

# Benign Bone Forming Tumors

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# Osseous Lesions of Bone

## Benign

- Enostosis and related conditions
- Osteoma
- Osteoid Osteoma
- Osteoblastoma

## Malignant

- **Osteosarcoma**
  - Intramedullary
    - Conventional
      - Osteoblastic
      - Fibroblastic
      - Chondroblastic
    - Telangiectatic
    - Small Cell
    - Low Grade Intraosseous
  - Juxtacortical
    - Parosteal
    - Periosteal
    - High grade surface
  - Intracortical

# Osseous Lesions of Bone

- **Definition:** Characterized by the presence or production of bone and/or osteoid
- **Radiographically:** Mineralization

# Benign Osseous Lesions of Bone

- **Enostosis (Bone Island)**

- Solitary foci, spot or island of dense compact bone within the medullary cavity (within cancellous bone)
- Considered a hamartoma or developmental abnormality
- Usually found incidentally
- Patient is usually asymptomatic
- Rare in children

# Enostosis

- **Anatomic Sites:**
  - Any site
  - Most Common
    - Ribs
    - Spine
    - Pelvis

# Enostosis

- **Radiology**

- Round to oval dense osteoblastic area within the intramedullary canal usually with thorny, radiating spicules at margin that blend with surrounding trabeculae but are well defined
- May be attached to inner cortex
- 0.2 to 2 cm
- Often epiphyseal or metaphyseal
- Bone scan: Normal to mild increase in activity which helps differentiate an enostosis from a sclerotic bone metastasis





# Enostosis

- **Radiology:**

- May slowly increase or decrease in size
- Up to 25% increase in diameter over 6 months
- Differential Dx:
  - Osteoblastic Metastasis
  - Osteoma
  - Osteoid Osteoma
  - Low Grade Osteosarcoma
- Bone scan is best test to differentiate
- Follow up: 1, 3, 6, 12 mos; Biopsy if grows too rapidly

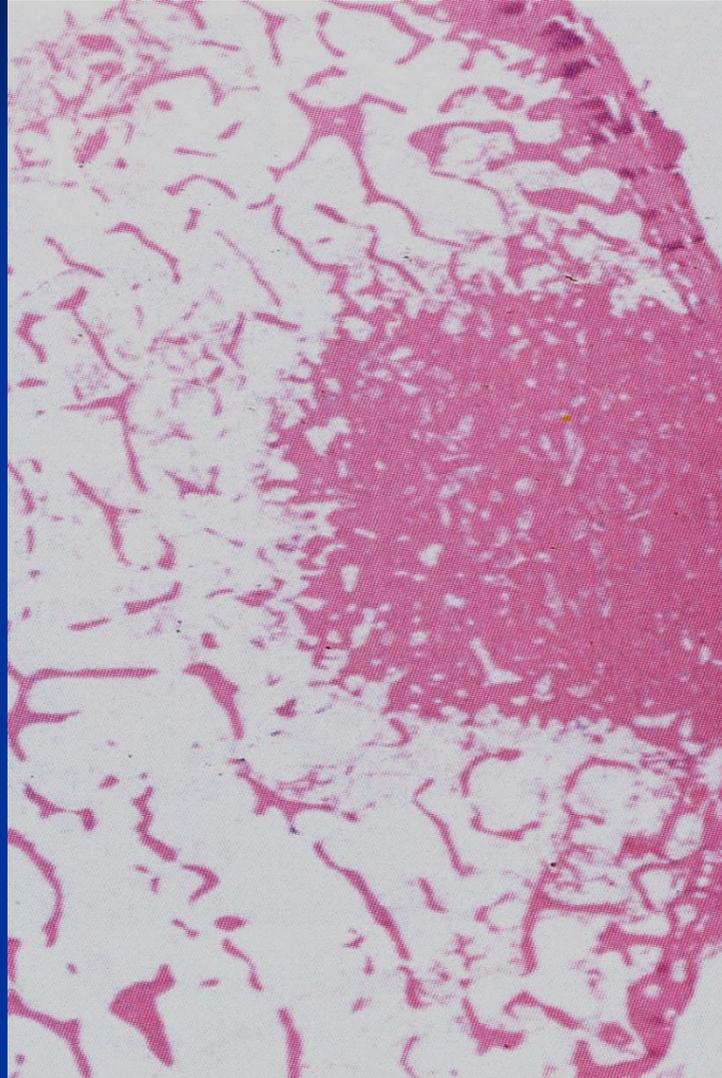
# Enostosis

- **Pathology:**
  - Intramedullary
  - Normal appearing **compact, lamellar (cortical) bone** with haversian canals within medullary bone
  - Thornlike projections at margins blend with surrounding trabeculae creating an irregular margin
  - **Haversian canals** with osteoblasts and osteoclasts (Howship's lacunae)
    - Features of active bone deposition and remodeling
  - Increased activity on bone scan reflects increased bone turnover

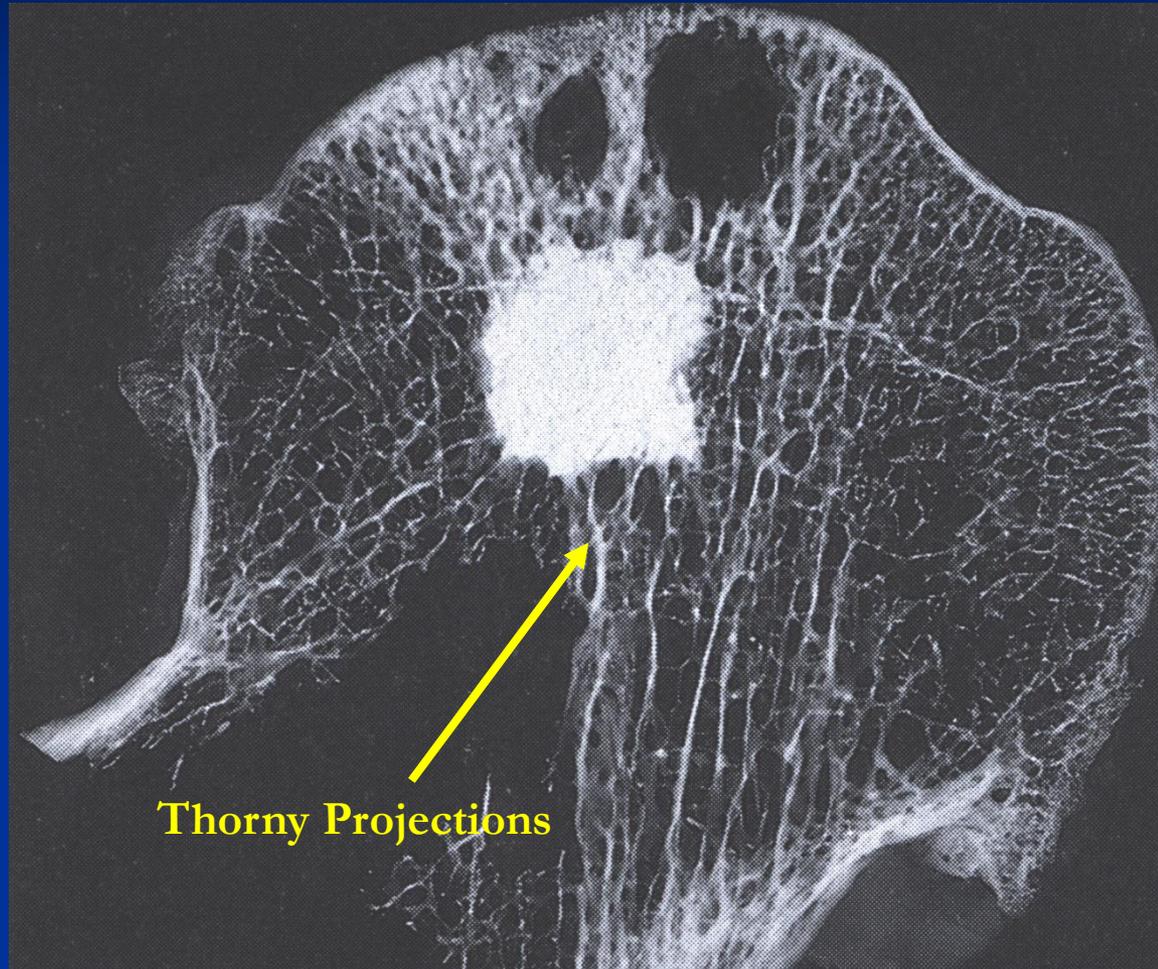
# Microscopic Pathology: Enostosis



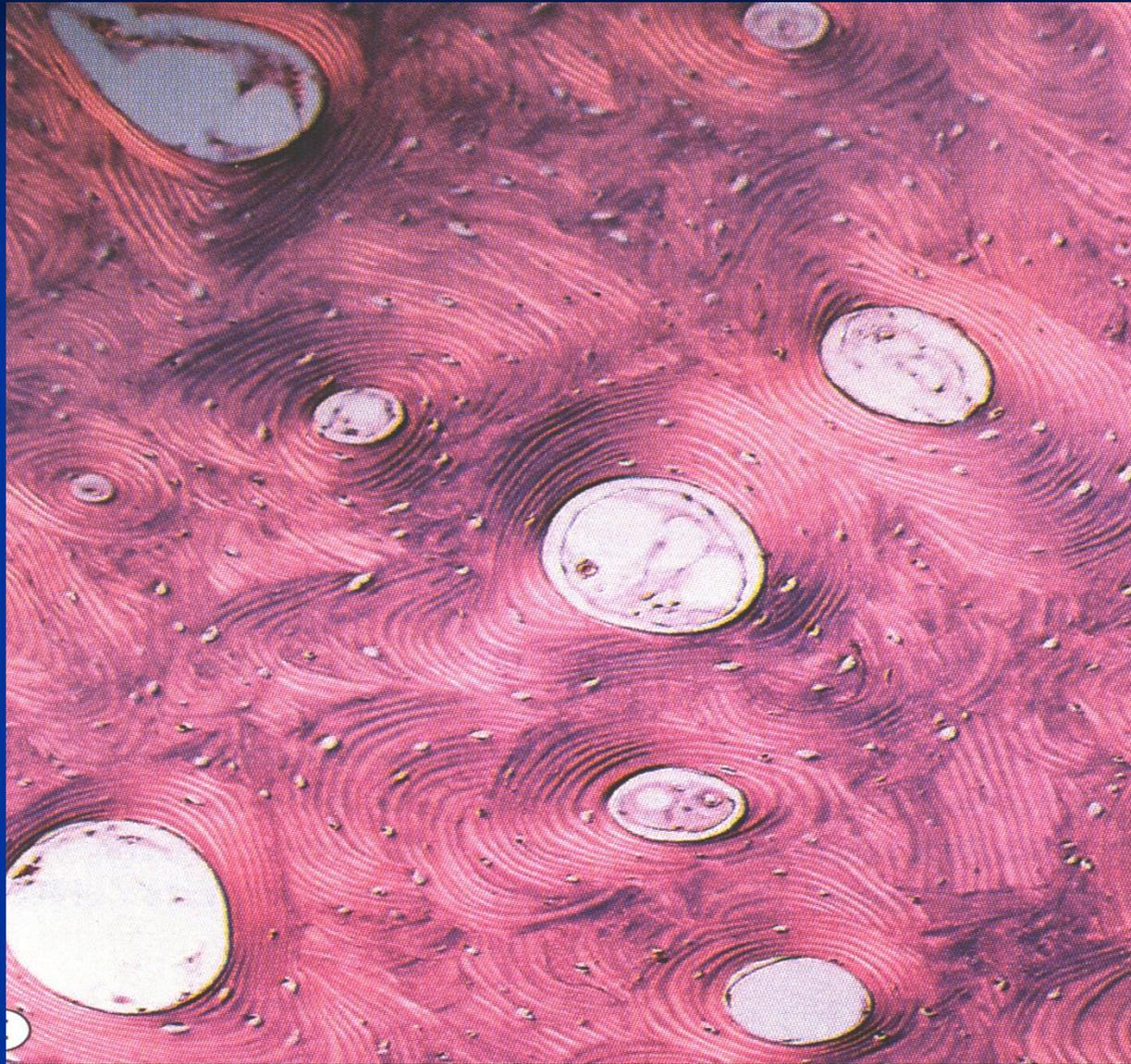
# Microscopic Pathology: Enostosis



# Microscopic Pathology: Enostosis



# Microscopic Pathology: Enostosis



# Giant Enostosis (Giant Bone Island)

- Greater than 2-3cm in size
- Pelvis is most common site
- Most likely to demonstrate increased activity on bone scan (25-30% show mild increased uptake vs osteoblastic metastasis or sclerosing osteosarcoma that show intense uptake)
- Osteoblastic met and sclerosing osteosarcoma show entrapped host lamellar bone on pathology

# Osteoma

- Rare, slow growing benign tumor or hamartoma composed of **mature osseous tissue (compact lamellar bone)**
- Protruding mass of dense periosteal intramembranous bone on **surface** of host bone
- Abnormally dense, but normal bone formed in the periosteum on the surface of bone
- **Distribution:**
  - Cranium, sinuses and mandible are most common
  - Long bones—rare

# Osteoma

- **Clinical:**
  - 4<sup>th</sup> to 5<sup>th</sup> decades
  - Usually asymptomatic
  - Sinus lesions may lead to sinusitis or can grow into cranial vault (found in 0.42% of sinus radiographs)
  - Orbital lesions—exophthalmos, diplopia, displacement of globe
  - May be associated with Gardner's syndrome
    - Familial Polyposis Coli
    - Refer to a Gastroenterologist for colonoscopy

# Osteoma

- **Radiology:**

- **XR:** Sharply defined, smooth, homogeneous bone protruding from the surface of a bone
- Usually remain unchanged on serial studies
- Usually diagnosed incidentally on radiographs

