Acute osteomyelitis (AOM) in children

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What a radiologist should know about acute osteomyelitis in children

- introduction
- epidemiology
- pathophysiology
- diagnostic work up
  - clinical and lab-findings
  - imaging
  - differential diagnosis

Acute osteomyelitis in children

- definition: duration of illness less than 2 weeks
- any bone can be affected
- multifocal mainly in neonates
- potentially limb- and life-threatening!
- diagnostic and therapeutic delay:
  - main risk factor for sequela

A musculoskeletal emergency!

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Epidemiology

- young age:
  - peak incidence 3y AOM*
  - mean age 7y

Dodwell, Curr Opin Pediatr 2013

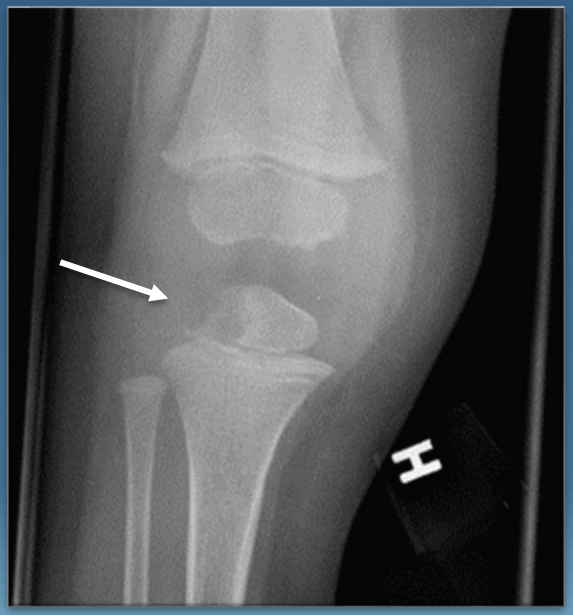
Epidemiology

- main causative pathogen: staph. aureus
- MRSA↑ (US: 30-40%)*
- Panton-Valentine leukocidin (PVL) – toxin
  - more aggressive infections
  - more frequently multifocal bone involvement
  - older children

Dodwell, Curr Opin Pediatr 2013

Epidemiology

- Kingella kingae - children < 4y (6-48 months)
  - difficult to culture
  - better detected by current PCR – technique
  - more benign clinical course
  - more often involvement of the epiphyseal cartilage



14 month old girl

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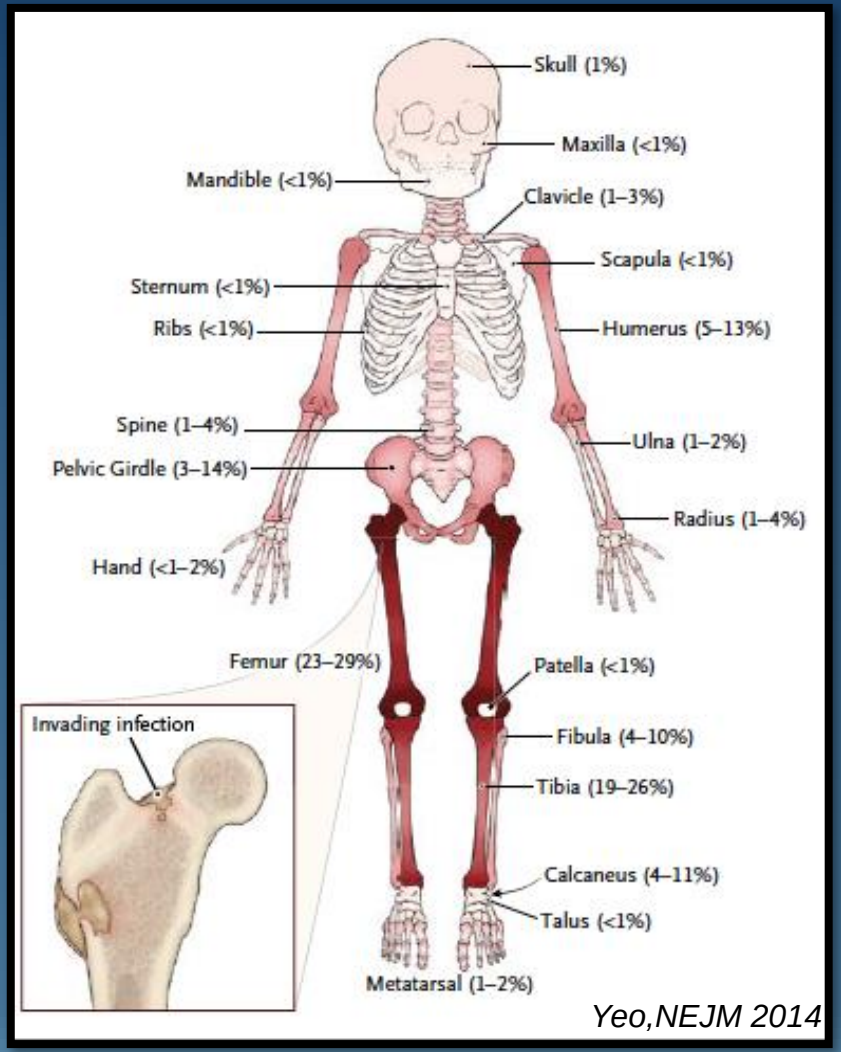
Pathophysiology

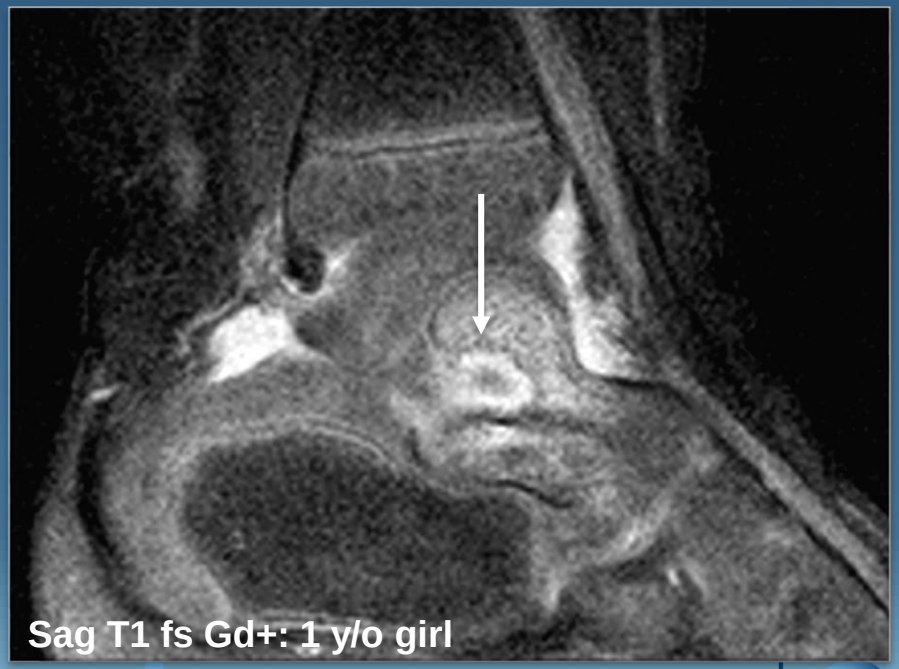
- hematogenous seeding
- metaphyses of long bones
  - rich and sluggish flow
- rapid growing metaphyses
- 70 % lower extremities



