

Imaging Evaluation of Bone Tumors and Tumor-like Lesions

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Disclosures

- Consultant: Bioclinica
- Advisor: Philips
- Book Royalties: Elsevier
- Not relevant to this lecture

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Fundamentals of Musculoskeletal Ultrasound are
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Objectives

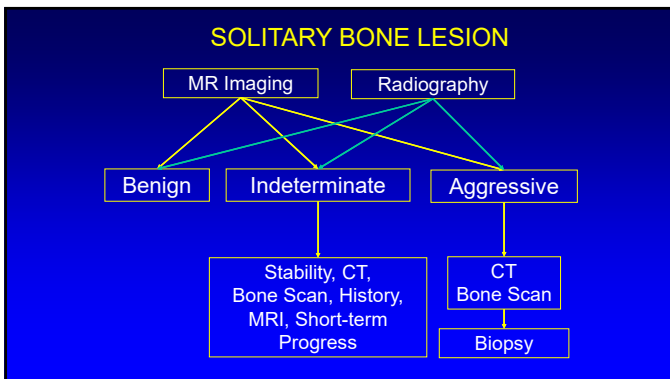
- Review algorithm for the work-up of solitary bone lesions
 - Starting point: MRI and radiograph
- Characteristic imaging features of specific bone lesions
- Determine which lesions require biopsy

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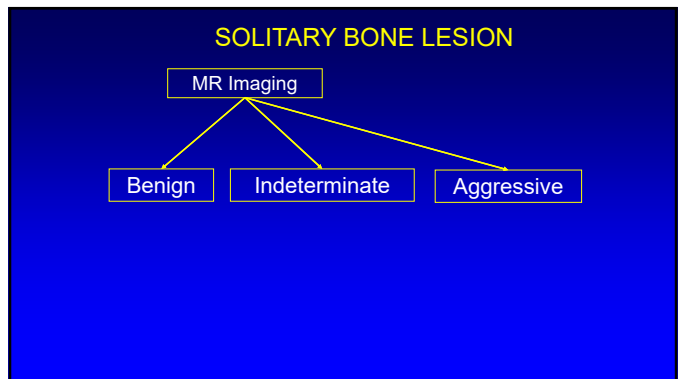
Take Home Points

- Radiography:
 - Essential: benign versus other
- MRI: sensitive but not specific
 - Contrast: only describes cyst versus solid
- CT: matrix mineralization characterization
- Bone scan / PET: global picture, activity

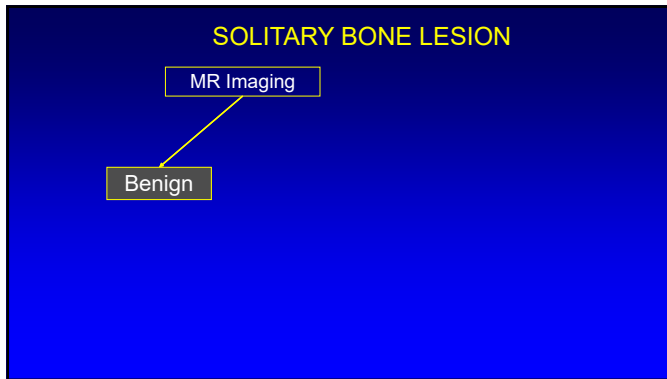
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MRI: Solitary Bone Lesion

- A lesion cannot be labeled benign by MRI unless pathognomonic
 - Malignancy may not appear aggressive
- MRI: sensitive but not specific
- Many lesions are indeterminate
- If considering tumor, need radiograph to further characterize

Metastasis

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**Benign Bone Lesions on MRI:
No biopsy indicated**

- Osteonecrosis
- Fracture
- Fibrous cortical defect
- Avulsive cortical irregularity
- Enchondroma: see *pitfall*

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Osteonecrosis

- Bone infarct (metaphysis) and avascular necrosis (epiphysis)
- Geographic low signal rim
- Variable internal signal
- Double line sign:
 - High signal (T2w) or enhancing rim on inner surface of rim

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Bone Injury and Fracture

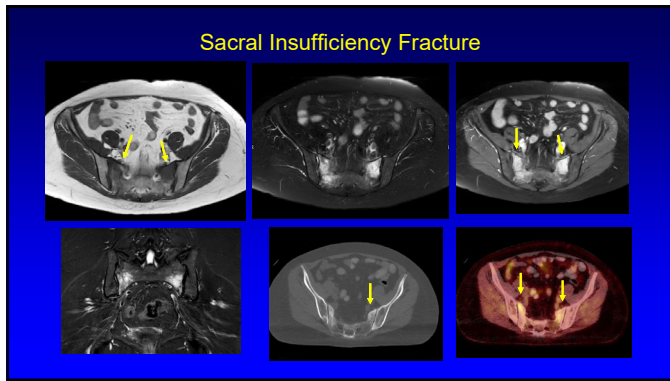
- Increased fluid signal: non-specific
- Reactive edema: does not replace fat
 - If unclear: get CT
 - Evaluate for lytic process
- Look for fracture line:
 - Low T1, variable T2 signal