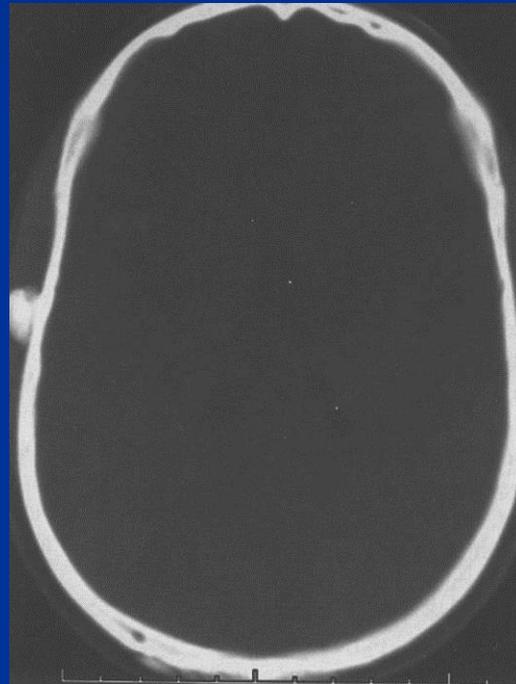
# Osteoma



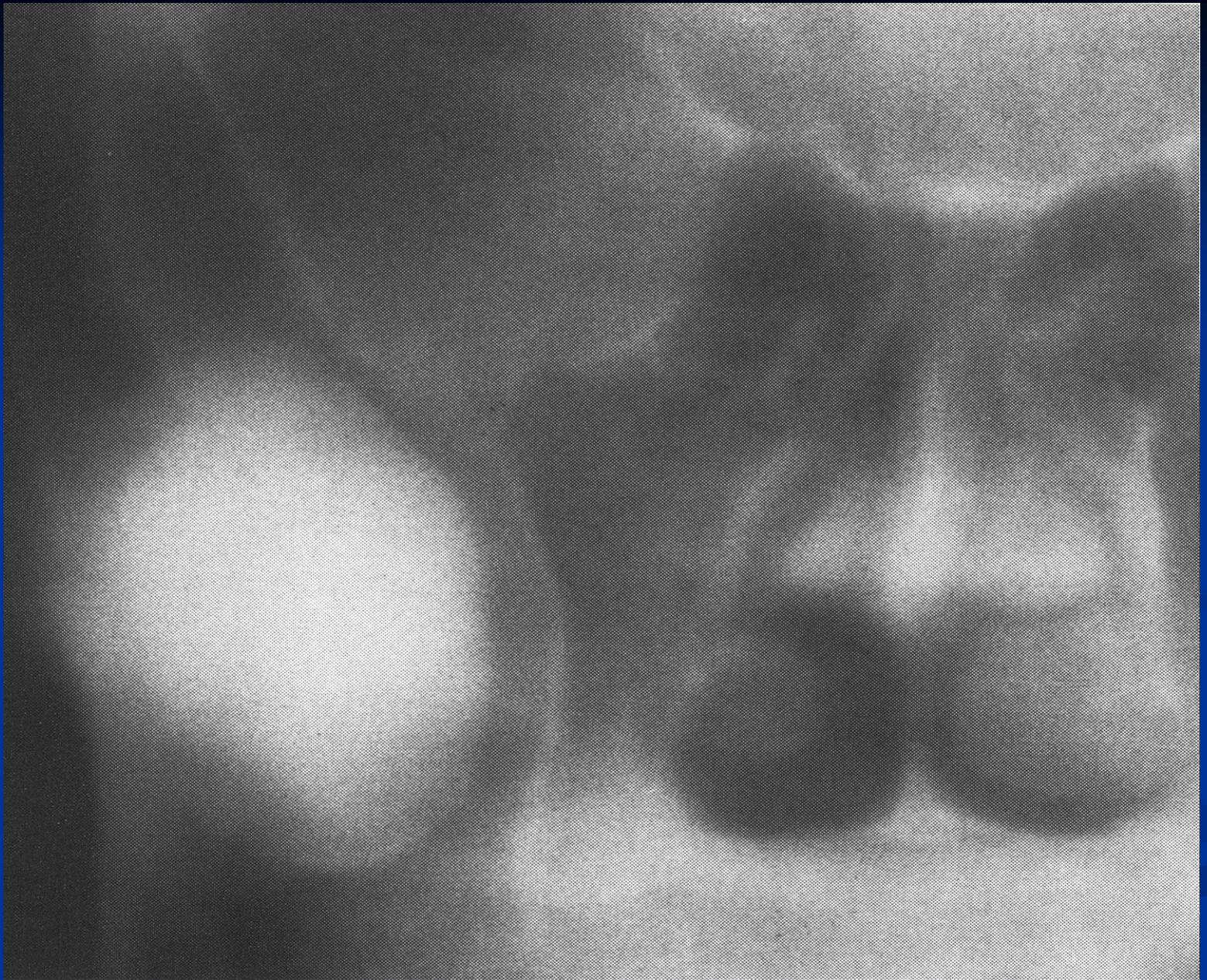
# Osteoma



# Osteoma of Calvarium





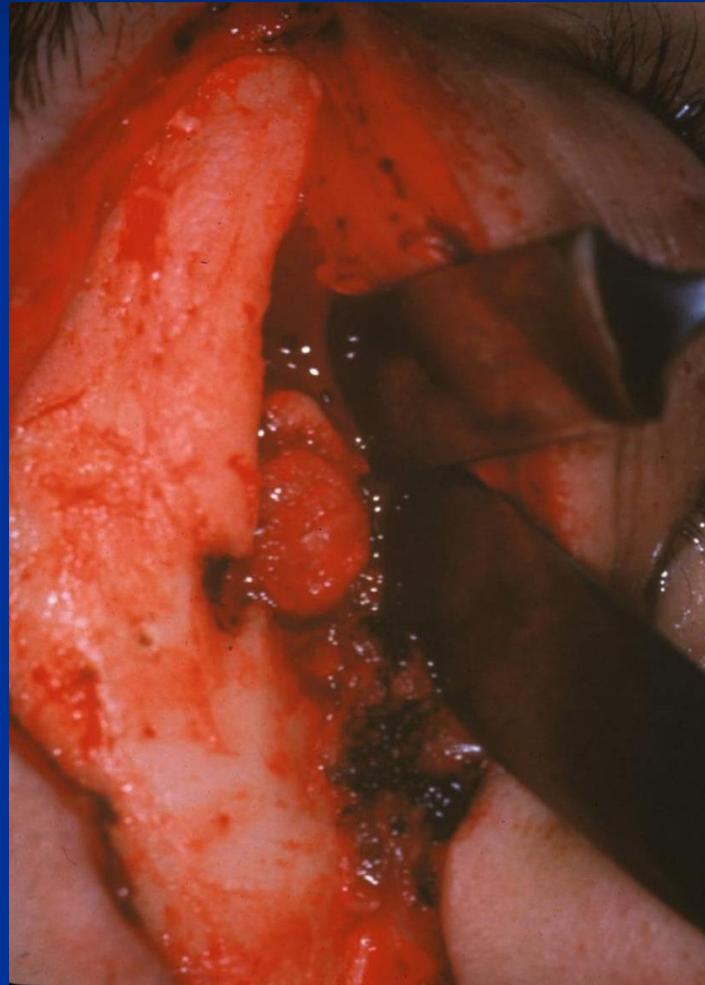




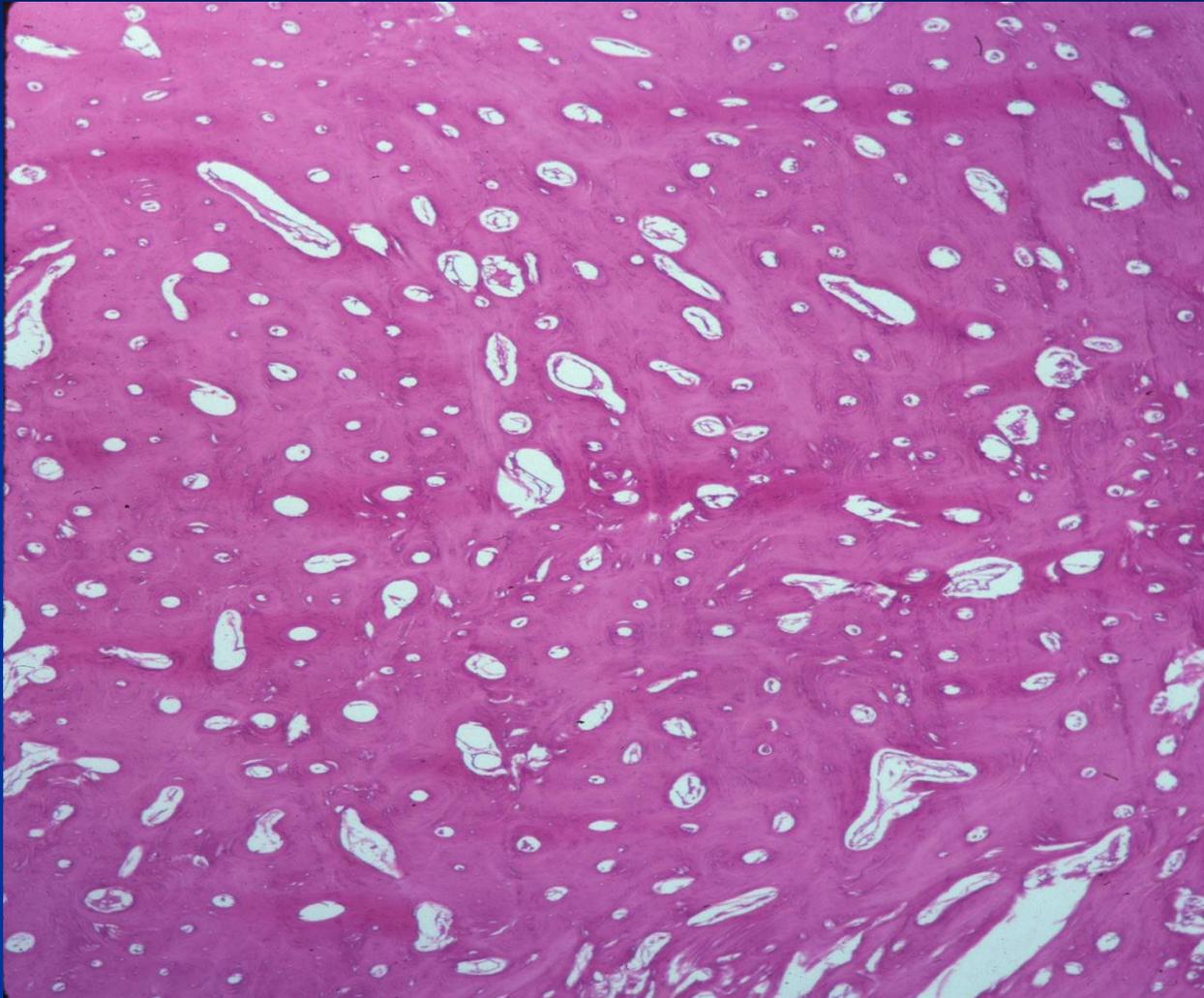
# Osteoma

- **Pathology:**
  - Nodules of dense, **mature, lamellar (cortical) bone** surrounding Haversian Canals (same as enostosis)
  - The bone is very orderly and mature
  - The bone is organized into lamellae
  - The cells are uniform and have small nuclei
  - No nuclear pleomorphism
  - No Mitoses