metaphyseal equivalents

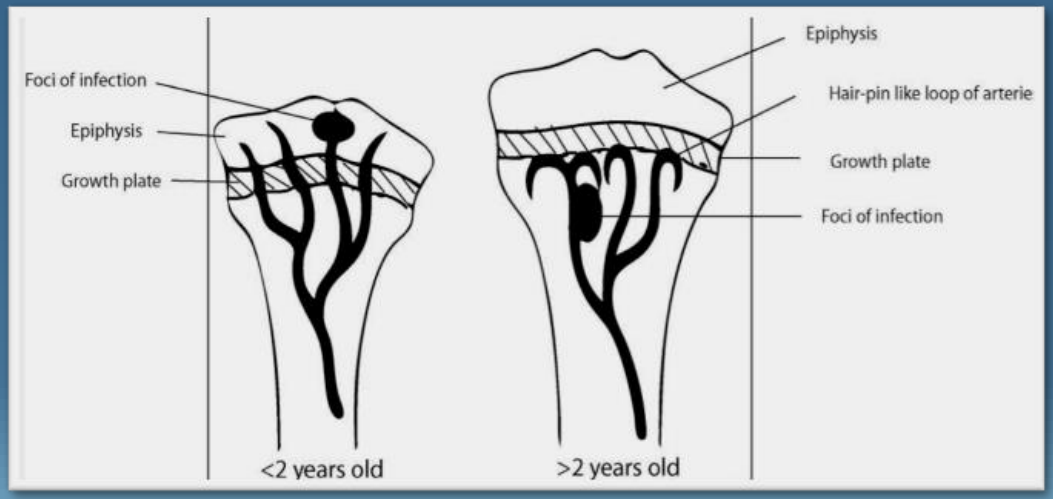
- osteocartilage junctions in flat bones (older children)
- periphery of round bones/secondary ossification centers


Cor STIR: 11 y/o boy


Sag T1 fs Gd+: 1 y/o girl

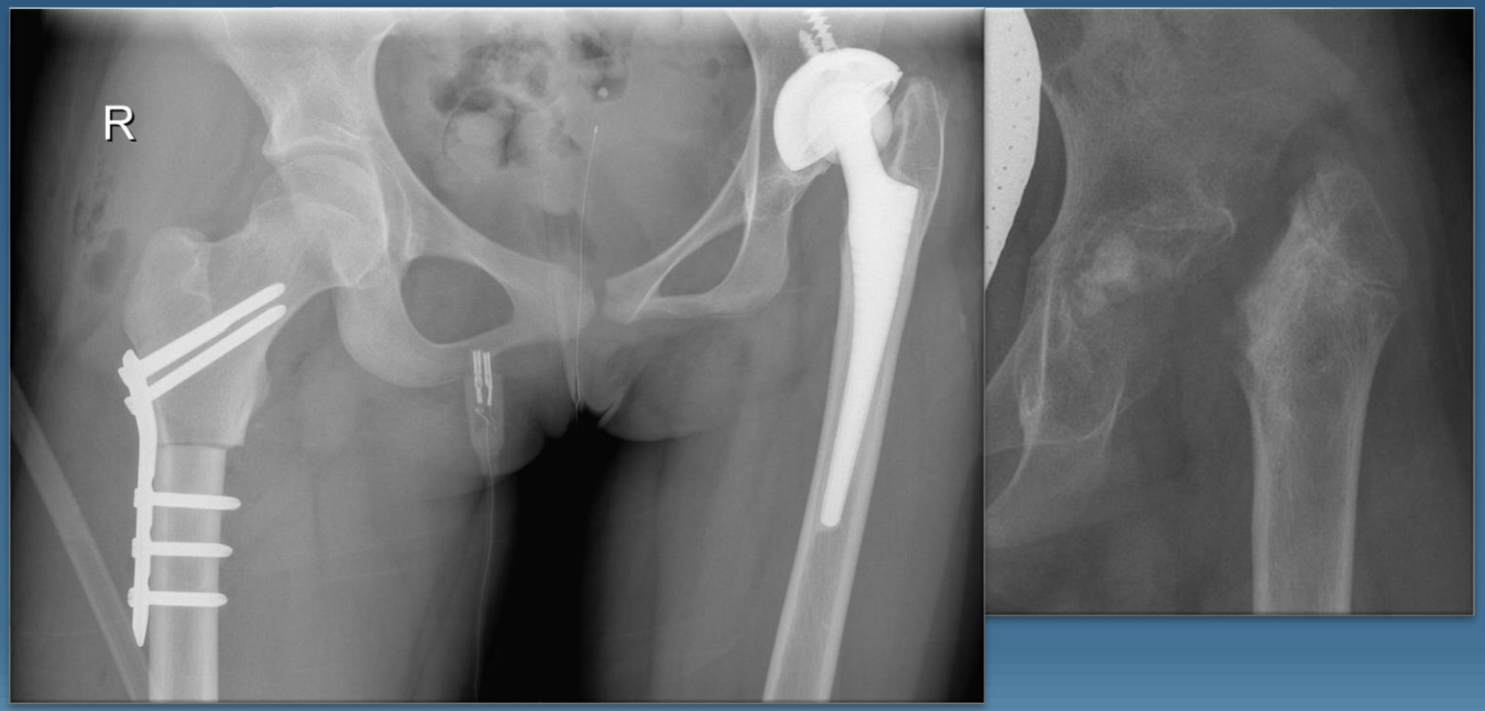
Septic arthritis

- often associated with osteomyelitis!
- neonates/infants: intracapsular metaphyses, transphyseal vessels
- older children: hematogenous seeding of synovium
- 75% joints of the lower extremity



Pathophysiology

- septic arthritis of the hip = extreme emergency!
  - treatment within 6–12 hours!
- uncomplicated AOM
  - treatment within 4 days acceptable



16 years

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Clinical and lab findings

- neonates/infants: few clinical signs
- older children: pain and limping
- erythema, swelling
- fever – often not present
- infection parameters may be normal
- blood cultures positive 30%
- bone and joint aspirate higher yield (70%)

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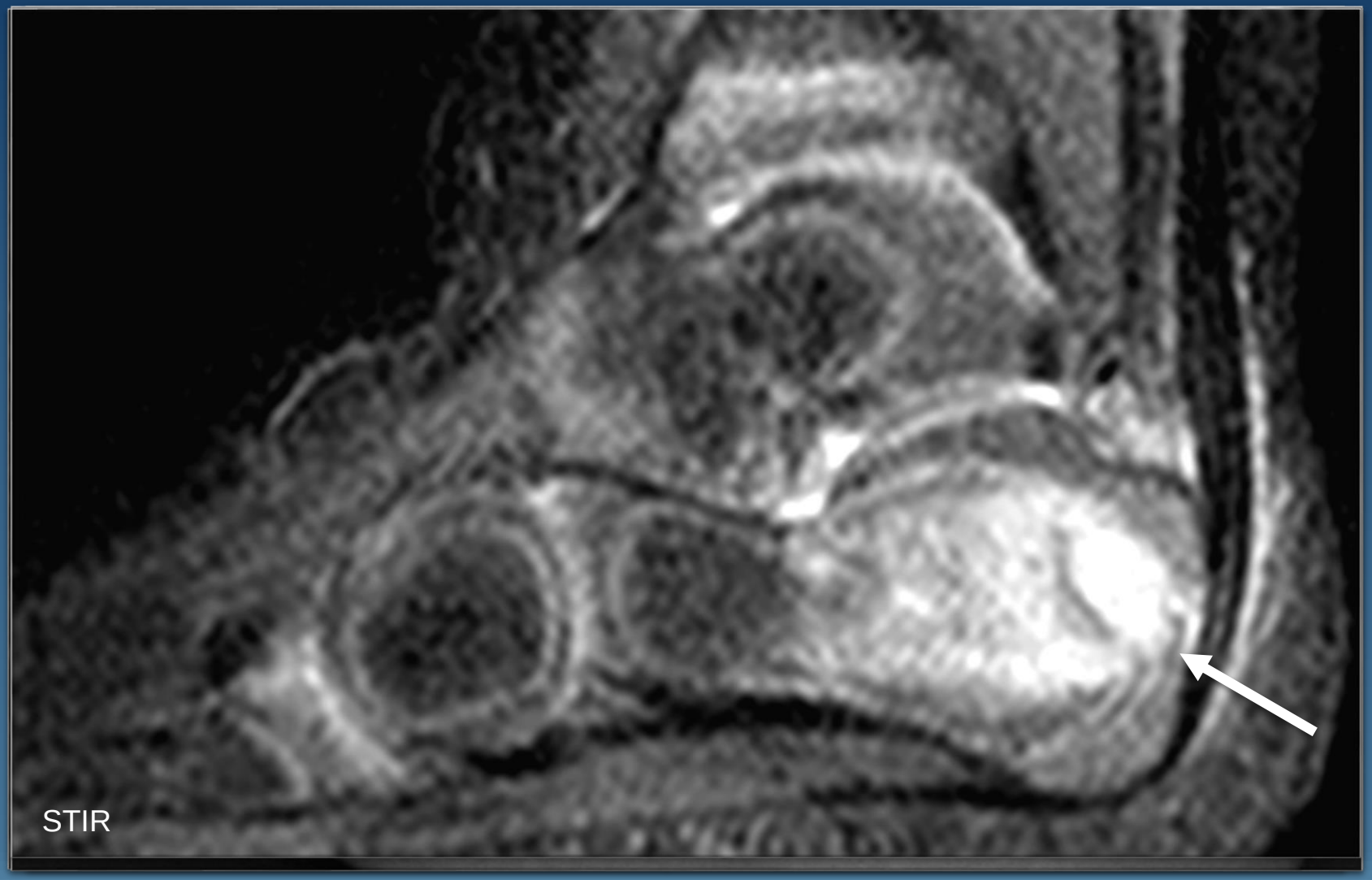
Plain radiography

