Imaging Differential Diagnosis of Osteolytic Lesions

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EXPERT'S OPINION (GENERAL REVIEW)

State-of-the-art approach for bone sarcomas

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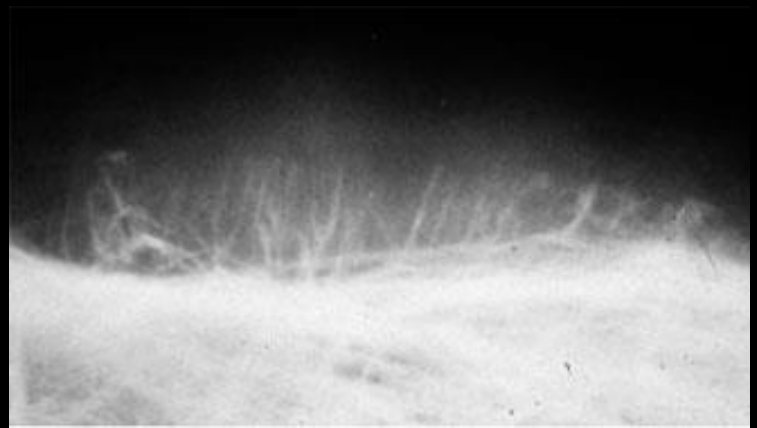
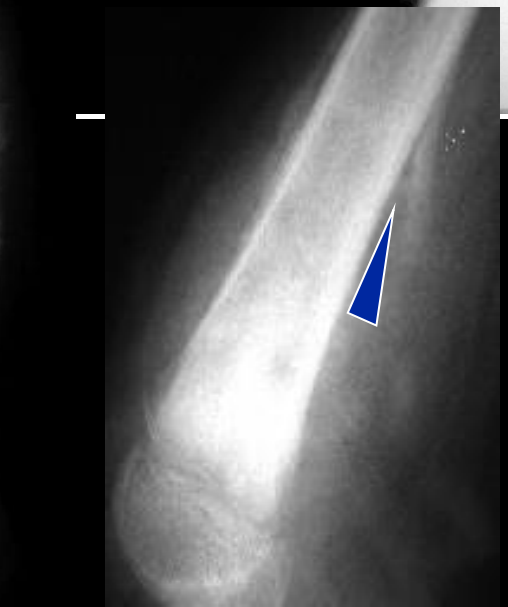
Staging

- *A systematic approach to obtain diagnosis and treatment*
- Always radiographs





Staging

- Paramount
- Especially in patients with a known history of cancer and solitary osteolytic lesions

Diagnosis and Management of Bone Sarcomas; Rizzoli`s Approach

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Staging

- History, age, trauma (>60%)
- Family history (multiple hereditary exostosis)
- Physical examination
- Imaging studies

2. Biopsy
3. Treatment

Imaging

Local

- **Radiographs**
- CT
  - If radiographs are normal
  - Evaluation of matrix
- **MRI**
- Bone scan
  - If radiographs are normal
  - Highly sensitive, not specific

Radiographs

Based on medical history, physical examination, and plain radiographs, the diagnosis of a bone tumor can be established in >80% of cases

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Imaging of bone tumors for the musculoskeletal oncologic surgeon

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Age

- Young

Benign	Malignant
Osteomyelitis	Osteosarcoma
EG	Ewing's tumors
	Lymphoma
	Leukemia

Ewing's sarc

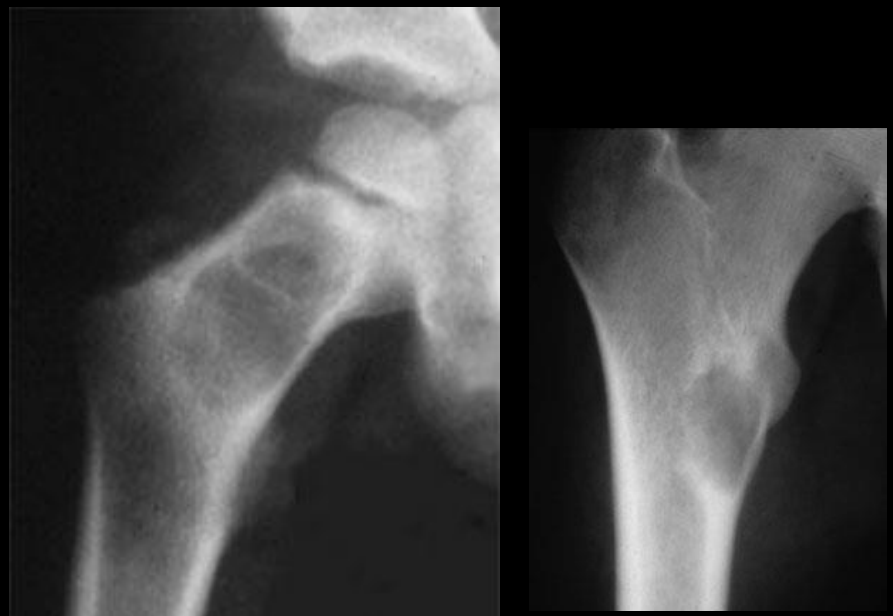
- Adults

Benign	Malignant
Enchondromas	Metastases
Paget's disease	Multiple myeloma
Bone infarct	Lymphoma
Bone island	Primary sarcomas
Hyperpara	Secondary sarcomas

Chondrosarc

Radiographs

- Initial detection of a lesion or incidental finding
- How the tumor affects the bone is best appreciated on initial radiographs
- Signs of benign
- Signs of malignancy