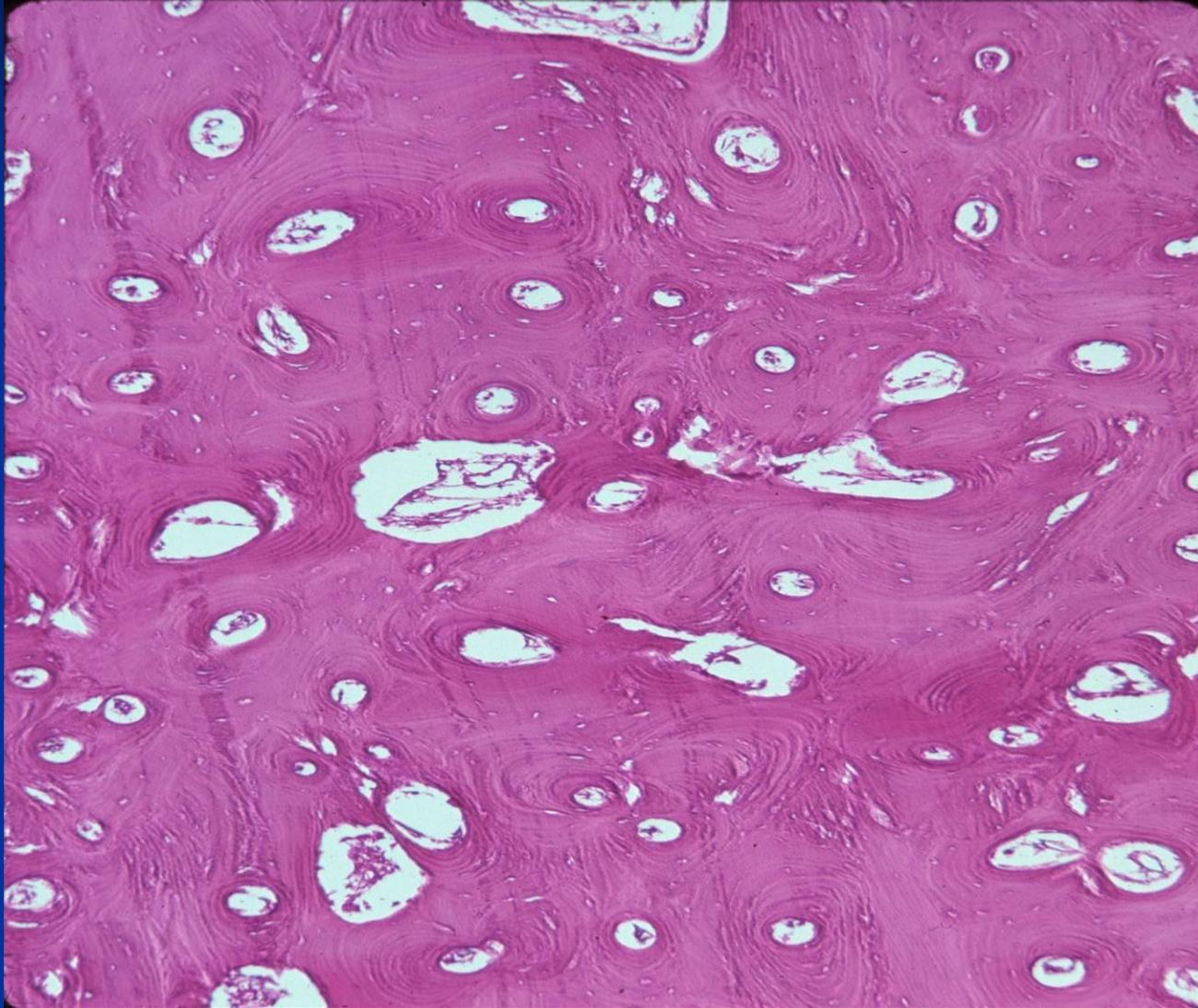
# Gross Pathology: Osteoma



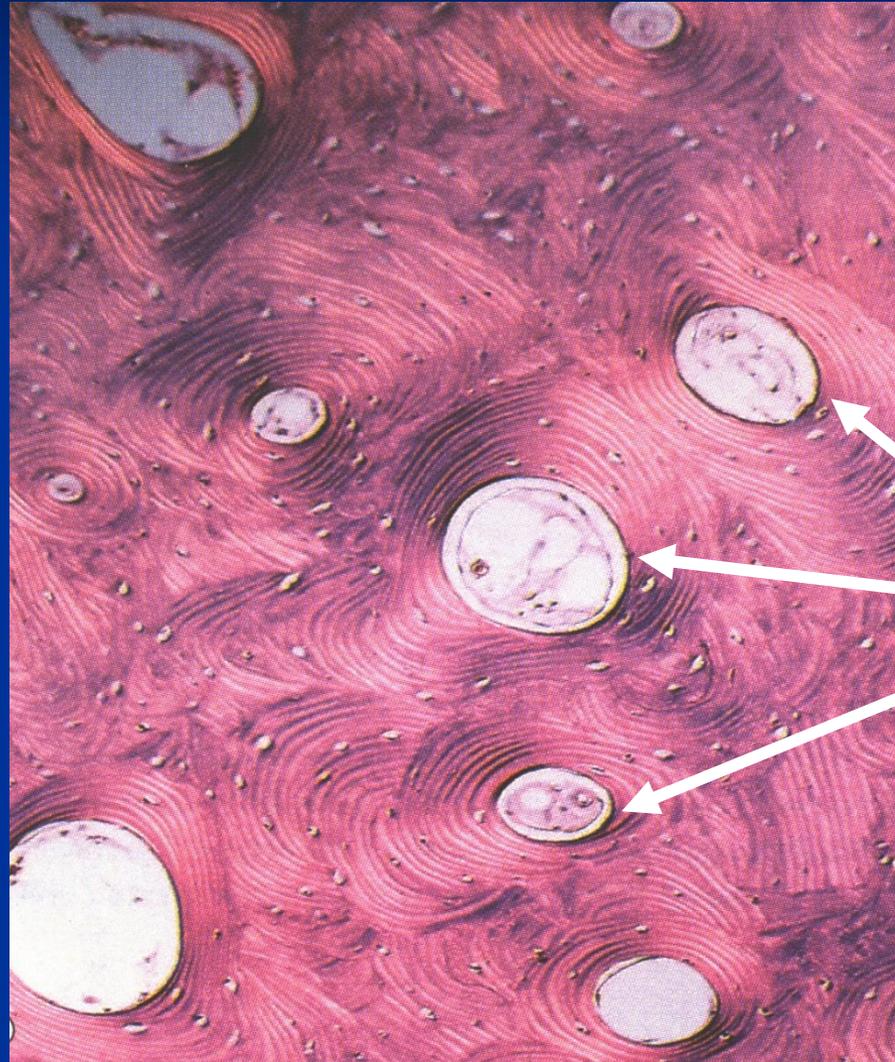
# Microscopic Pathology: Osteoma



# Microscopic Pathology: Osteoma



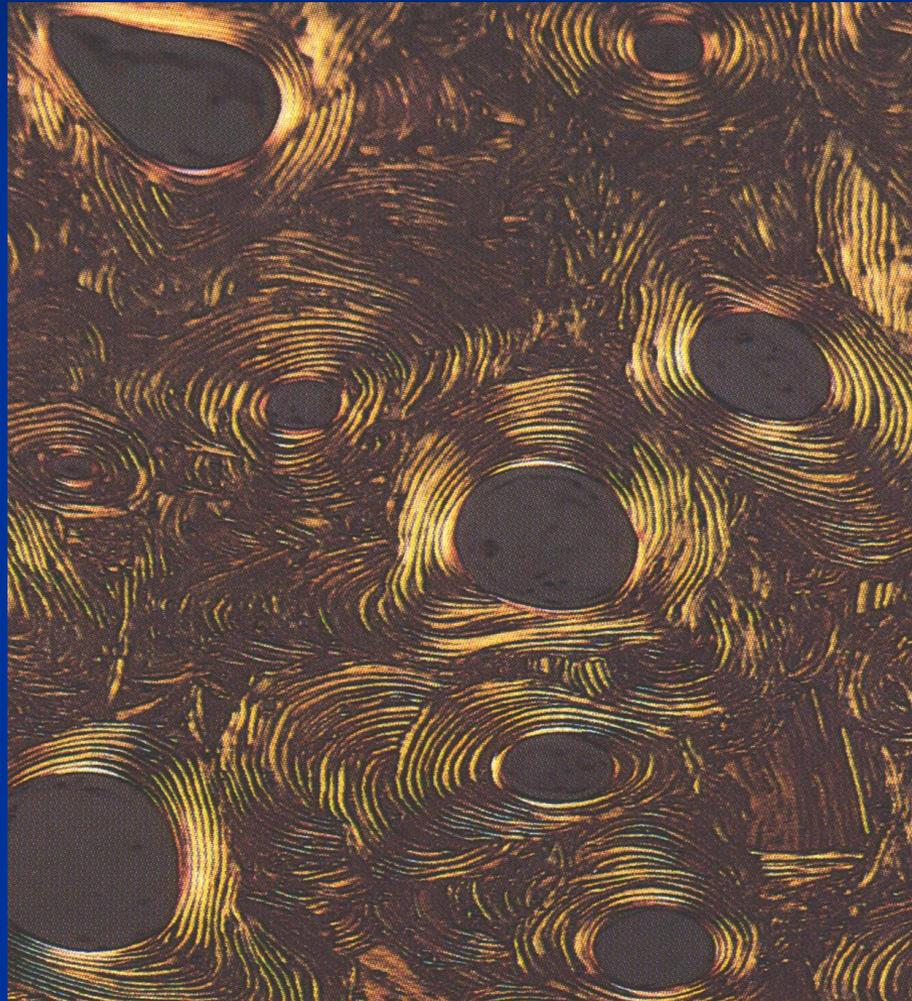
# Microscopic Pathology: Osteoma



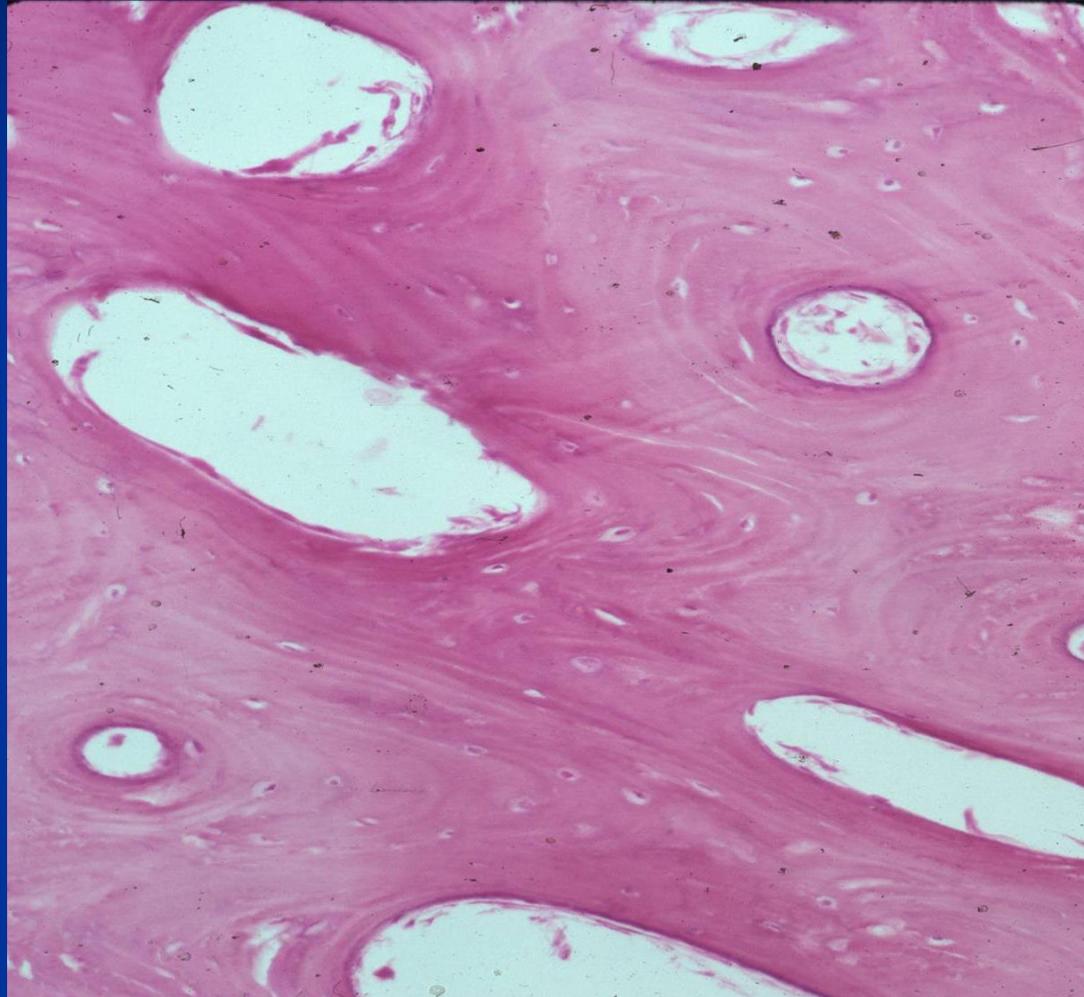
**Haversian  
Canals**



# Polarized Light Demonstrating Lamellar Arrangement

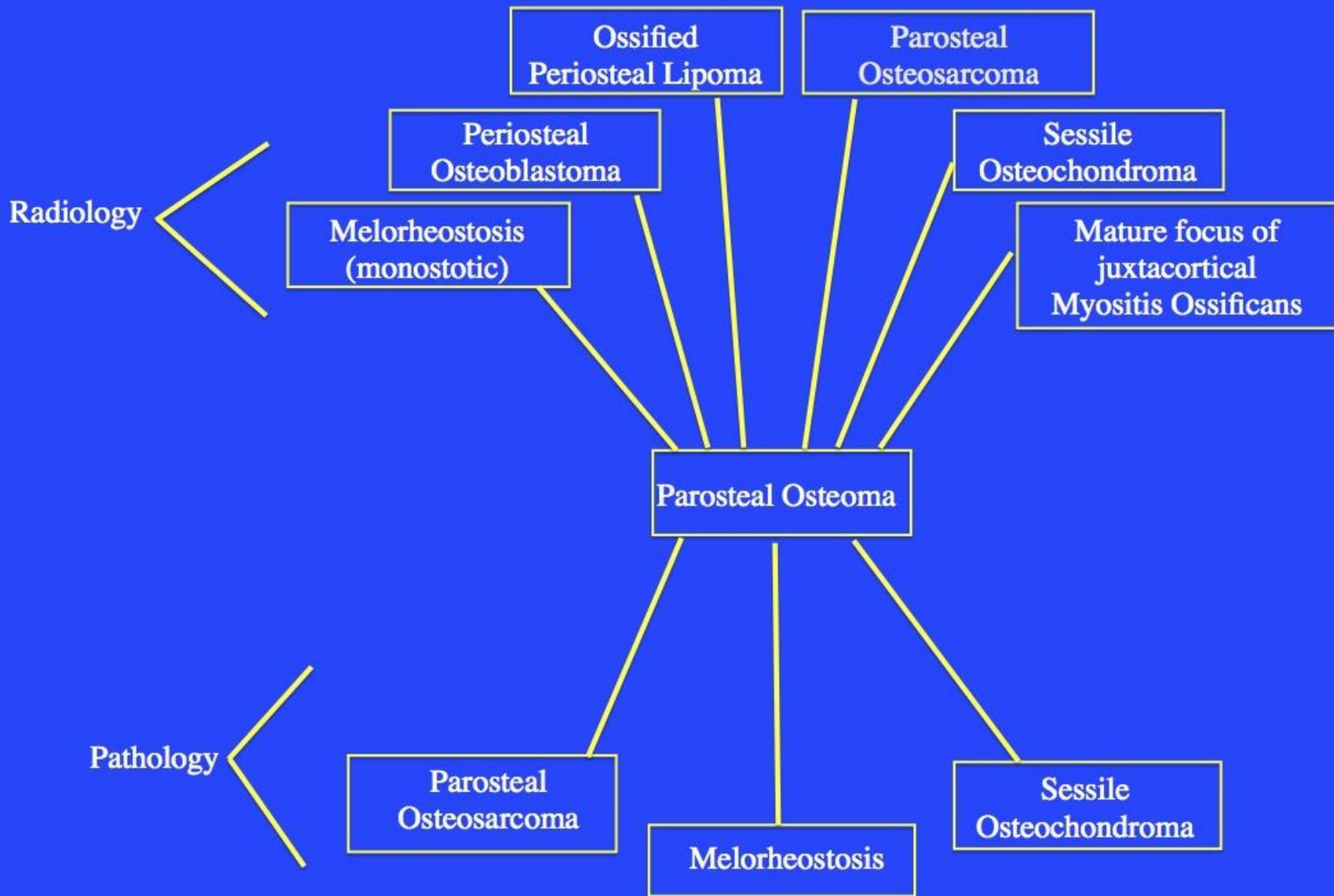


# Microscopic Pathology: Osteoma



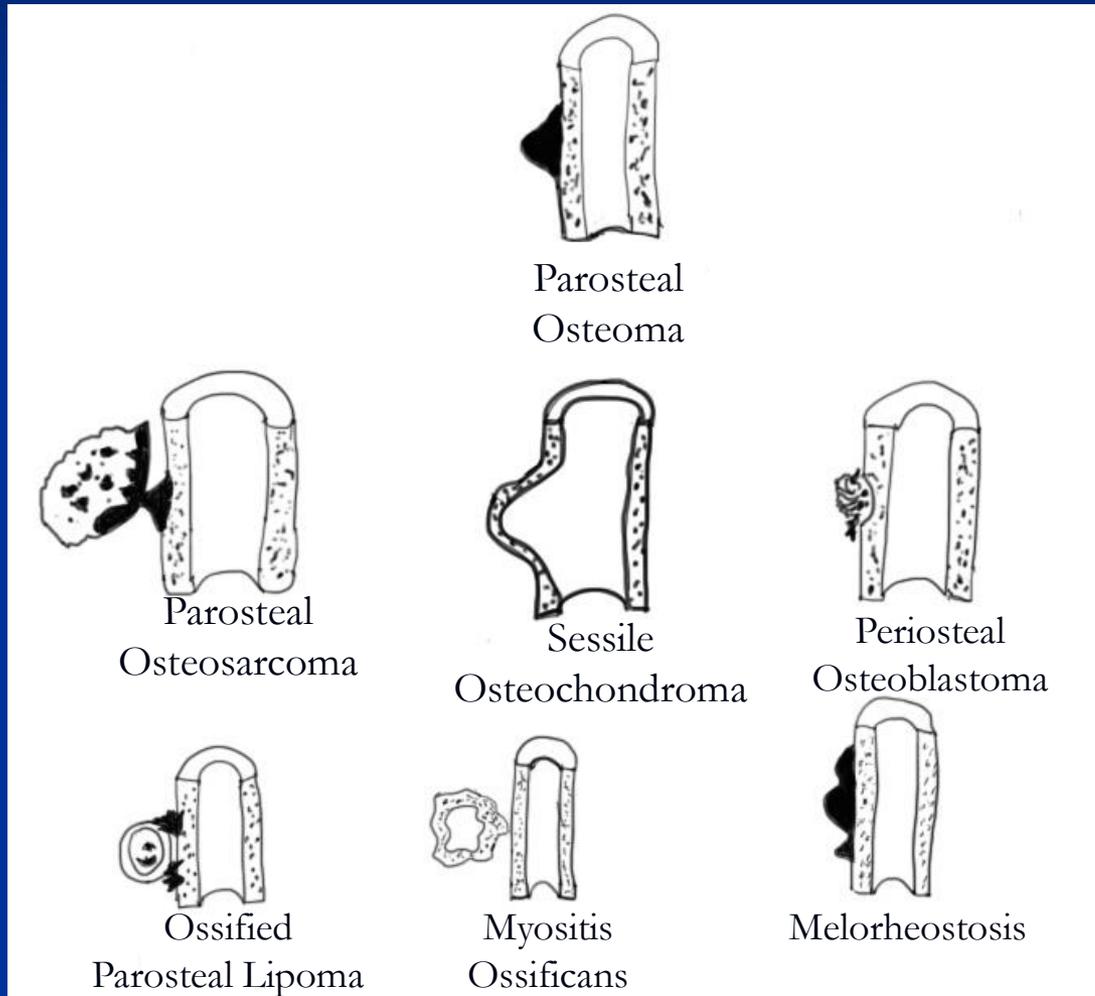
# Differential Diagnosis of Osteoma

- The following chart demonstrates the radiological and pathological differential diagnosis of an osteoma



# Differential of an Osteoma

## Relationship of Lesions to Cortex of Bone: How to Differentiate

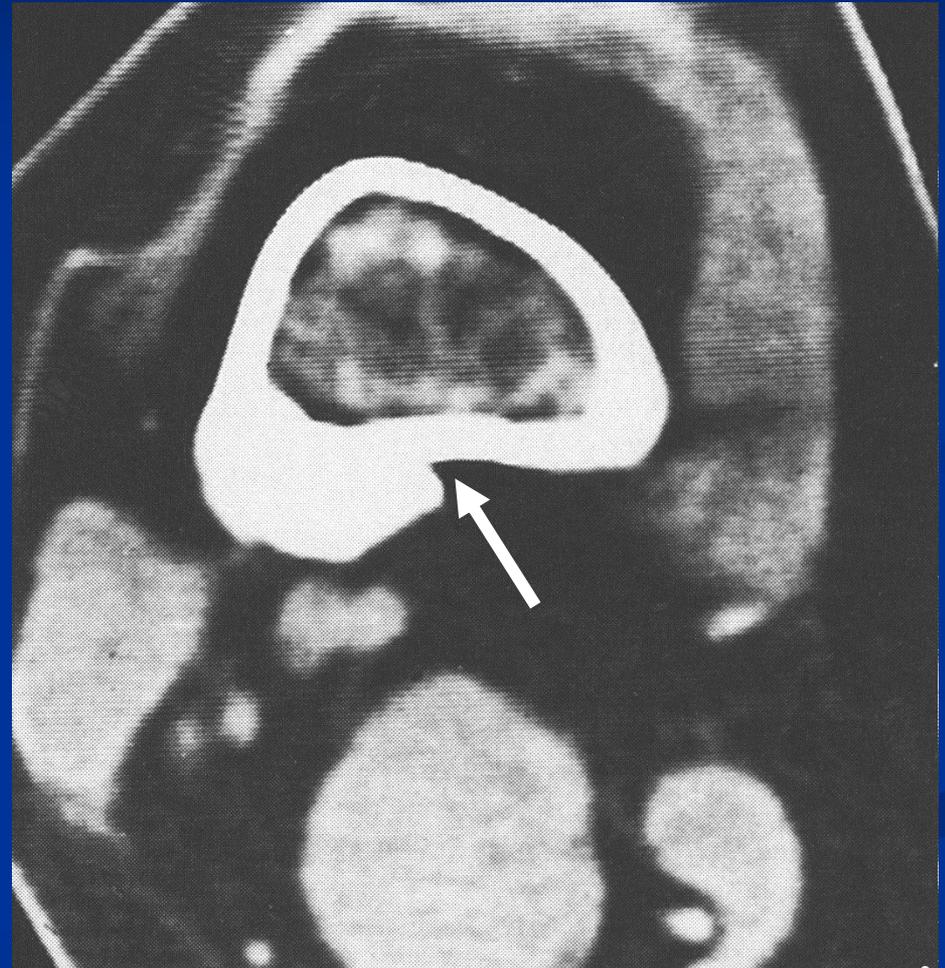


# Parosteal Osteosarcoma



# CT Scan of Parosteal Osteosarcoma

- A cleft (arrow) can often be identified at the periphery of the tumor between the tumor and underlying cortex
- There is no cleft associated with an osteoma

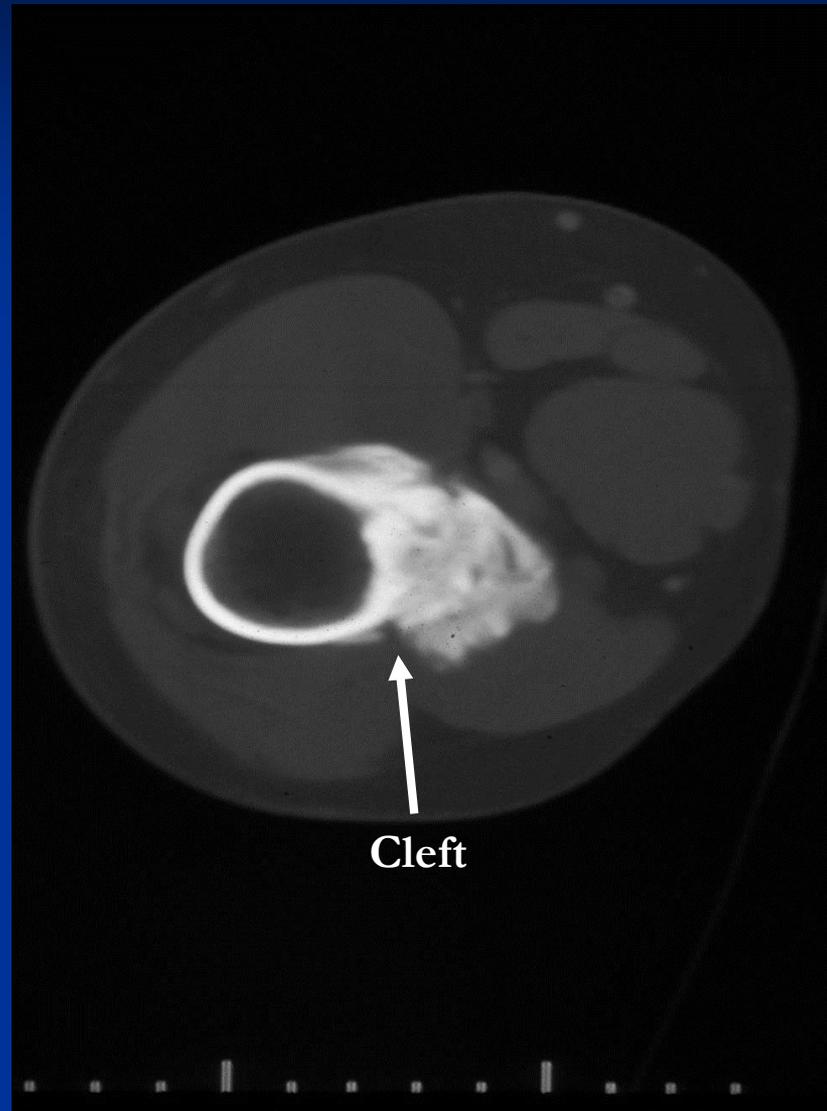


# Parosteal Osteosarcoma

- The cortex is usually intact with a parosteal osteosarcoma unless it has grown through the cortex and invaded the medullary canal (this would indicate a more aggressive parosteal osteosarcoma). The cortex is also intact with an osteoma.



# CT Scan Parosteal Osteosarcoma



# Osteochondroma

- Cartilaginous tumor
- Calcifications in a ring and arc manner
- It grows from a piece of the growth plate that branches off and grows outward instead of longitudinally
- Corticomedullary continuity
- Notice that there is no cortex between the osteochondroma and underlying bone; the medullary cavities are continuous



# Myositis Ossificans

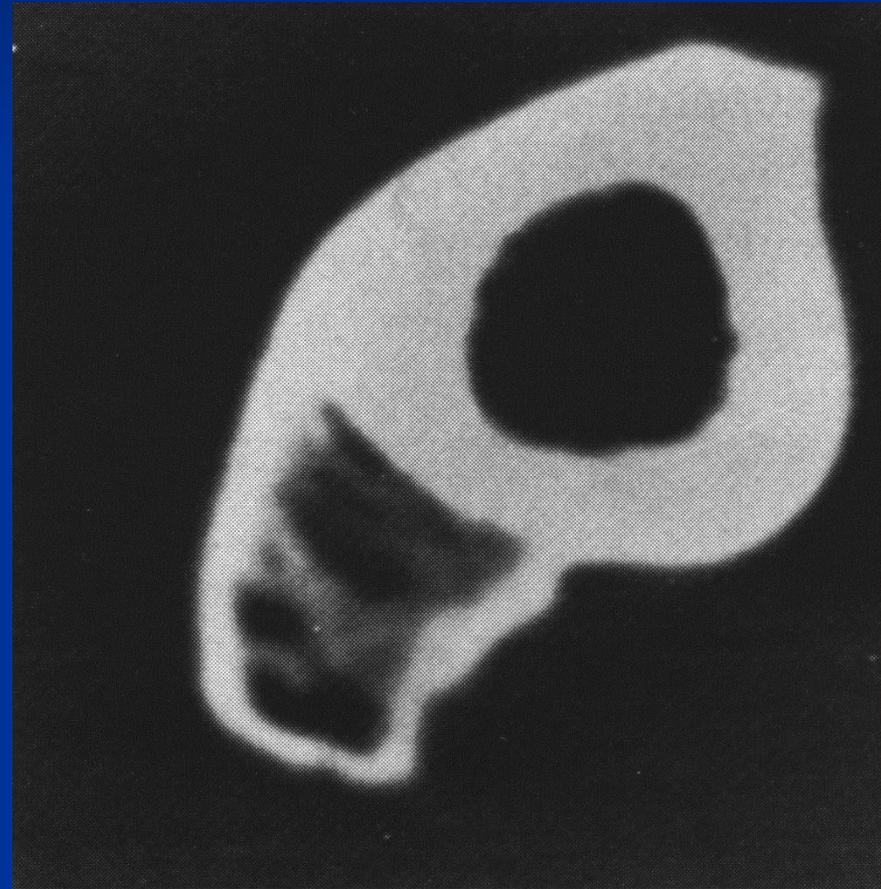


# Myositis Ossificans

- Myositis ossificans occurs from an injury
- It can form directly in a muscle or form closely applied to the surface of a bone

# Myositis Ossificans

- Zonal Phenomenon: The periphery of the lesion matures and the central portion of the lesion appears to form a medullary canal that contains fat and marrow.
  - Myositis ossificans goes through a maturation phase.
  - Initially it may show minimal ossification and mineralization
  - Usually after 6-12 weeks, the amount of mineralization increases. As the process matures, a zonal phenomenon occurs.



# Melorheostosis

- **Definition:** Rare sclerosing bone disorder that is symptomatic and usually becomes manifest after early childhood; “Candle Wax Drippings”
- Localized, diffuse thickening of cortical bone; wax dripping down the side of a candle
- Sometimes initial signs appear in adult patients
- Equal sex distribution
- No inheritance pattern

# Melorheostosis

- **Clinical Manifestations:**

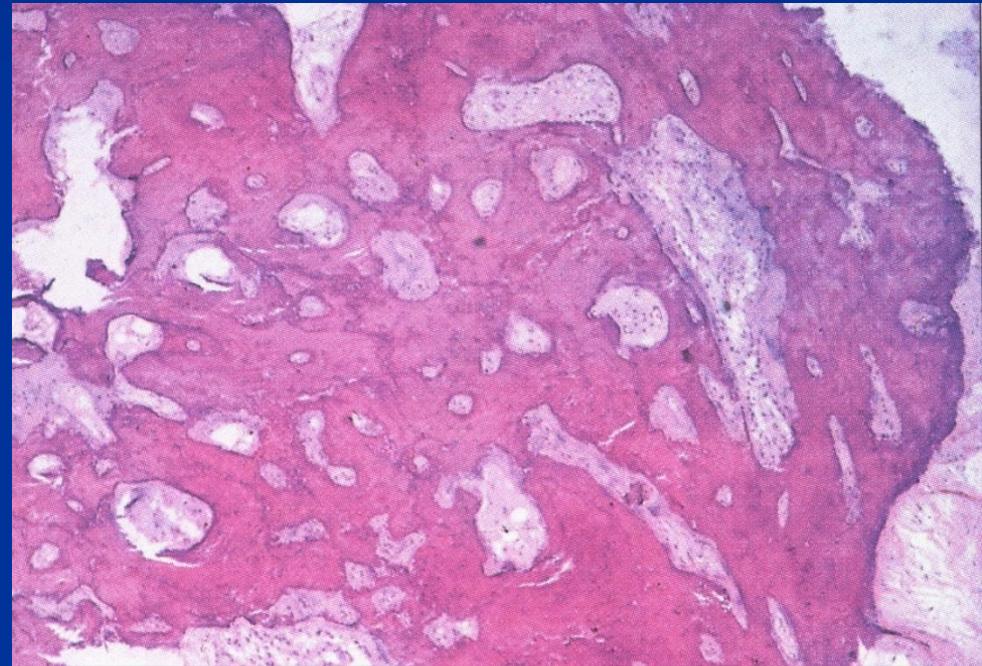
- Asymmetric; Usually a single limb involved
- Lower extremity > Upper extremity
- Signs/Symptoms
  - Pain and swelling of joints
  - Decreased ROM
  - Joint contractures; tendon and ligament shortening
  - Soft tissue involvement and juxtaarticular masses
  - Growth disturbances that can lead to scoliosis, joint contracture, and foot deformity
  - Scleroderma like skin lesions over affected bones

# Melorheostosis

- **Radiology:**

- Osseous excrescences often exuberant and lobulated along bone surface (Peripherally located cortical hyperostosis)
- Wavy, sclerotic bone contour
- Endosteal involvement (rare) may encroach on marrow space
- Soft tissue masses: Soft tissue ossification and calcification---ankylosis
- Bone scan: Intense activity
- MR: Bone and soft tissue lesions demonstrate low signal on all pulse sequences

# Melorheostosis



**Thickened and enlarged cortical bone with prominent haversian canals**



# Melorheostosis

- **Associations:**

- Linear scleroderma
- Osteopoikilosis
- Osteopathia striata
- Neurofibromatosis
- Tuberous sclerosis
- Hemangiomas
- In the axial skeleton, can be accompanied by overlying fibrolipomas in adjacent areas including the spinal canal and retroperitoneum

# Parosteal Lipoma

- A parosteal lipoma consists of an exostosis protruding from the surface of a bone that is surrounded by a benign fatty tumor
- There is no corticomедullary continuity between the exostosis and underlying bone



# Osteoid Osteoma

# General Information

- Osteoid Osteoma is a benign osteoblastic (bone forming) tumor that is usually less than 2cm in size.
- It consists of a central vascularized nidus that represents the neoplastic tissue. The nidus is surrounded by normal reactive bone.
- Usually a single lesion that is very painful. The nidus microscopically resembles the same type of tissue as an osteoblastoma.