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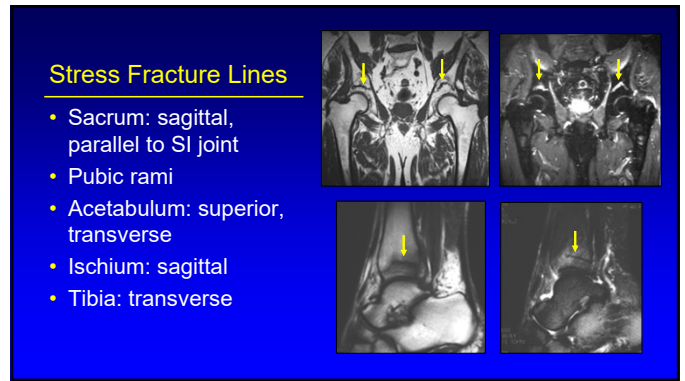
Stress Fracture

- Insufficiency: normal stress, abnormal bone
 - Sacrum, pubic rami, pelvis, tibia, calcaneus
- Fatigue: abnormal stress, normal bone
 - Metatarsal shaft, femoral neck
- Imaging: often non-specific
 - Hot bone scan, abnormal PET, enhancement
- MRI: fracture line, location, distribution, configuration

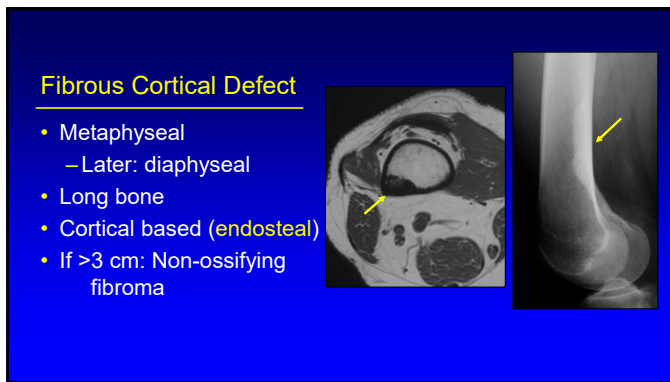
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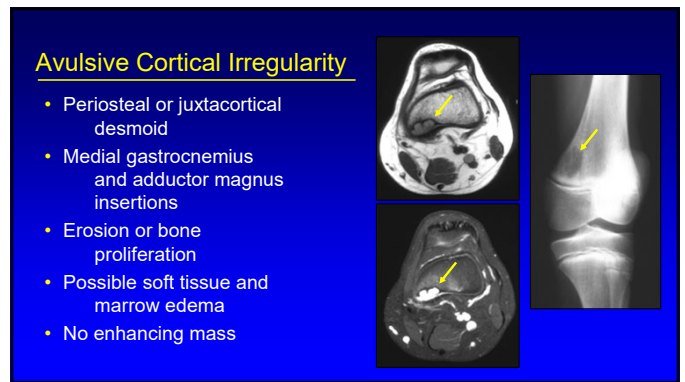
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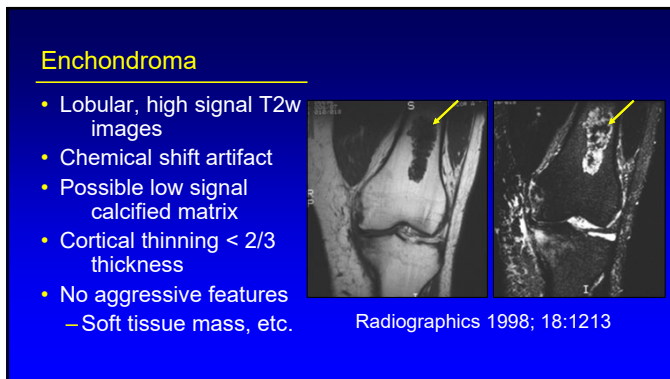
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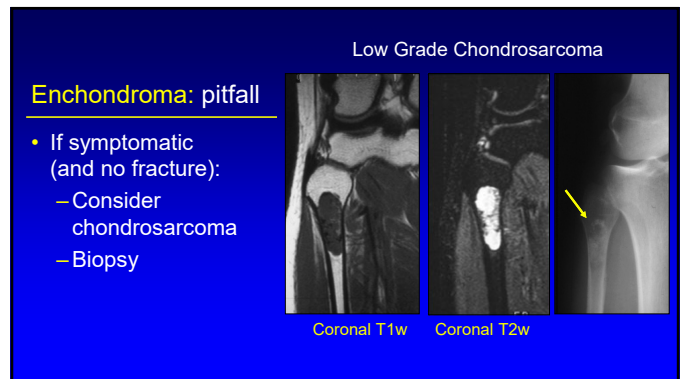
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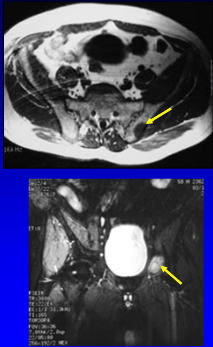
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Rule: Solitary Bone Lesion

- If lesion is symptomatic or hot on bone scan:
 - May not be benign
 - Complication of a benign lesion
 - Fracture, malignant degeneration
- Must correlate with radiography
 - Benign vs. malignant