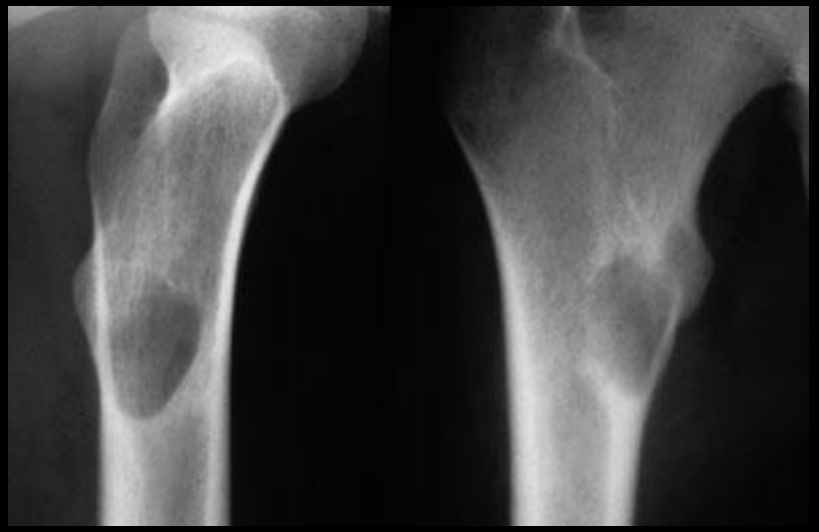


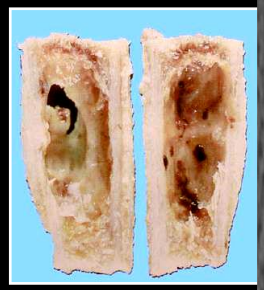
UBC

GCTB

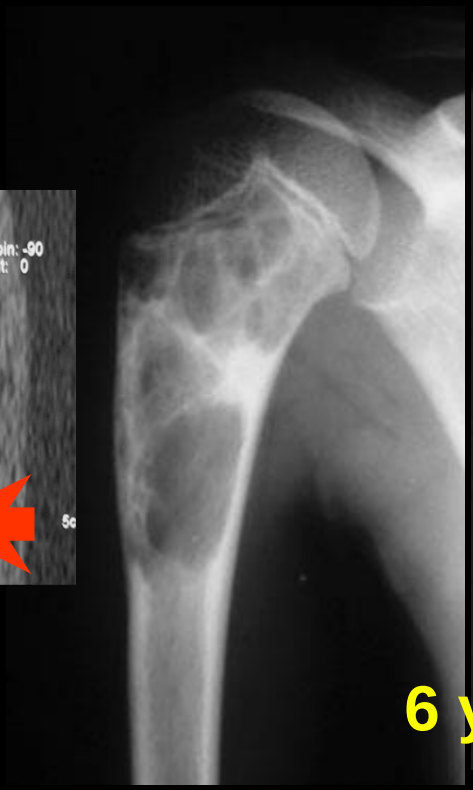
Radiographs

- Signs of benign
  - Well-defined margins
  - Peripheral sclerosis
  - Cortex intact

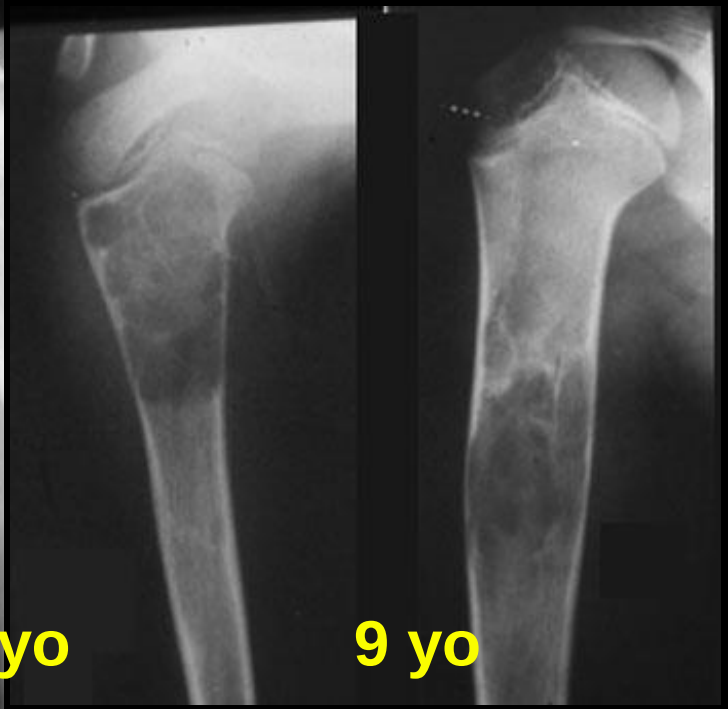




UBC



6 yo



9 yo

Radiographs

- Signs of malignancy
  - Irregular/unclear margins
  - Extensive osteolysis
  - Cortical erosion or breakage
  - Periosteal reaction
    - Infection
    - Histiocytosis
  - Soft tissue extension

Codman's triangle

Leukemia

“Sunburst” pattern

Osteosarcoma

Sharpey’s fibers

Radiographs

GCTB

Chondrosarcoma

Radiographs

Acrometastasis

Metastatic bone disease (lung cancer)

Radiographs

- Signs of malignancy

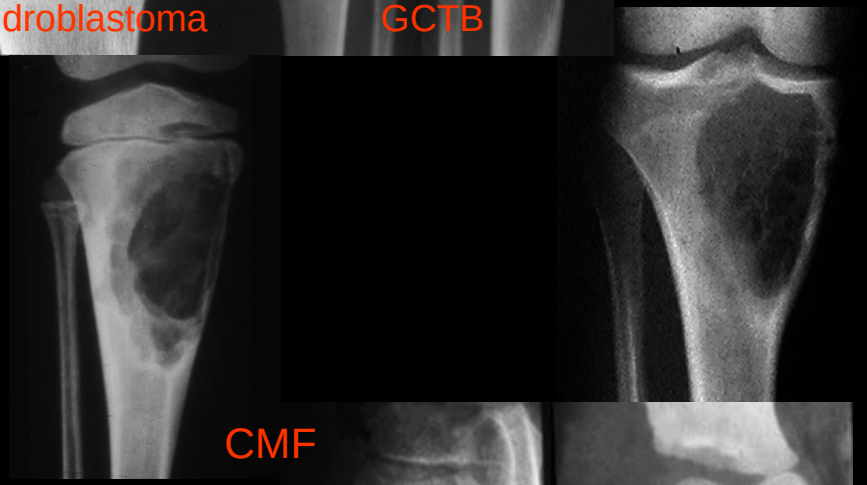
Pay attention:

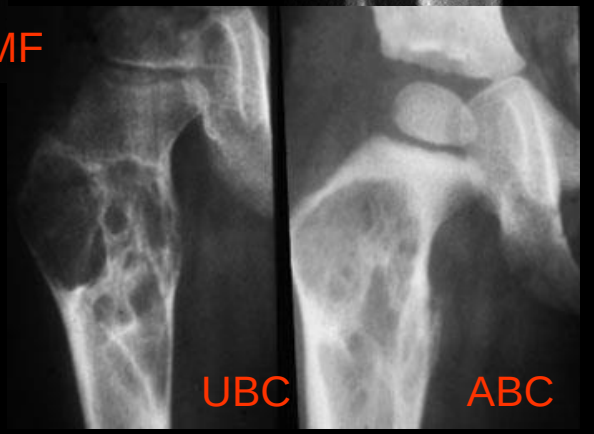
- **Area of soft intensity in bone**

- **Periosteal reaction (even small) in area of major sclerosis**

Radiographs – Bone topography

- Epiphysis
  - Chondroblastoma
  - GCTB
  - ABC
  - Clear cell chondrosarcoma
- Metaphysis
  - Cartilaginous tumors
  - Cysts
  - Histiocytic fibromas
- Diaphysis
  - Osteoid osteoma
  - FD
  - EG
  - Ewing' sarcoma