# Clinical Presentation

- **Signs/Symptoms:** Progressive pain that is significantly relieved by aspirin or an NSAID (very rarely, less than 1%, may be painless)
  - The pain is often the worst at night
  - Unmyelinated nerve fibers have been demonstrated in osteoid osteomas
  - Osteoid Osteomas produce high levels of PGE2 (this may be the reason why aspirin works at relieving pain, by inhibiting PGE2 production)
  - Tumors next to growth plates may increase growth and cause skeletal asymmetry
  - Epiphyseal lesions may cause a joint effusion and clinical picture similar to rheumatoid arthritis
  - Vertebral lesions may cause a scoliosis due to muscle spasm
- **Prevalence:**
  - 3% of all bone tumors
  - Males more commonly affected than females ~ 3:1

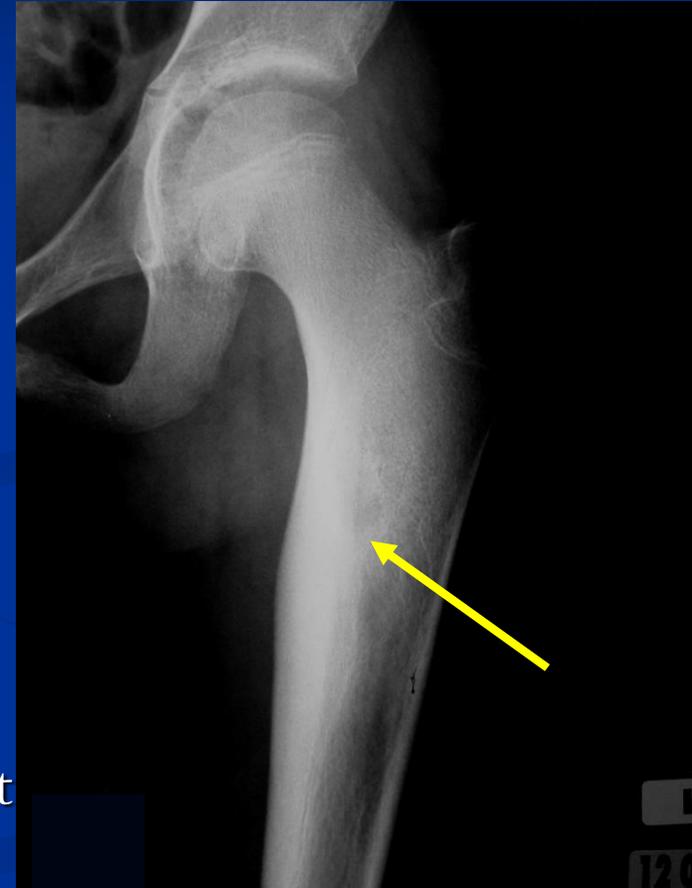
# Clinical Presentation

- **Age:** Most common in second decade of life
  - 75%-80% of patients < 25 years
  - Rarely over 30 years
- **Sites:** Femoral neck most common but can occur in any bone and any site within a bone (metaphyseal, diaphyseal, epiphyseal; cortical, medullary and periosteal)
  - 50% occur in long bones of lower extremities
  - Most osteoid osteomas are intracortical in origin but can also occur in the medullary canal or subperiosteal

# Radiographic Presentation

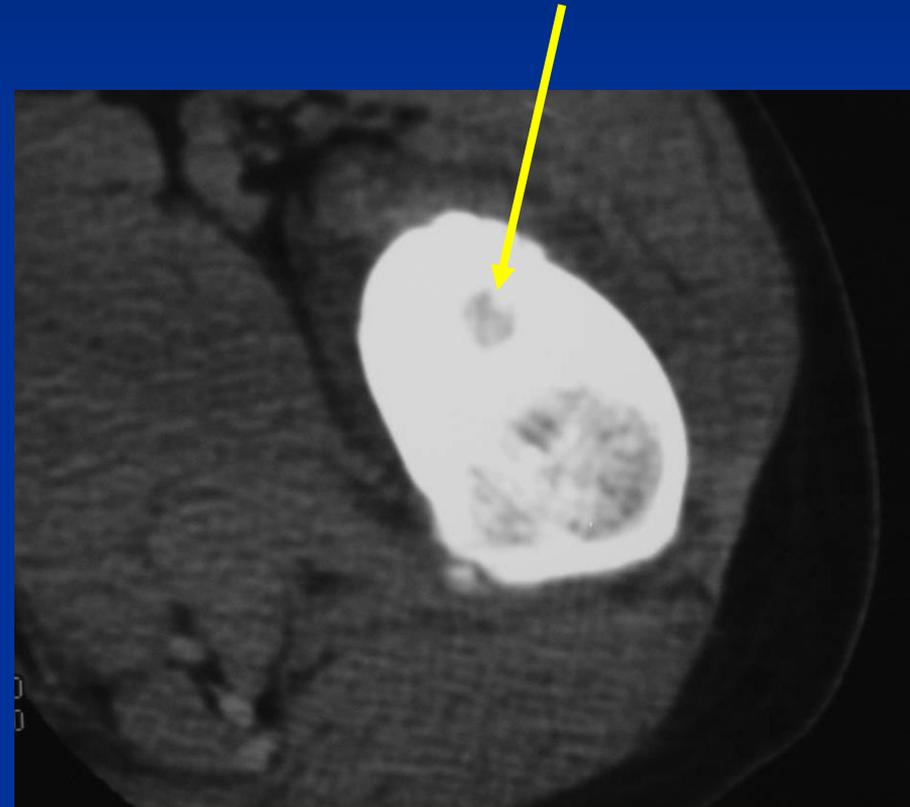
## • Plain X-Rays:

- Lucent nidus (well defined) surrounded by a zone of marked sclerosis
  - Nidus may be a few millimeters to 2 cm in diameter
- Central zone of density within center of nidus due to mineralization of osteoid/ossification
- Periosteal reaction is solid and continuous, rarely lamellated and often appears as cortical thickening
- Cortical and subperiosteal osteoid osteomas usually more reactive sclerosis than medullary tumors
- Intracapsular osteoid osteomas are difficult to identify because there is no periosteum in the intracapsular region and hence a periosteal reaction does not occur.



# Radiographic Presentation

- **CT Scan:** Well defined nidus with a smooth peripheral margin; +/- mineralization (CT more sensitive than XR and MRI for detecting mineralization); CT is better for detecting nidus in presence of exuberant sclerosis



# Radiographic Presentation

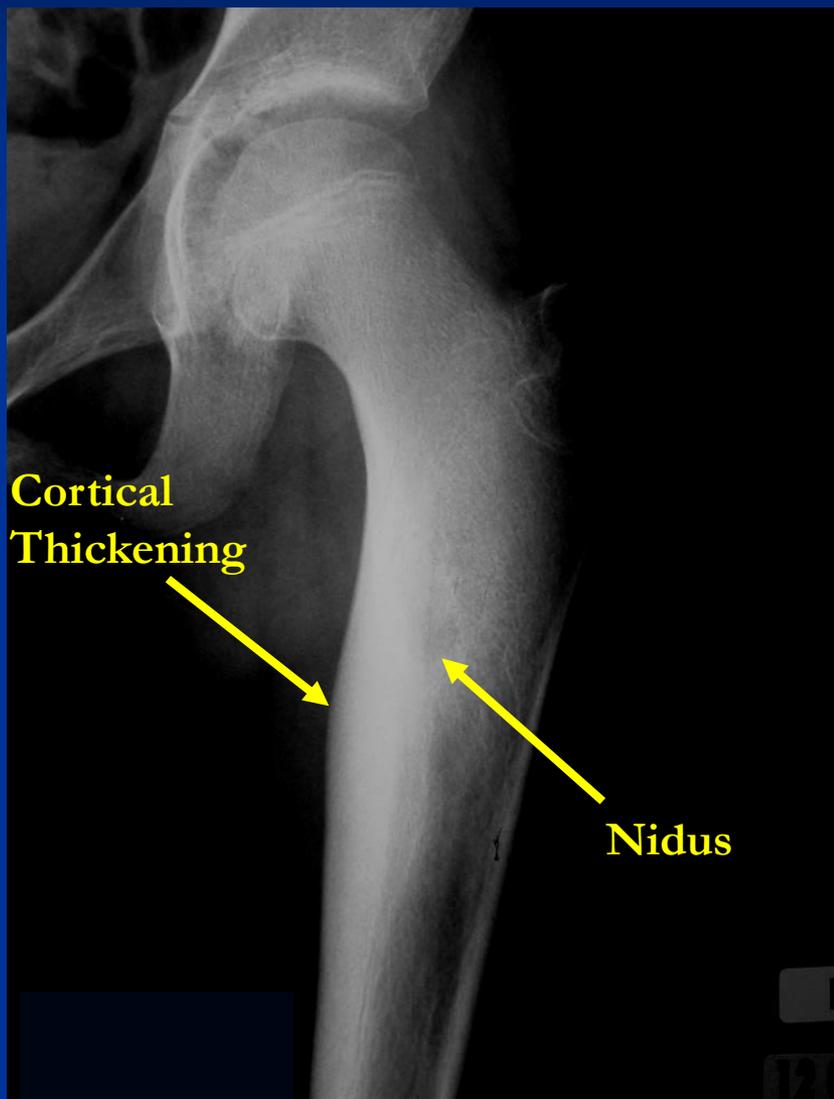
- **Bone Scan:**

- **Double Density Sign:** Hot within the nidus and less intense accumulation peripherally within the sclerotic bone

- **MRI:**

- MRI should be performed with gadolinium. The nidus should enhance with gadolinium
- Marrow and soft tissue edema is extensive that it may be difficult to visualize the nidus and may mimic a malignant tumor such as Ewing's sarcoma or osteomyelitis. CT is more useful for detecting the nidus if there is extensive edema
- MRI is good for detecting synovitis and joint effusion with intraarticular osteoid osteomas

# Plain X-ray: Osteoid Osteoma

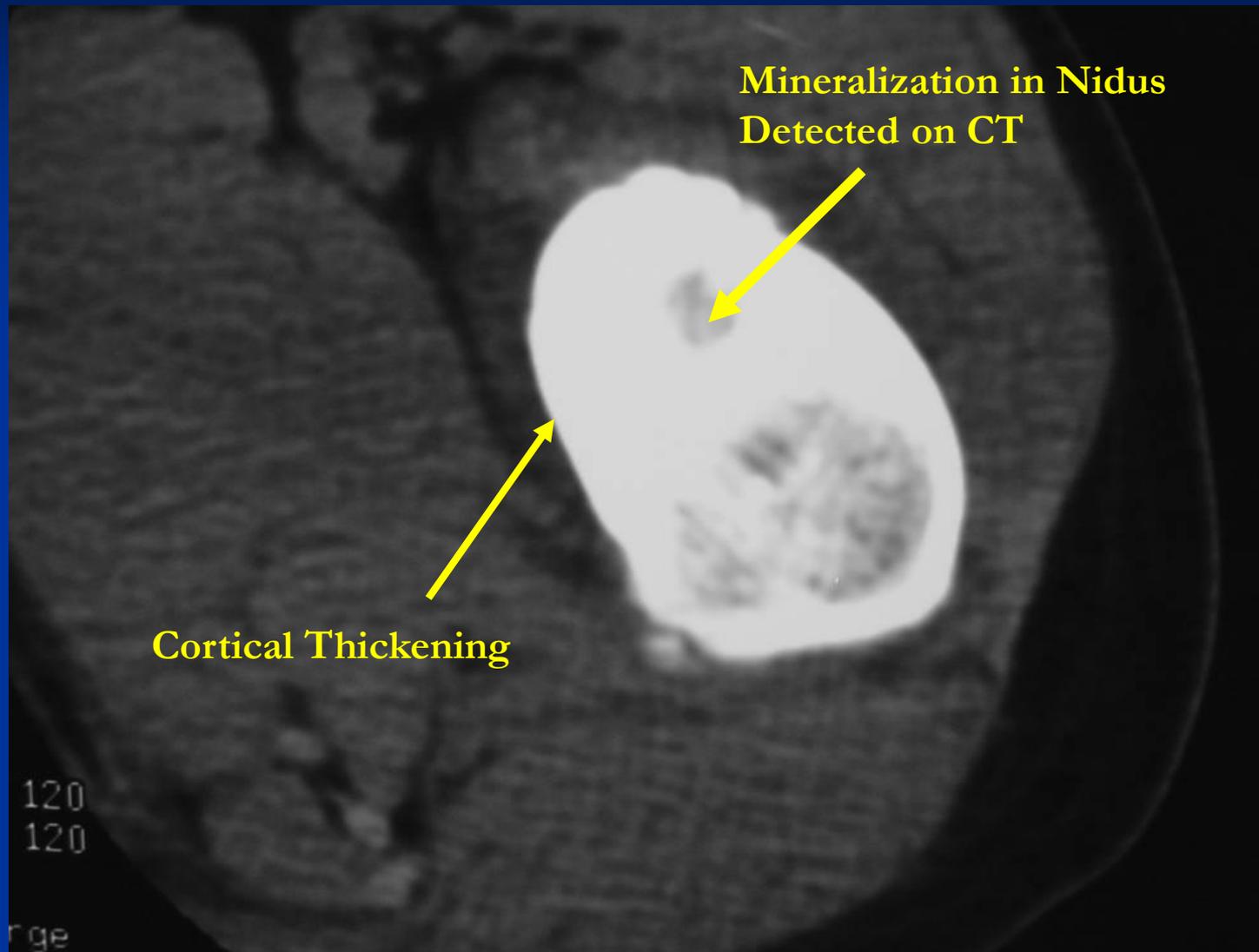


# Plain X-Ray: Osteoid Osteoma

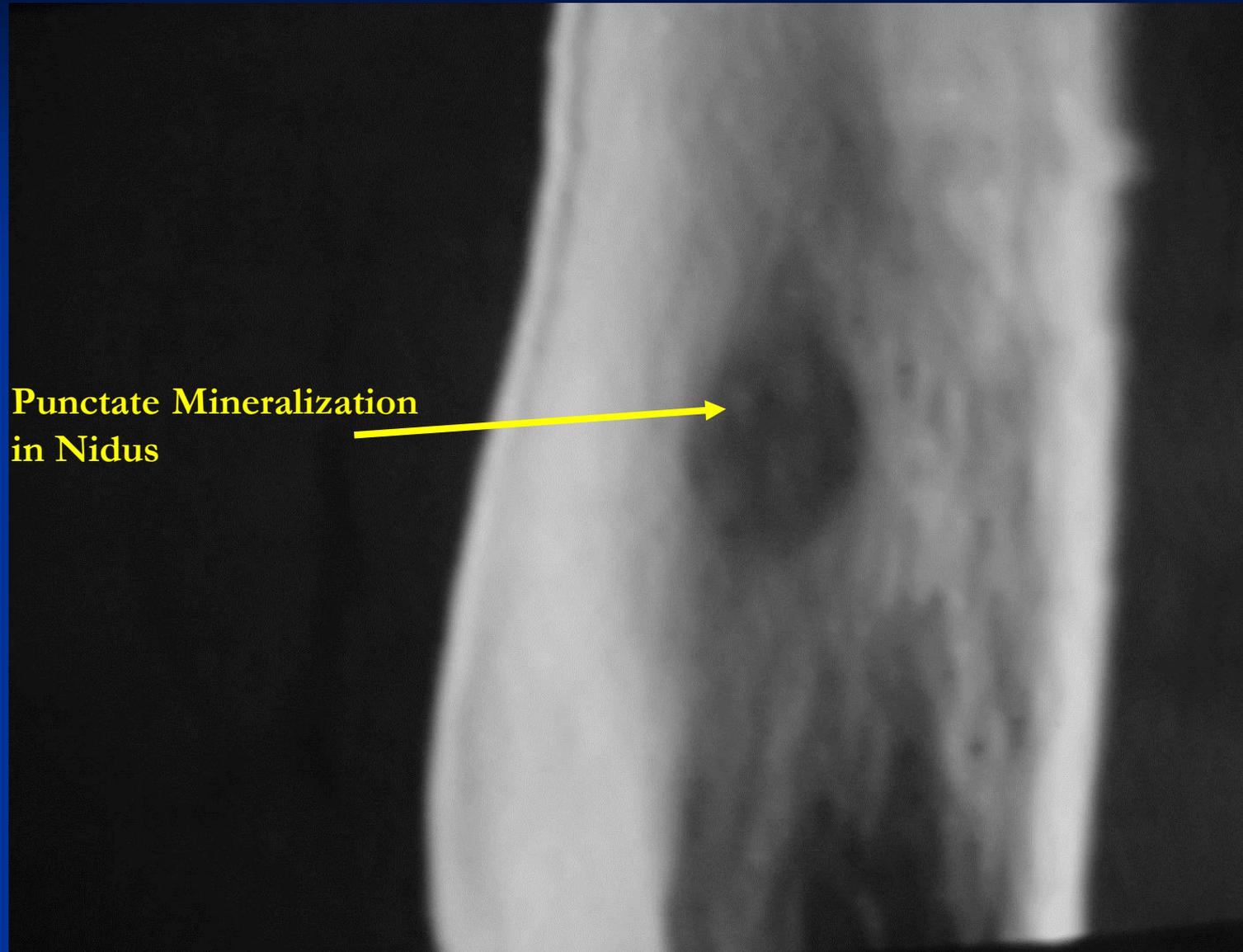
- Radiolucent Nidus (arrow)
- Surrounding Sclerosis
- Benign Periosteal Reaction causing Cortical Thickening