- the initial modality of choice !
  - to exclude other pathologies (malignancies, fractures)
  - important for interpretation of MRI findings!

- *low sensitivity for the evaluation of AOM*
  - *only 20% have abnormal radiographical findings by the second week* *(Jaramillo, Pediatr radiol 2011)*

Diagnostic work-up – imaging



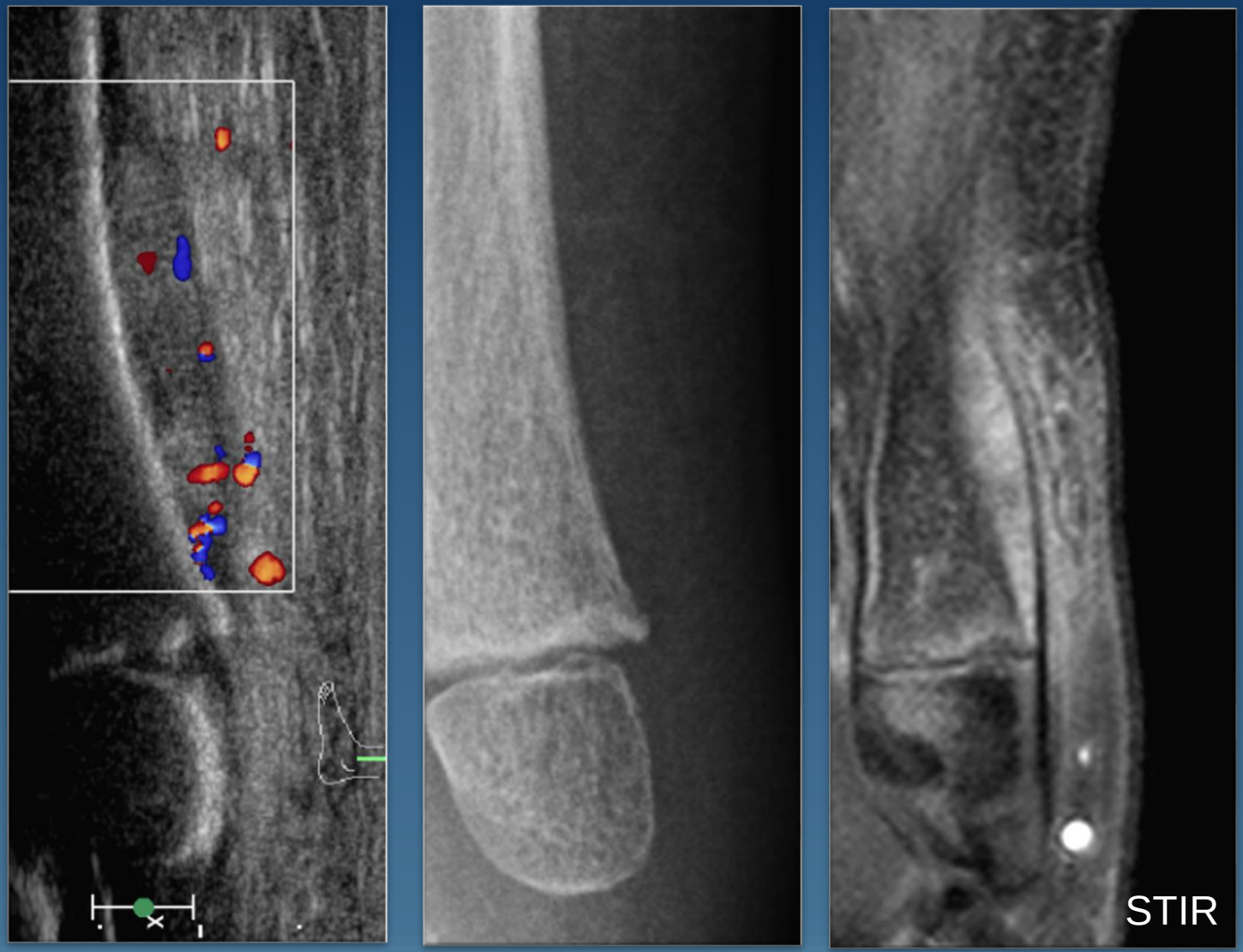
1 y/o boy with 1 week of limping, slightly elevated infection parameters

2 weeks later (3 weeks of symptoms)

Ultrasound

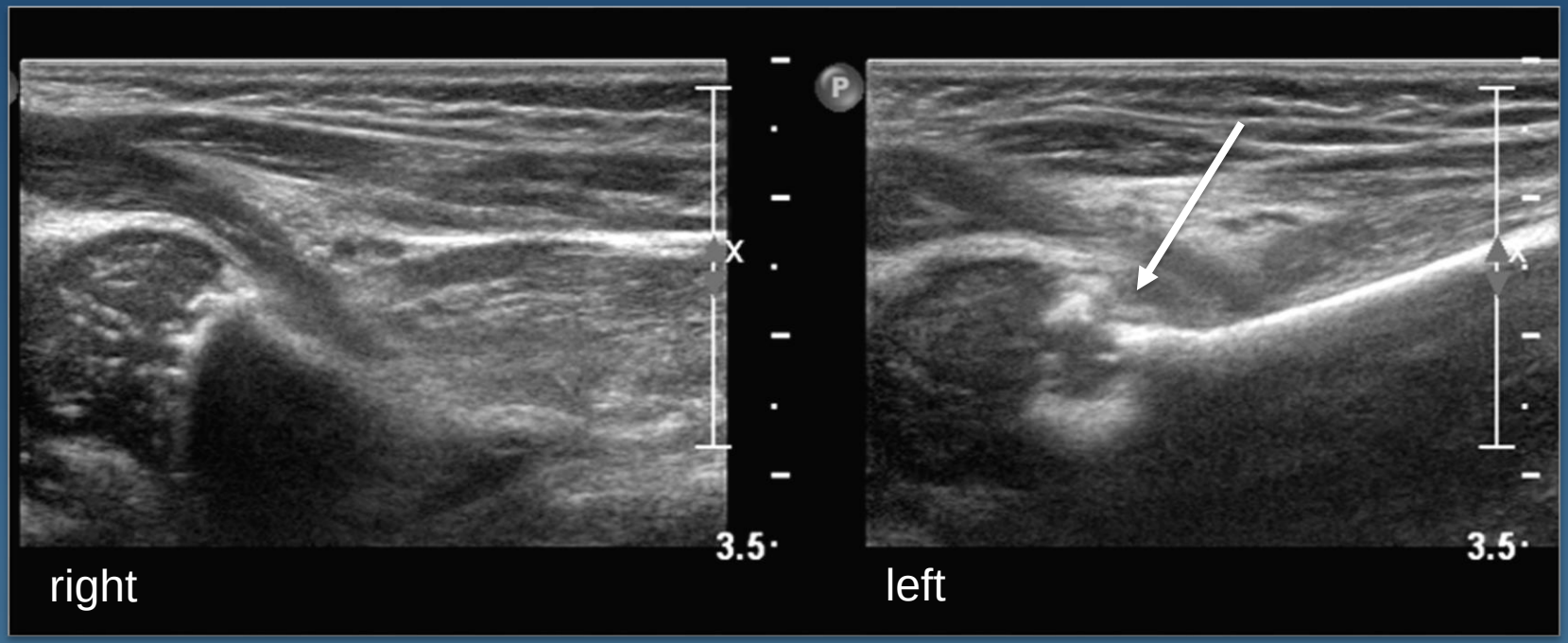
- not routinely used in the diagnostic workup
- soft tissue swelling
- periosteal thickening, sub-periostal abscess
- soft-tissue abscess
- cortical defects