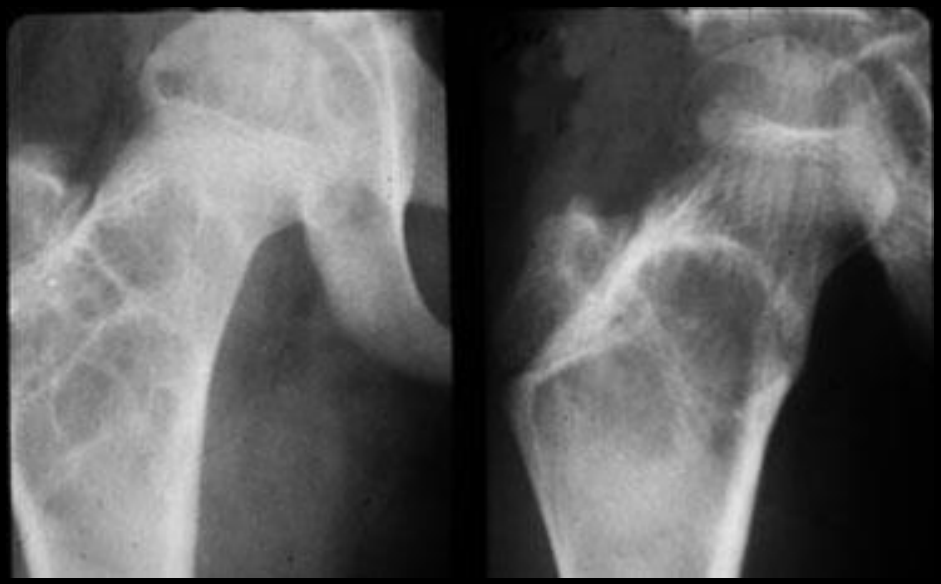
Epiphysis

Chondroblastoma

GCTB

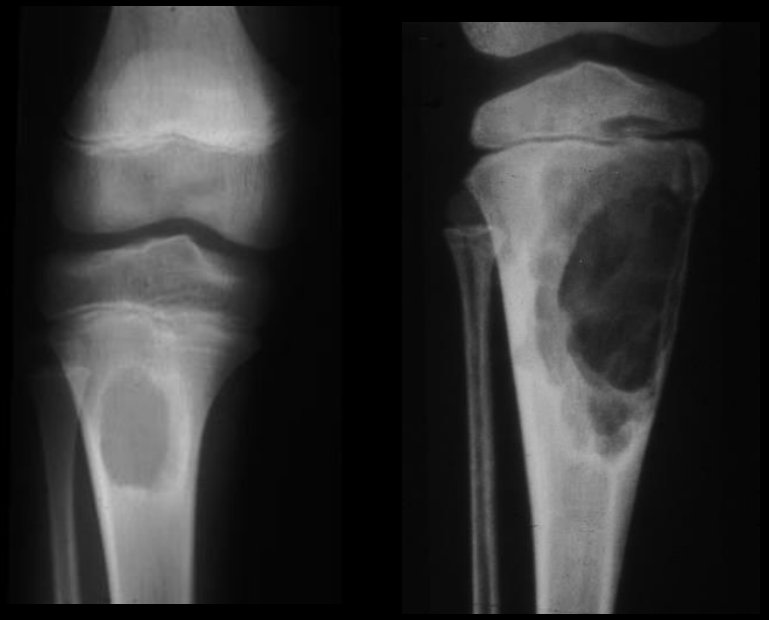
ABC

Metaphysis



UBC FD

UBC ABC



CMF

Diaphysis

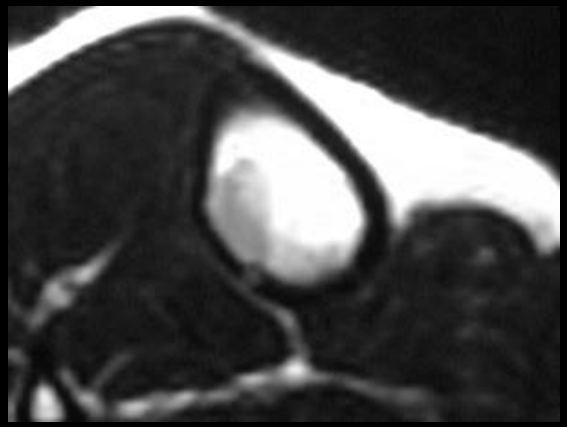
Periosteal reaction (thick, dense, homogenous)

Cortical nidus

Osteoid osteoma

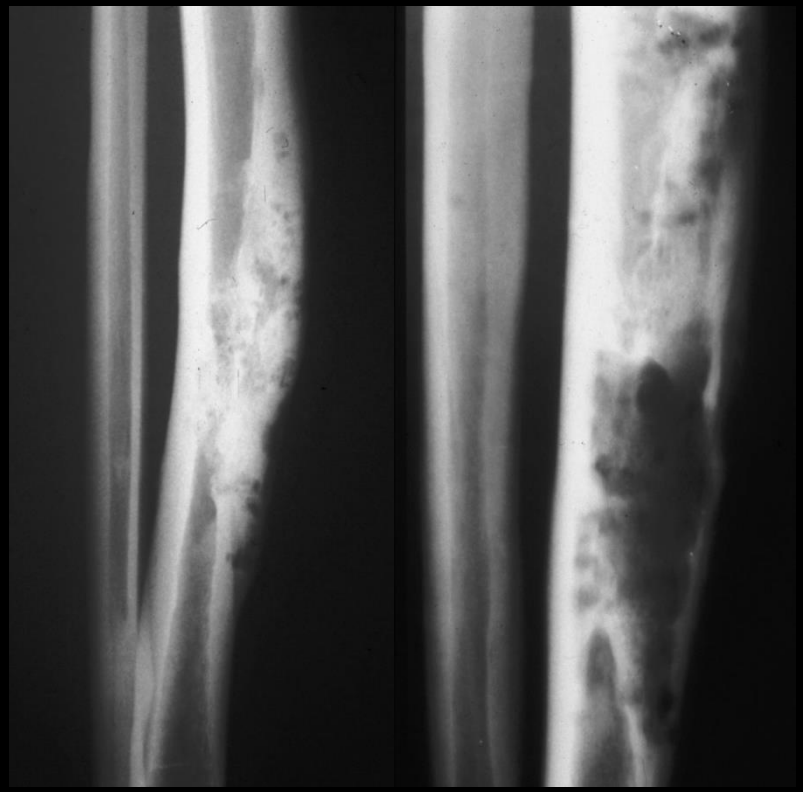
Diaphysis

FD



Diaphysis

Mirra JM, *"Bone Tumors", 1989*
“OFD progression to adamantinoma”
Czerniak B, *Cancer, 1989*
“Adamantinoma regression to OFD”



