

Bone Tumors: In 1 Simple Chart

Bone Tumors In 1 Simple Chart

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with PowerPoint Interactivity

Overview slide Last slide viewed The Chart

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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma Osteomyelitis (Active) Mets (NB <5yo) <small>Cortical Desmoid (Helmis, DNT)</small>	ABC UBC CB FCD/NOF EG FD	Chondroid: Enchondroma Osseous: Osteoid Osteoma Osteoblastoma Osseous & Chondroid: Osteochondroma
20-40	Lymphoma Chondrosarcoma Fibrosarcoma/MFH Osteomyelitis (Active) ...Mets Surface OS Adamantinoma	GCT FD "Pitts Pit" <small>PHALANX: Enchon, Glomus Epidermoid, Felon GCTTS, Sarcoid Gout, Met (lung)</small>	Bone Infarct Enchondroma Stress Fracture Osteomyelitis (Chronic) <small>"Ivory Vertebra": Lymphoma, Paget, Met</small>
>40	Mets/Mult Myeloma Osteomyelitis (Active) 2° Osteosarc (>60)	Mets/MM FD	Mets/MM ("POEMS") Osteomyelitis (Chronic) Paget's

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Overview of this Presentation

- Why Bone Tumors are Intimidating
- Describing Bone Tumors
 - 1) Patient's Age
 - 2) "Aggressive"
 - Zone of Transition
 - Periosteal Reaction
 - 3) Matrix
 - 4) Location

Building the Bone Tumor Chart

Underlined Text = PowerPoint Interactivity

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Why Bone Tumors are Intimidating

- Bone Tumors are Rare

2009
1,500,000
New Cancer
Cases in
USA

NATIONAL CANCER INSTITUTE Annual Cancer Statistics Review, updated 5/29/09, p34
http://seer.cancer.gov/csr/1975_2006/results_merged/sect_01_overview.pdf

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Why Bone Tumors are Intimidating

- Bone Tumors are Rare

Radiologists in USA = 30,000
÷ 2,570

Bone Tumors 2,570 0.17%

Only 1-in-12 Radiologists will even see a Bone Tumor per year

NATIONAL CANCER INSTITUTE Annual Cancer Statistics Review, updated 5/29/09, p34
http://seer.cancer.gov/csr/1975_2006/results_merged/sect_01_overview.pdf

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Bone Tumors: Many Types

30!

GREENSPAN: OrthoRad 15.24

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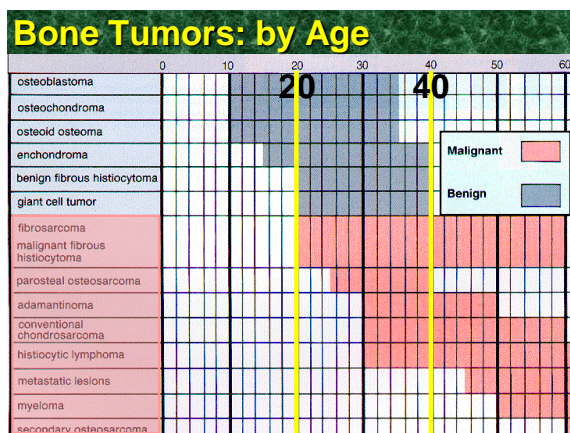
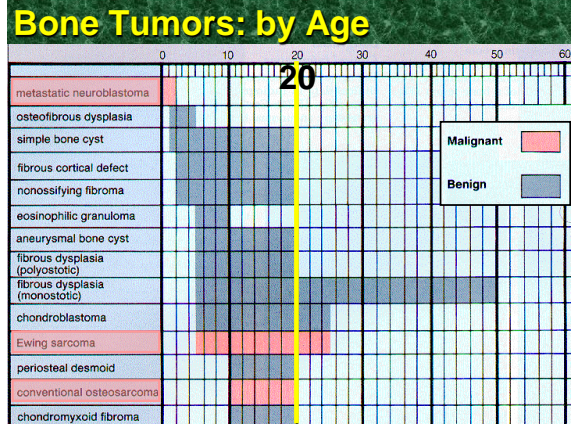
Bone Tumors: In 1 Simple Chart

Why Bone Tumors are Intimidating

- Bone Tumors are Rare 😊
Don't see enough to be confident 😞
- Many types of Bone Tumors 😞
- Have Confusing (similar) Names
"Osteosarcoma" 😞
"Osteochondroma" 😊
- Occur in children 😞
Essentially only 2 😊
bone malignancies occur in children

http://seer.cancer.gov/statfacts/html/bones.htm

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Overview of this Presentation

- Why Bone Tumors are Intimidating
- Describing Bone Tumors
 - 1) Patient's Age
 - <20
 - ✓ Osteogenic Sarcoma
 - ✓ Ewing Sarcoma
 - ✓ Everything else benign
 - 20-40
 - ✓ Could be anything
 - >40
 - ✓ Multiple Myeloma, Metastases

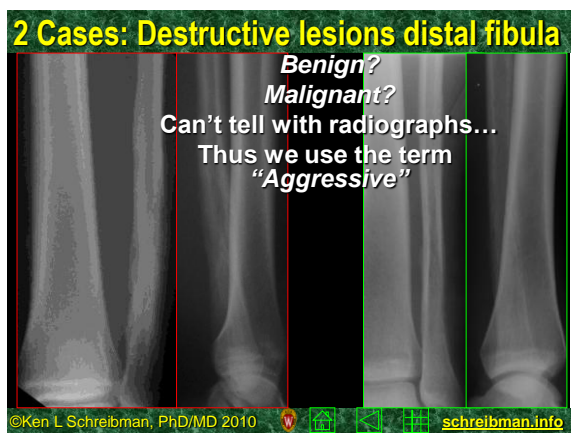
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Overview of this Presentation

- Why Bone Tumors are Intimidating
- Describing Bone Tumors
 - 1) Patient's Age
 - 2) "Aggressive" vs "Non-aggressive" (NOT "Malignant" vs "Benign")
 - Zone of Transition
 - Periosteal Reaction


Not everything that looks aggressive is malignant (e.g. osteomyelitis)

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Bone Tumors: In 1 Simple Chart

Aggressive vs Non-aggressive
Zone of Transition
Periosteal Reactions



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Aggressive vs Non-aggressive
Zone of Transition

Grow Slowly

- "Narrow"
- "Geographic"
- "Well Defined"

Can Outline Lesion with Sharp Pencil

✓ Sclerotic Margins ⇒ Grows VERY Slowly!



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Aggressive vs Non-aggressive
Zone of Transition


Grow Slowly

- "Narrow"
- "Geographic"
- "Well Defined"

Can Outline Lesion with Sharp Pencil

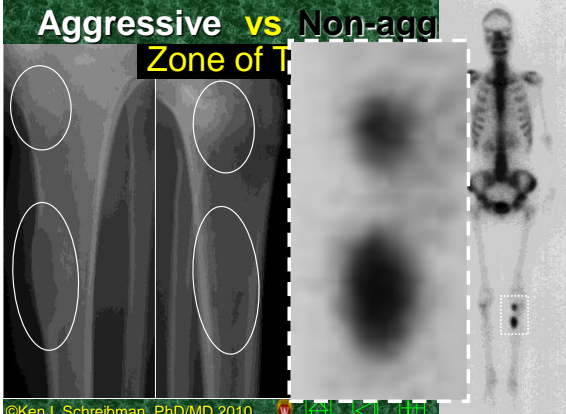
✓ Sclerotic Margins ⇒ Grows VERY Slowly!

Asymptomatic, incidental finding



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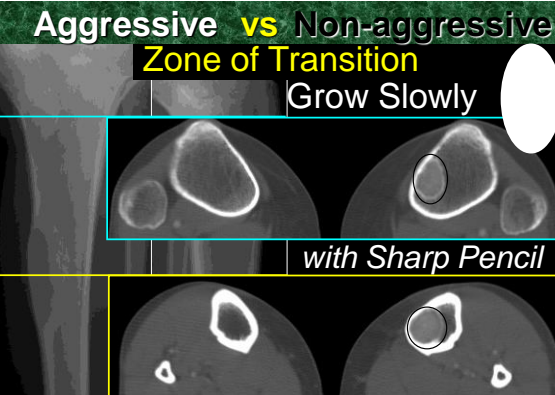
Aggressive vs Non-aggressive
Zone of Transition



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Aggressive vs Non-aggressive
Zone of Transition

Grow Slowly



with Sharp Pencil

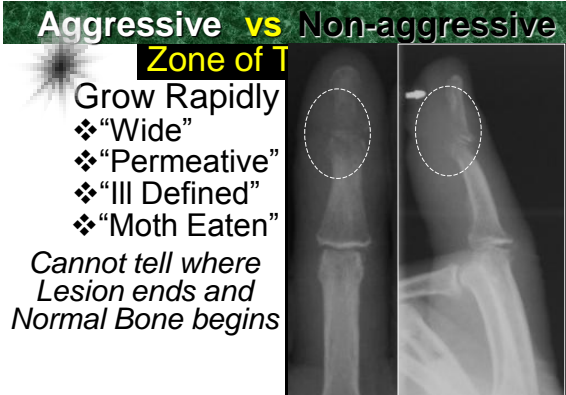
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Aggressive vs Non-aggressive
Zone of Transition