# CT Scan: Osteoid Osteoma

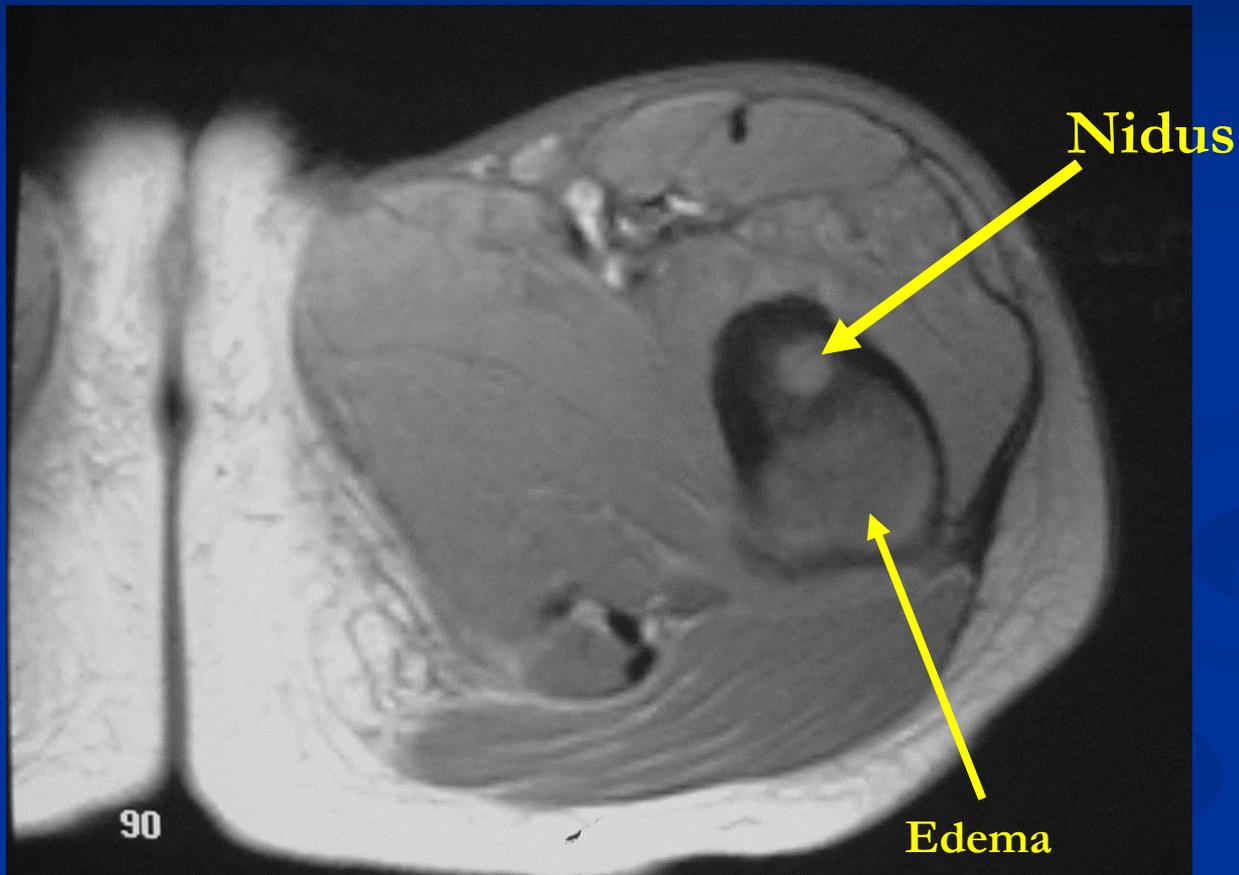


# CT Reformatted Image: Osteoid Osteoma

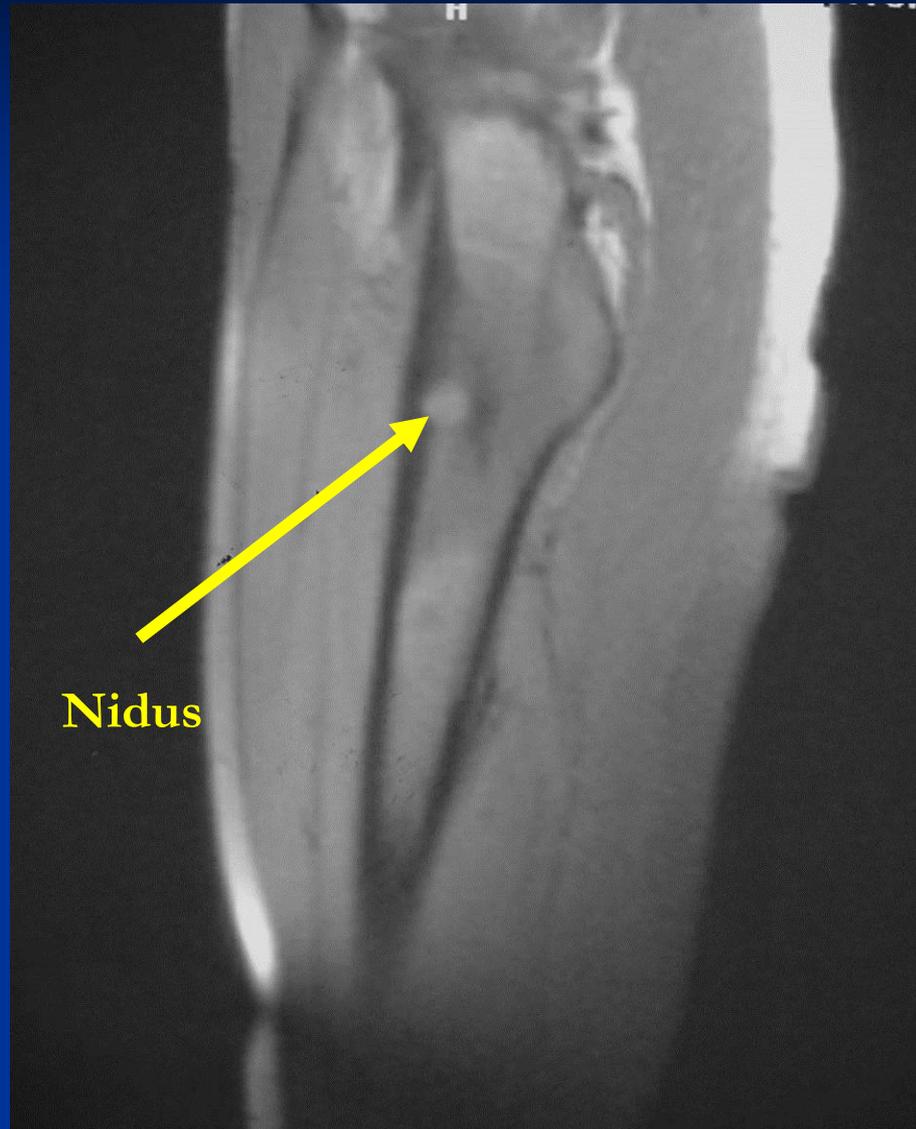


**Punctate Mineralization  
in Nidus**

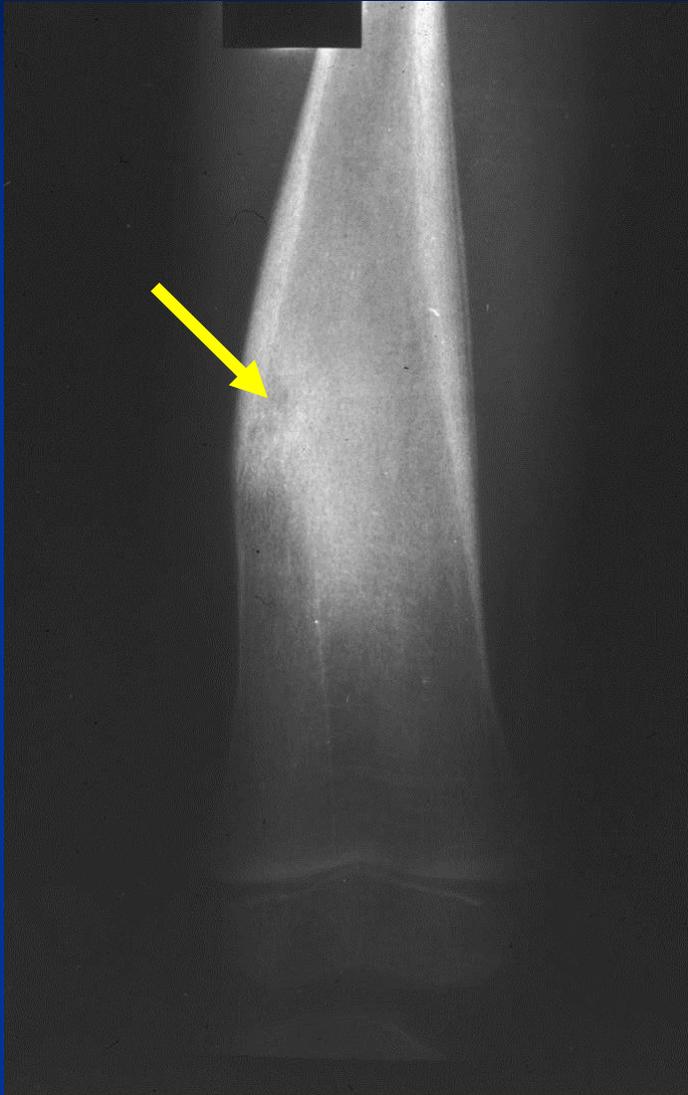
# MRI: Osteoid Osteoma



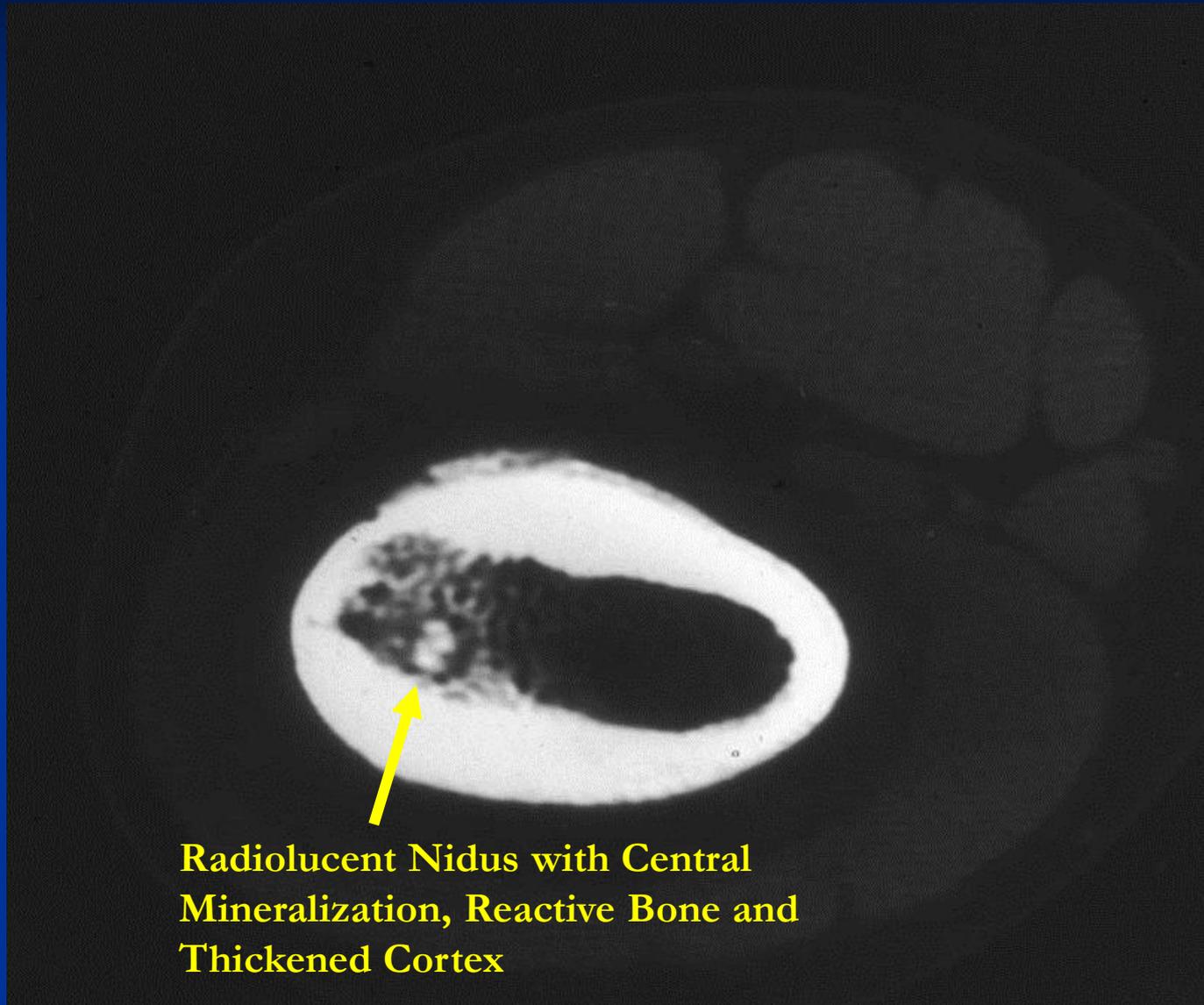
# MRI: Osteoid Osteoma



# Plain X-ray: Osteoid Osteoma of Femur

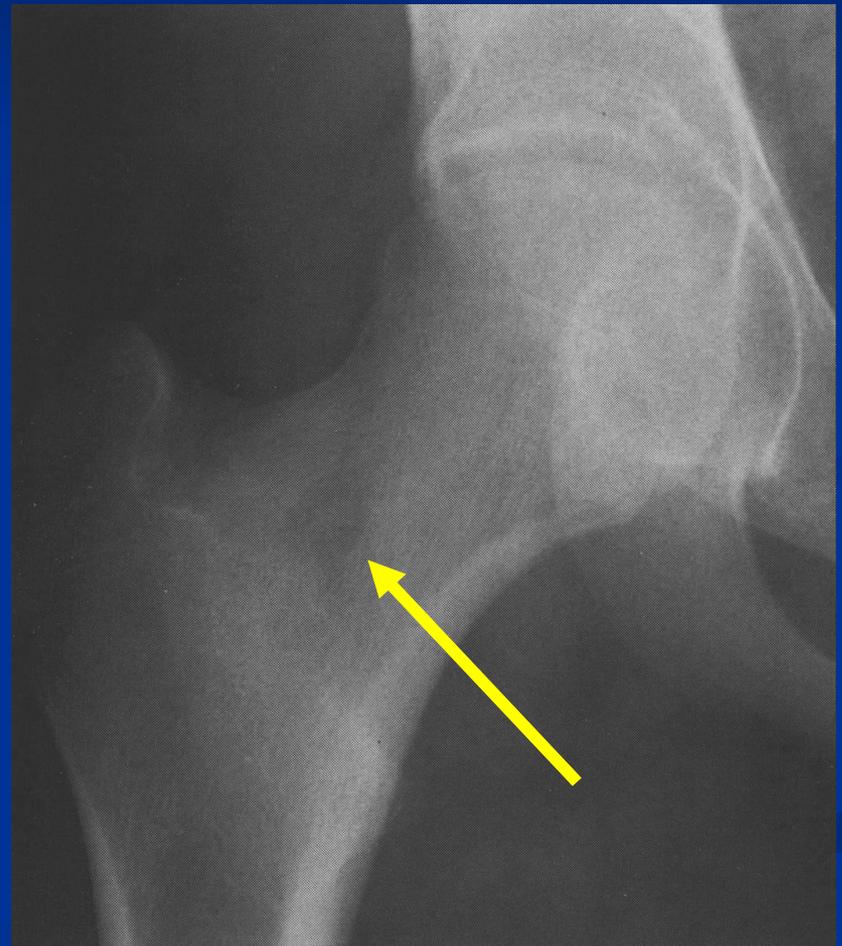


# CT Scan: Osteoid Osteoma of Femur

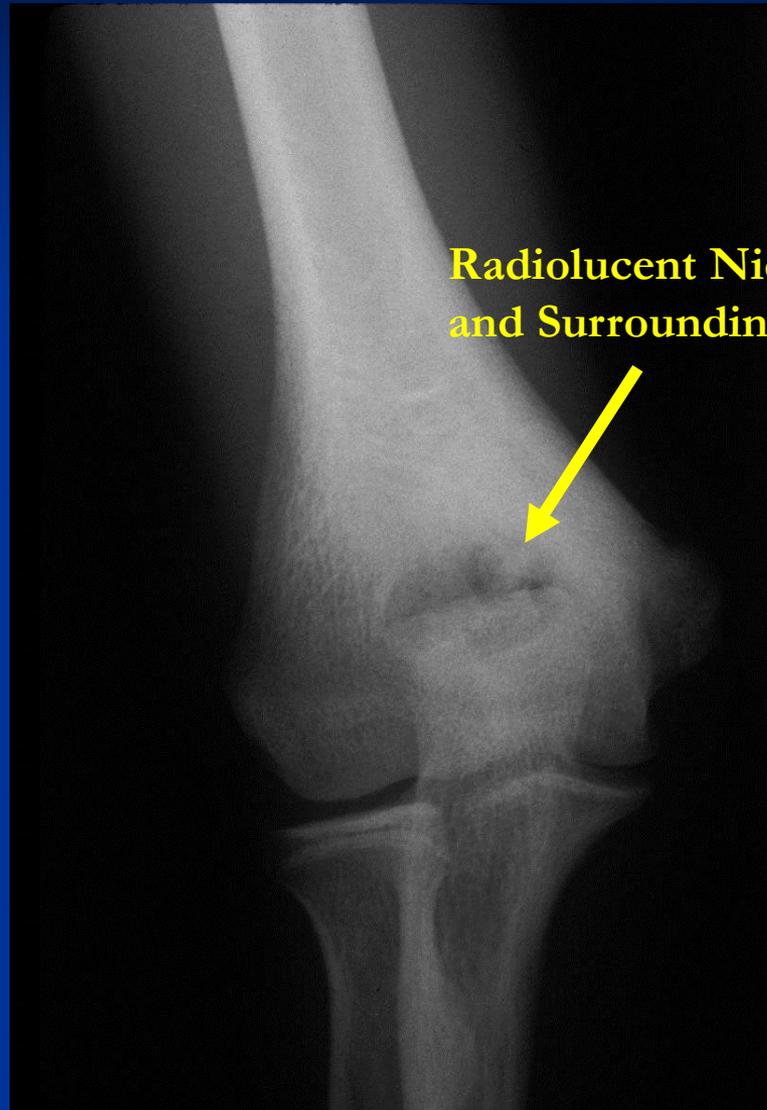


# Xray: Intramedullary Osteoid Osteoma of Proximal Femur

- Radiolucent nidus
- Mild reactive sclerosis around lesion
- Intramedullary lesions are associated with less reactive bone than intracortical lesions that usually demonstrate intense reactive sclerosis

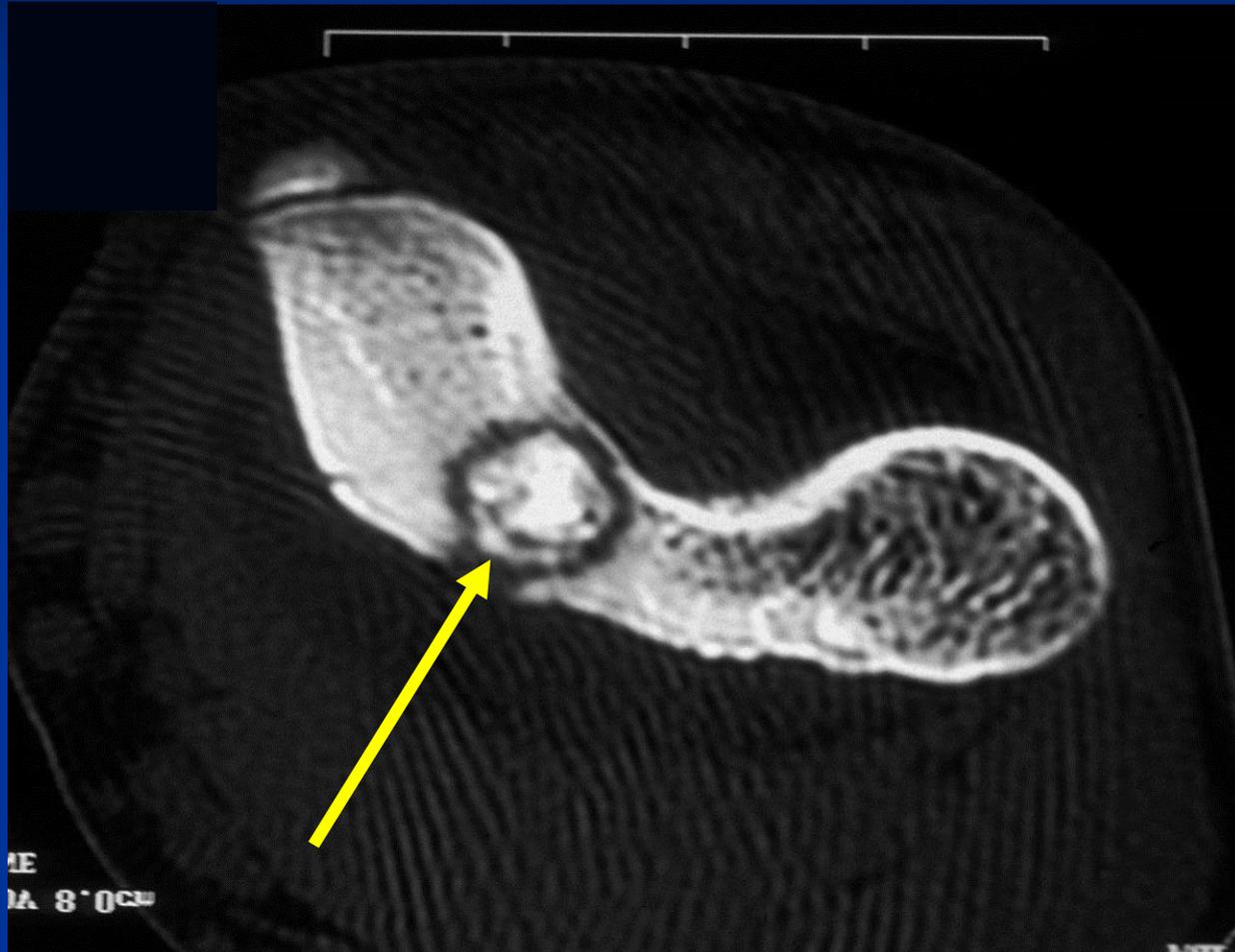


# X-ray: Osteoid Osteoma of Distal Humerus Olecranon Fossa



**Radiolucent Nidus with Mineralization  
and Surrounding Sclerosis**

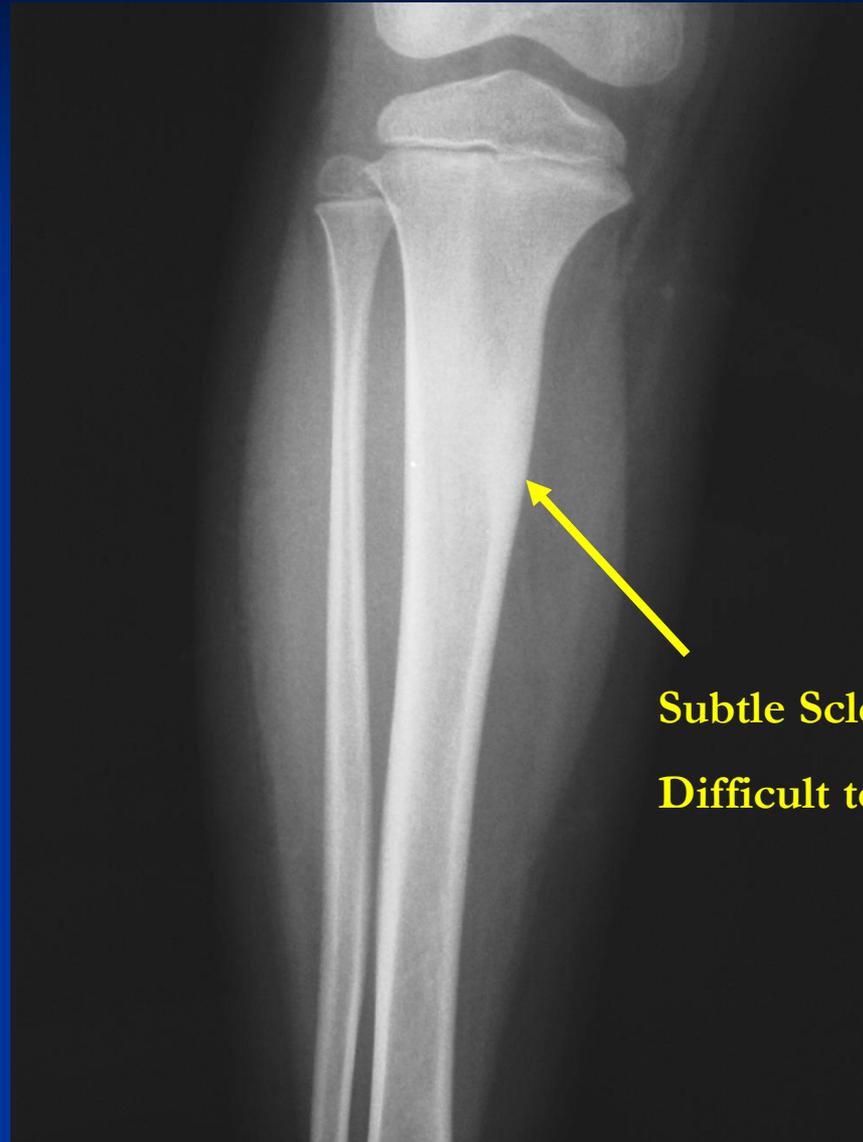
## Osteoid Osteoma of Distal Humerus: CT Shows Nidus with Extensive Mineralization