Osteofibrous dysplasia

Anterior tibia cortex

Bubble soap appearance

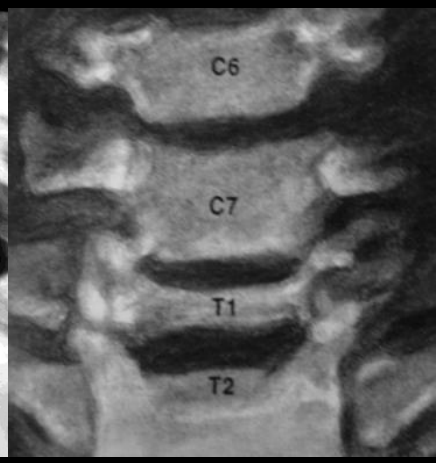
Adamantinoma

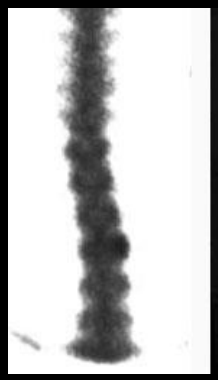
Imaging – Skeletal tomography

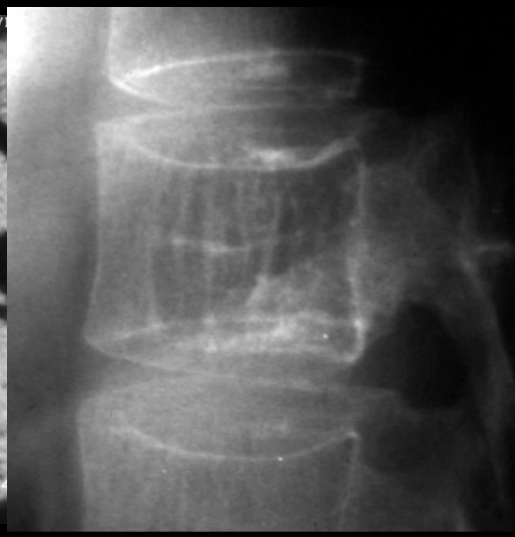
- Spine
  - EG
  - Hemangiomas, ABC, Osteoblastoma, Chordoma
- Flat bones
  - EG
- Hands
  - Chondromas
- Multifocal
  - FD
  - Encondromatosis
  - Osteocondromatosis
  - Hemangiomas
  - Infections

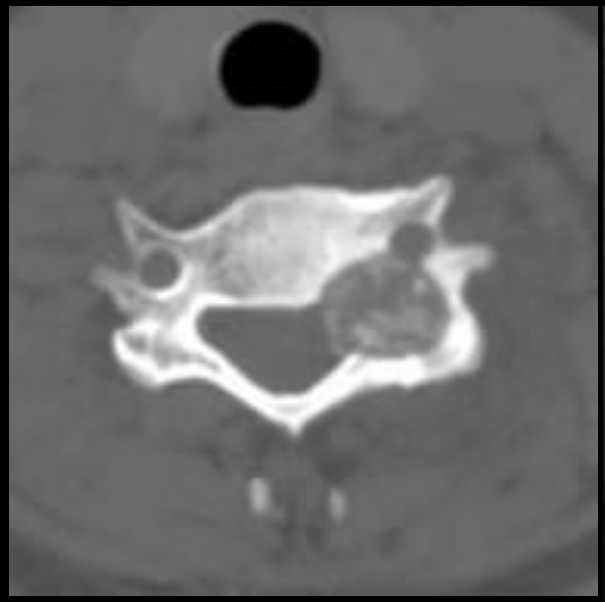
Radiographs

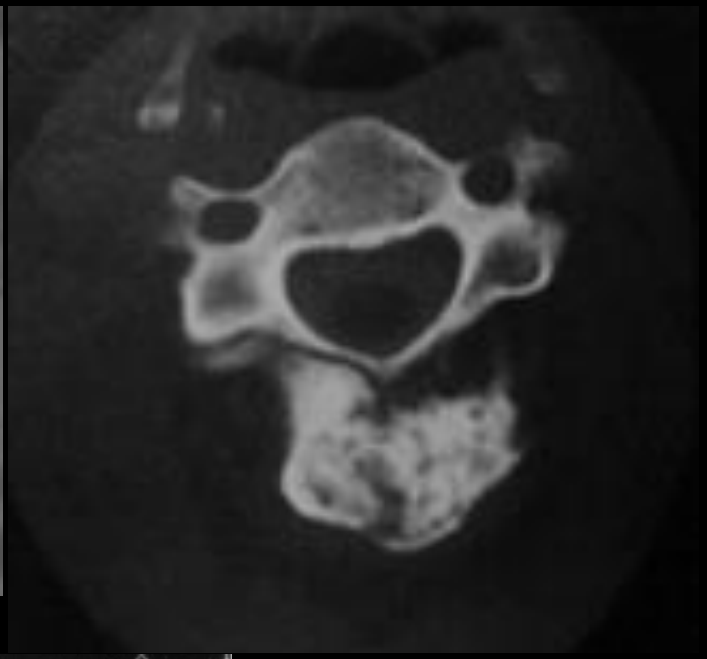
- Spine
- <u>≤30-yo</u>
  - *Vertebral body*
    - EG
    - Hemangioma
  - *Posterior elements*
    - Osteoid osteoma
    - Osteoblastoma
    - ABC
- <u>≥40-yo</u>
  - Metastases

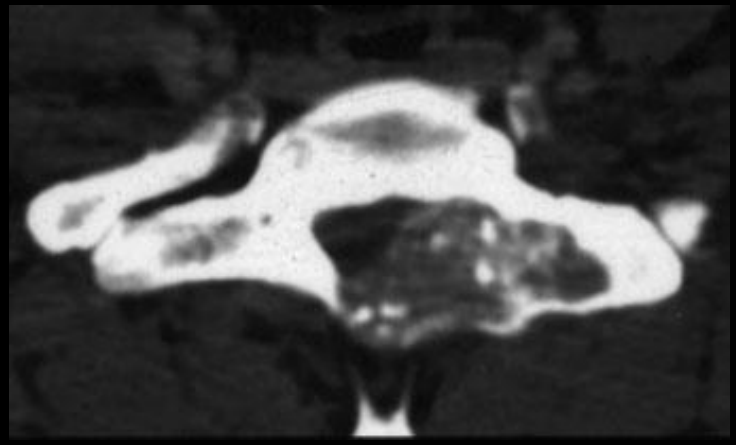












Osteoblastoma

Radiographs

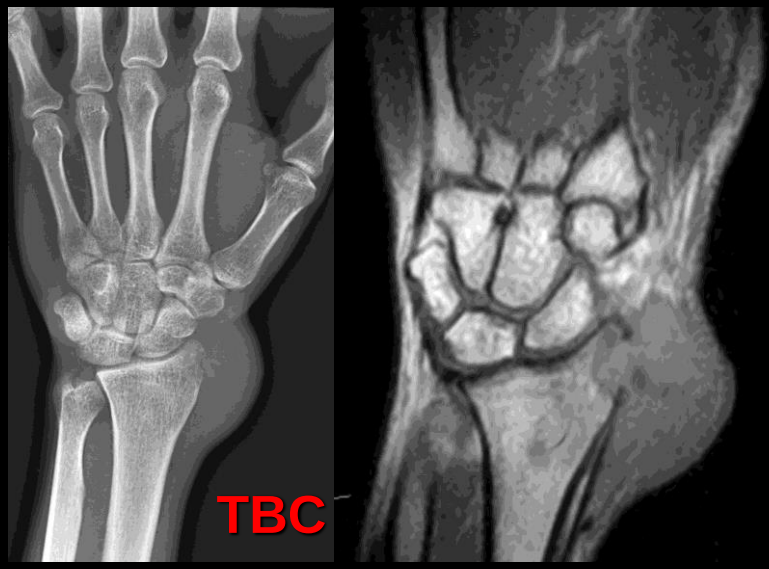
- Hand
  - Enchondromas
  - Synovial sarcoma

