MRI of the immature bone

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Objectives

- The immature bone
- Bone marrow
- Trauma
- Infection

Growth plate
Normal Marrow

• Trabecular matrix
• Red marrow (hematopoietic)
  – 40% fat
  – 40% water
  – 20% protein
• Yellow marrow (fatty)
  – 80% fat
  – 15% water
  – 5% protein

Marrow Signal Intensity

• T1
  – Differentiates red from yellow
  – Fat > red marrow > muscle
  – Neonates: red < muscle
  – Yellow marrow: high signal
• STIR and fat suppressed T2
  – Red may have mild increased signal
  – Most sensitive for detection of pathology

Newborn

T1

STIR

Epiphysial ossification center

1 yo girl

T1

STIR

Epiphysial ossification centers
**5 yo boy**

- T1
- STIR

**5 to 10 years - diaphysis**
**15 to 25 years - metaphysis**

**18 yo female**

- T1
- STIR

**Newborn**
- 6 months: Vertebral body < discs
- 2 years: Vertebral body > discs
- 7 years: Vertebral body >> discs

**Post contrast enhancement of red marrow and epiphysis**

- 20 sec
- 50 sec
- 70 sec
- 120 sec

**Ped Radiol 2002 32:580-585**

**13 YO female**

- T2 FS
- T1
Patchy high T2 signal in the ankle and foot in children is:

1. typical for osteomyelitis
2. a common variant
3. typical for overuse syndrome
4. none of the above

Diffuse and Multifocal Bone Marrow Disorders

Bone marrow hyperplasia, treated with granulocyte colony-stimulating factor
18 yo with sickle cell disease and right knee pain

Bone marrow hyperplasia with multifocal infarcts

Diffuse and Multifocal Abnormalities

- Marrow conversion (hyperplasia)
  - Hemolytic anemias
  - Granulocyte colony-stimulating factor
- Marrow replacement
  - Lymphoproliferative diseases
  - Metastases
  - Storage diseases
- Multifocal osteomyelitis
- Multifocal infarction

Focal Bone Marrow Disorders

18 yo female

GRE T1

In Phase

Out of Phase

T1

Regenerative or Residual Red Marrow

- Red marrow contains fat
- Malignant lesions completely replace fatty marrow
- Voxel containing both fat and water shows reduced signal out of phase
- Few malignant lesions may show reduced signal

17 yo boy with Hodgkin's disease, treated for right knee metastasis

Red marrow contains fat

Malignant lesions completely replace fatty marrow

Voxel containing both fat and water shows reduced signal out of phase

Few malignant lesions may show reduced signal

Zampa V. Eur Radiol 2002 12:1811-8
Zajick DC. Radiology 2005 237:590-6
Disler DG. AJR 1997 169:1439-47
2 yo girl with right leg pain and limping

9 yo female with persistent right hip pain

18 yo male with low back pain

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Growth plate injuries

Salter Harris classification

- 1 - Slipped epiphysis
- 2 - Above growth plate
- 3 - Lower than the growth plate
- 4 - Through the growth plate
- 5 - Raised epiphysis

Pediatric growth plate injuries

- Salter Harris type I - 4%
- Salter Harris type II - 75%
- Salter Harris type III - 10%
- Salter Harris type IV - 10%
- Salter Harris type V - 1%

Risk for bony bar

7 yo boy

Bony bar
11.5 YO girl plays competitive tennis

2 years later

11.5 YO

6 years later

12 YO girl with knee pain
**Sinding Larsen Johanson syndrome**
- Apophysitis of the inferior pole of the patella
- Affects children at the age of 10-12 yo
- Fragmentation of the inferior patellar pole
- Patellar tendon swelling

**Ischial apophysitis**
- Ossification center for the ischial origin of the hamstring and adductor magnus muscles: 13-16 YO
- Fuses at the age of 16-25 YO
- Tendons are stronger than the bone
- Treatment
  - Conservative
  - >2cm displacement - surgical fusion

**Quadriiceps tendon avulsion**
- Tendon avulsion at the inferior pole of the patella
- Fragmentation of the inferior patellar pole
- Patellar tendon swelling
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4 yo male with fever and left hip pain

A 14 year-old female with 7 days of high fever and right hip pain.

16 YO with fever and acute Lt hip pain

WBC ↑  SED ↑
3 yo boy with scalp swelling and refusal to walk

STIR

15 YO with pain, fever and marked swelling in the proximal right forearm
Ewing’s sarcoma

Osteomyelitis

- MRI is indicated
  - Negative radiographs
  - No response to treatment
  - Evaluation of complications
- Whole body MRI
  - Multifocal osteomyelitis
  - Alternative to bone scintigraphy

MRI evaluation of immature bone

- Can differentiate between normal physiology and pathology
  - The bone marrow
  - The cartilaginous structures
    - Growth plate
    - Epiphysis
    - Apophysis
  - Joints
  - Soft tissues