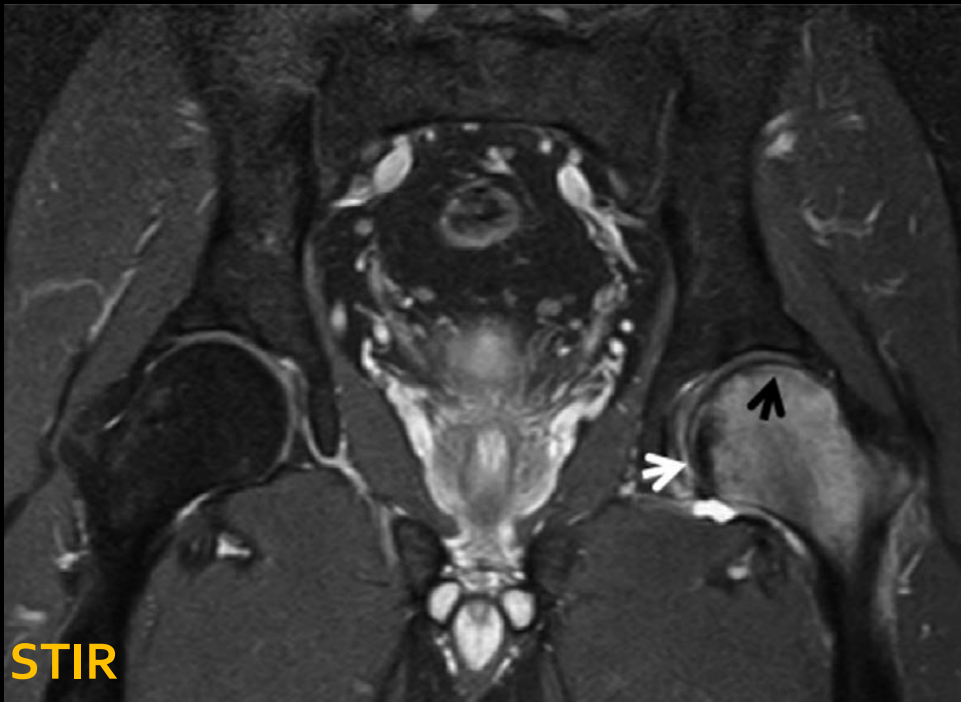
T2-w FS



STIR

40 m, RT hip pain since 5w,
deterioration since 1 week

43 m, LT hip pain since 1m

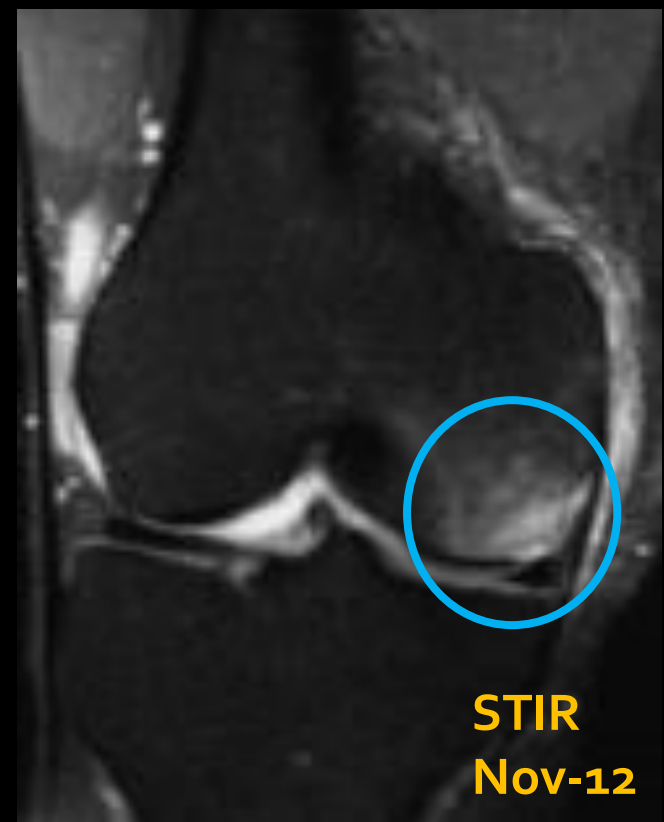
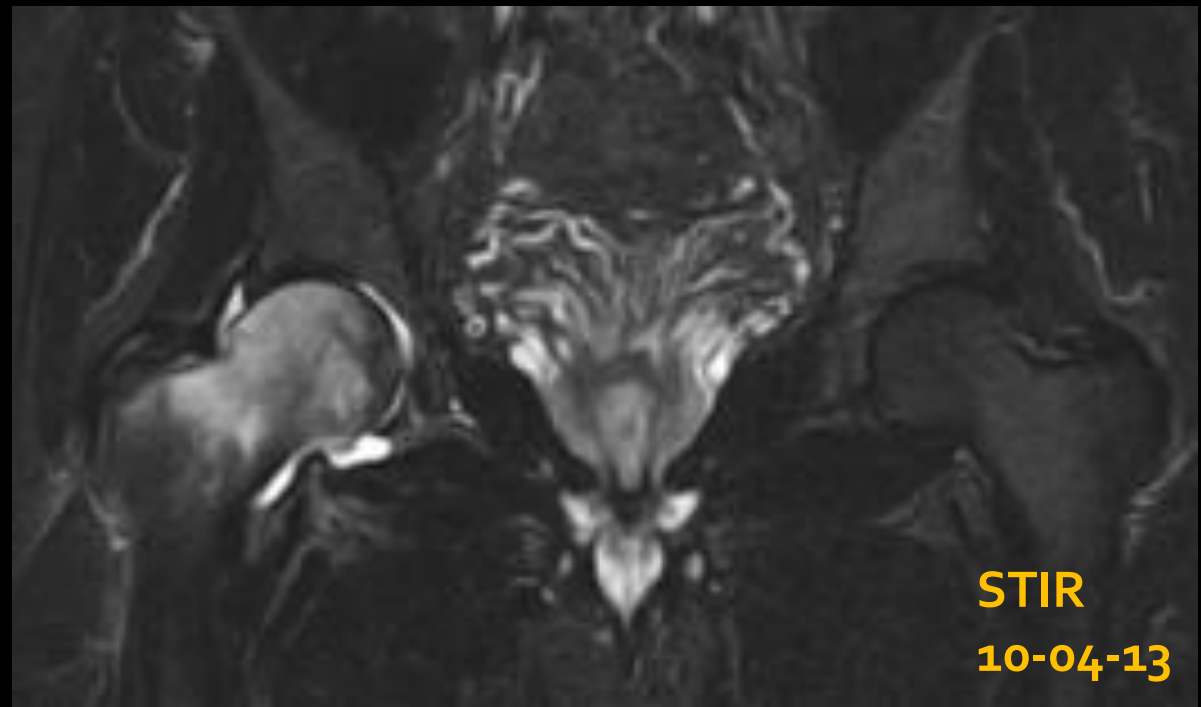
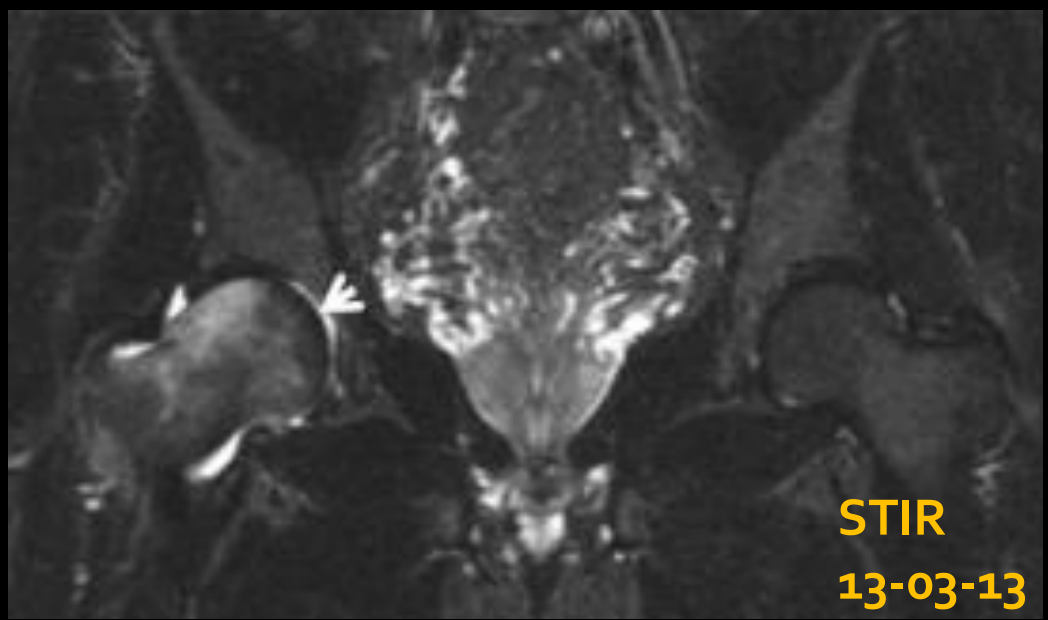


Regional migratory osteoporosis (RMO)

- 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





55 m, DEXA: osteopenia

Take home

AVN

- **MRI** ARCO I/II
 - “band-like” lesion, “double line”, “bright band-like”
 - BME \leftrightarrow “crescent sign”, articular surface collapse, OA
- **X-ray** advanced disease (ARCO III/IV)

TOH

- Insufficiency fracture \leftrightarrow osteopenia
- **TOH \neq AVN**
 - Sudden onset
 - Conservative treatment
 - BME
- **MRI**: BME (“sparing sign”), articular fluid, subchondral fracture

RMO

- Progression of TOH
- Expected affected site (4m-1y)



Thank you!