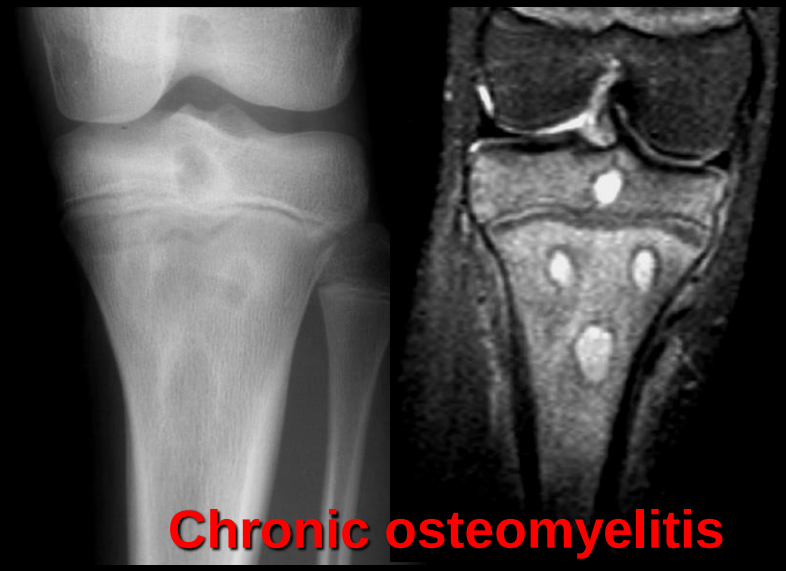
Enchondroma

Ollier's

Imaging

- Multiple lesions
  - Histiocytosis
  - Enchondromatosis
  - Osteochondromatosis
  - FD
  - Vascular tumors
  - Infection
  - Hyperparathyroidism



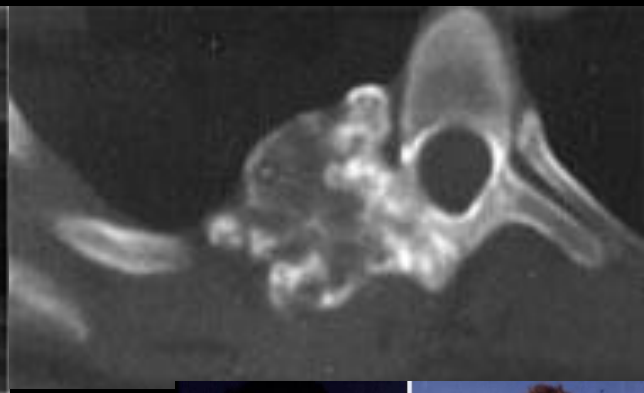


Multiple skeletal osteochondromas
Bessel-Hagen disease

- Multiple Hereditary Exostoses, Hereditary Multiple Osteochondromas, Multiple Cartilaginous Exostoses.
- 1/50,000; 70-80% autosomal dominant; 20-30% *de novo* mutations (EXT1, EXT2, EXT3)

Multiple skeletal osteochondromas
Bessel-Hagen disease

- Exostoses
- Deformities, LLD



Multiple skeletal osteochondromas Bessel-Hagen disease

- Malignant transformation (chondrosarcoma)
  - up to 8.3%

Multiple chondromas

- Chondrodysplasias or enchondromatoses
  - Ollier's disease
  - Maffucci's syndrome
- Most cases sporadic

Enchondromatoses
Ollier's disease

- 1/100,000 births
- Multiple enchondromas
  - Hands and feet
    - Palpable masses
  - Deformities, LLD
  - Bilateral involvement
    - Unilateral predominance

Louis Léopold Ollier (1830–1900)

Enchondromatoses
Ollier's disease

- Increased risk of secondary chondrosarcoma
  - 25-40% by age 40 yrs

Enchondromatoses
Maffucci's syndrome

- Rare (160 cases)
  - Multiple enchondromas
    hands and long bones
  - Multiple hemangiomas
  - Lymphangiomas

Angello Maffucci, 1881

Enchondromatoses
Maffucci's syndrome

Cancer-prone syndrome (up to 100%)

- In enchondromas:
  - Chondrosarcoma
- In hemangiomas, lymphangiomas:
  - Angiosarcomas
  - Lymphangiosarcomas
- CNS, pancreatic, and ovarian tumors

Metachondromatosis

- Multiple exostoses
- Multiple enchondromas
- Periarticular calcifications
- Frequent unilateral or bilateral Legg-Calvé-Perthes-like changes in the femoral heads

- Autosomal-dominant

Maroteaux P. La metachondromatose. Z Kinderheilkd. 1971;109:246-61.

Pathological fractures

Children

- UBC (humerus, femur; 80% at presentation)
- NOF (femur, tibia)
- EG
- FD

Adults

- GCTB (5-10% at presentation)
- ABC
- Metastatic bone disease

Pathological fracture

Chondromas (solitary)

Pathological fracture

Osteosarcoma

Pathological fracture

Metastatic bone disease (RCC)

Metastatic bone disease (breast cancer)

Radiographs

- Shape of the lesion
- Some lesions tend to have a more spherical shape
  - GCT, osteosarcoma

- Other lesions tend to conform to the shape of the bone in which they arise
  - chondrosarcoma

Radiographs

- Margins of the lesion
- Provide most of the information regarding rate of growth
  - Static (solid, dense boundary)
  - Slow-growing (sharp demarcation, not dense)
  - Faster-growing (moth-eaten)
  - Fastest (permeative)

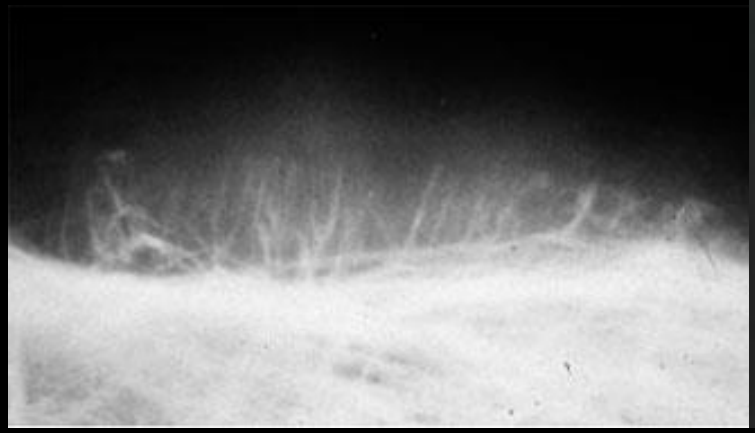
Radiology. 1980 Mar;134(3):577-83.

Determining growth rates of focal lesions of bone from radiographs.

Lodwick GS, Wilson AJ, Farrell C, Virtama P, Dittrich F.