Grow Rapidly

- ❖ "Wide"
- ❖ "Permeative"
- ❖ "Ill Defined"
- ❖ "Moth Eaten"

Cannot tell where Lesion ends and Normal Bone begins



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Bone Tumors: In 1 Simple Chart

Aggressive vs Non-aggressive
Zone of Transition

Cannot tell where Lesion ends and Normal Bone begins

Abnormal

Normal

W.S 16yoF

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Aggressive vs Non-aggressive
Zone of Transition

Grows Rapidly

- ❖ "Wide"
- ❖ "Permeative"
- ❖ "Ill Defined"
- ❖ "Moth Eaten"

Cannot tell where Lesion ends and Normal Bone begins

Grows Slowly

- "Narrow"
- "Geographic"
- "Well Defined"

Can Outline Lesion with Sharp Pencil

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Aggressive vs Non-aggressive
Periosteal Reaction

Grows Rapidly

TOO COMPLICATED

Grows Slowly

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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Rapidly

- ❖ "Interrupted"

Grows Slowly

- "Solid"
- ✓ Smooth
- ✓ Continuous

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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Slowly

- "Solid"
- ✓ Smooth
- ✓ Continuous

Looks like Healing Callus

Bone Model

F.A 2moM

1m later

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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Slowly

- "Solid"
- ✓ Smooth
- ✓ Continuous

Stable over 1y

HPOA
Hypertrophic
Pulmonary
Osteo-
Arthropathy

V.T 49yoM

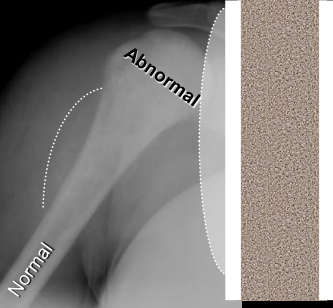
Bone Model

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Bone Tumors: In 1 Simple Chart

Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Rapidly
❖ "Interrupted"
May grow so rapidly it doesn't have time to ossify
(Unossified periosteum is not radiopaque)




The X-ray shows a humerus with a dashed line indicating an 'Abnormal' periosteal reaction that is interrupted and unossified. A 'Normal' periosteal reaction is also shown for comparison. The histology shows a porous, unossified bone structure.

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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Rapidly
❖ "Interrupted"
✓ Lamellated
✓ Onionskin
Grows... ossifies..
Grows... ossifies..
Grows... ossifies..

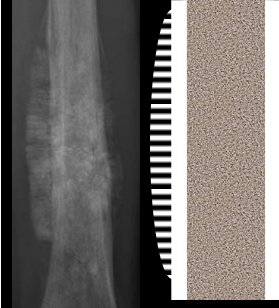


The X-ray shows a humerus with a dashed line indicating an 'Abnormal' periosteal reaction that is interrupted but shows some ossification. The histology shows a more solid, ossified bone structure.

Courtesy of James Choi, MD
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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Rapidly
❖ "Interrupted"
✓ Lamellated
✓ Onionskin
✓ Spiculated
✓ Hair-on-end

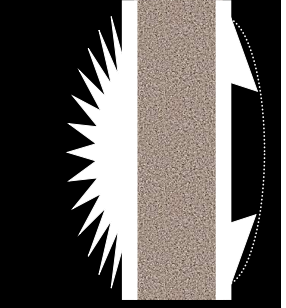


The X-ray shows a humerus with a dashed line indicating an 'Abnormal' periosteal reaction that is interrupted and shows spiculations and hair-on-end projections. The histology shows a porous, unossified bone structure.

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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Rapidly
❖ "Interrupted"
✓ Lamellated
✓ Onionskin
✓ Spiculated
✓ Sunburst
✓ Codman's Triangles
(Growing so rapidly, has time to ossify only at corners)




The X-ray shows a humerus with a dashed line indicating an 'Abnormal' periosteal reaction that is interrupted and shows sunburst patterns and Codman's triangles. The histology shows a porous, unossified bone structure.

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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Rapidly
❖ "Interrupted"
✓ Lamellated
✓ Onionskin
✓ Spiculated
✓ Sunburst
✓ Codman's Triangles
(Growing so rapidly, has time to ossify only at corners)




The X-ray shows a humerus with a dashed line indicating an 'Abnormal' periosteal reaction that is interrupted and shows sunburst patterns and Codman's triangles. The histology shows a porous, unossified bone structure.

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Aggressive vs Non-aggressive
Simplifying Periosteal Reaction

Grows Slowly
➤ "Solid"
✓ Smooth
✓ Continuous
Looks like Healing Callus



The X-ray shows a humerus with a dashed line indicating a 'Normal' periosteal reaction that is solid, smooth, and continuous. The histology shows a solid, continuous bone structure.

8w post Fx, ORIF =more mature callus
3w post Fx, ORIF =very early callus
S.C 15yoM
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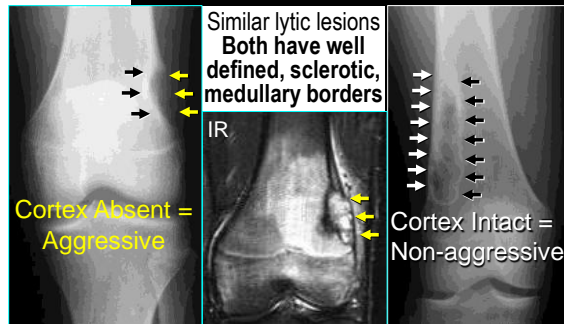
Bone Tumors: In 1 Simple Chart

Overview of this Presentation

- Why Bone Tumors are Intimidating
- Describing Bone Tumors
 - 1) Patient's Age
 - 2) "Aggressive" vs "Non-aggressive"
 - Zone of Transition
 - Periosteal Reaction
 - Cortical Destruction

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Aggressive vs Non-aggressive Cortical Destruction



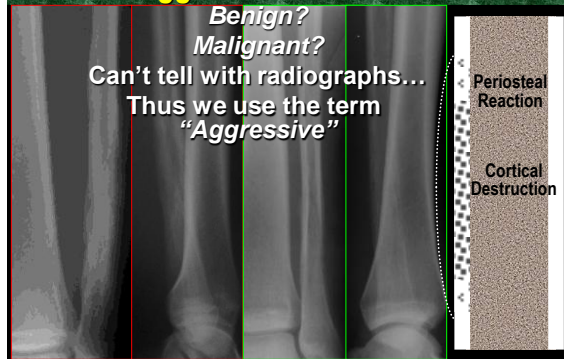
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Overview of this Presentation

- Why Bone Tumors are Intimidating
 - Describing Bone Tumors
 - 1) Patient's Age
 - 2) "Aggressive" vs "Non-aggressive"
 - Zone of Transition
 - Periosteal Reaction
 - Cortical Destruction
 - Soft Tissue Extension
- } Radiographs
} MRI

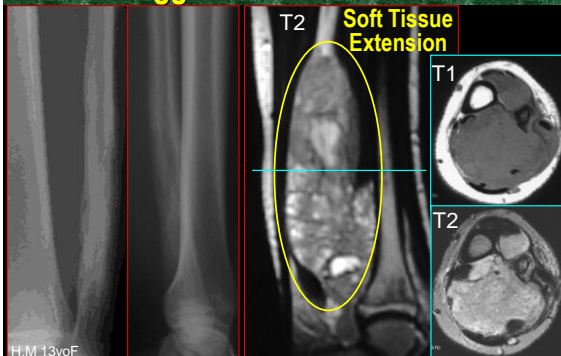
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2 Cases: Aggressive lesions distal fibula



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2 Cases: Aggressive lesions distal fibula



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Active Osteomyelitis vs Chronic Osteo. Aggressive vs Non-aggressive



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Bone Tumors: In 1 Simple Chart


Bone Matrix: 4 Types

<p>⊙ Chondroid "rings & arcs"</p>  <p>Calcified Uterine Fibroid</p>	<p>☁ Osseous "cloud-like" "amorphous"</p>  <p>Myositis Ossificans</p>
<p>🧱 Fibrous "Ground Glass"</p> 	<p>○ None Purely Lytic <i>Not necessarily cystic</i></p>  <p>Multiple Myeloma</p>


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Bone Matrix: 4 Types

⊙ **Chondroid**
"rings & arcs"



Enchondroma

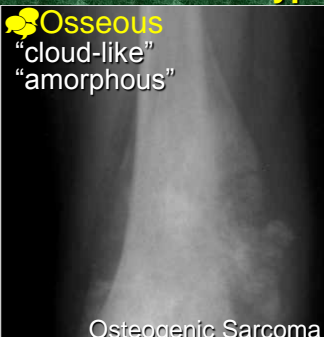


Calcified Uterine Fibroid

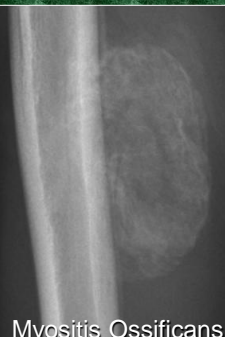
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Bone Matrix: 4 Types