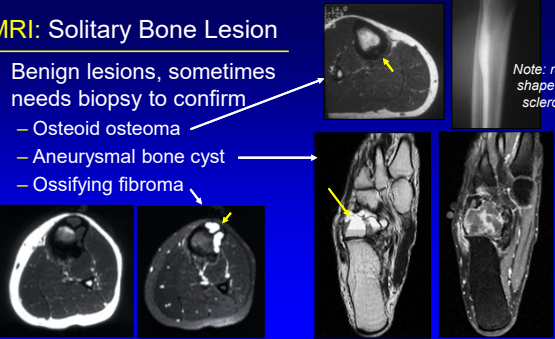


Lung Carcinoma Metastasis

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MRI: Solitary Bone Lesion

- Benign lesions, sometimes needs biopsy to confirm
 - Osteoid osteoma
 - Aneurysmal bone cyst
 - Ossifying fibroma

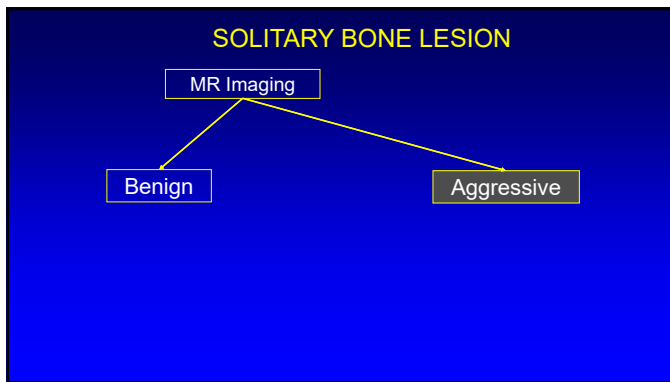


Note: round shape and sclerosis

Note: anterior tibial cortex location

Note: fluid-fluid levels

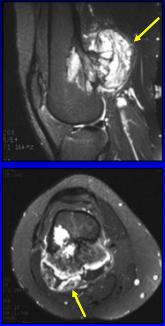
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MRI: Solitary Bone Lesion

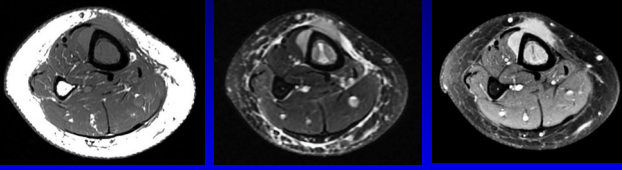
- **Aggressive**
 - Ill defined
 - Surrounding high T2w signal
 - Cortical destruction
 - Soft tissue mass
- If considering tumor, need radiograph to further characterize