Radiographs

- Periosteal reaction (biologic activity)
  - uninterrupted, smooth (slow-growing, benign lesion)
  - disrupted periosteal (bone sarcomas)
    - amorphous (thick)
    - laminated (“onion-skin”)
    - spiculated (“sunburst”)

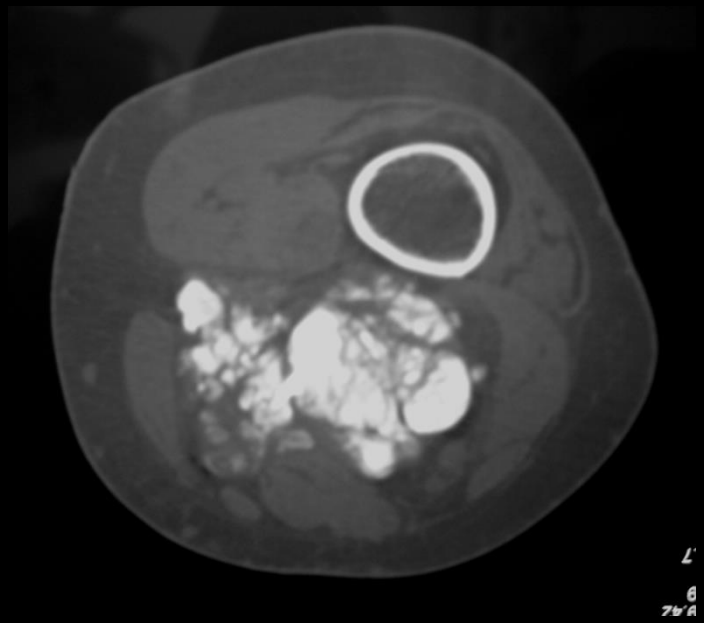


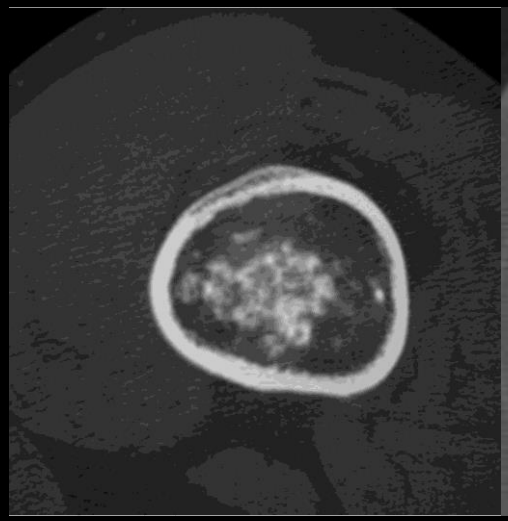
Radiographs (+/-CT)

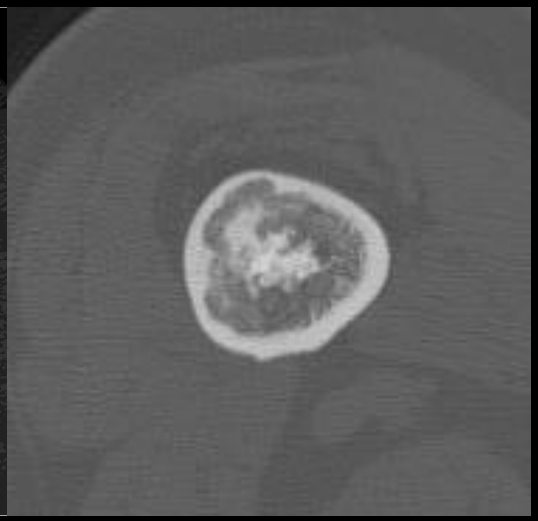
- Matrix mineralization
  - Characterizes the intercellular material produced by the lesion
- Osteoblastic lesion
  - ossified matrix (ossification, dense lumps or clouds, fuzzy or sharp margins)
- Chondroblastic lesion
  - chondroid matrix (calcification, rings or arcs - enchondral ossification along lobules of cartilage)
- Ewing's sarcoma
  - matrix mineralization is absent

CT

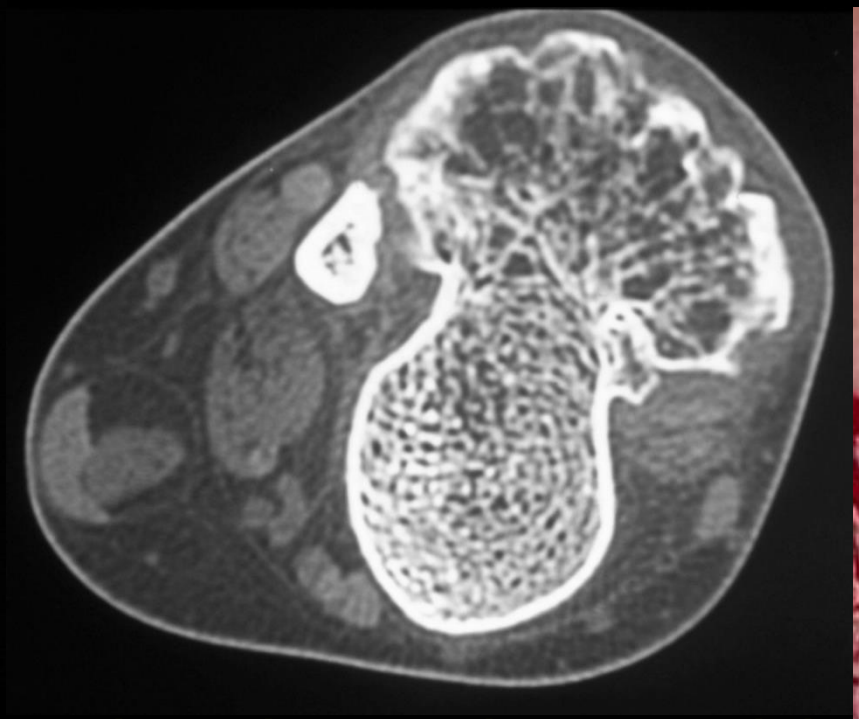
- Superior to Rx
  - evaluation of matrix
  - evaluation of path fx
- Superior to MRI
  - detection and characterization of cortical involvement
  - evaluation of occult pathological fractures





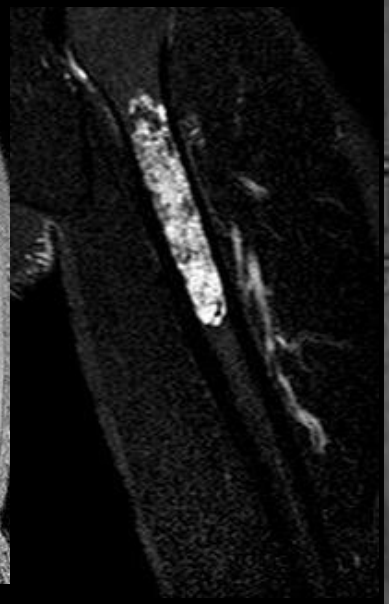


CT – “Flaring”