☁ **Osseous**
"cloud-like"
"amorphous"



Osteogenic Sarcoma




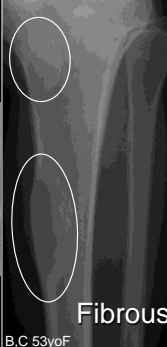
Myositis Ossificans

F.C 8yoF H.S 15yoM

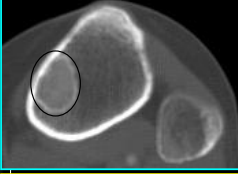
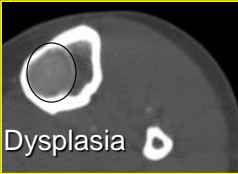
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Bone Matrix: 4 Types

🧱 **Fibrous**
"Ground Glass"

Fibrous Dysplasia

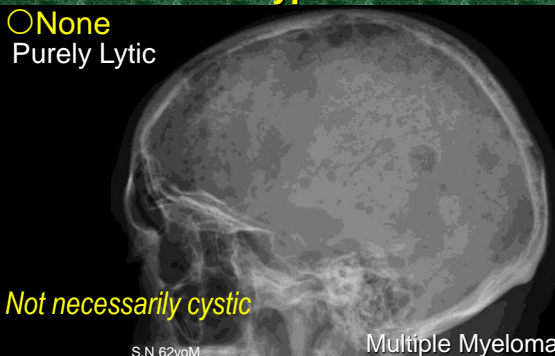



B.C 53yoF

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Bone Matrix: 4 Types

○ **None**
Purely Lytic



Not necessarily cystic


Multiple Myeloma

S.N 62yoM

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Bone Matrix: 4 Types

○ **None**
Purely Lytic

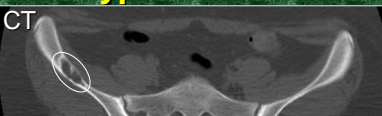


Not necessarily cystic


Intraosseous Lipoma

G.B 18yoF

CT



T1



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Bone Tumors: In 1 Simple Chart

Overview of this Presentation

- Why Bone Tumors are Intimidating
- Describing Bone Tumors
 - 1) Patient's Age
 - 2) "Aggressive"
 - 3) Matrix
 - 4) Location
 - ✓ Which bone?

Some tumors have propensity for certain bones

 - ✓ Which part of the bone?

*MANY tumors characteristically occur at the:
Epiphysis / Metaphysis / Diaphysis*

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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma		
20-40			
>40			

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Osteogenic Sarcoma

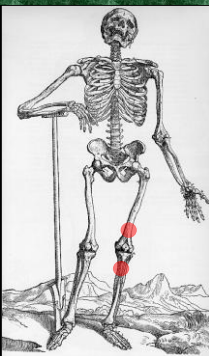
Pt Age: 10-20 years
(when growth spurt occurs)

Location: Metaphyseal
(where growth occurs)

- Distal Femur
- Proximal Tibia
(where most growth occurs)

Matrix: Osseous
"osteo-genic": makes bone

Need to eval for "skip mets"
MR entire length of bone



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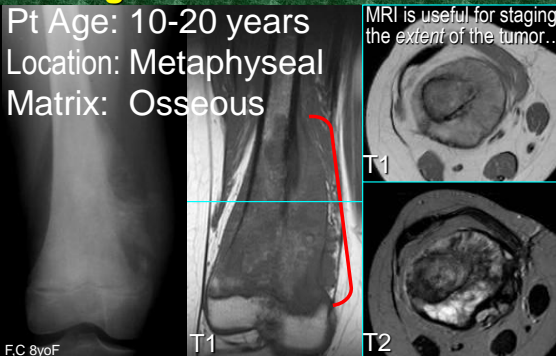
Osteogenic Sarcoma

Pt Age: 10-20 years

Location: Metaphyseal

Matrix: Osseous

MRI is useful for staging the extent of the tumor...



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Osteogenic Sarcoma

MRI is useful for staging the extent of the tumor...

Radiographs show us what we need to know to diagnose type of tumor!

- ✓ Skeletally immature
- ✓ Aggressive lesion
 - Wide zone of trans.
 - Sunburst periost.
- ✓ Osseous matrix
- ✓ Metaphyseal

Osteogenic Sarcoma!



F,C 8yoF

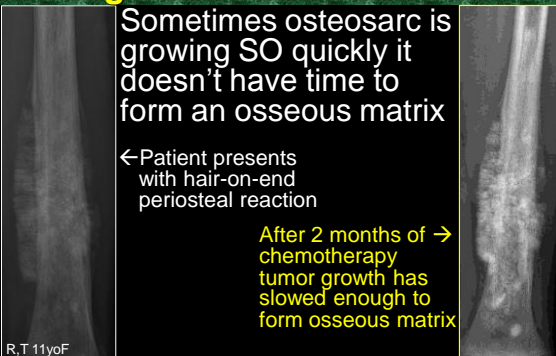
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Osteogenic Sarcoma

Sometimes osteosarc is growing SO quickly it doesn't have time to form an osseous matrix

← Patient presents with hair-on-end periosteal reaction

After 2 months of → chemotherapy tumor growth has slowed enough to form osseous matrix




R,T 11yoF

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Bone Tumors: In 1 Simple Chart

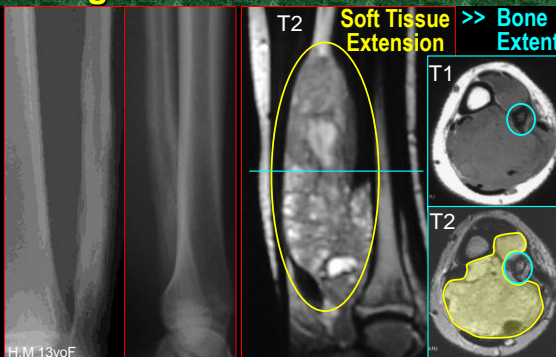
Ewing Sarcoma

Pt Age: 5-25 years
Tumor of *Bone Marrow*
Location: Diaphyseal
Flat Bones
Matrix: *Permeative*
 >Cortical Destruction
 >Aggressive
 Periosteal Reaction
Soft Tissue Extension
 >> Bone Extent




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Ewing Sarcoma



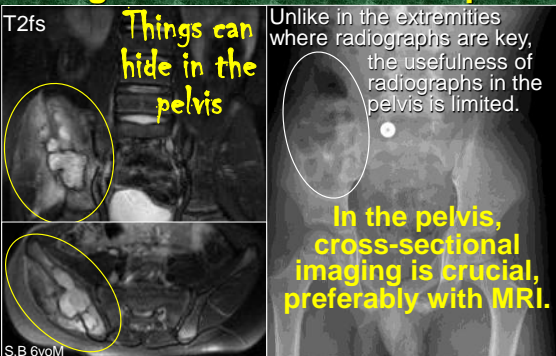
T2 Soft Tissue Extension >> Bone Extent
T1
T2
H.M 13yoF
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Ewing Sarcoma common in pelvis

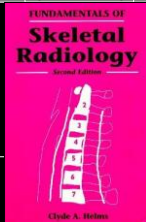


Air in colon
Air in colon?
Things can hide in the pelvis
3 months later...
S.B 6yoM
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Ewing Sarcoma common in pelvis

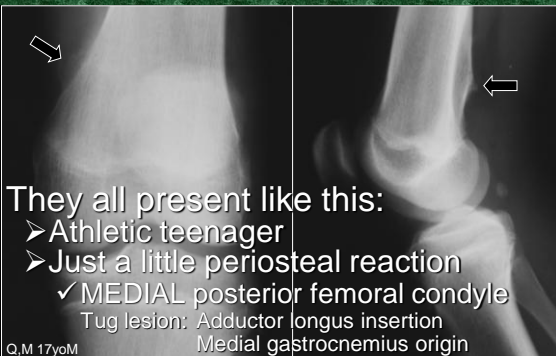


T2fs
Things can hide in the pelvis
Unlike in the extremities where radiographs are key, the usefulness of radiographs in the pelvis is limited.
In the pelvis, cross-sectional imaging is crucial, preferably with MRI.
S.B 6yoM
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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma Osteomyelitis (Active) Mets (NB <5yo) <small>Cortical Desmoid (Helms' DNT)</small>	Osteomyelitis resembles Tumor! Whenever doing a bone biopsy, ALWAYS send samples for BOTH surgical pathology AND microbiology culture!	
20-40		"Do Not Touch" lesions	
>40			

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Cortical Desmoid: Do Not Touch!



They all present like this:
 >Athletic teenager
 >Just a little periosteal reaction
 ✓MEDIAL posterior femoral condyle
 Tug lesion: Adductor longus insertion
 Medial gastrocnemius origin
 Q.M 17yoM
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Bone Tumors: In 1 Simple Chart

Cortical Desmoid: Do Not Touch!