# X-Ray: Osteoid Osteoma of Tibia



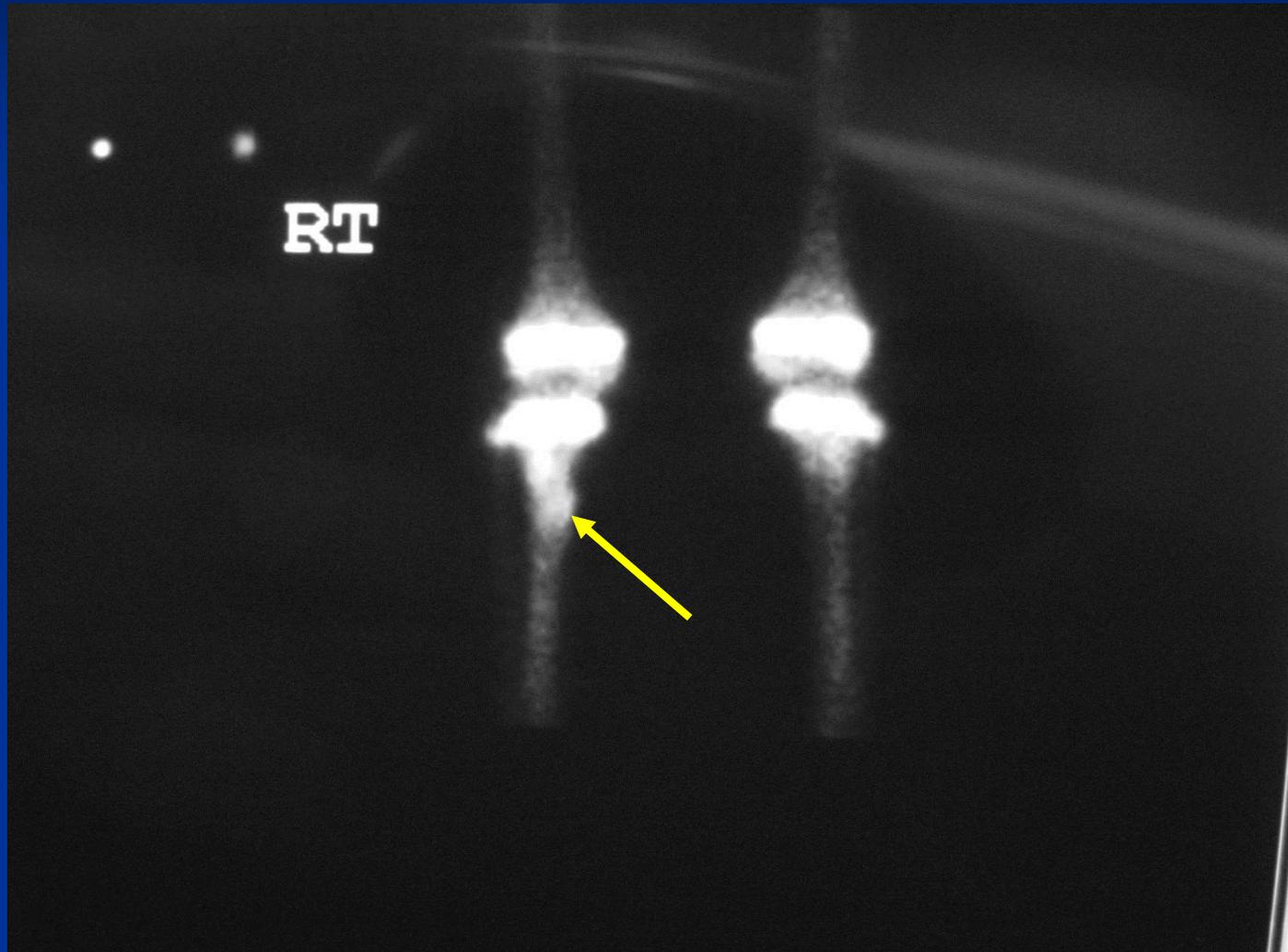
# X-Ray: Osteoid Osteoma of Tibia



Subtle Sclerosis

Difficult to see nidus on X-ray

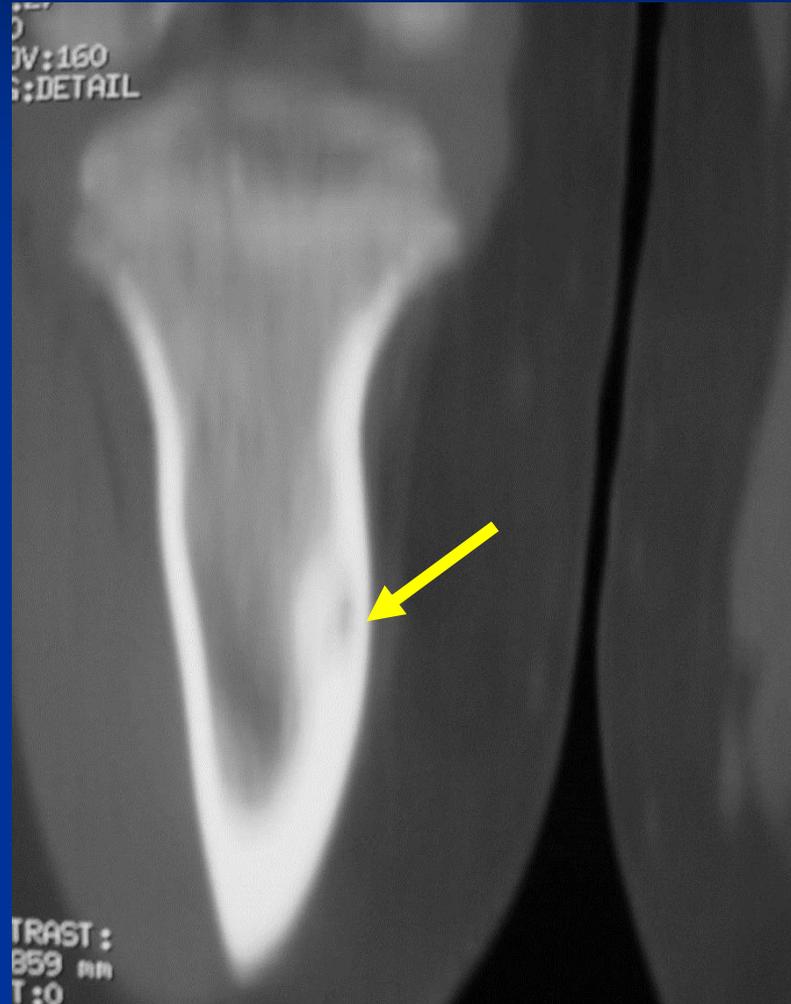
# Bone Scan: Osteoid Osteoma of Tibia



# Bone Scan: Osteoid Osteoma of Tibia

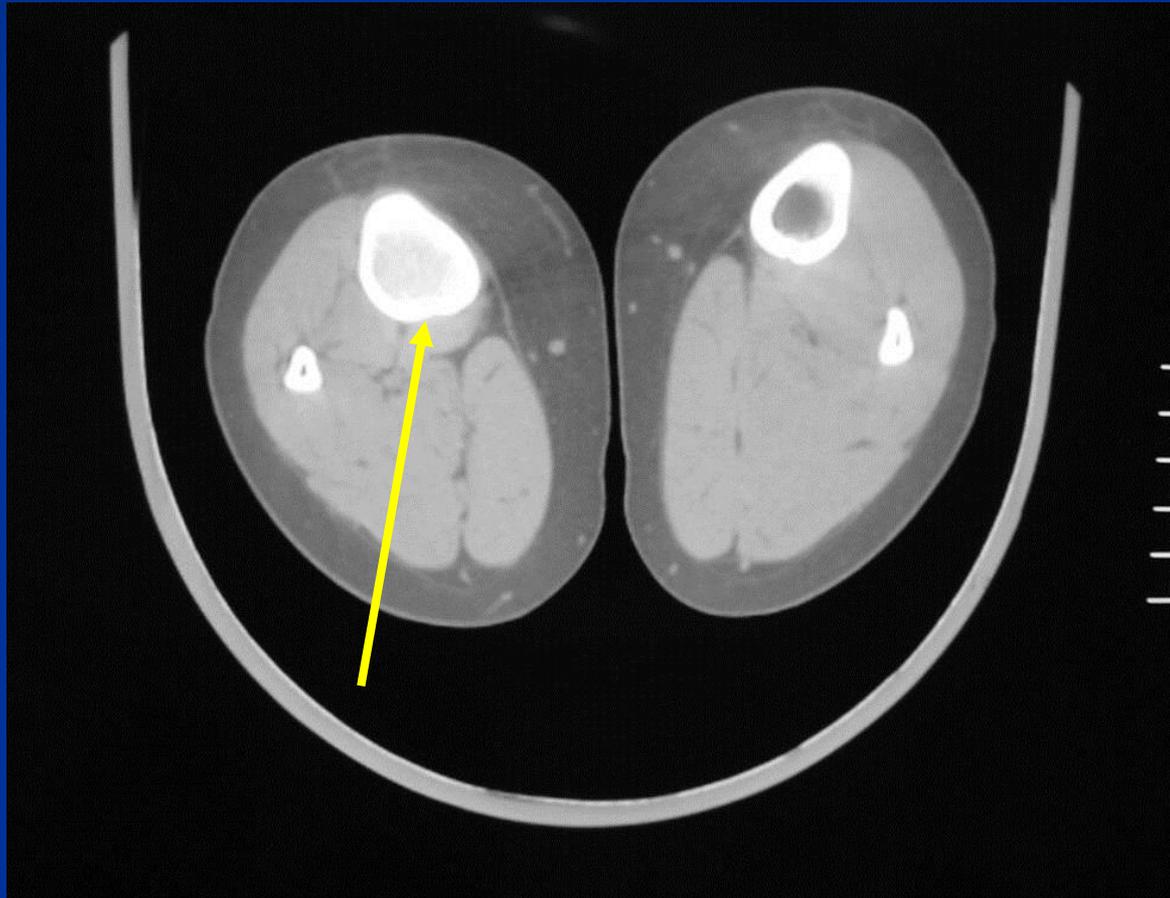


# CT Scan: Osteoid Osteoma of Tibia



# CT Scan: Osteoid Osteoma of Tibia

## Extensive Sclerosis Obliterated the Canal of the Right Tibia



# X-ray: Osteoid Osteoma of Left Acetabulum (Not Detectable on Plain X-ray)



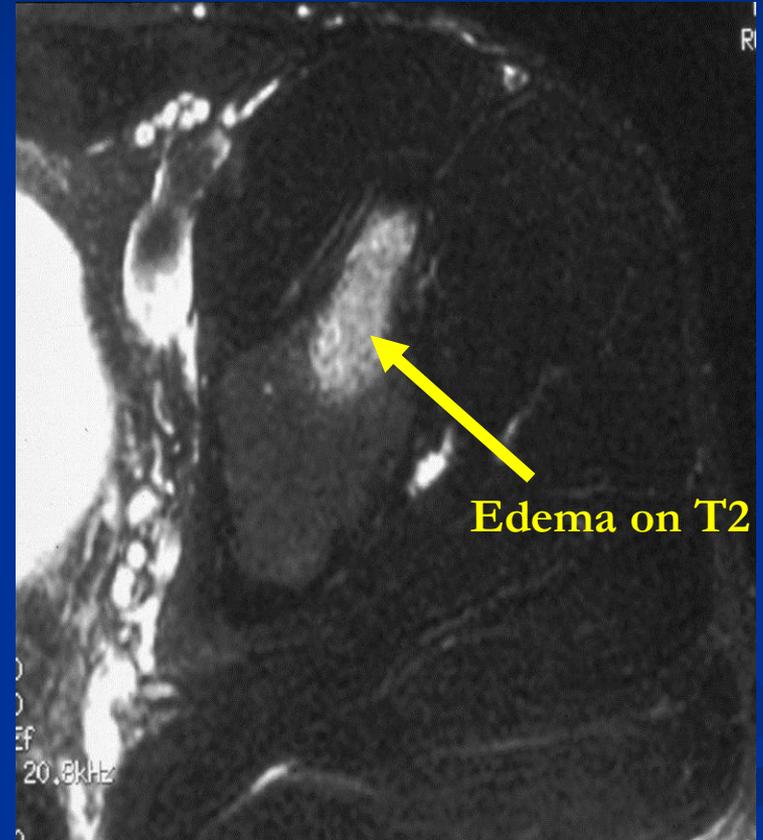
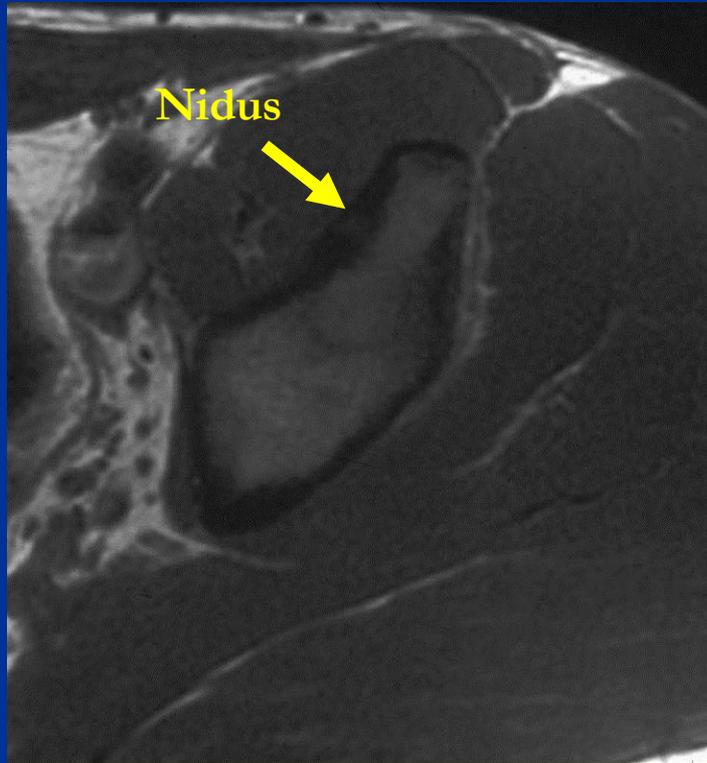
## Bone Scan: Osteoid Osteoma of Left Acetabulum



# CT Scan: Osteoid Osteoma of Left Acetabulum (The nidus is a few millimeters)



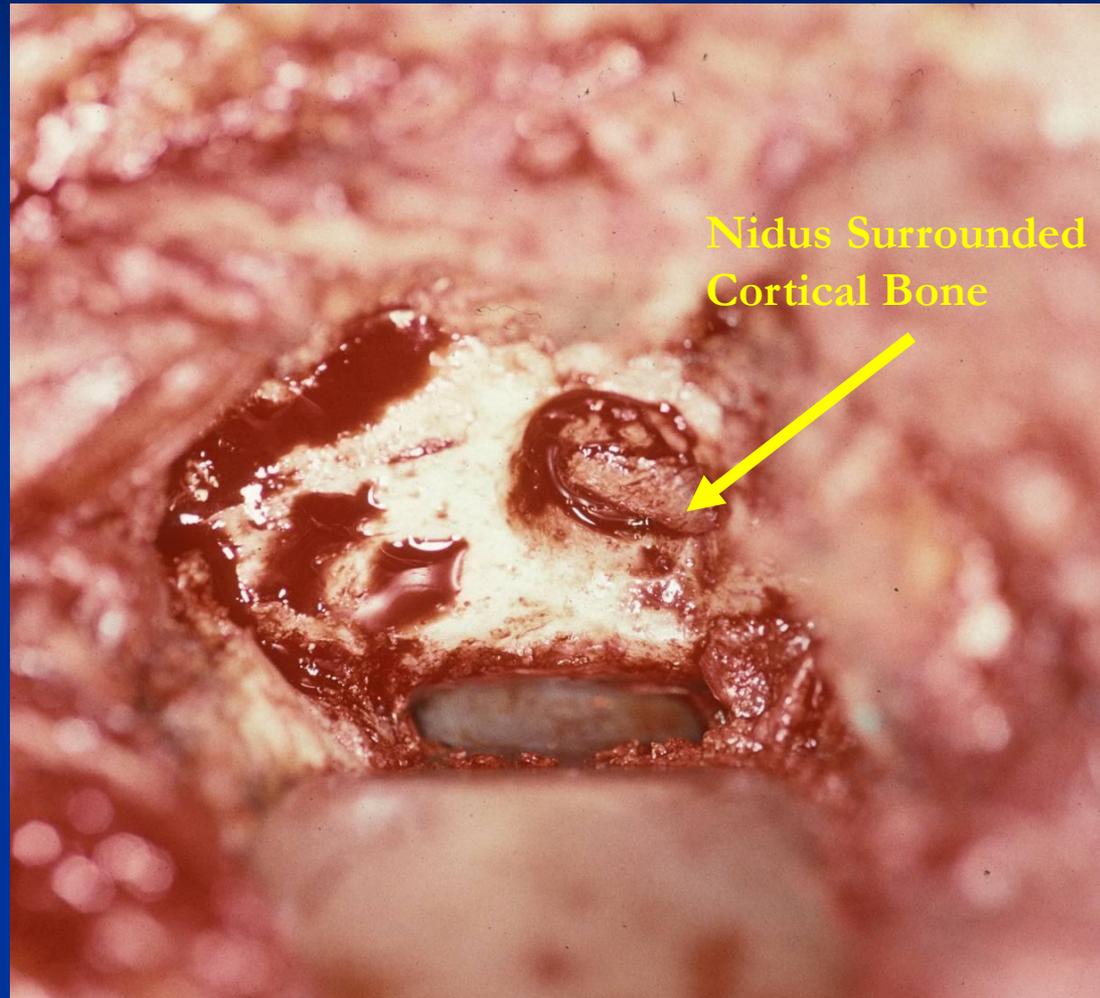
# MRI of Osteoid Osteoma of Acetabulum (Nidus not Clearly Visualized) There is Extensive Surrounding Edema



# Gross Pathology

- The nidus is distinct oval/round and reddish from vascularity
- It is well circumscribed and easily separated from surrounding bone
- The nidus is usually less than 1 cm but may be up to 2 cm
- The nidus may have a variable consistency depending on the extent of mineralization
  - Friable, soft and granular to densely sclerotic

# Gross Pathology: Osteoid Osteoma



# Gross Pathology: Osteoid Osteoma Nidus

- The nidus is reddish due to its vascularity
- It may be friable, granular and gritty



# Gross Pathology: Osteoid Osteoma

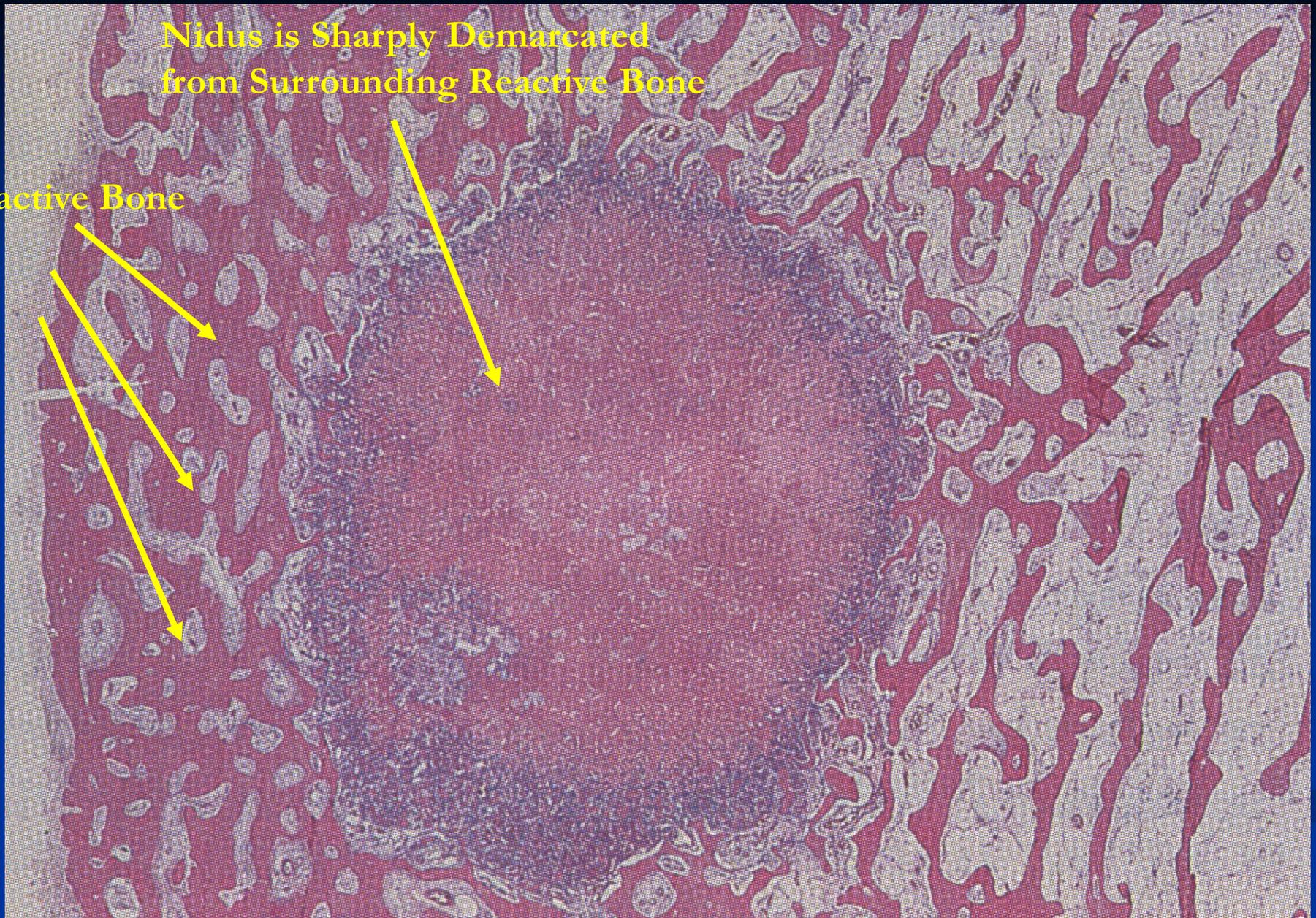


# Microscopic Pathology

- Vascularized fibrovascular stroma and trabeculae of **immature woven bone**
- Nidus is **sharply demarcated** from surrounding reactive bone and there is an abrupt zone of transition between normal bone and the osteoid osteoma. There is no permeation of the lesion through the surrounding reactive trabeculae of bone
- The trabeculae are uniformly lined by plump, uniform, active osteoblasts (**“Osteoblastic Rimming”**)
- Osteoclasts may be prominent
- Mature nidus consists of more heavily calcified trabeculae of woven bone and osteoid
- No abnormal mitoses