Diagnostic work-up – imaging



5,5 y/o girl with 4 days of pain in left ankle

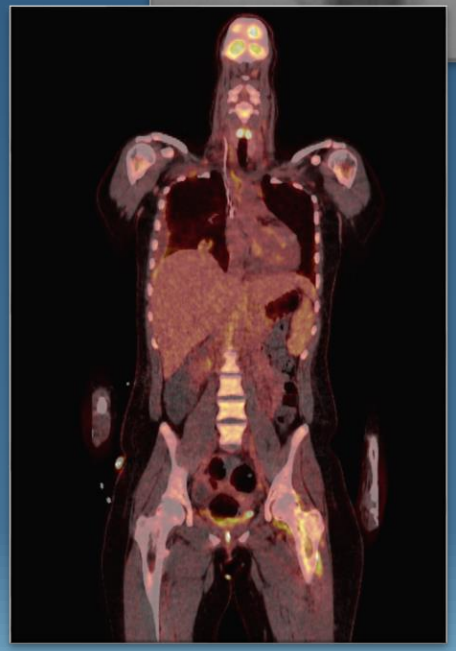
Diagnostic work-up – imaging



3,5 week old girl. Pseudoparalysis left leg. Elevated CRP and SR. No fever.

Nuclear imaging

- bone scintigraphy
  - localisation of osteomyelitis, multifocality
  - high sensitivity, low specificity
- PET-CT
  - higher specificity
  - limited availability
- high radiation dose
- replaced by WBMRI



CT

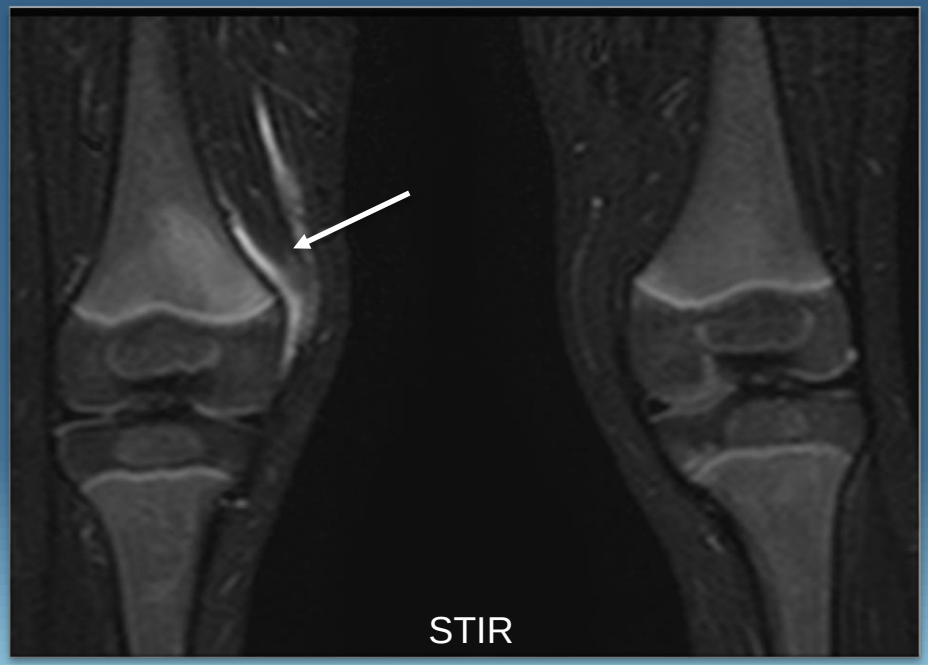
- plays no role in the acute workup of *acute* osteomyelitis and septic arthritis
  - high amount of radiation, poor soft tissue contrast
- can be used for image-guided intervention

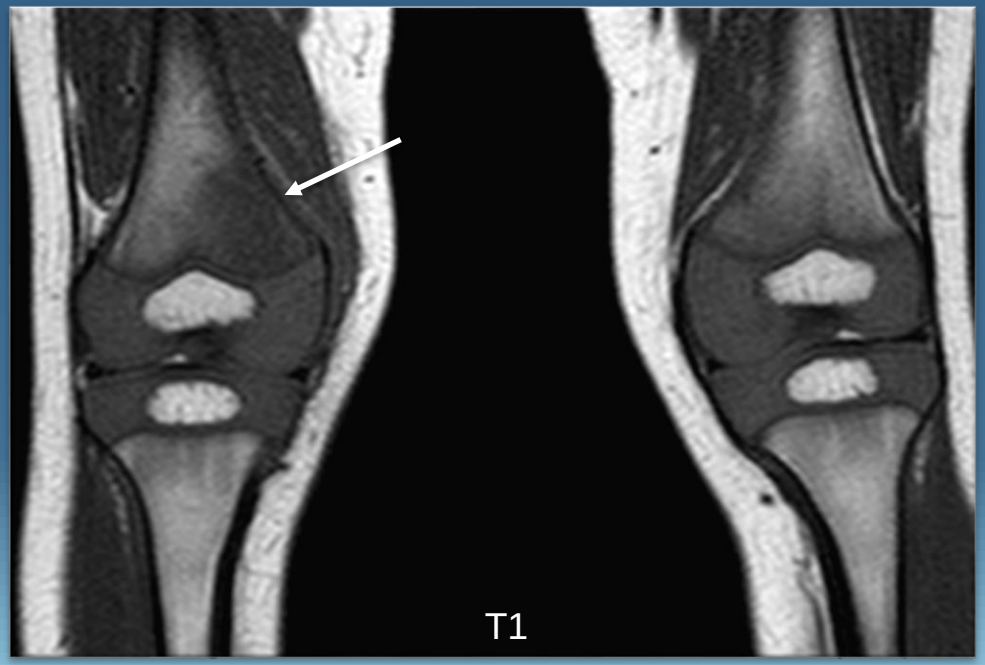
MRI

- second modality for evaluating osteomyelitis
- high sensitivity
- early marrow abnormalities
- soft tissue extension, joint effusion
- multifocality: whole body MRI (WBMRI)