Cross-sectional imaging doesn't really help

CT
T2fs

Just a little periosteal reaction
✓ MEDIAL posterior femoral condyle
Tug lesion: Adductor longus insertion
Medial gastrocnemius origin

Q,M 17yoM

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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma Osteomyelitis (Active) Mets (NB <5yo)	ALWAYS consider Lymphoma! Lymphoma is 29x more common than all Bone Tumors combined Lymphoma = 74,490	
20-40	Lymphoma	<p>Bone Tumors = 2,570 0.17%</p>	
>40	Mets/Mult Myeloma Osteomyelitis (Active) 2° Osteosarc (>60)	New Cancer Cases, USA, 2009	

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Lymphoma

Resembles Ewing

Tumor of bone marrow
Can be lytic or blastic

T1
T1
T2fs

R,H 22yoM

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Why Age is Important

Location: Diaphyseal
Soft tissue extension

Age: < 20
Ewing Sarcoma

Age: 20-40
Lymphoma

Age: > 40
Metastases
Multiple Myeloma

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Chondrosarcoma

Cartilage malignancy

Matrix: Chondroid

Location: Ends of bones
Pelvis
Soft tissues

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Chondrosarcoma

Cartilage malignancy

Matrix: Chondroid


©Chondroid
"rings&arcs"
✓ Radiographs

S,B 39yoM

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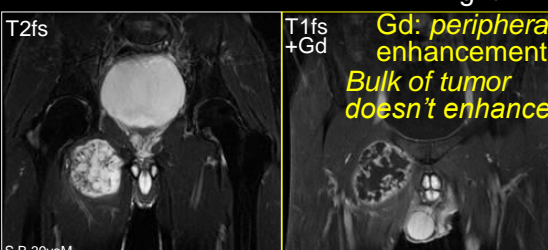
Bone Tumors: In 1 Simple Chart

Chondrosarcoma
 Cartilage malignancy ☉Chondroid
 Matrix: Chondroid
 ✓Radiographs
 ✓CT



S,B 39yoM
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Chondrosarcoma
 Cartilage malignancy ☉Chondroid
 Matrix: Chondroid
 ✓MRI
 T2: Bright



T2fs
 T1fs +Gd
 Gd: *peripheral* enhancement
 Bulk of tumor doesn't enhance


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Chondrosarcoma
 Cartilage malignancy
 Matrix: Chondroid

- Normal cartilage has no blood supply
 - ✓ Injured cartilage doesn't regrow
- Chondrosarcoma: poor blood supply
 - ✓ Shows very little Gd enhancement
 - ✓ Doesn't respond to chemotherapy
- Treatment: Complete tumor resection

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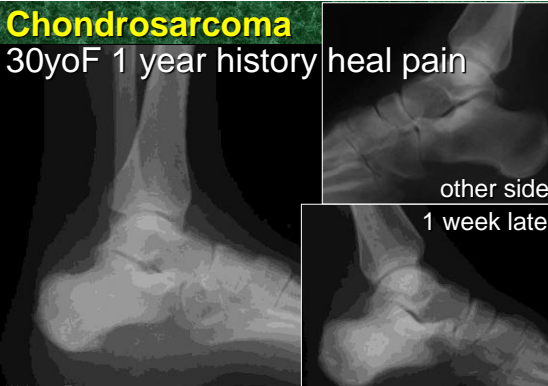
Chondrosarcoma



➤ Treatment: Complete tumor resection

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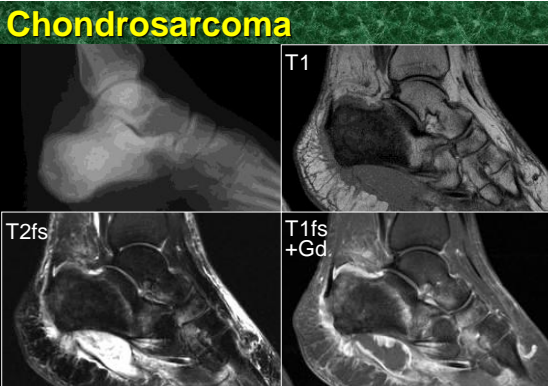
Chondrosarcoma
 30yoF 1 year history heel pain



other side
 1 week later

W,A 30yoF
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Chondrosarcoma



T1
 T2fs
 T1fs +Gd

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Bone Tumors: In 1 Simple Chart

age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma Osteomyelitis (Active) Mets (NB <5yo) <small>Cortical Desmoid (Heims: "DNT")</small>		
20-40	Lymphoma Chondrosarcoma Fibrosarcoma/MFH		
>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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Fibrosarcoma

Malignant Fibroblastic Cells
Malignant Fibrous Histiocytoma (MFH)
Pt Age: > 20
May involve the bones

- ✓ Secondarily
- ✓ Primarily

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Fibrosarcoma

MRI is useful for staging the extent of the tumor...

T1 T2fs

FB 23yoF

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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma Osteomyelitis (Active) Mets (NB <5yo) <small>Cortical Desmoid (Heims: "DNT")</small>		
20-40	Lymphoma Chondrosarcoma Fibrosarcoma/MFH Osteomyelitis (Active) ...Mets Surface OS		
>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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Osteogenic Sarcoma

Pt Age: 10-20 years
Location: Metaphyseal
Matrix: Osseous
4 Subtypes:

- 1) Conventional
- 2) Telangiectatic
- 3) PERIosteal
- 4) PARosteal

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Osteogenic Sarcoma

- 1) Conventional
Pt Age: 10-20 years
Location: Metaphyseal
Matrix: Osseous
- 2) Telangiectatic
Highly vascular/bloody
Very aggressive
Nearly purely lytic
Usually present after pathologic fracture
→ Diffuse metastases

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Bone Tumors: In 1 Simple Chart

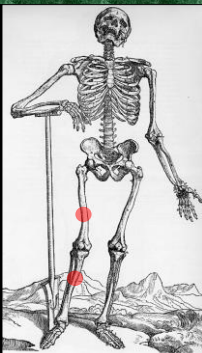
Osteogenic Sarcoma

Surface Osteosarcoma

Pt Age: 20-30 years
Good prognosis if
marrow not involved,
can resect tumor.
If spreads to marrow,
→ conventional OS.

3) PERIosteal

Looks like aggressive
periosteal reaction
Location: Long bones



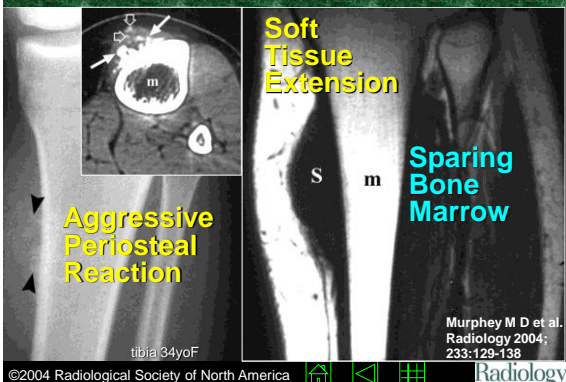
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Periosteal Osteosarcoma



Periosteal Osteosarcoma



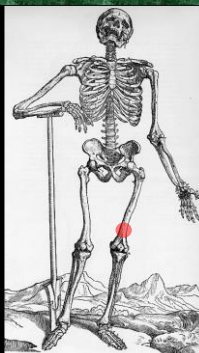
Osteogenic Sarcoma

Surface Osteosarcoma
Pt Age: 20-30 years
Good prognosis if
marrow not involved,
can resect tumor
If spreads to marrow,
→ conventional OS.