Osteosarcoma

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Lymphoma: tibia

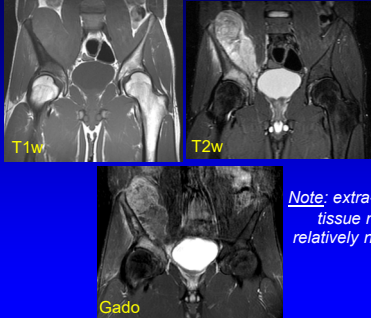


Axial T1w Axial T2w Gadolinium

Note: extra-osseous soft tissue mass with relatively normal cortex

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Ewing Sarcoma: ilium

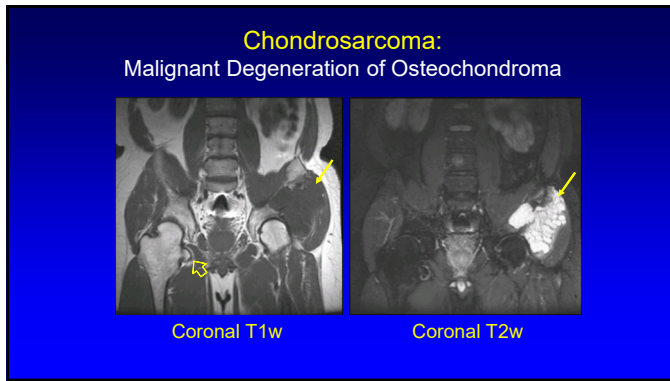


T1w T2w

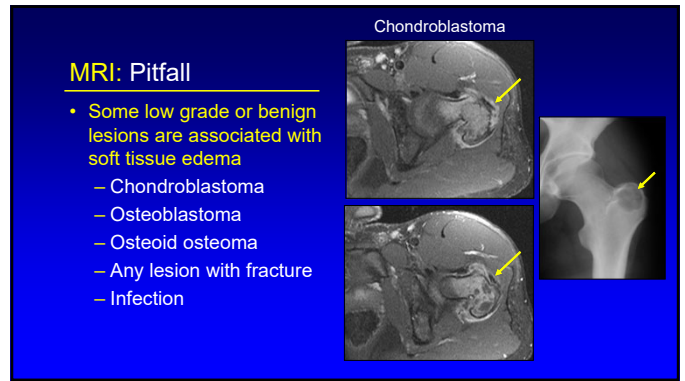
Gado

Note: extra-osseous soft tissue mass with relatively normal cortex

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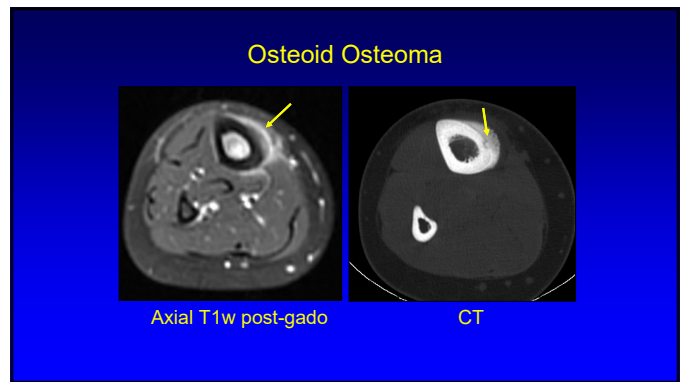
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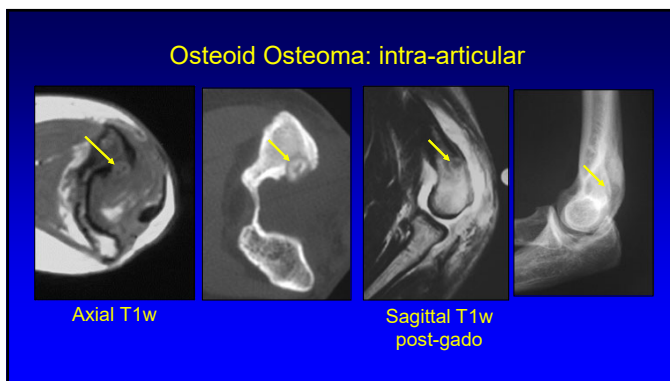
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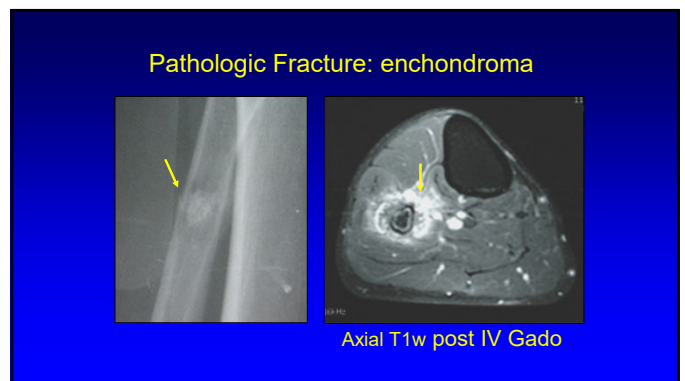
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Pathologic Fracture: aneurysmal bone cyst

Teaching Point
Expansile bone lesion with fluid-fluid levels and NO enhancing soft tissue mass = ABC

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MRI: Solitary Bone Lesion

Osteosarcoma

- Aggressive
- Report:
 - Osseous extent and skip lesion
 - Soft tissue extension
 - Intra-articular extension
 - Neurovascular involvement
 - Necrotic areas after gadolinium administration

T1w T2w

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SOLITARY BONE LESION

MR Imaging

- Benign
- Indeterminate
- Aggressive

- Indeterminate
 - Does not fit into either benign or aggressive categories
 - Not symptomatic

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SOLITARY BONE LESION

Radiography

- Benign
- Indeterminate
- Aggressive

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Radiography: Solitary Bone Lesion

Plasmacytoma: scapula

- Primary question: *Joint process or bone process?*
 - Joint process:
 - Arthritis
 - Synovial proliferative disorder
 - Bone process:
 - Tumor, infection

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Subchondral Cyst: intra-articular gas

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SOLITARY BONE LESION

Radiography

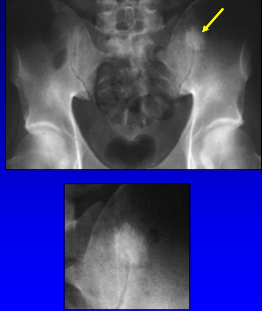
Benign

- If lytic:
 - Well-defined + sclerotic border = **benign**
 - Well-defined, non-sclerotic border = indeterminate
 - Ill-defined border: aggressive

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Radiography: Solitary Bone Lesion

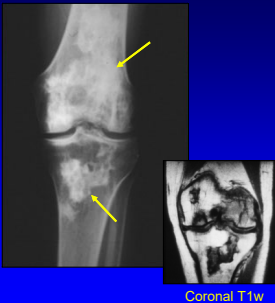
- Benign - *sclerotic*:
 - Well defined
 - Uniformly dense
 - Spiculated = **Bone Island (enostosis)**



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Radiography: Solitary Bone Lesion

- Benign - *sclerotic*:
 - Serpiginous sclerotic border
 - Geographic
 - No endosteal scalloping
 - Smoke-like appearance
 - **Osteonecrosis**



Coronal T1w

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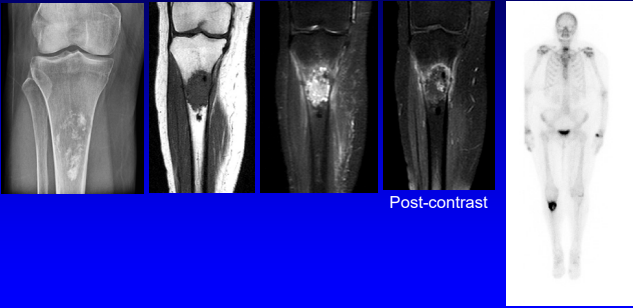
Radiography: Solitary Bone Lesion