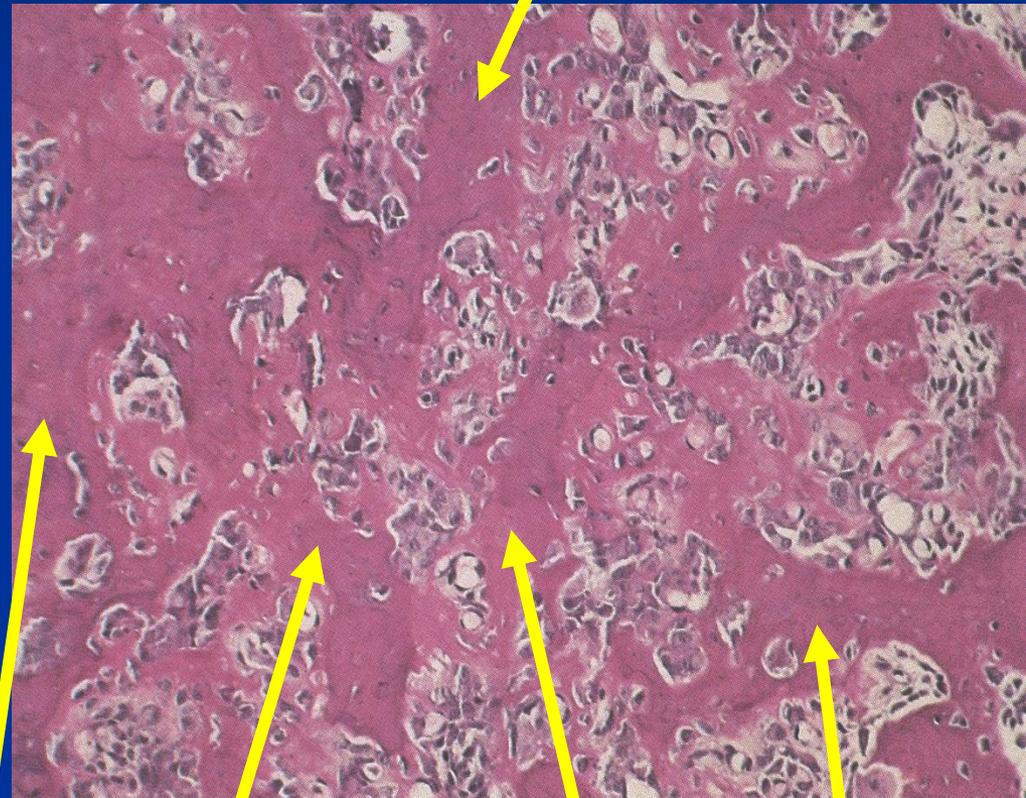
**Nidus is Sharply Demarcated  
from Surrounding Reactive Bone**

**Reactive Bone**



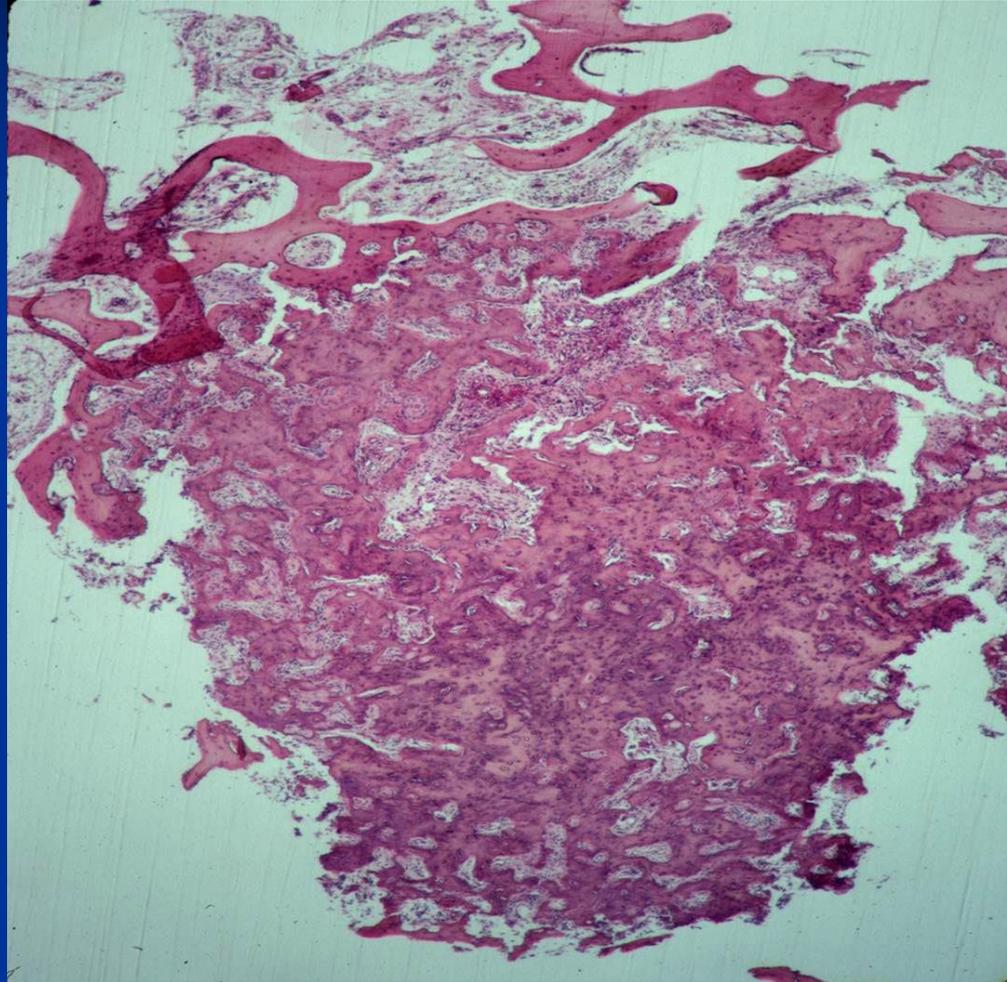
# Microscopic Pathology: Osteoid Osteoma

- Interlacing trabeculae of woven (immature) bone and osteoid (Arrows)
- Bone is lined by plump, uniform, regularly arranged osteoblasts (**Osteoblastic Rimming**)
- No mitotic figures
- No pleomorphism
- The intervening stroma is very well vascularized

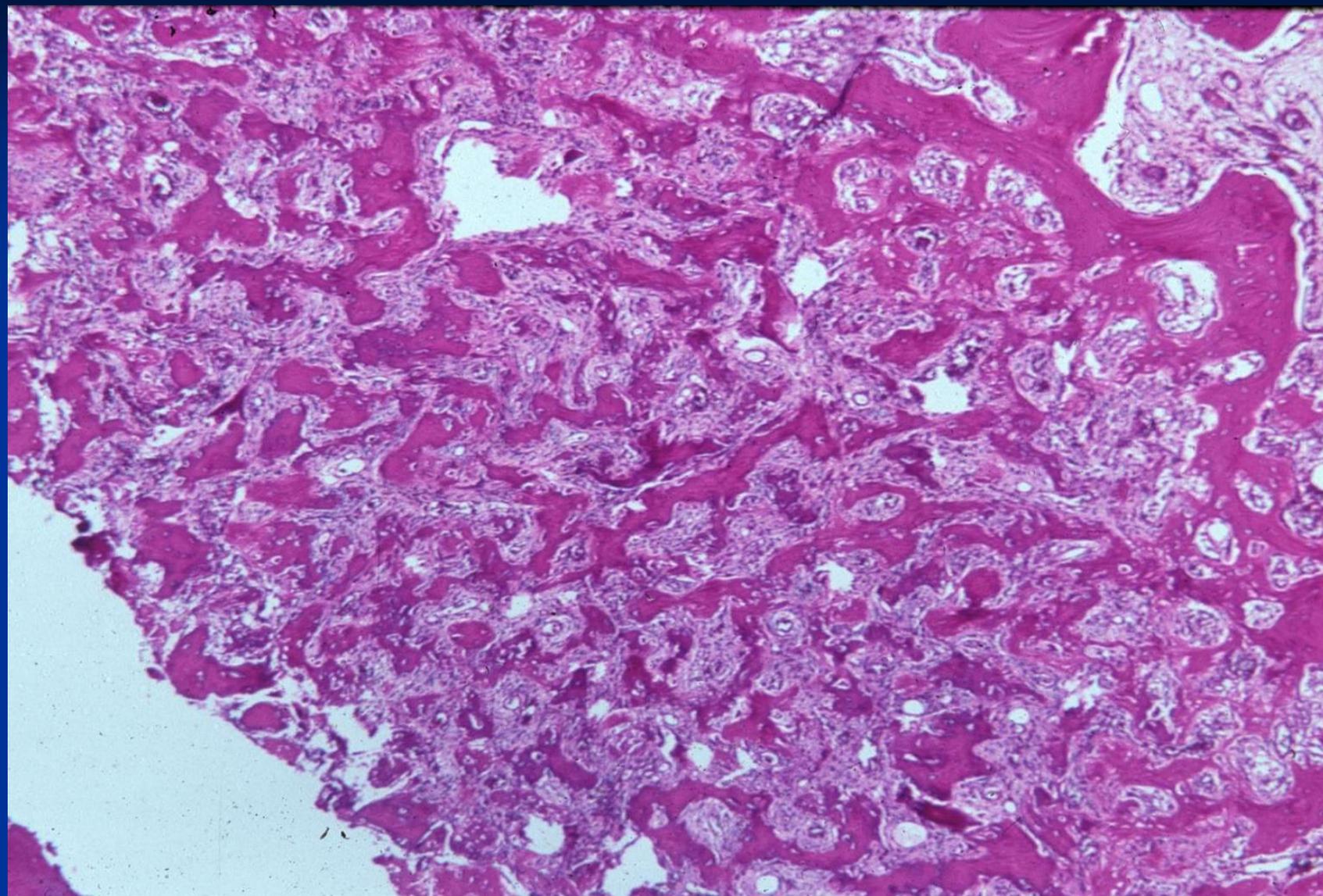


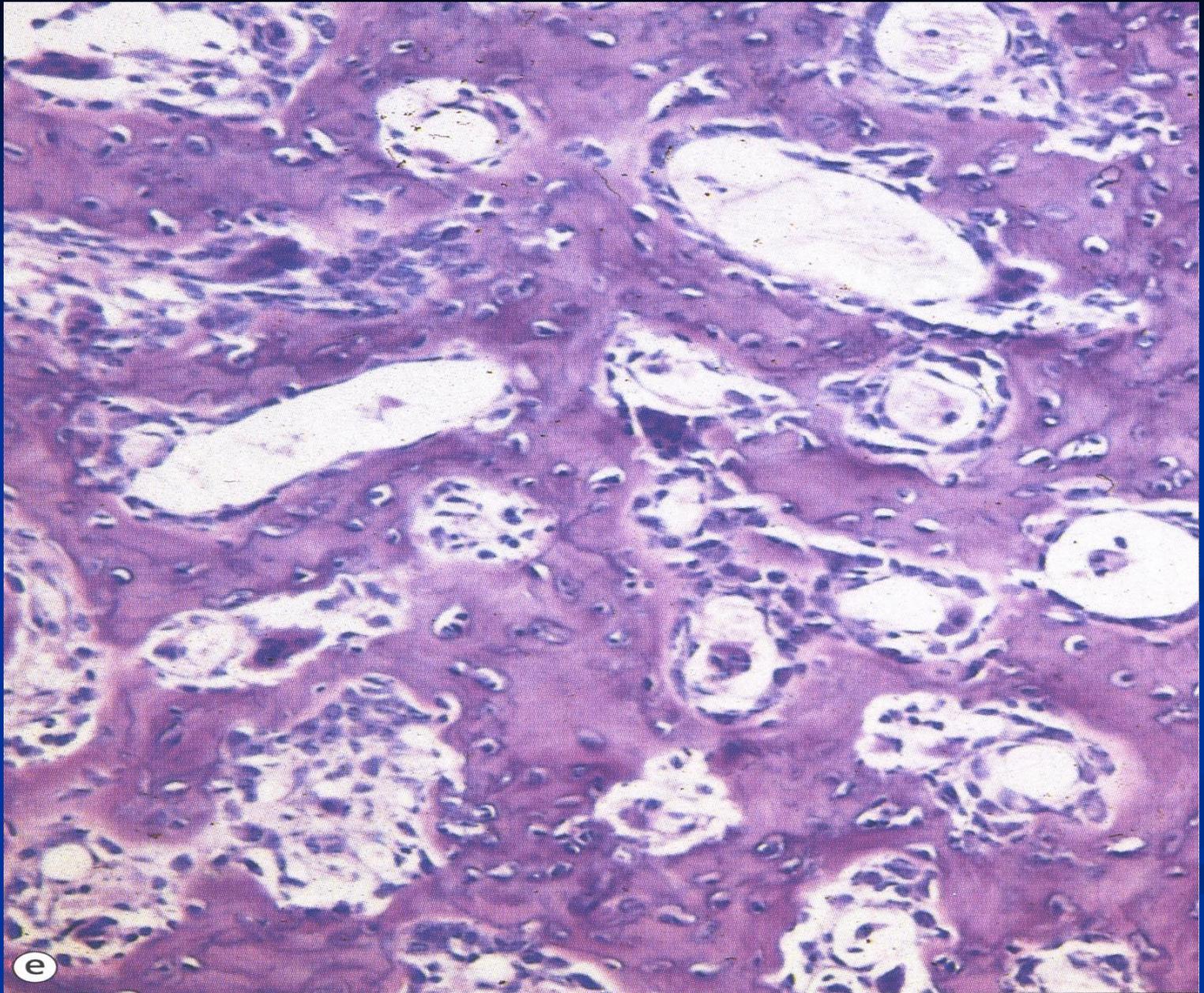
# Microscopic Pathology: Osteoid Osteoma Nidus

## Low Power View



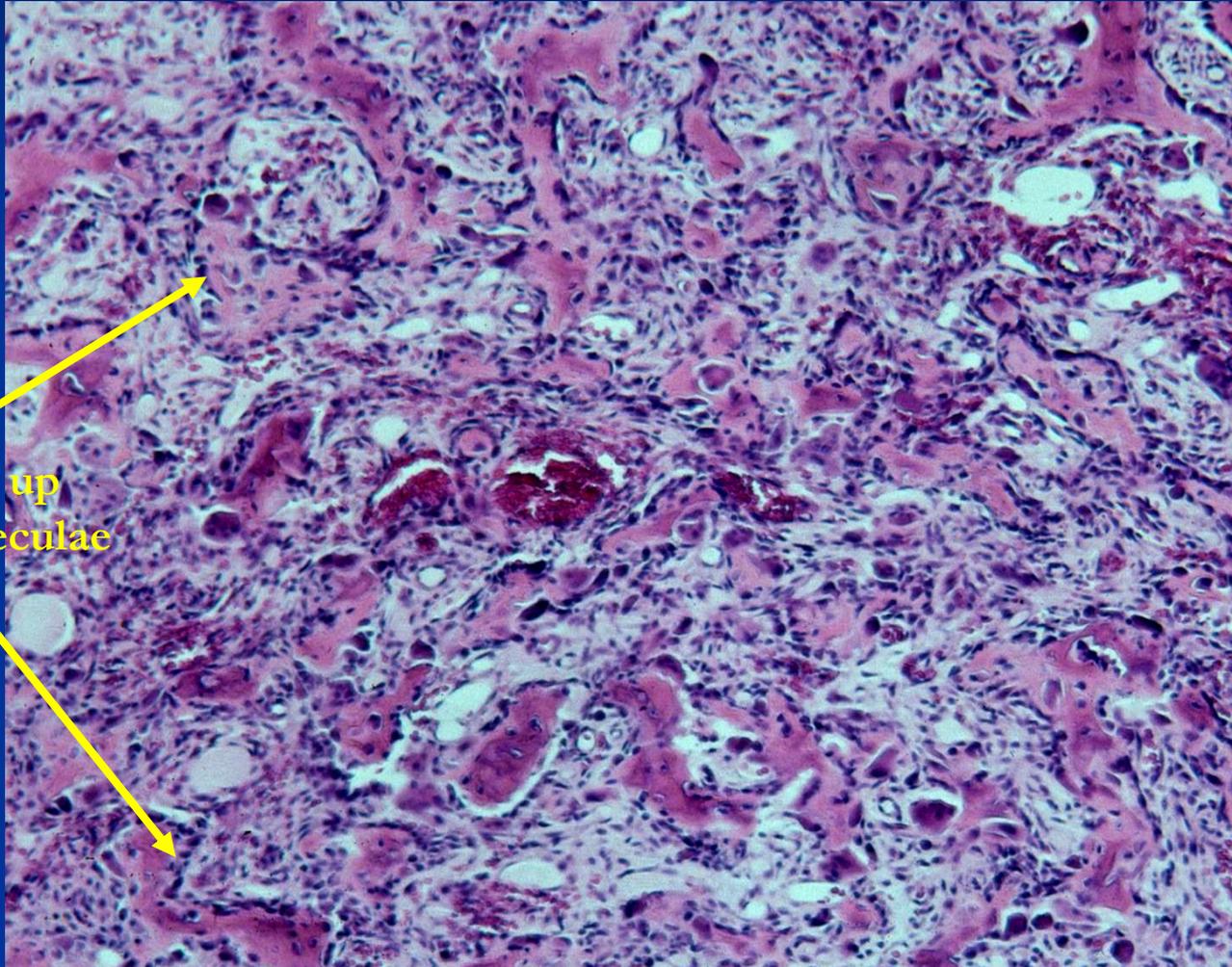
# Microscopic Pathology: Osteoid Osteoma