MRI

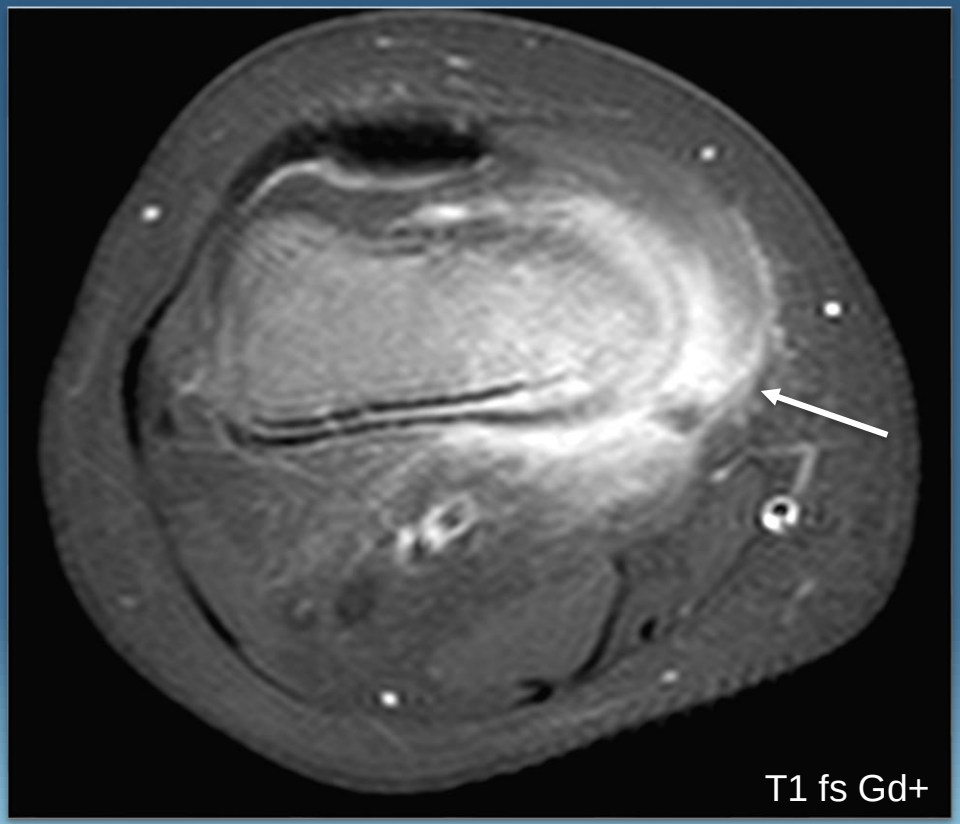
- earliest manifestation: edema
  - STIR /T2 Dixon Water: high signal
  - T1/ T2 Dixon Fat: lower signal than muscle (fat↓)
  - periosteal reaction: layered high STIR