- Benign - *sclerotic*:
 - Lobular contours
 - Rings and arcs = chondroid
 - Little endosteal scalloping
 - No aggressive features
 - **Enchondroma**: must be asymptomatic



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Dedifferentiated Chondrosarcoma

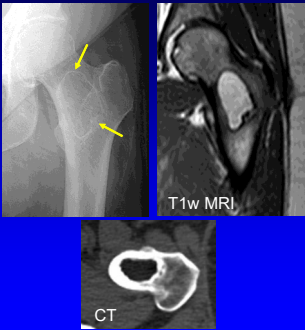


Post-contrast

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Radiography: Solitary Bone Lesion

- Benign - *lucent*:
 - Sclerotic border
 - Intertrochanteric or calcaneal
 - Lucent center: fat
 - Requires CT or MRI to confirm
 - **Intra-osseous Lipoma**

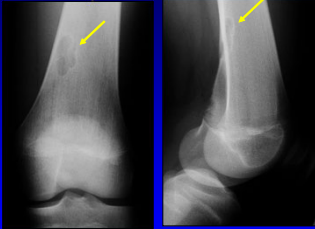


T1w MRI
CT

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Radiography:
Solitary Bone Lesion


- Benign - *lucent*:
 - Sclerotic border
 - Endosteal location*
 - Metaphyseal
 - Later: diaphyseal and sclerotic
 - Fibrous Cortical Defect or Non-ossifying Fibroma (if >3 cm)



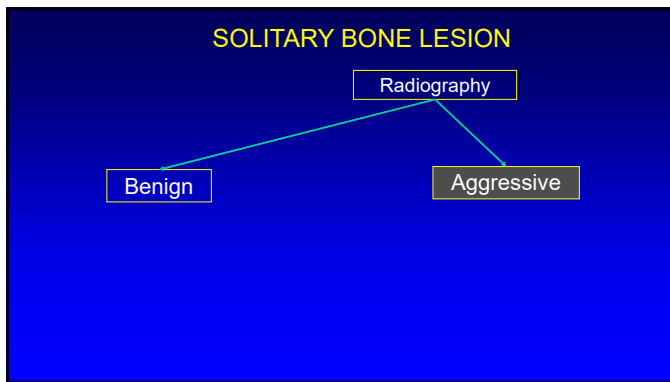
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Radiography:
Solitary Bone Lesion

- Benign - *lucent*:
 - Sclerotic border
 - Metaphyseal
 - Fallen fragment sign from pathologic fracture
 - MRI: confirms cyst
 - Unicameral Bone Cyst



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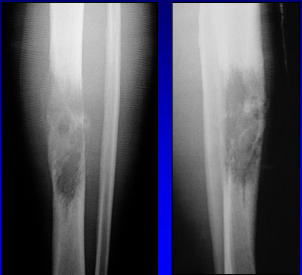


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Radiography:
Solitary Bone Lesion

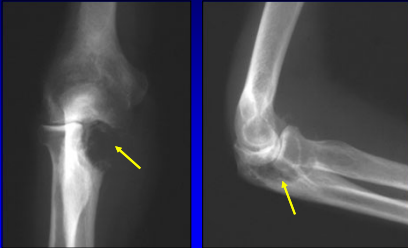
- Aggressive
 - Ill defined
 - Permeative
 - Wide zone of transition
 - Aggressive periostitis

Lymphoma



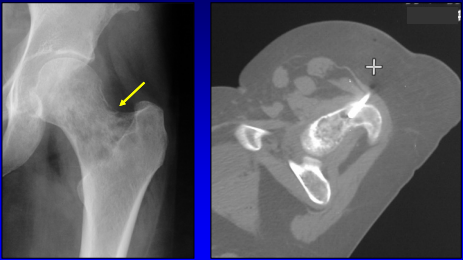
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Renal Cell Carcinoma Metastasis



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Metastasis: unknown primary



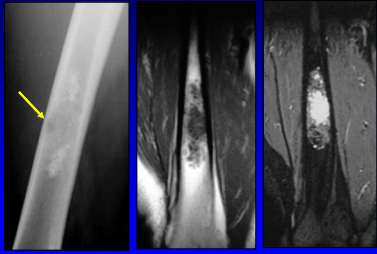
11 ga. Bone Biopsy

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Chondrosarcoma

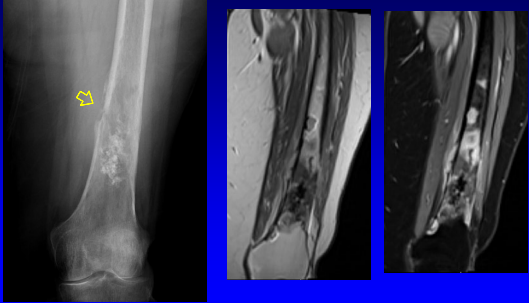
- Pain
- Deep scalloping >2/3 cortical thickness
- Cortical destruction
- Soft tissue mass
- Periosteal reaction
- Uptake bone scan > anterior iliac crest
- > 5-6 cm in size