3) PERIosteal

Looks like aggressive
periosteal reaction

4) PARosteal



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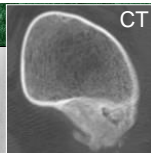
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Osteogenic Sarcoma

Surface Osteosarcoma

4) PARosteal

Pt Age: 20-30 years
Location: **Back of Femoral Condyles**
Arise from cortex,
grow outward
Do NOT contain normal marrow
(As opposed to osteochondroma)



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Osteogenic Sarcoma



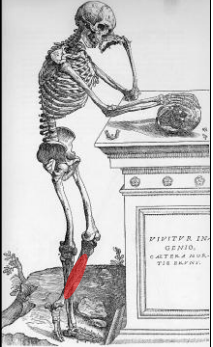
Bone Tumors: In 1 Simple Chart

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>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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Adamantinoma



➤VERY RARE
0.1% Primary Bone Tumors
Pt Age: 30-50
Matrix: *Permeative*
Location: **TIBIA** (90%)
✓ Diaphyseal
✓ Anterior Cortex
✓ Soft Tissue Mass:
Likely Malignant



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Adamantinoma



➤VERY RARE
0.1% Primary Bone Tumors
Pt Age: 30-50
Matrix: *Permeative*
Location: **TIBIA** (90%)
✓ Diaphyseal
✓ Anterior Cortex
✓ Soft Tissue Mass:
Likely Malignant

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Adamantinoma

➤VERY RARE
0.1% Primary Bone Tumors
Pt Age: 30-50
Matrix: *Permeative*
Location: **TIBIA** (90%)
✓ Diaphyseal
✓ Anterior Cortex
✓ Soft Tissue Mass:
Likely Malignant

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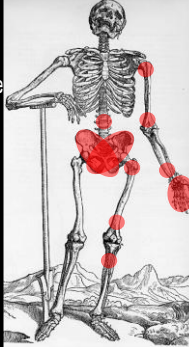
Bone Tumors: In 1 Simple Chart

age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
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20-40	Lymphoma Chondrosarcoma Fibrosarcoma/MFH Osteomyelitis (Active) ...Mets Surface OS Adamantinoma		
>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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A) Aneurysmal Bone Cyst

Pt Age: < 20
Matrix: None (Cyst)
Only tumor named for x-ray appearance
Aneurysmal & Cystic
"AVM of Bone"
✓MRI: fluid/fluid level
Location: Metaphyseal
Posterior Spine
Hands
Pelvis



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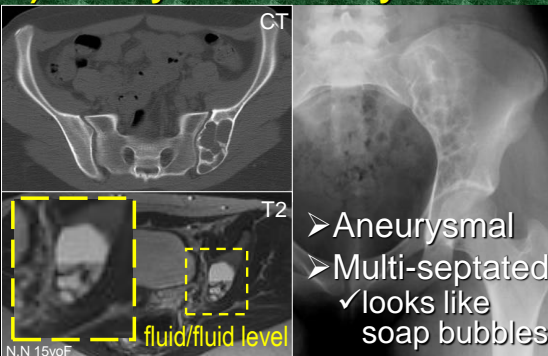
A) Aneurysmal Bone Cyst



- Aneurysmal
- Multi-septated
- ✓ looks like soap bubbles

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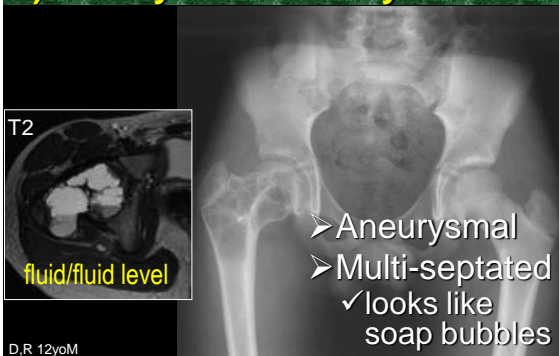
A) Aneurysmal Bone Cyst



- Aneurysmal
- Multi-septated
- ✓ looks like soap bubbles

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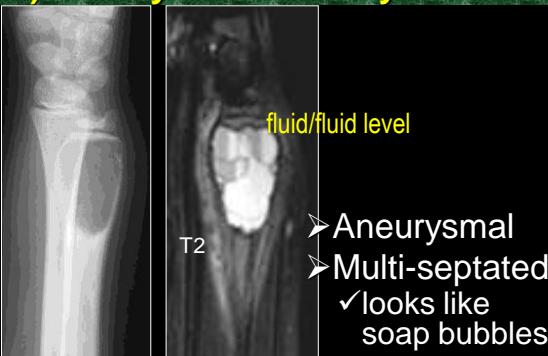
A) Aneurysmal Bone Cyst



- Aneurysmal
- Multi-septated
- ✓ looks like soap bubbles

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A) Aneurysmal Bone Cyst



- Aneurysmal
- Multi-septated
- ✓ looks like soap bubbles

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Bone Tumors: In 1 Simple Chart

B) Unicameral (Simple) Bone Cyst

Uni-cameral: Latin "one" - "chamber"
(in US we have bi-cameral legislature)

Pt Age: < 20

Matrix: None (True Cyst)

Location: **Metaphyseal**

>50% Proximal Humerus

20-30% Proximal Femur

50% - Incidental Finding

50% - Pathologic Fx

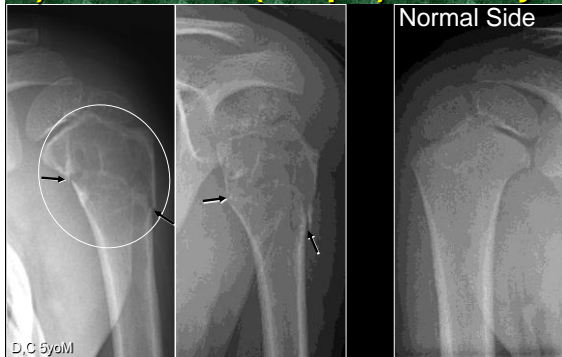
✓ "Fallen Fragment"



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B) Unicameral (Simple) Bone Cyst



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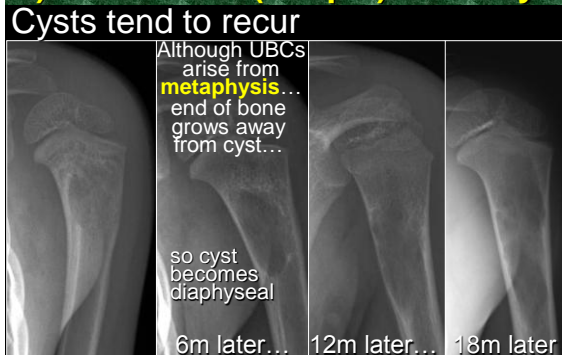
B) Unicameral (Simple) Bone Cyst



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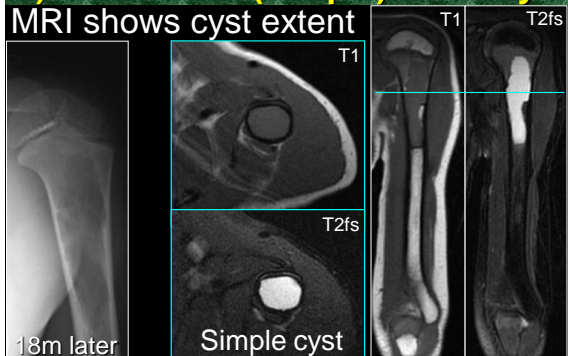
B) Unicameral (Simple) Bone Cyst



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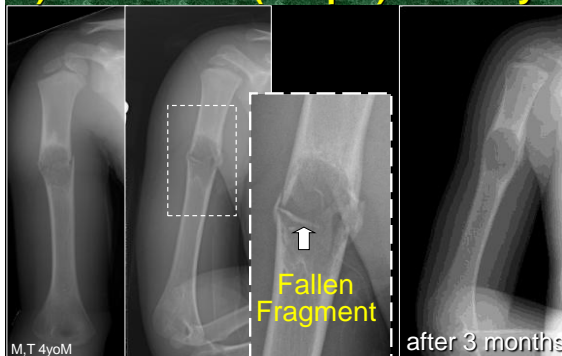
B) Unicameral (Simple) Bone Cyst



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B) Unicameral (Simple) Bone Cyst

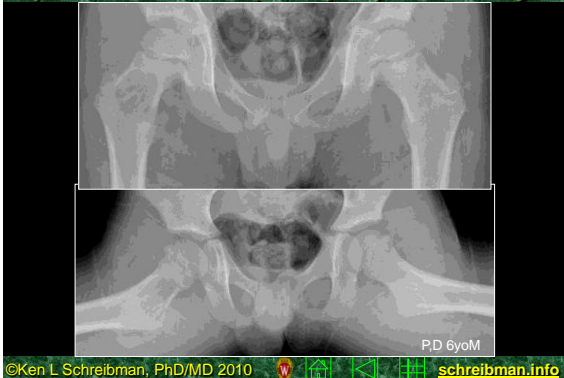


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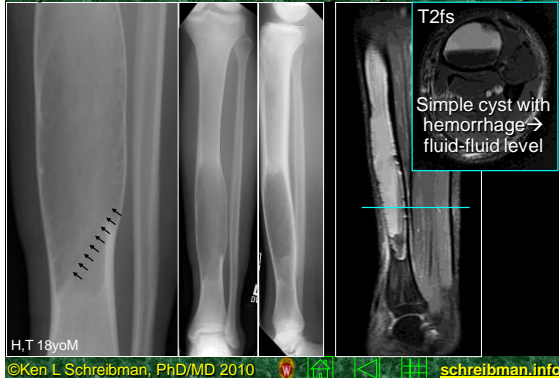
Bone Tumors: In 1 Simple Chart

B) Unicameral (Simple) Bone Cyst



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B) Unicameral (Simple) Bone Cyst



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C) Chondroblastoma

Pt Age: **Skeletally immature**

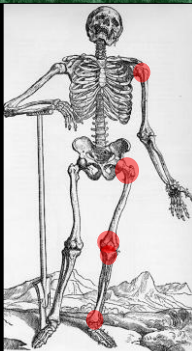
Location: **Epiphyseal**

Matrix: *Chondroid*
(No matrix if not calcified)

Benign...

Aggressive appearance!