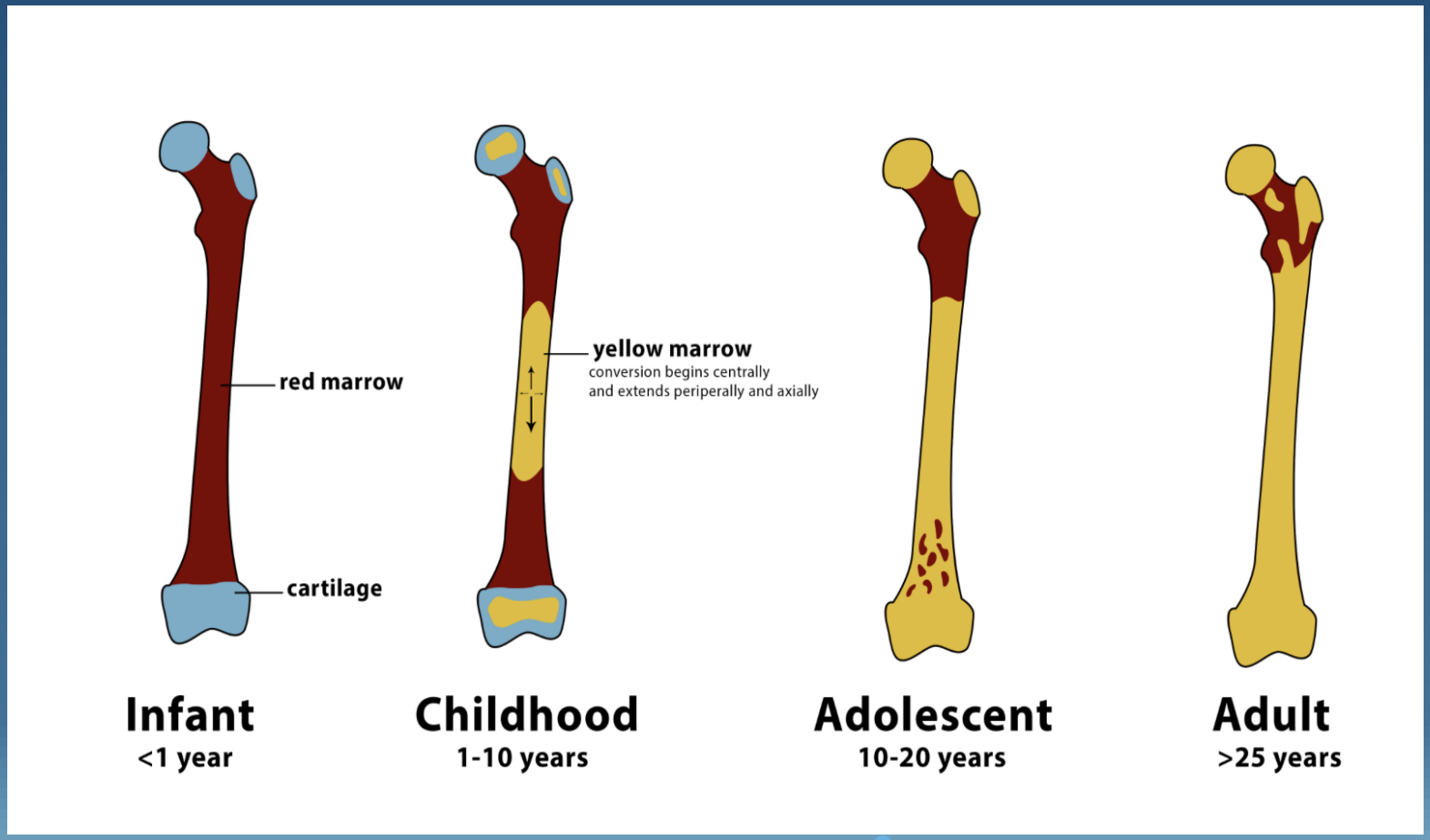
MRI

- contrast enhancement of bone marrow, periost/soft tissue



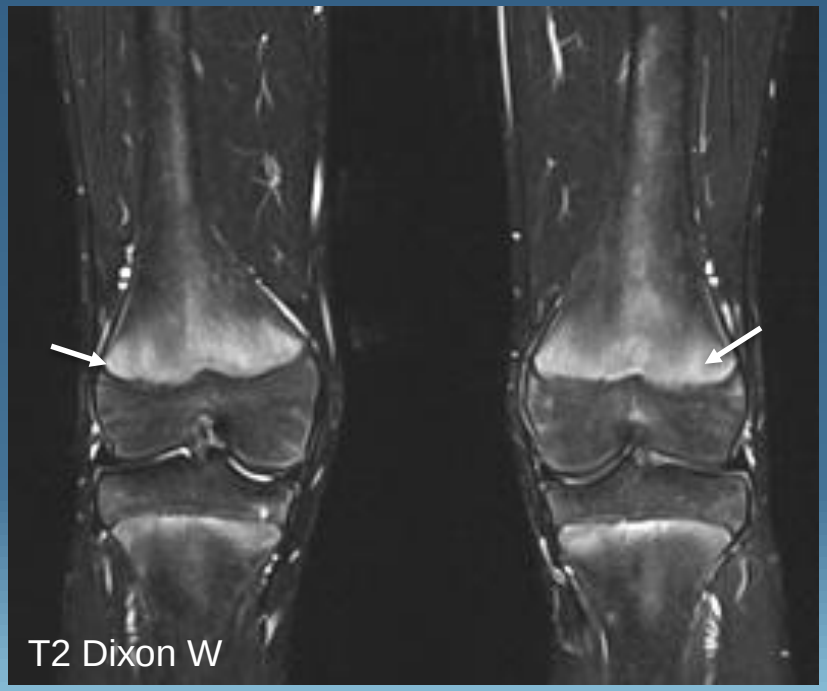
Normal hematopoetic bone marrow

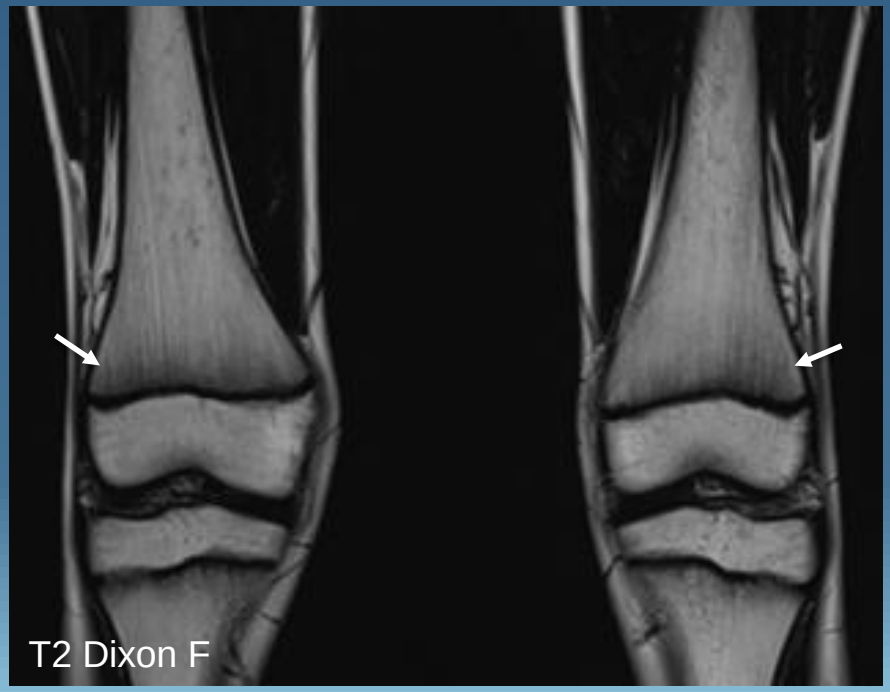
Bone maturation and bone marrow conversion



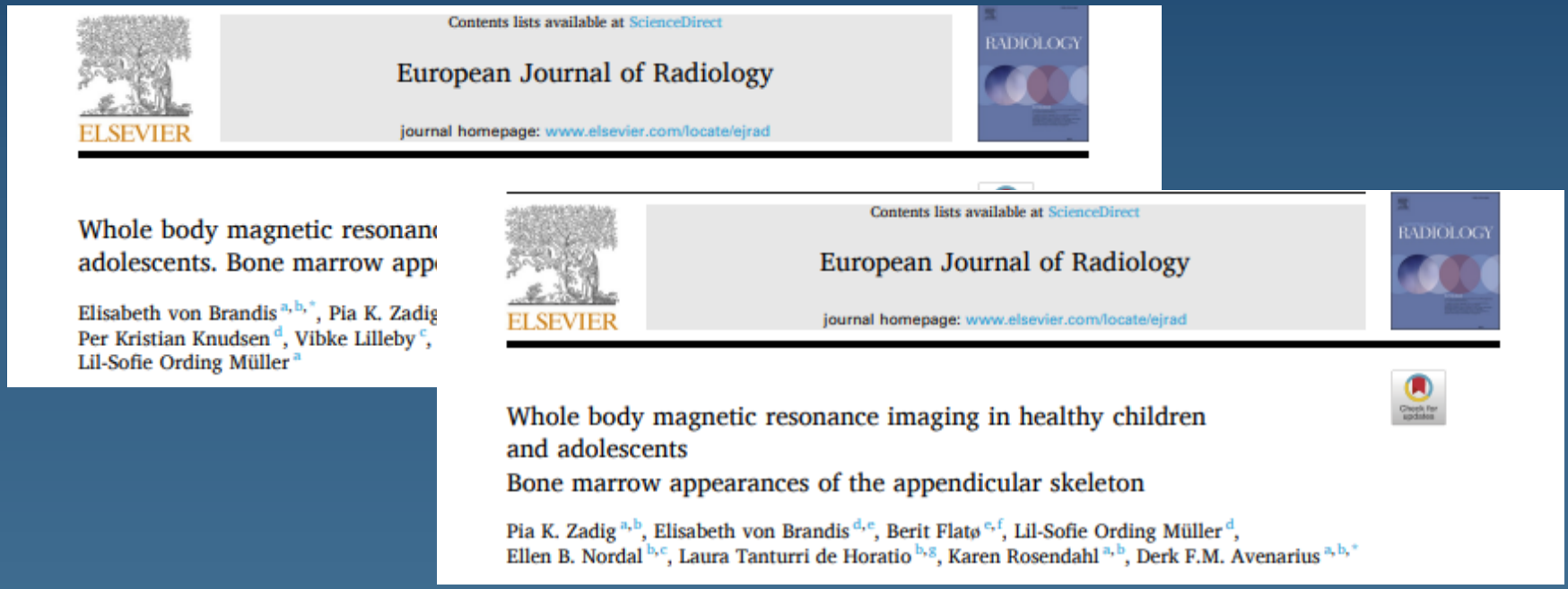
Diagnostic work-up – imaging

- metaphyseal
- contains abundant water
- higher signal than muscle on T1
- often symmetrical
- no periostal reaction





Pathology or normal?



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Whole body magnetic resonanc
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Elisabeth von Brandis [a,b,*], Pia K. Zadig
Per Kristian Knudsen [d], Vibke Lilleby [c],
Lil-Sofie Ording Müller [a]

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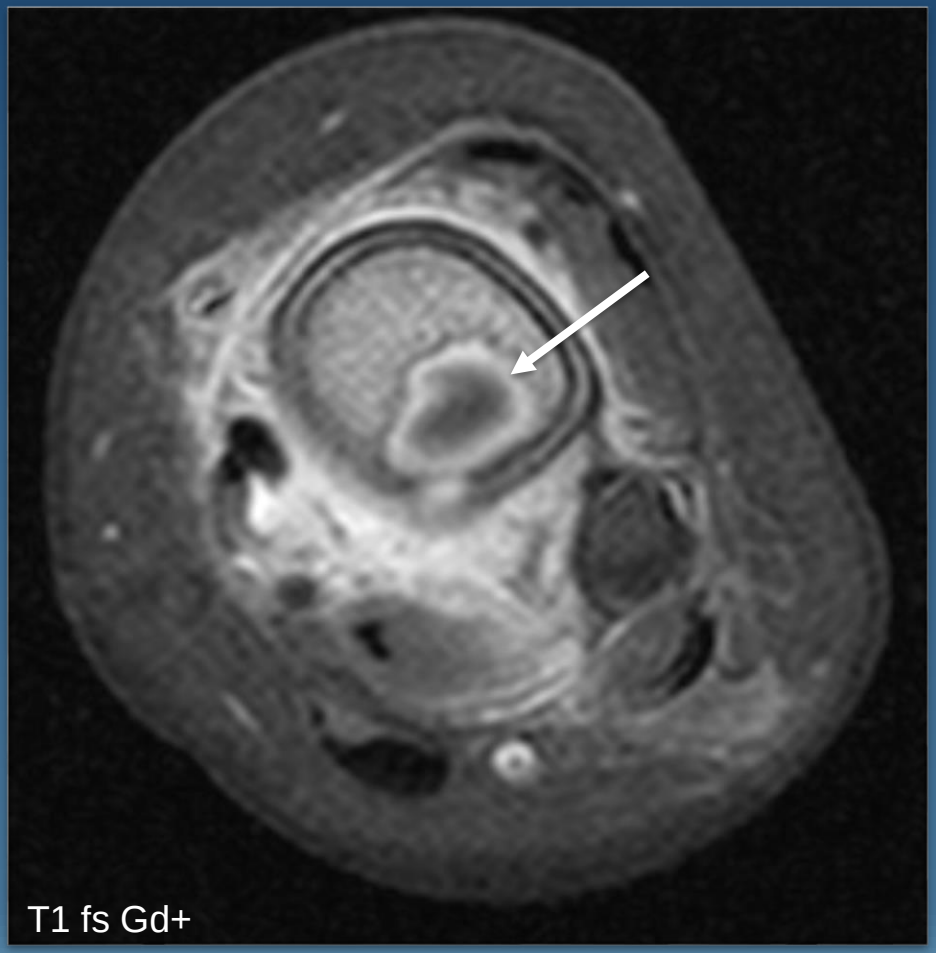
Whole body magnetic resonance imaging in healthy children and adolescents
Bone marrow appearances of the appendicular skeleton