Radiographics 1998; 18:1213



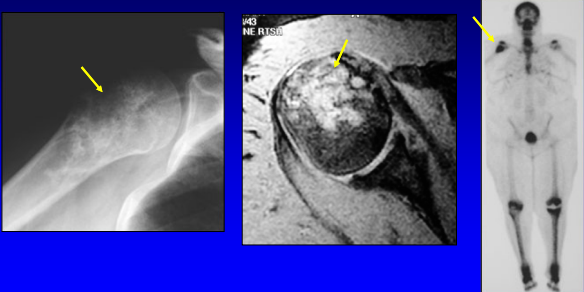
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Dedifferentiated Chondrosarcoma:

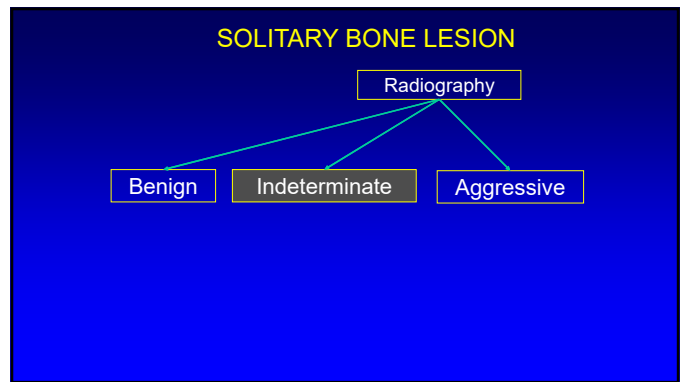


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Low Grade Chondrosarcoma



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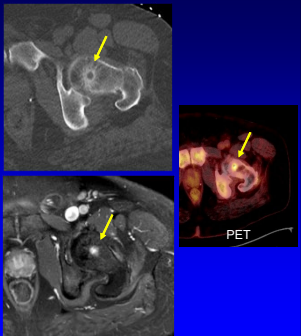
Radiography: Solitary Bone Lesion

- Indeterminate
 - Does not fit into either benign or aggressive categories
 - If pain: consider aggressive
 - Consider MRI with gadolinium: cyst versus solid
 - Consider biopsy

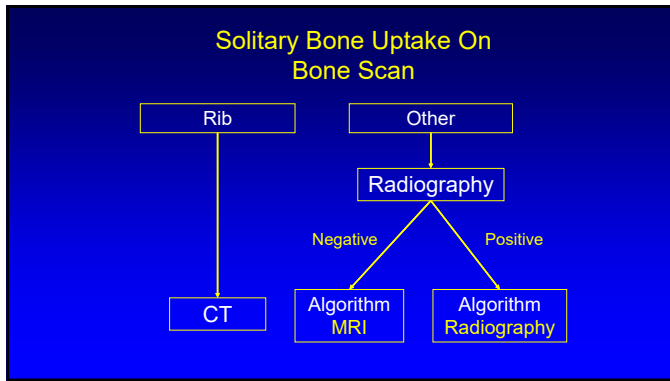
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Radiography: Solitary Bone Lesion

- Indeterminate - *lucent*:
 - Ill-defined sclerotic border
 - Not specific for a benign etiology
 - Consider further imaging: MRI- cyst versus solid
 - **Metastasis**



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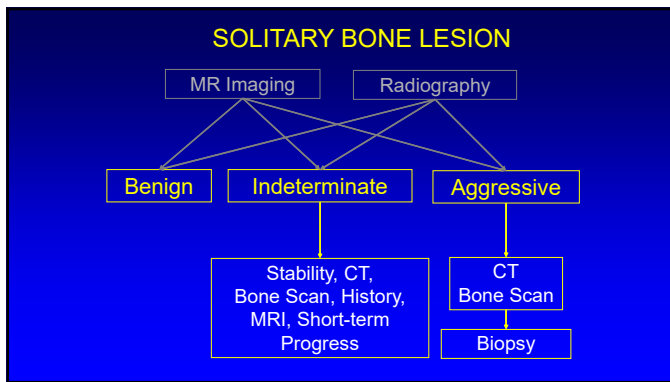
Solitary Bone Lesion: Bone Scan

- Rib
 - Get thin section CT
- Benign
 - Old fracture
 - Fibrous dysplasia (ground glass)
- Aggressive
 - Biopsy