- Periosteal Reaction
- Surrounding Edema
 - ✓ Bone Marrow
 - ✓ Soft Tissues



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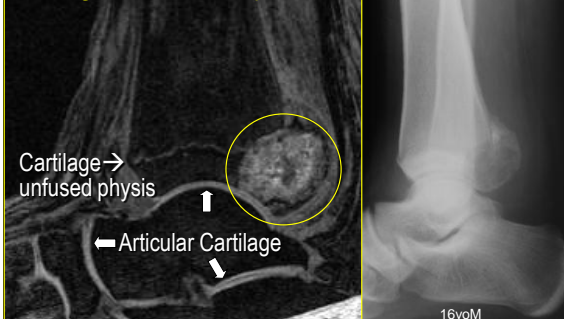
C) Chondroblastoma



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C) Chondroblastoma

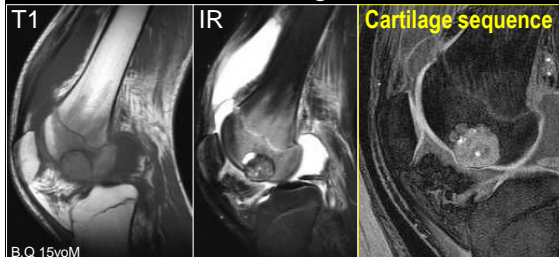
Cartilage-sensitive sequence



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C) Chondroblastoma

- ✓ Epiphyseal mass, skeletally immature
- ✓ Aggressive appearance
 - Edema in surrounding marrow & tissues



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Bone Tumors: In 1 Simple Chart

D) Fibrous Cortical Defect Non-Ossifying Fibroma (NOF)

THE most common bone lesion

- Occurs up to 40% ALL children (75% occur 10 – 20 years old)
- Regress after skeletal maturity

Asymptomatic, incidental finding (e.g. on knee MR for ACL tear)

If >50% bone diameter → Fx

Location: Metaphysis
Femur & Tibia



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D) Fibrous Cortical Defect Non-Ossifying Fibroma (NOF)

Radiographic appearance:
Characteristic & Diagnostic

- If asymptomatic, no further workup is needed
- ✓ **Eccentric, sub-cortical**
- Cortex thinned, expanded
- ✓ **Sclerotic margin**
- Scalloped
- ✓ **Multi-loculated**



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D) Fibrous Cortical Defect Non-Ossifying Fibroma (NOF)



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D) Fibrous Cortical Defect Non-Ossifying Fibroma (NOF)



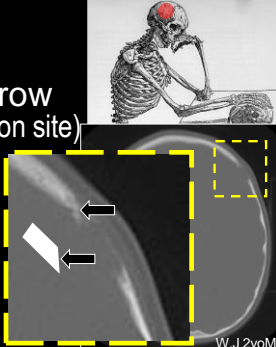
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Bone Tumors: In 1 Simple Chart

E) Eosinophilic Granuloma
Non-neoplastic proliferation histiocytes
Langerhans Cell Histiocytosis
 Pt Age: typically <12yo (can occur young adult)
 > EG (aka Histiocytosis X)
 > Hand-Schuller-Christian (>3yo)
 ✓ Triad: skull lesions, exophthalmos, DI
 > Letterer-Siwe (<3yo, fatal)
 Pain, swelling, fever, ↑ESR, eosinophilia
 > Diff.Dx: Osteomyelitis (Ewing, Lymph/Leuk)
 Bone lesions may resolve spontaneously
 Often get Dx Bx/curettage. Steroids?

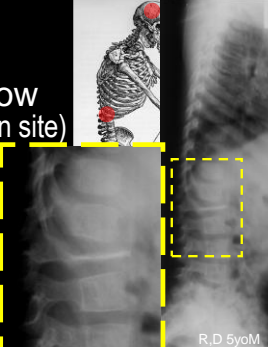
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E) Eosinophilic Granuloma
 Pt Age: < 12
 Matrix: None
 Location: Bone Marrow
 > Skull (most common site)
 ✓ Sharp
 ✓ Punched-out
 ✓ "Beveled Edge"
 due to uneven involvement of outer/inner table




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E) Eosinophilic Granuloma
 Pt Age: < 12
 Matrix: None
 Location: Bone Marrow
 > Skull (most common site)
 > Spine
 ✓ **vertebra plana**
 Can regrow height with treatment!




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E) Eosinophilic Granuloma
 Pt Age: < 12
 Matrix: None
 Location: Bone Marrow
 > Skull (most common site)
 > Spine
 > Pelvis
 ✓ supra-acetabulum
 > Long bones (Femur)
 ✓ diaphysis



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E) Eosinophilic Granuloma
 Pt Age: < 12
 Matrix: None
 Location: Bone Marrow
 > Skull (most common site)
 > Spine
 > Pelvis
 ✓ supra-acetabulum
 > **Long bones (Femur)**
 ✓ diaphysis



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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma Osteomyelitis (Active) Mets (NB <5yo) <small>Cortical Desmoid (Helms: "DNT")</small>	ABC UBC CB FCD/NOF EG FD	
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>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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Bone Tumors: In 1 Simple Chart

F) Fibrous Dysplasia

Pt Age: <30 years

Location: Any bone

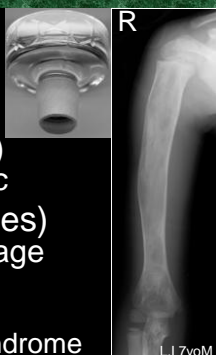
Matrix: Ground Glass

Monostotic (one bone)

- Usually asymptomatic

Polyostotic (many bones)

- Presents at younger age
- Usually symptomatic
- Syndromes
 - ✓ McCune–Albright syndrome



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McCune–Albright syndrome

Triad

- Polyostotic Fibrous Dysplasia
- ✓ Unilateral



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McCune–Albright syndrome

Triad

- Polyostotic Fibrous Dysplasia
 - ✓ Unilateral
- Endocrine Abnormalities
 - ✓ Precocious puberty in girls
- café au lait spots
 - ✓ “coast of Maine”

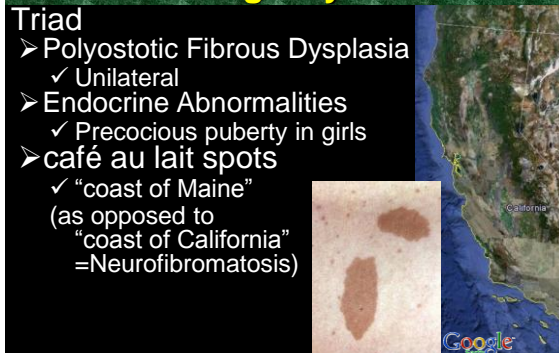


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McCune–Albright syndrome

Triad

- Polyostotic Fibrous Dysplasia
 - ✓ Unilateral
- Endocrine Abnormalities
 - ✓ Precocious puberty in girls
- café au lait spots
 - ✓ “coast of Maine”
 - (as opposed to “coast of California” = Neurofibromatosis)



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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
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>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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Bone Tumors: In 1 Simple Chart

age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	Osteosarcoma Ewing Sarcoma Osteomyelitis (Active) Mets (NB <5yo) <small>Cortical Desmoid (Helms: "DNT")</small>	ABC UBC CB FCD/NOF EG FD	
20-40	Lymphoma Chondrosarcoma Fibrosarcoma/MFH Osteomyelitis (Active) ...Mets Surface OS Adamantinoma	GCT	
>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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Giant Cell Tumor

Pt Age: Skeletally Mature
(as opposed to Chondroblastoma)

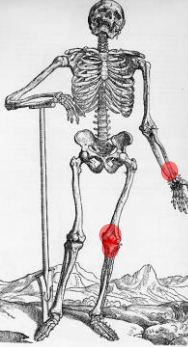
- THE most common bone tumor in young adults 20-40yo

Location: **Subarticular**

- Arise from Metaphysis
- Extend across fused Growth Plate

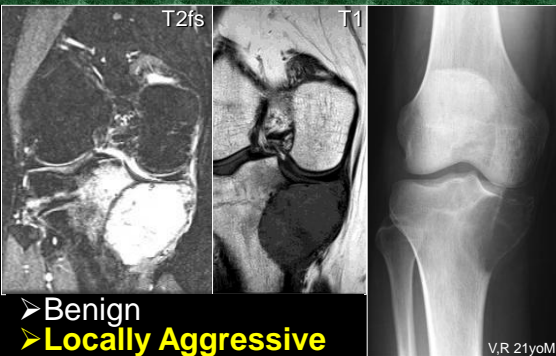
Matrix: Purely Lytic

- Narrow Zone of Transition
- **NO SCLEROTIC MARGIN**



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Giant Cell Tumor

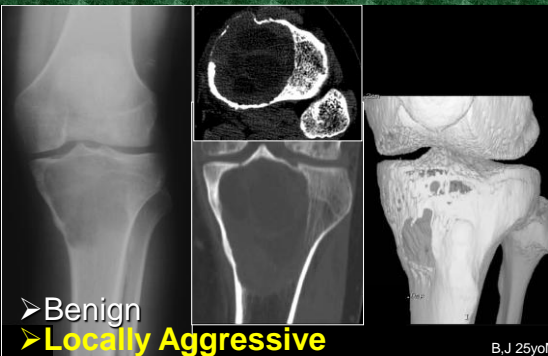


➢ Benign
➢ **Locally Aggressive**

V,R 21yoM

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Giant Cell Tumor




➢ Benign
➢ **Locally Aggressive**

B,J 25yoM

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Giant Cell Tumor




➢ Solid & Cystic components
➢ Histologically, similarities GCT ↔ ABC

B,J 25yoM

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Giant Cell Tumor

Pt Age: Skeletally Mature
Physis fused



16yoM

18yoM

C,A 18yoM

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Bone Tumors: In 1 Simple Chart