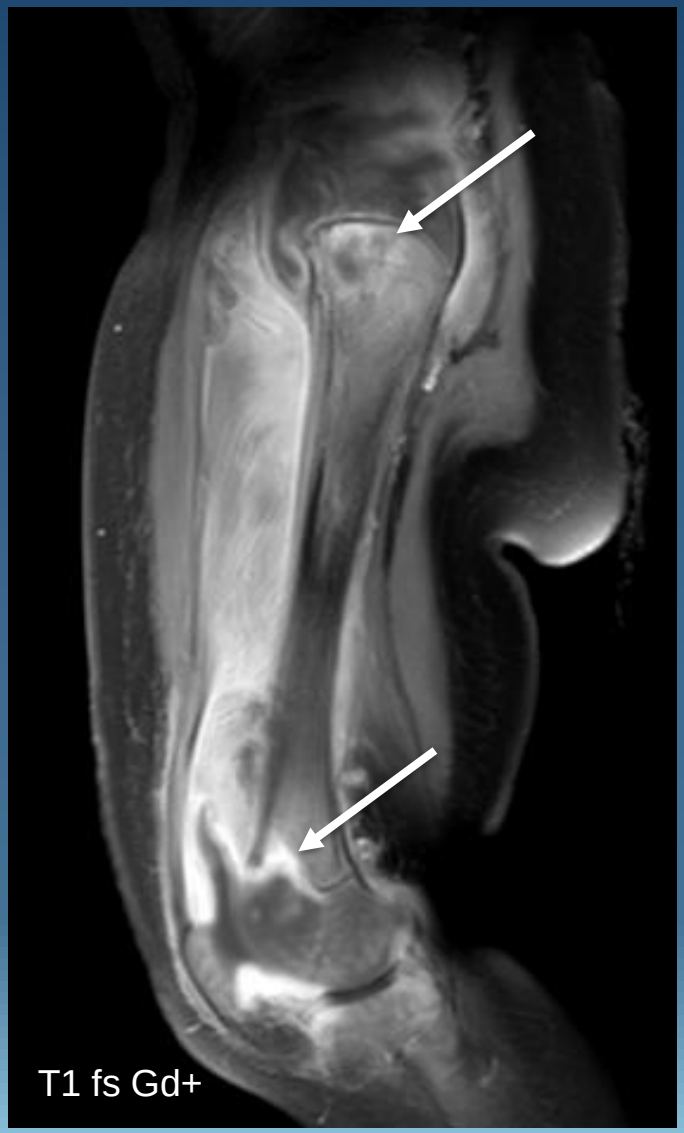
Pia K. Zadig [a,b], Elisabeth von Brandis [d,e], Berit Flatø [e,f], Lil-Sofie Ording Müller [d],
Ellen B. Nordal [b,c], Laura Tanturri de Horatio [b,g], Karen Rosendahl [a,b], Derk F.M. Avenarius [a,b,*]

WBMRI of 200 healthy, asymptomatic children:

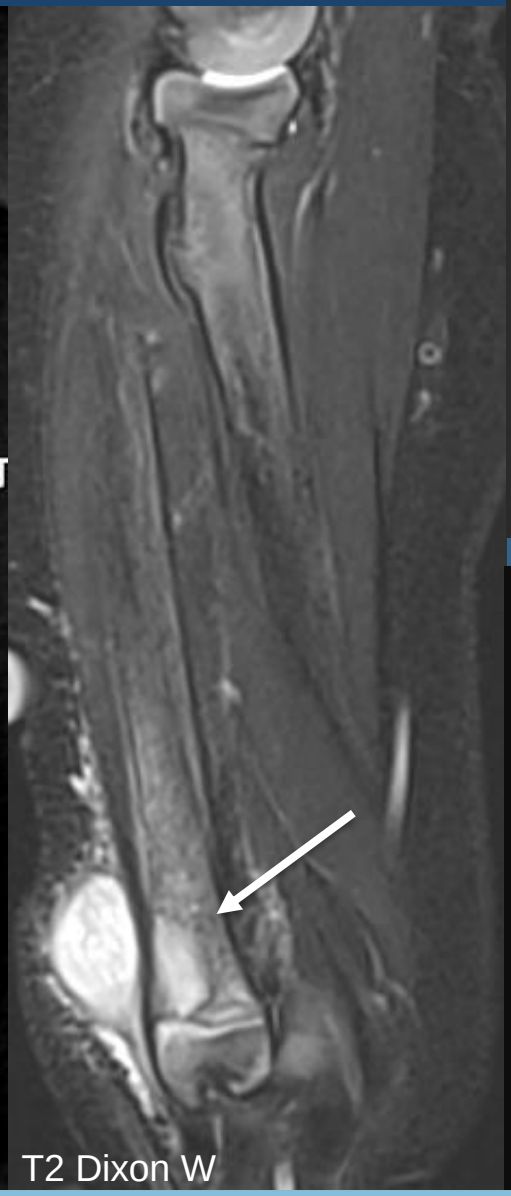
- 75% at least one BM finding potentially resembling pathology in clinical setting