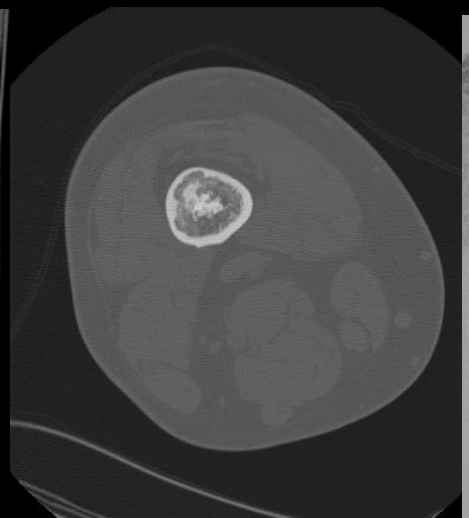


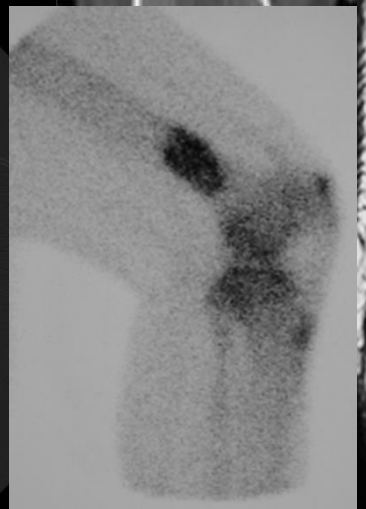
Skeletal Osteochondroma (exostosis)

CT – Scalloping



Enchondromas





MR imaging

- Bone marrow edema
- Benign lesions – Large edema
  - osteoid osteoma, osteoblastoma, chondroblastoma, EG
- Malignant lesions
  - Minimal edema surrounding a large lesion
  - Large inflammatory response of surrounding soft tissues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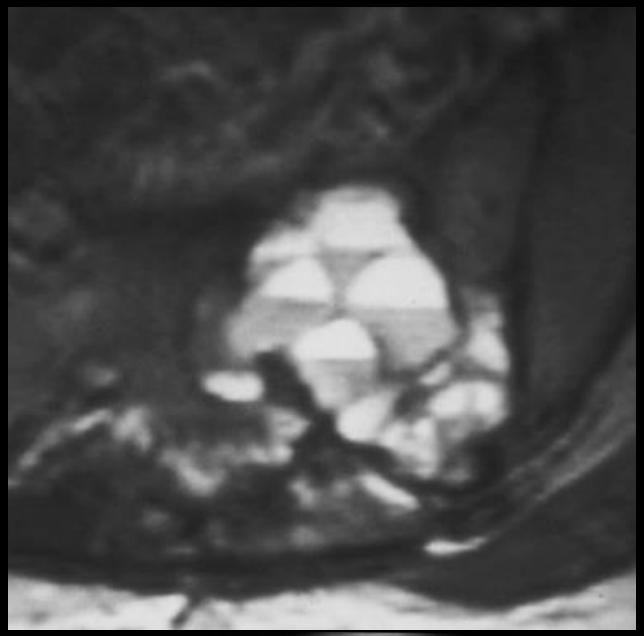
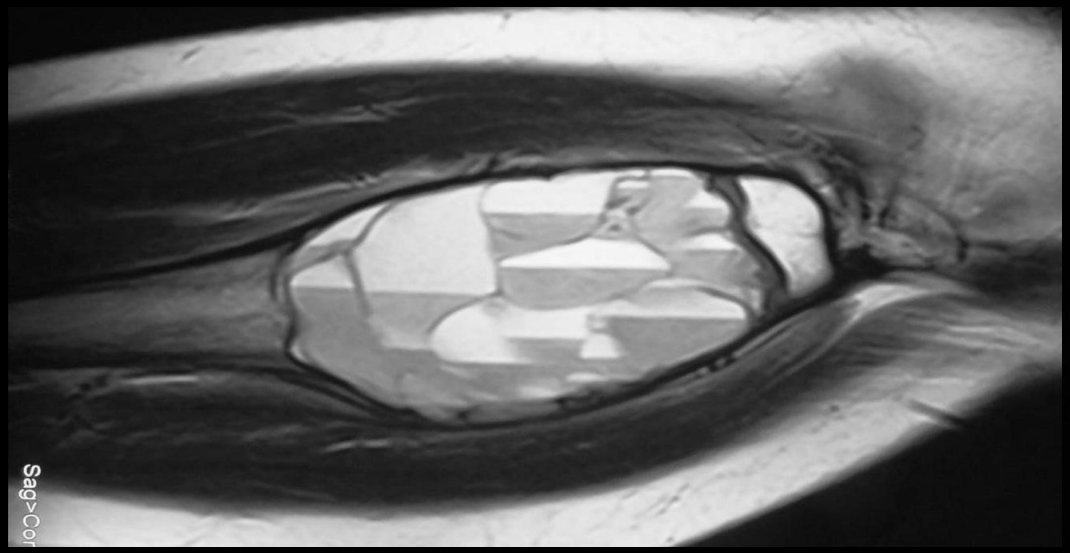
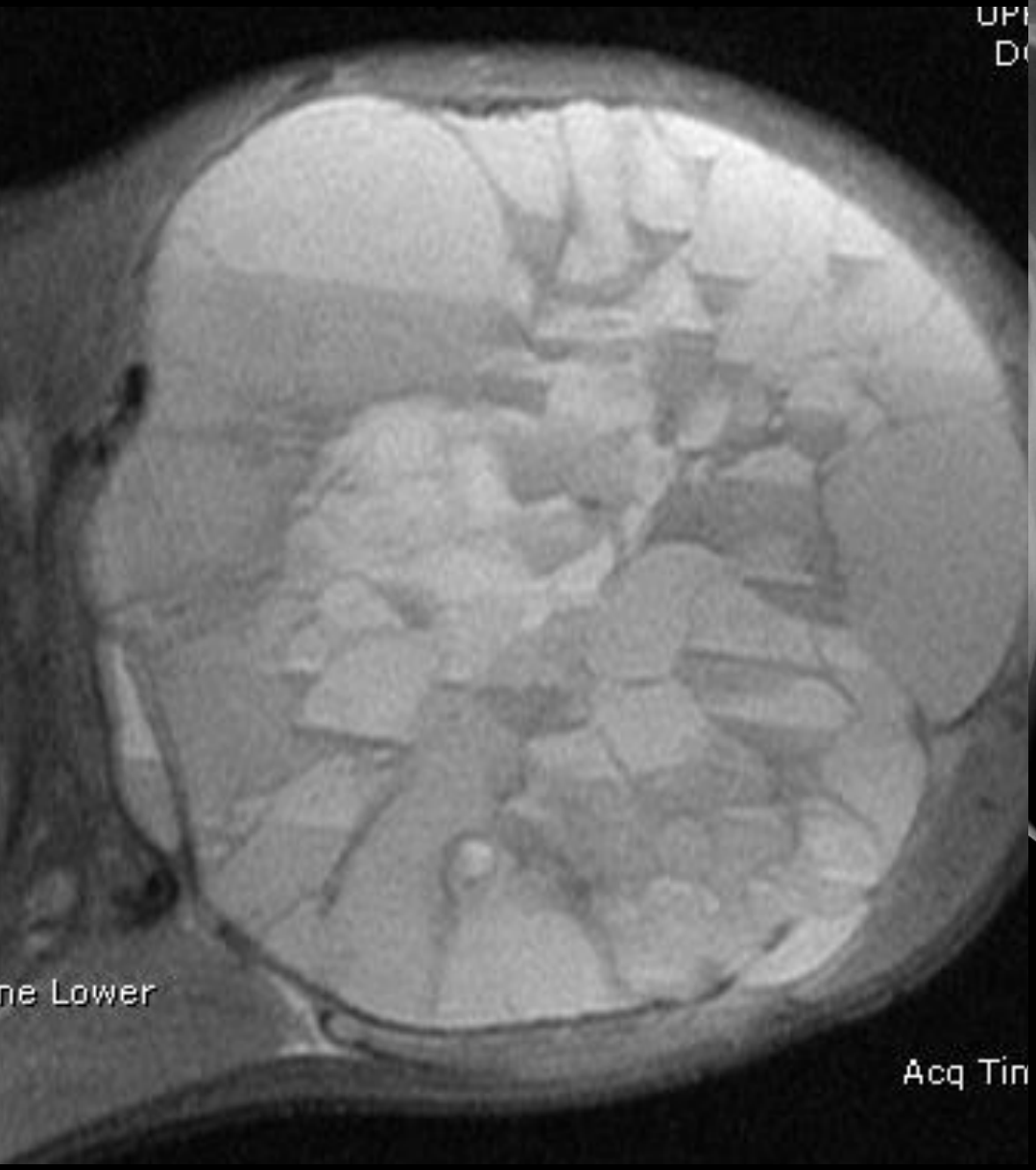
MR imaging