Why Age is Important

Location: **Subarticular**
Matrix: Purely Lytic

Age: < 20 (skeletally immature)
Chondroblastoma

Age: 20-40 (skeletally mature)
Giant Cell Tumor

Age: > 40
Metastases
Multiple Myeloma

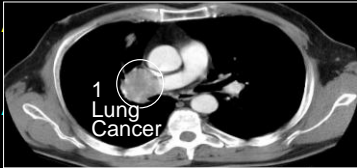


V,R 21yoM


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Why Age is Important

Location: **Subarticular**
Matrix: Purely Lytic



Age: > 40
Metastases
Multiple Myeloma



C,G 61yoM

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>40	Mets/Mult Myeloma Osteomyelitis (Active) 2°Osteosarc (>60)		

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Herniation Pit of the Femoral Neck
aka "Pitt's Pit"

Michael Pitt, et.al. AJR 1982
vol 138, 6, p 1115-1121

- ✓ Round lucency
- ✓ Thin sclerotic rim
- ✓ Proximal Superior
 - Anterior



courtesy Donna Blankenbaker, MD

Incidental finding 1/3 patients
Mechanical, not neoplastic

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Lytic Lesion: Distal Phalanx

- ✓ Enchondroma
 - Lytic: phalanges
 - Pathologic Fx
- ✓ Glomus Tumor
 - Nail bed
 - ↔ Dorsal
- ✓ Epidermoid Inclusion Cyst
 - Puncture
 - ↔ Volar
- ✓ Giant Cell Tumor
- ✓ Tendon Sheath (Localized PVNS)
- ✓ Felon (Fingertip infection)
- ✓ Sarcoidosis
- ✓ Gout
- ✓ Metastases
 - Lung

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Bone Tumors: In 1 Simple Chart

Enchondroma

Benign rests of hyaline cartilage

- Common
 - ✓ Often discovered incidentally
- Typically asymptomatic
- 50% small tubular bones
 - ✓ Mostly lytic
 - ❖ Pathologic Fracture



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Glomus Tumor

Benign vascular tumor (neuromyoarterial apparatus)

Subungual, erodes bone

↳ Dorsal cortex distal phalanx

Age: 30 – 50 (3x>)

Triad

- Sensitivity to cold
- Localized tenderness
- Severe intermittent pain



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Glomus Tumor

↳ Dorsal cortex distal phalanx



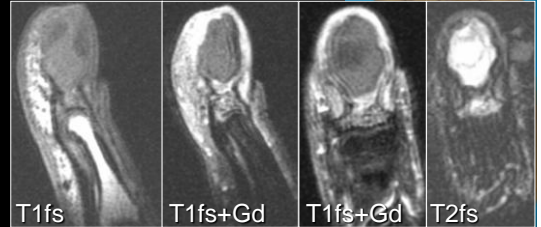
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Epidermoid Inclusion Cyst

Implantation of epidermal elements

- Amputation
- Puncture (seamstress)

↳ Volar cortex distal phalanx



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Epidermoid Inclusion Cyst



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Gout



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POEMS syndrome

Polyneuropathy
Organomegaly
Endocrinopathy
Monoclonal gammopathy
Skin abnormalities
(Sclerotic bone lesions)
✓ Medial Clavicle
✓ Pelvis

http://www.scielo.br/scielo.php?pid=S0100-39842008000600002&script=sci_arttext&lng=en

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Paget's Disease

Becoming less common
Three Phases
 > Lytic: Wedge with sharp borders
 ✓ "Blade of grass", "Candle flame"
 > Mixed: Bone destruction & formation
 > Blastic: Cortical/Trabecular thickening

2 Osteosarcoma

APR 5, 1997 B.S 83yoF

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Ivory Vertebra

- > Lymphoma
- > Paget
- > Blastic Met
 - ✓ Breast
 - ✓ Prostate
- > Treated Met
- > Chronic Osteo
- > (Sarcoid) rare

K.K. 76yoM

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Bone Tumors: In 1 Simple Chart

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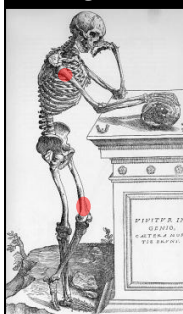
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Enchondroma

Benign rests of hyaline cartilage

- Common
 - ✓ Often discovered incidentally
 - Typically asymptomatic
 - ✓ can be painful (40%)
 - ❖ Pathologic Fracture
 - 50% long tubular bones
 - ✓ Metaphyseal
 - ✓ **Chondroid matrix**



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 - 50% small tubular bones
 - ✓ Mostly lytic



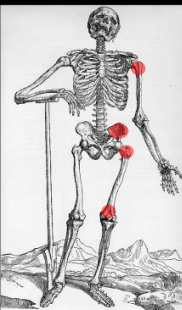
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Chondrosarcoma

Malignant tumor of cartilage

- ✓ Pelvis
- ✓ Ends of bones
- **Presents with PAIN!**
 - ✓ 99% Painful
 - ✓ 40% Enchondromas
- Low Grade difficult to differentiate from benign
 - ☹ Radiologist
 - ☹ Pathologist
- 30% - Low Grade



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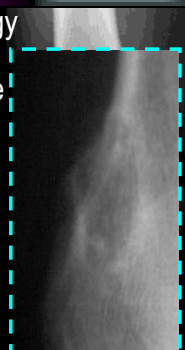
Chondrosarcoma

Histopathology

- 1: Low Grade
- 2: Intermediate
- 3: High Grade

Cellularity:
markedly
increased

Nuclei Size:
markedly
increased

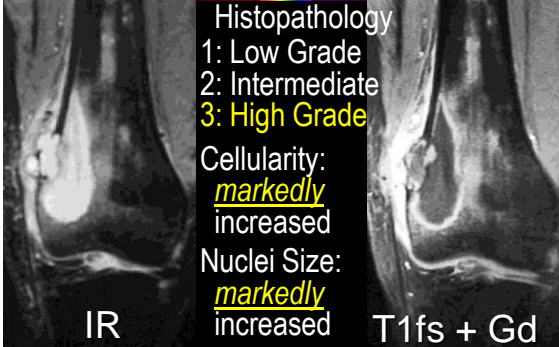


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Bone Tumors: In 1 Simple Chart

Chondrosarcoma



Histopathology
 1: Low Grade
 2: Intermediate
 3: High Grade

Cellularity: **markedly** increased

Nuclei Size: **markedly** increased

IR T1fs + Gd

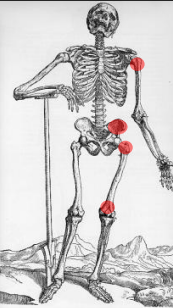
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Chondrosarcoma

Histopathology
 1: Low Grade
 2: Intermediate
 3: High Grade

Cellularity: **slightly** increased

Nuclei Size: **slightly** increased



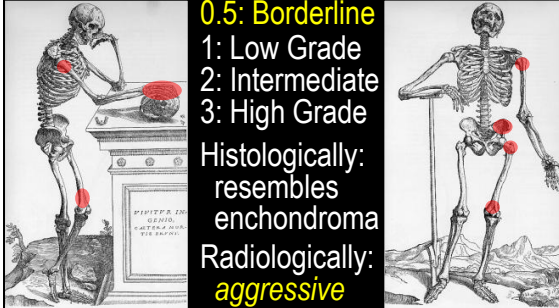
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Enchondroma Chondrosarcoma

Histopathology
 0.5: **Borderline**
 1: Low Grade
 2: Intermediate
 3: High Grade

Histologically: resembles enchondroma


Radiologically: **aggressive**



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Enchondroma Chondrosarcoma

T1 T2fs



B.B. 42yoF


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Enchondroma Chondrosarcoma

How do you distinguish between them?
 Very difficult, sometimes you can't ☹️

Clues:

- Some Enchon Hot on BS
- All Chondrosarc Hot on BS



This pt had pain uncontrollable with oral narcotics


40% Enchon Painful

All Chondrosarc Painful (never incidental)

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Enchondroma Chondrosarcoma

Pt was very happy with outcome!
 ✓She's now pain free
 ✓She's doesn't have cancer



This pt had pain uncontrollable with oral narcotics

Histopathology: No malignant cells
 So was this: Enchondroma? 0.5 Borderline Chondrosarcoma?