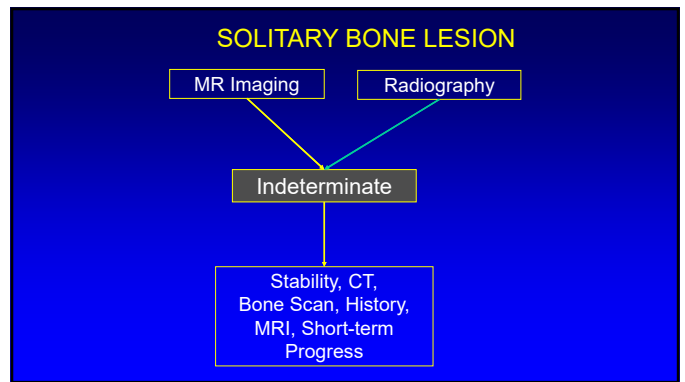
Rib Fracture

Plasmacytoma

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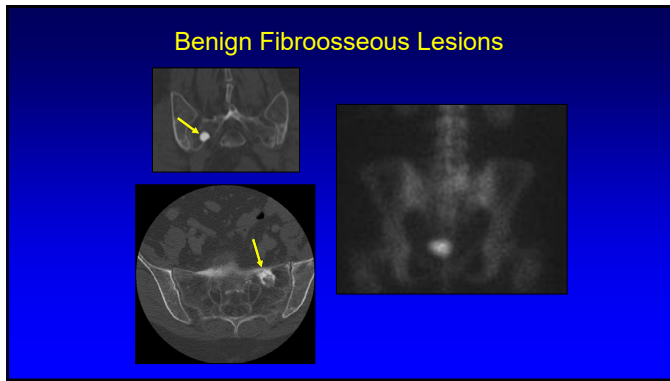
Solitary Bone Lesion: Indeterminate Lesion

- Prior imaging
 - To document stability
- Additional history
 - If painful, may need to biopsy
- Bone scan (or PET)
 - To determine if uptake

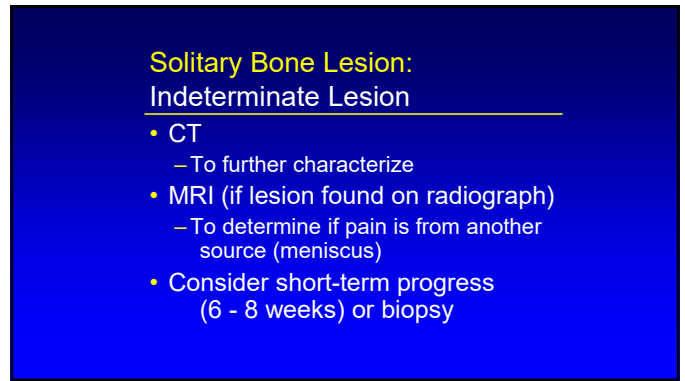
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Fibrous Dysplasia or Benign Fibro-osseous Lesion