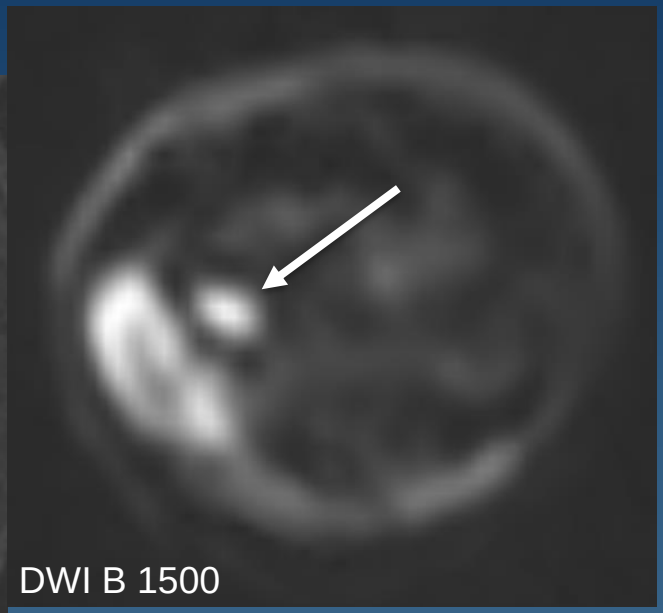
Intraosseous abscess

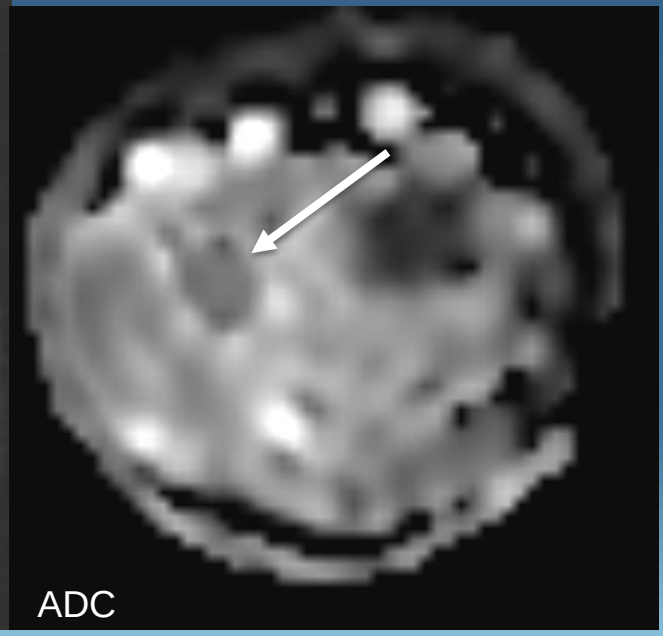




Diagnostic work-up – imaging

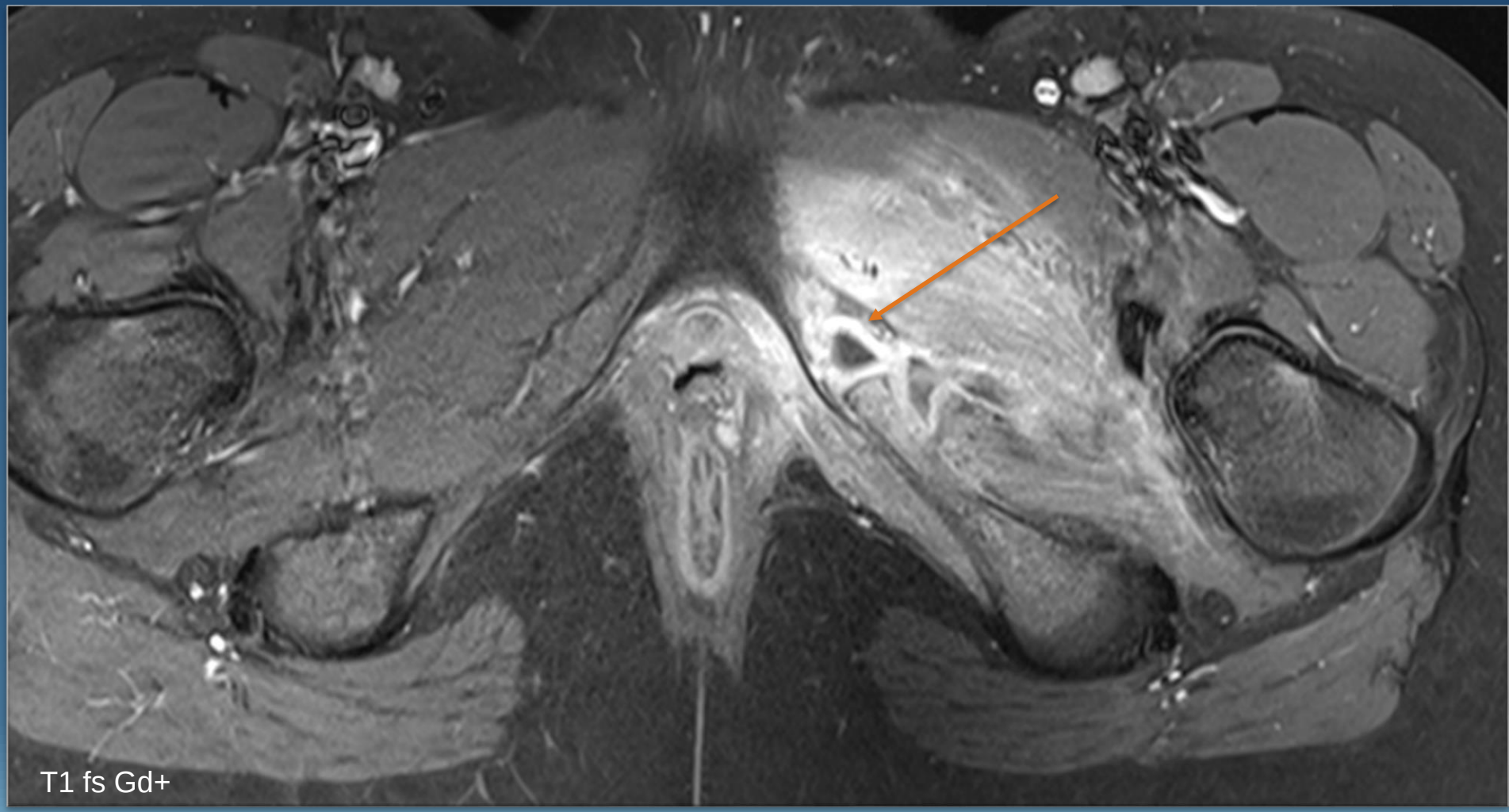






Sub-periosteal abscess

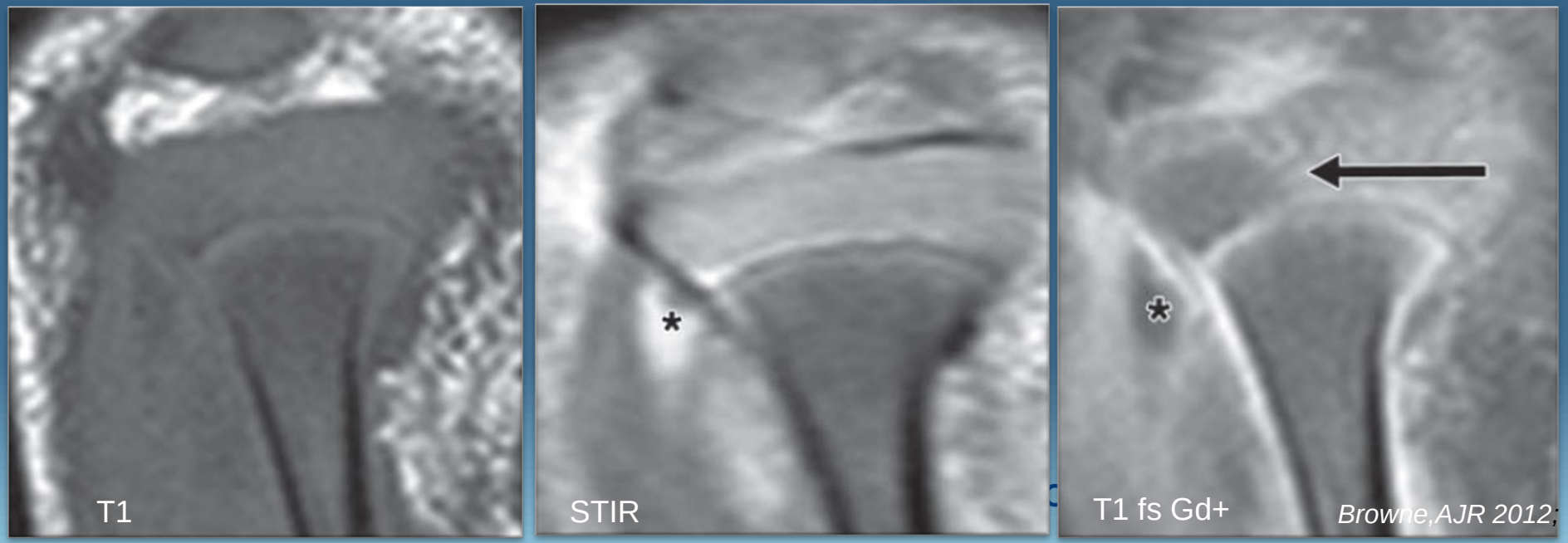
Soft tissue extension



Contrast?

- does not increase the sensitivity or specificity
- increasing confidence in the diagnosis of an abscess
- no additional diagnostic value if preGd is normal
- *acute infection of ephiphyseal cartilage: only visible after contrast!*

2-month-old boy with biopsy-proven osteomyelitis in proximal tibial epiphysis



Browne,AJR 2012;

Multifocality

- neonates, infants
- MRSA, PVL+
- whole body MRI

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DD in AOM
with no infection parameters

Vascular

- bone infarction (sickle cell disease)

Trauma

- stress fracture

Neoplasm

- osteoid osteoma
- acute leukemia
- Langerhans cell histiocytosis
- metastatic neuroblastoma
- Ewing`s sarcoma
- osteosarcoma

Take home messages

- AOM : a musculoskeletal emergency!
- Increasing virulence (MRSA/PVL-toxin)
- Diagnostic challenge
  - be alert!
  - cannot be excluded if no fever or infection parameters
- Plain radiography – still first modality of choice
- MRI – best modality to evaluate AOM
- WBMRI: multifocality - replacing scintigraphy
- Many differential diagnoses; NB: childhood malignancies!


Thank you!