B.B. 42yoF

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Osteoid Osteoma (Osteoblastoma)

Pt Age: < 30

- Presents with PAIN!
 - ✓ 98% Painful
 - ✓ Night pain, Rx NSAID

Matrix: Lucent Nidus

Location:

- Diaphyseal
 - ✓ Surrounding Sclerosis
- Intra-capsular
 - ✓ No Sclerosis
- Posterior Elements (OB)
 - ✓ Painful Scoliosis



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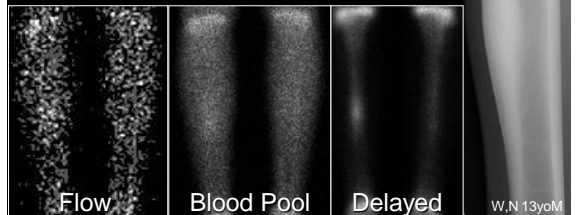
Osteoid Osteoma

Radiographs

- Cortical thickening

Bone Scan

- Hot all 3 phases



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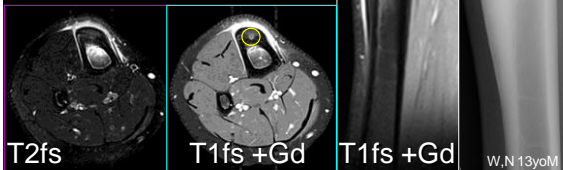
Osteoid Osteoma

Radiographs

- Cortical thickening

MR

- Edema
- Enhancement
- ±Nidus



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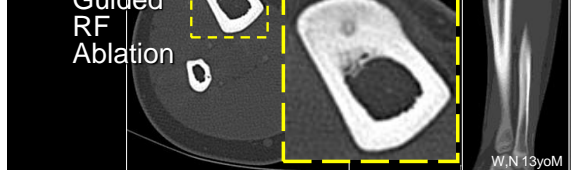
Osteoid Osteoma

CT: Gold Standard for OO

- Diagnosis
 - ✓ Lucent Nidus
 - ✓ Central Dot Calcium

➢ Rx

- ✓ CT Guided RF Ablation



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Bone Tumors: In 1 Simple Chart

Osteoblastoma (= Osteoid Osteoma)

Term osteoblastoma used for:

- Larger lesions (> ≈1cm)
- Lesion in spine posterior elements
- ✓ Painful scoliosis (Typically scoliosis is painless)



S,T 16yoM

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Osteoblastoma (= Osteoid Osteoma)



Bone Scan (Posterior)



SPECT (Axial)

S,T 16yoM

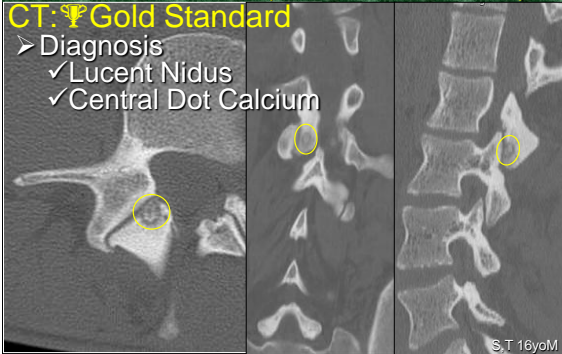
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Osteoblastoma (= Osteoid Osteoma)

CT: ⚡ Gold Standard

- Diagnosis
- ✓ Lucent Nidus
- ✓ Central Dot Calcium



S,T 16yoM

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Osteoblastoma



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Bone Tumors: In 1 Simple Chart

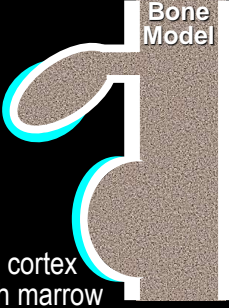
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Osteochondroma

Most Common Benign Neoplasm of Bone

- "Exostosis"
 - ✓ Pedunculated (stalk)
 - ✓ Sessile (flat)
- Cartilage Cap
 - ✓ seen only on MR
- Point away from joint
- **Continuity with underlying bone**
 - ✓ Cortex continuous with cortex
 - ✓ Marrow continuous with marrow




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PN 20yeF
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Bone Tumors: In 1 Simple Chart

Osteochondroma

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Osteochondroma

✓ Cortex continuous with cortex
✓ Marrow continuous with marrow

K.J 11yoM

Osteochondroma

Most Common Benign Neoplasm of Bone

Malignant Transformation to Chondrosarcoma

- Solitary: 1%
- Multiple Hereditary Exostoses (MHE): 10-30%
- Signs of malignant transformation:
 - ✓ Growth of lesion after skeletal maturity (can grow during childhood)
 - ✓ Cartilage cap > 1cm (can be 2-3cm during childhood)

Osteochondroma

Malignant Transformation to Chondrosarcoma

Hot on BS
c/w Chondrosarc

Chondroid matrix
Aggressive appearance

Funny shaped femurs
MHE?

Osteochondroma

Malignant Transformation to Chondrosarcoma

T2fs T1fs+Gd

CT: Tissue Window CT: Bone Window

Bone Tumors: In 1 Simple Chart

Osteochondroma

Most Common Benign Neoplasm of Bone
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Can cause mechanical problems

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Osteochondroma

Can cause mechanical problems

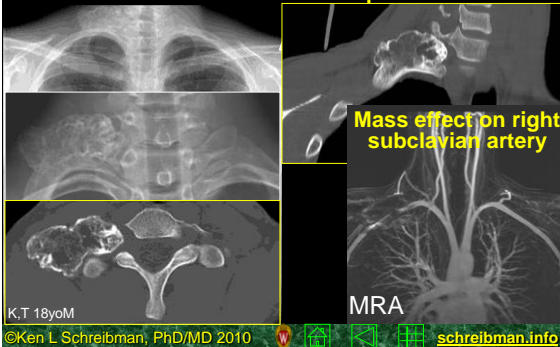
Multiple miscarriages



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Osteochondroma

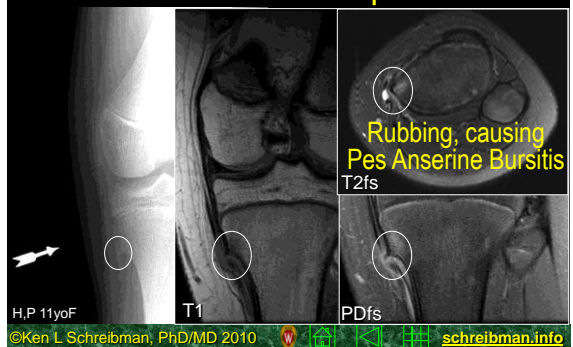
Can cause mechanical problems



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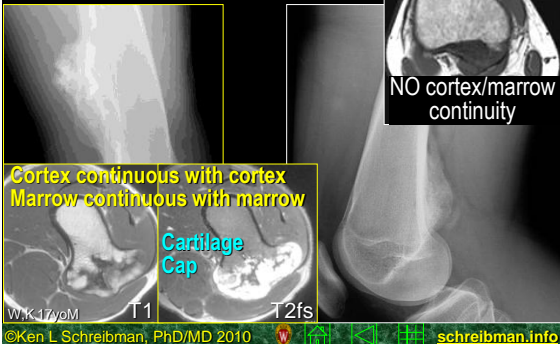
Osteochondroma

Can cause mechanical problems



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Osteochondroma vs PARosteal Osteosarcoma



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age	AGGRESSIVE	NON-aggressive Lytic	NON-aggressive Blastic
<20	<u>Osteosarcoma</u> <u>Ewing Sarcoma</u> Osteomyelitis (Active) Mets (NB <5yo) <small>Cortical Desmoid (Femur: DNT)</small>	<u>ABC</u> <u>UBC</u> <u>CB</u> <u>FCD/NOF</u> <u>EG</u> <u>FD</u>	Chondroid: <u>Enchondroma</u> Osseous: <u>Osteoid Osteoma</u> <u>Osteoblastoma</u> Osseous & Chondroid: <u>Osteochondroma</u>
20-40	<u>Lymphoma</u> <u>Chondrosarcoma</u> <u>Fibrosarcoma/MFH</u> Osteomyelitis (Active) ...Mets <u>Surface OS</u> <u>Adamantinoma</u>	<u>GCT</u> <u>FD</u> "Pitts Pit" <small>PHALANX: Enchond, Glomus Epidermoid, Felon GCTTS, Sarcoid Gout, Met(lung)</small>	<u>Bone Infarct</u> <u>Enchondroma</u> <u>Stress Fracture</u> <u>Osteomyelitis (Chronic)</u> <small>"Ivory Vertebra": Lymphoma, Paget, Met</small>
>40	Mets/Mult Myeloma Osteomyelitis (Active) <u>2°Osteosarc (>60)</u>	Mets/MM <u>FD</u>	Mets/MM ("POEMS") Osteomyelitis (Chronic) Paget's

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