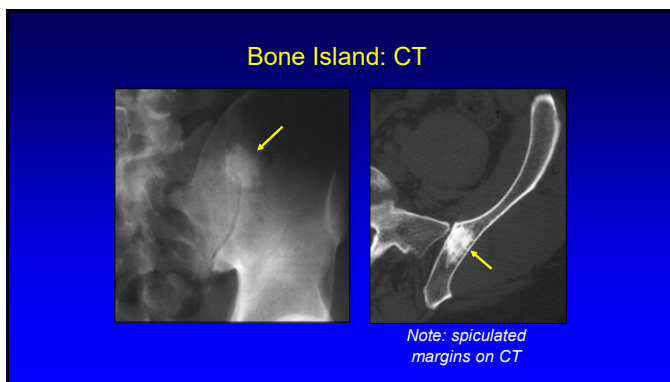
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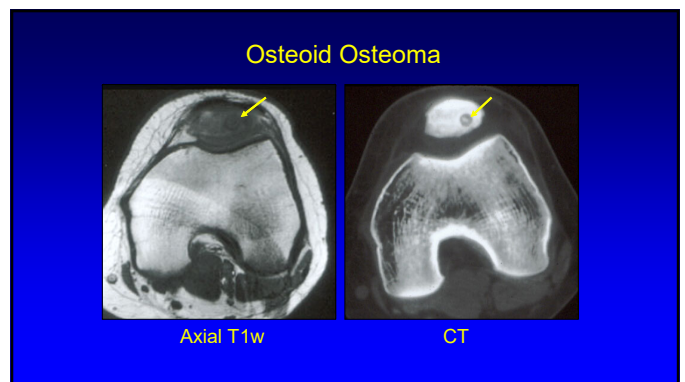
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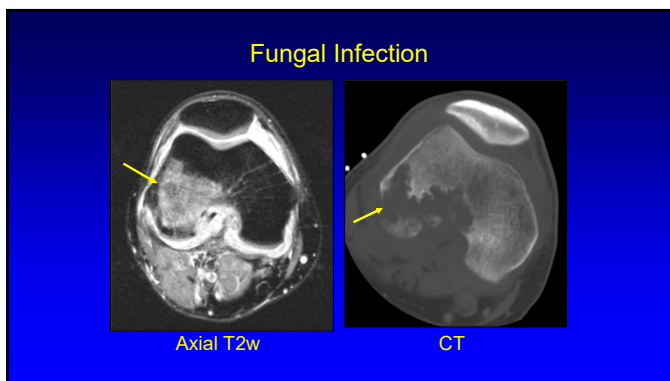
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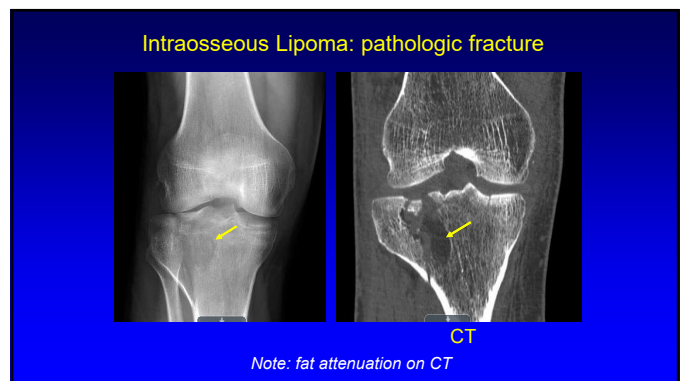
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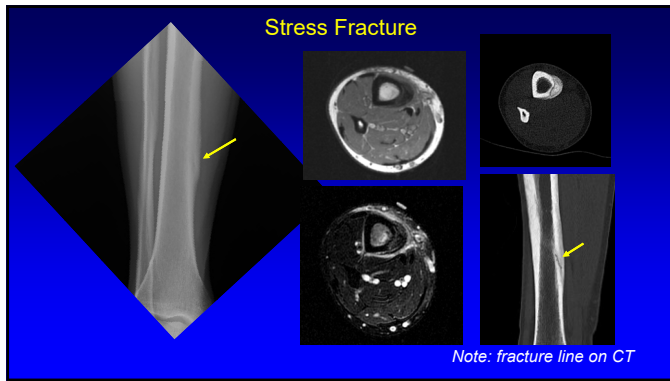
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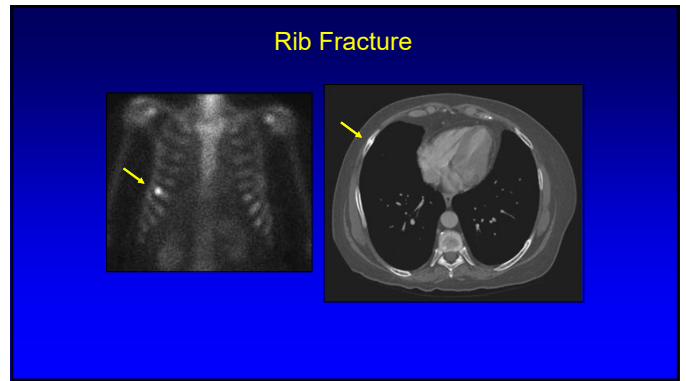
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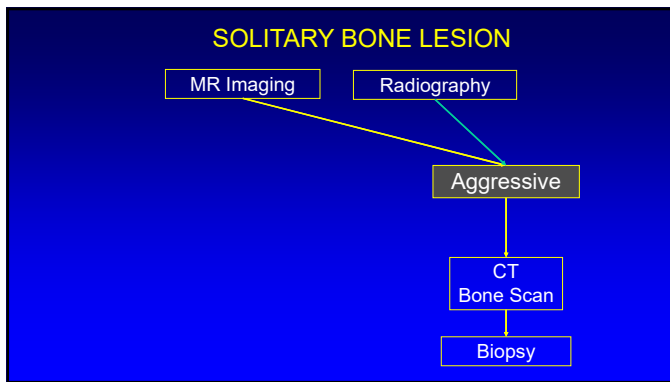
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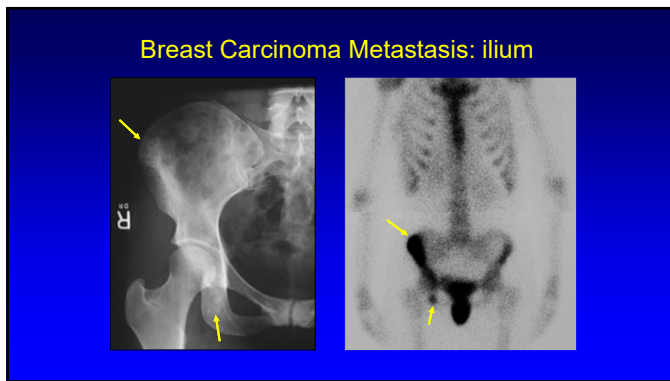
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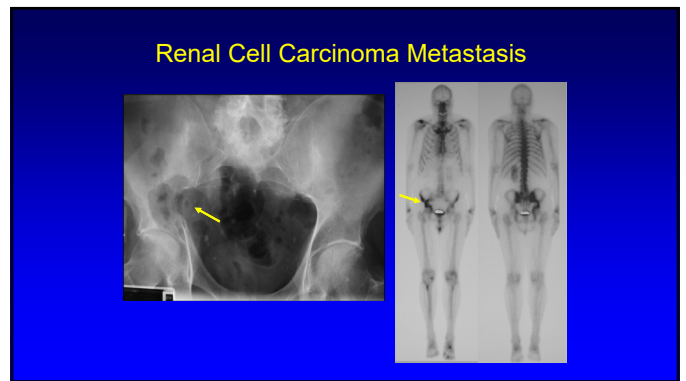
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- ### Solitary Bone Lesion: Aggressive Lesion
- Bone scan:
 - Multiplicity (differential)
 - Safest site of biopsy
 - Which site to biopsy (area of increased uptake)
 - CT: safest route of biopsy
 - MRI: extent

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Take Home Points

- MRI:
 - Sensitive but non-specific
 - Gadolinium: cyst versus solid
 - Radiographic correlation essential
- Radiography and CT:
 - Sclerotic well-defined border: benign
 - Characterize mineralization
- Bone / PET scan: activity

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Thank you!



Syllabus on line and other educational material:
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