- Fluid-fluid levels
  - ABC
  - GCTB
  - Ewing's sarcoma
  - Telangiectatic OGS



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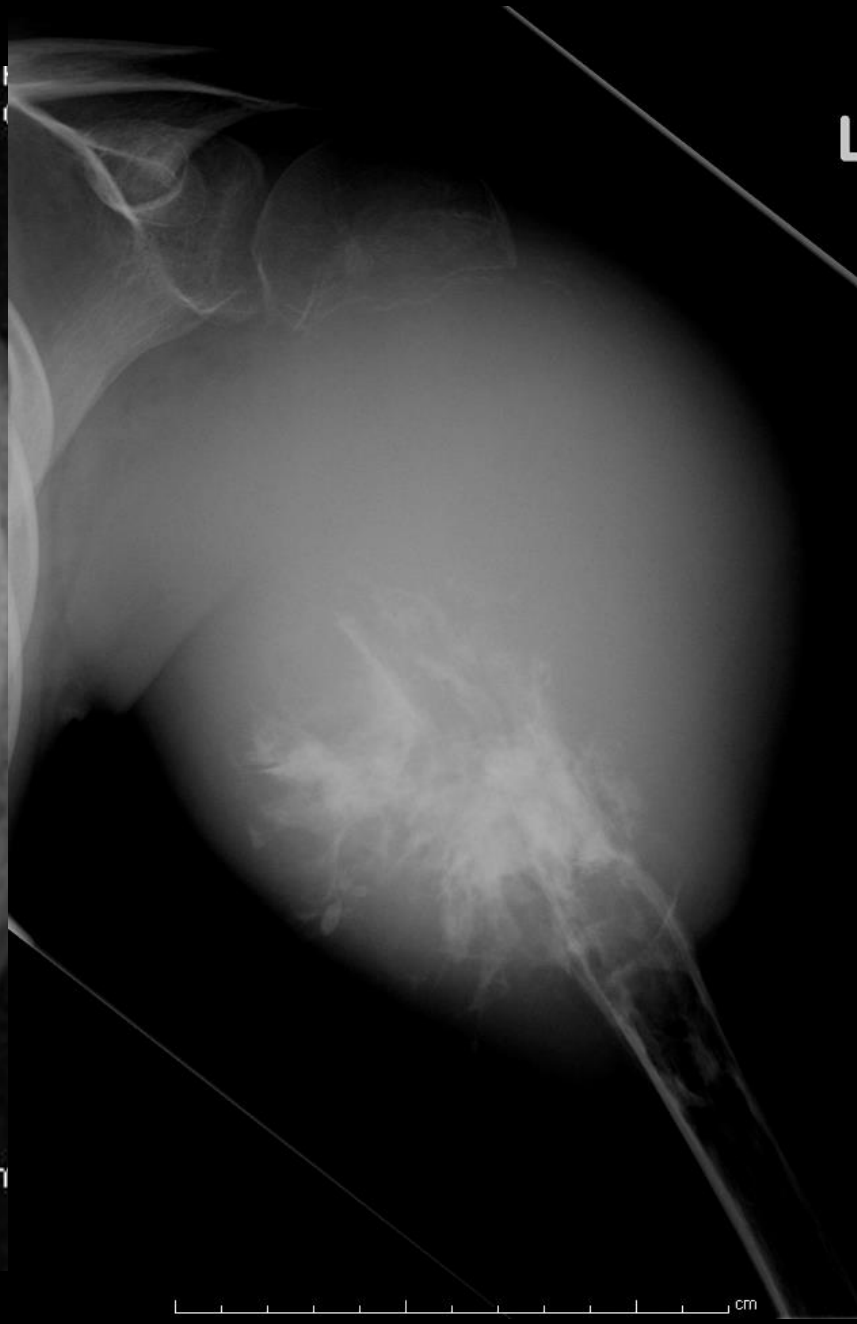
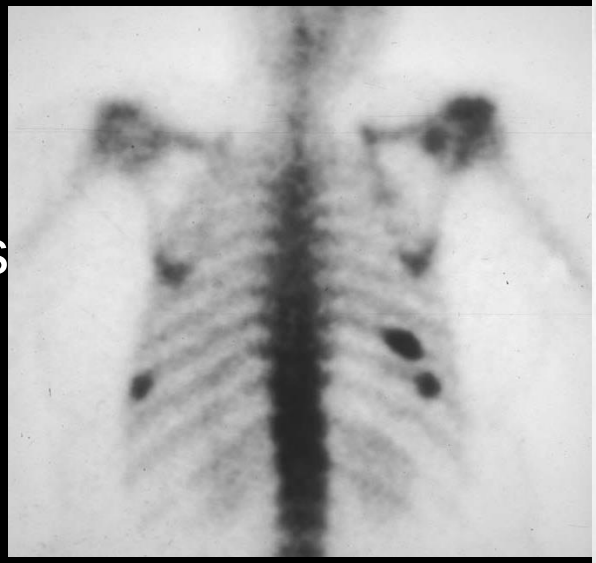

cm

Bone scan

- Highly sensitive
- Dynamic images (aggressiveness)
- Delayed-phase images (non-specific)
- False negative “cold” scan
  - plasmacytoma, multiple myeloma, and occasionally in chordoma



FDG-PET

- It quantifies the biologic activity of tissue
- It does not quantify morphologic abnormality
- It correlates with the cellularity, mitotic activity, and over-expression of p53 in bone sarcomas
  - May have prognostic value in sarcoma