# Osteoid Osteoma

## Intermediate Power

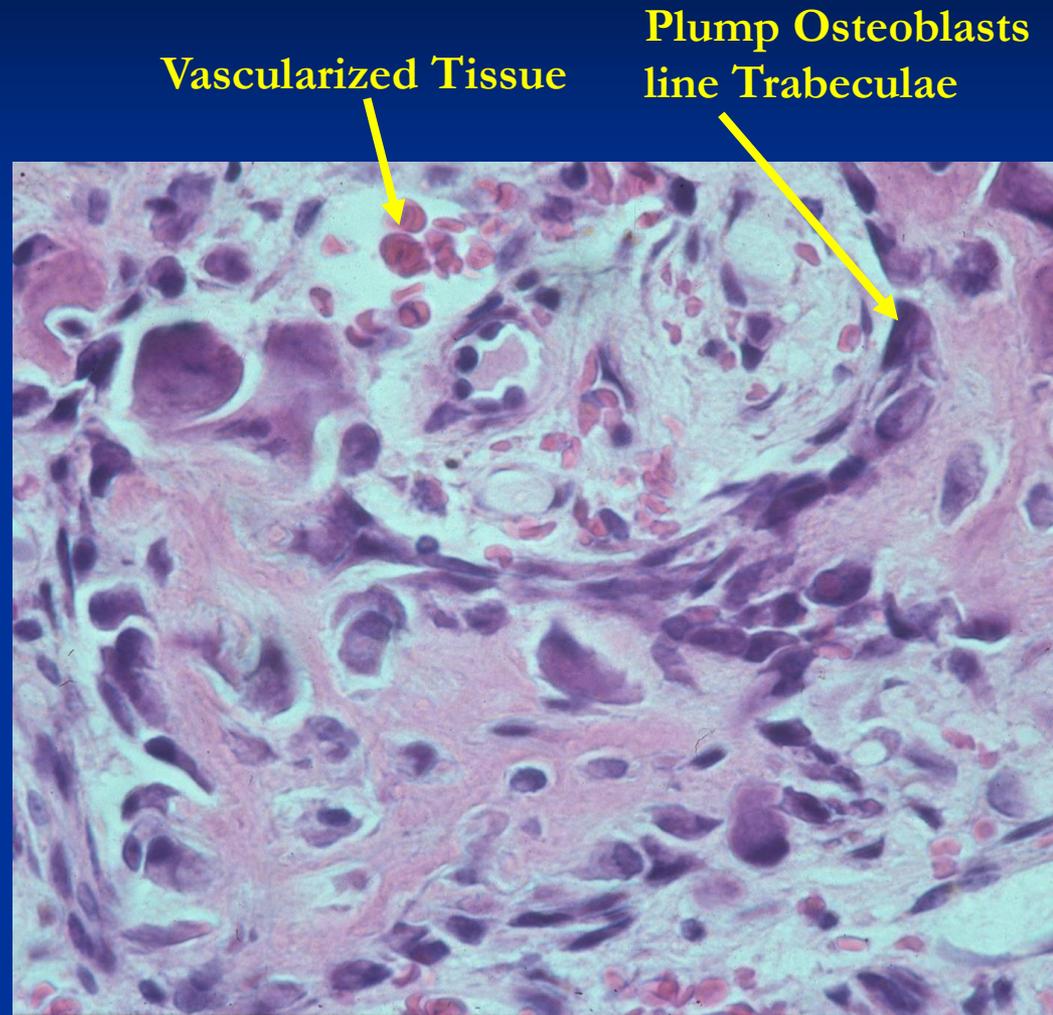


Osteoblasts line up  
around the trabeculae



# Osteoid Osteoma High Power

- Osteoblasts are plump and regularly arranged around and line the woven bone trabeculae. This is referred to as “Osteoblastic Rimming”
- There are no mitoses and minimal pleomorphism



# Differential Diagnosis: Osteoid Osteoma

- Differential DX of Cortical Osteoid Osteoma
  - Brodie's Abscess
  - Stress Fracture
  - Eosinophilic Granuloma
  - Intracortical Hemangioma
  - Bone Island
  - Intracortical Osteosarcoma
  - Ewing's Sarcoma

# Osteoid Osteoma

- Differential Diagnosis of Intraarticular lesions
  - Rheumatoid arthritis
  - JRA
  - Tuberculous arthritis
  - Nonspecific synovitis
  - Septic arthritis
  - Osteoblastoma (especially the spine)



Cortical Osteoid Osteoma



Cortical  
Bone Abscess



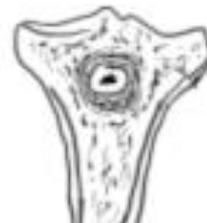
Stress Fracture



Intracortical  
Osteosarcoma



Medullary  
Osteoid Osteoma



Medullary Osteoid Osteoma  
With Sclerotic Center



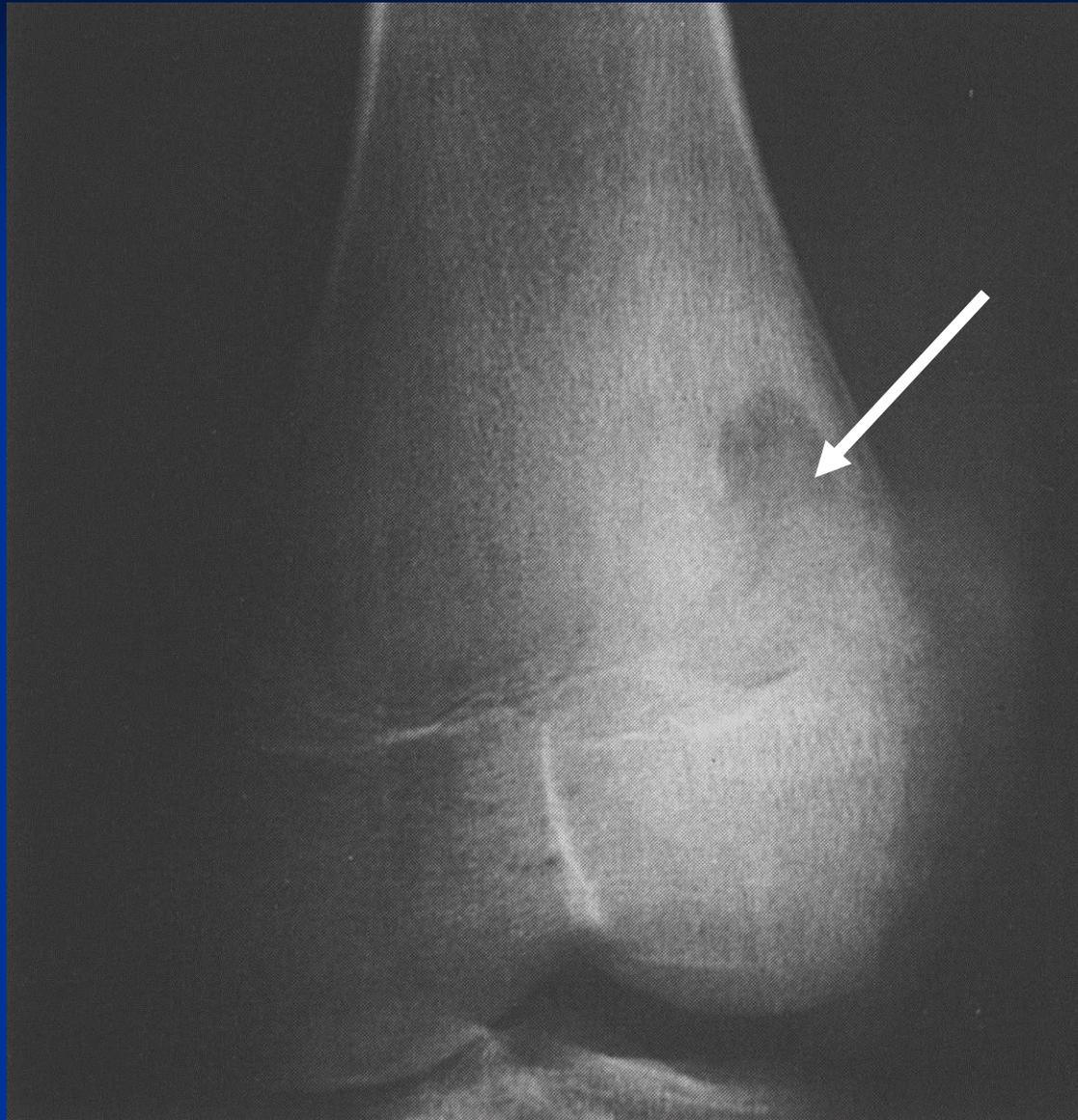
Brodie Abscess



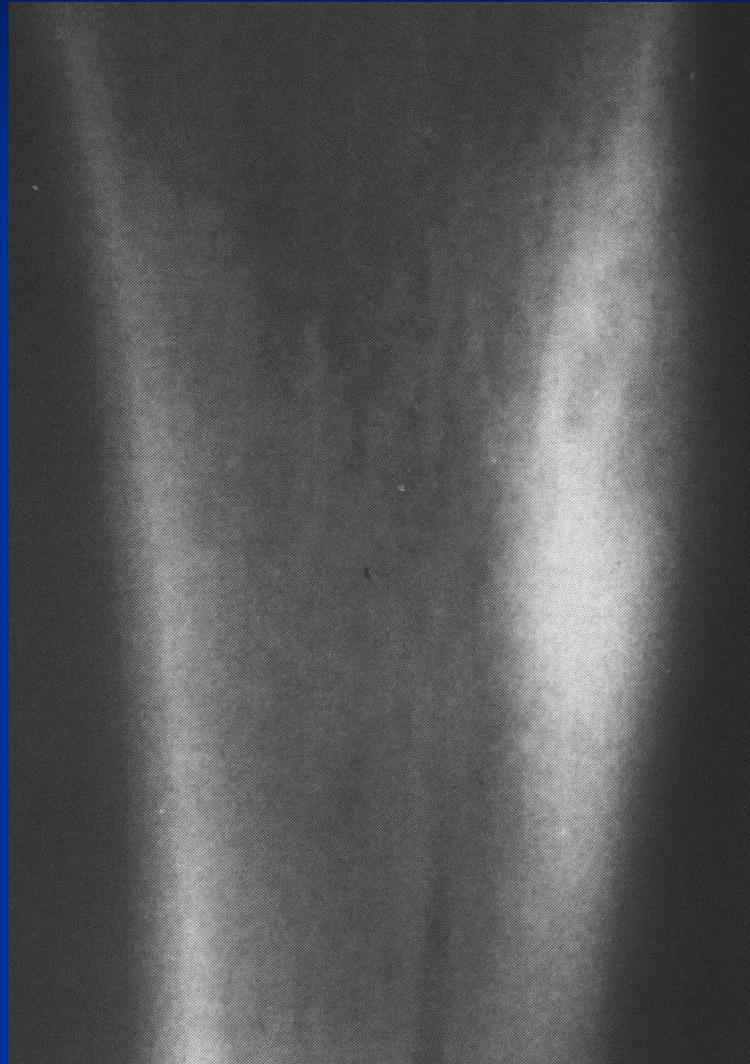
Bone Island  
(Enostosis)



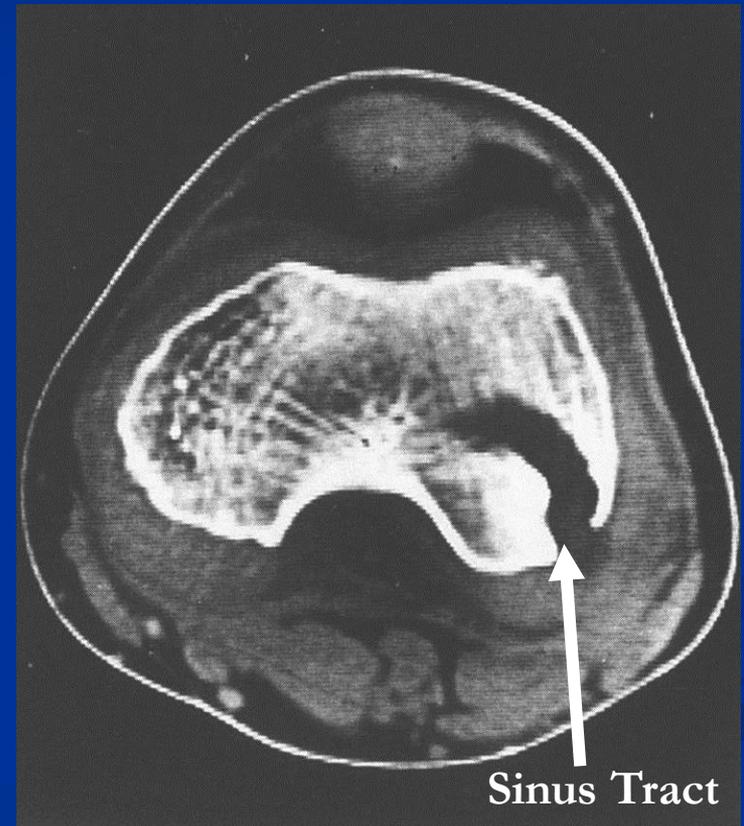
# Brodie's Abscess



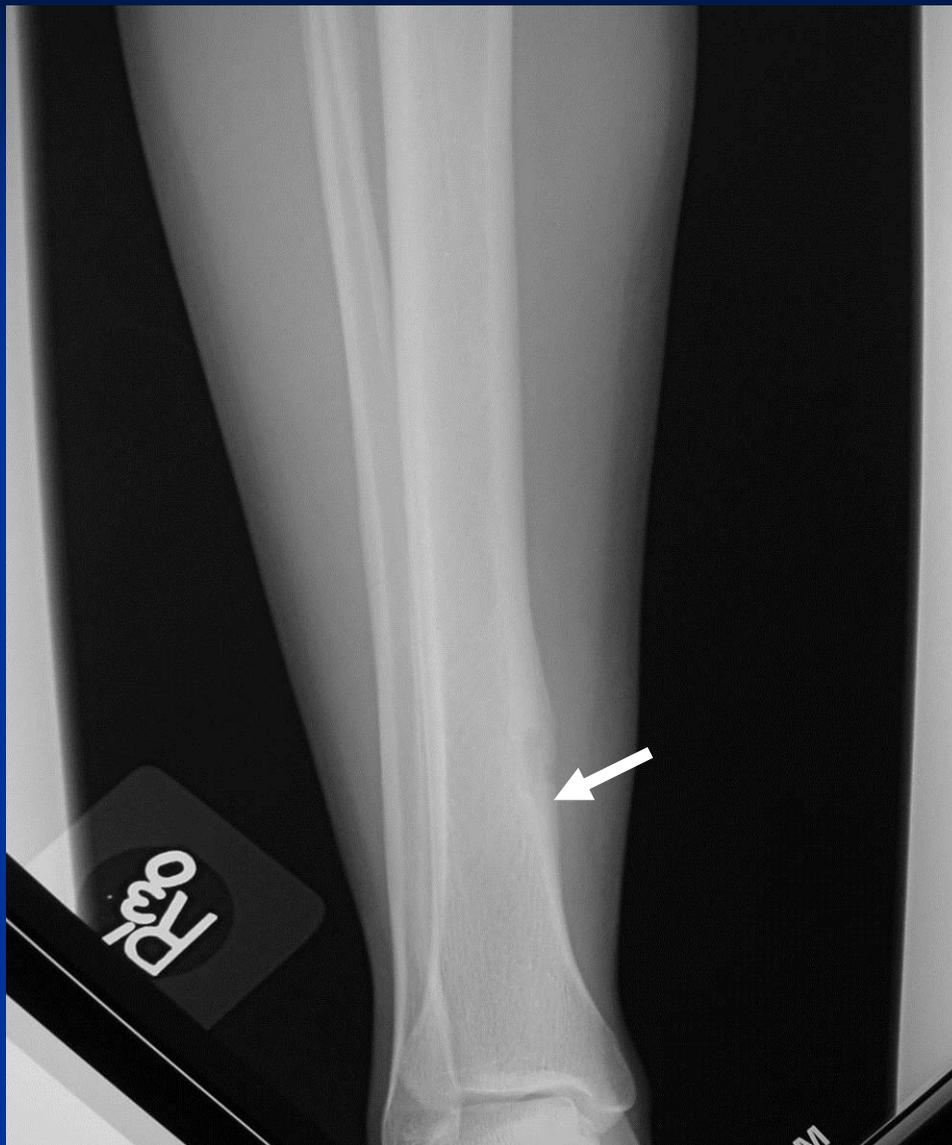
# Bone Abscess



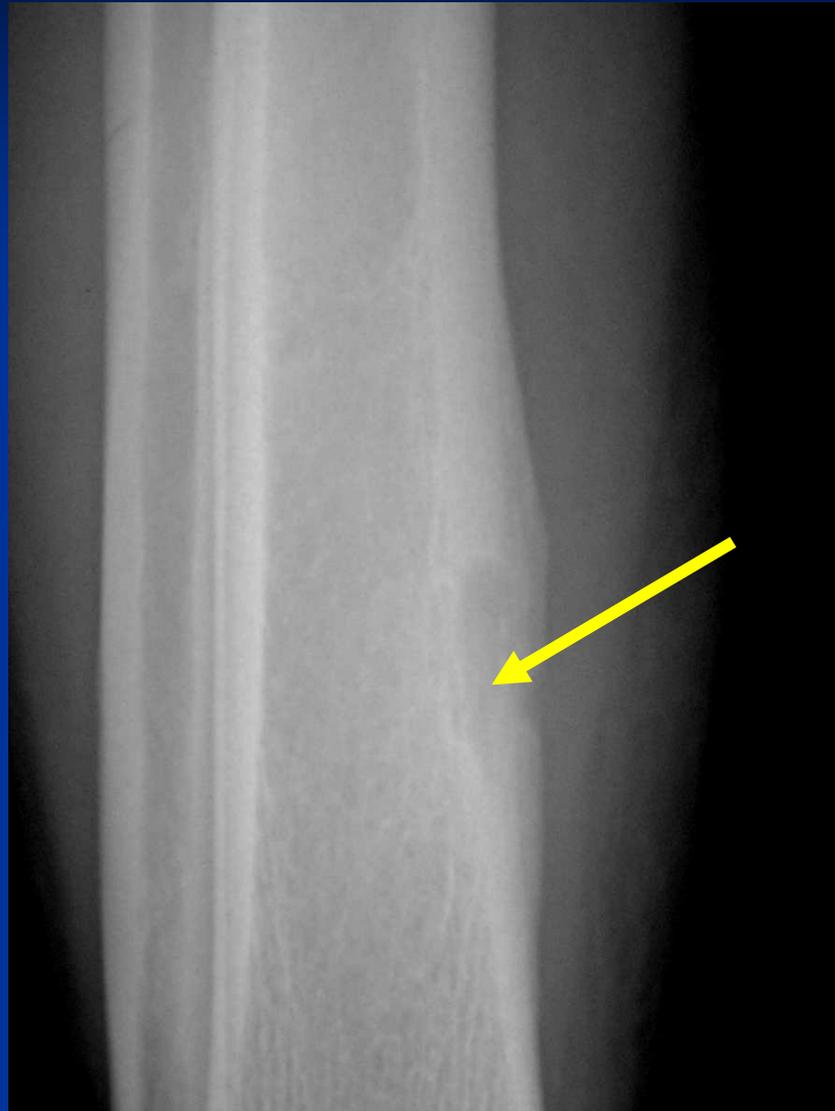
# Bone Abscess



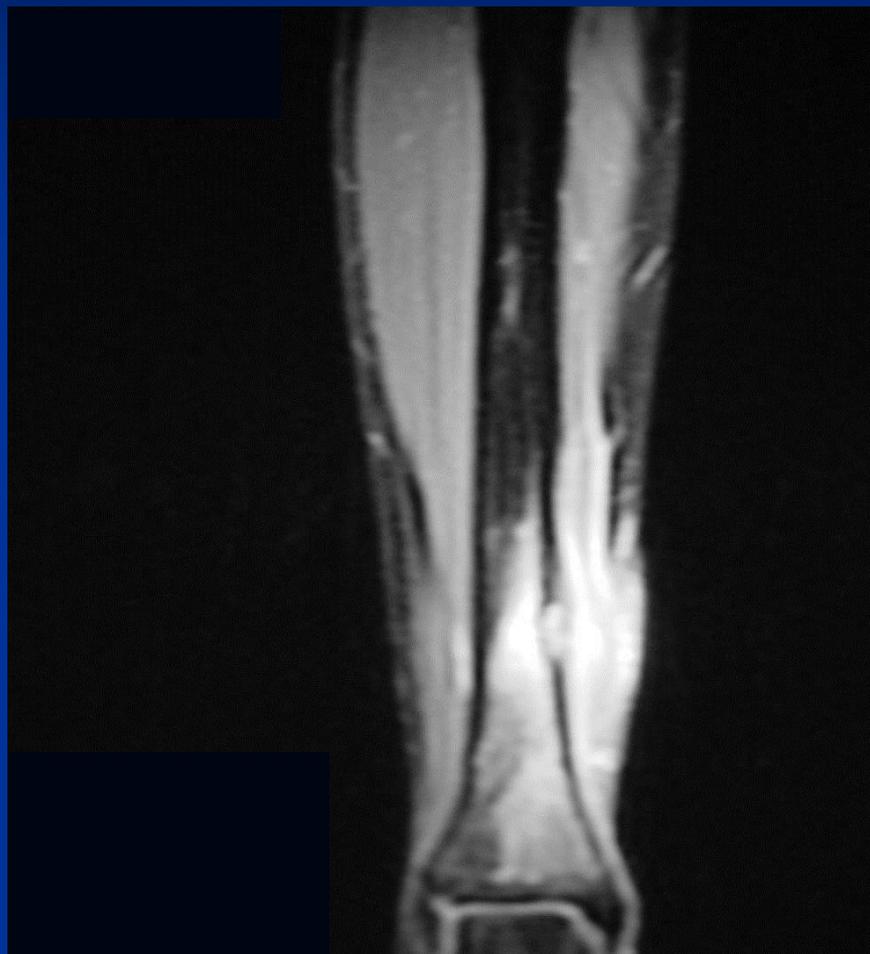
# Brodie's Abscess



# Brodie's Abscess

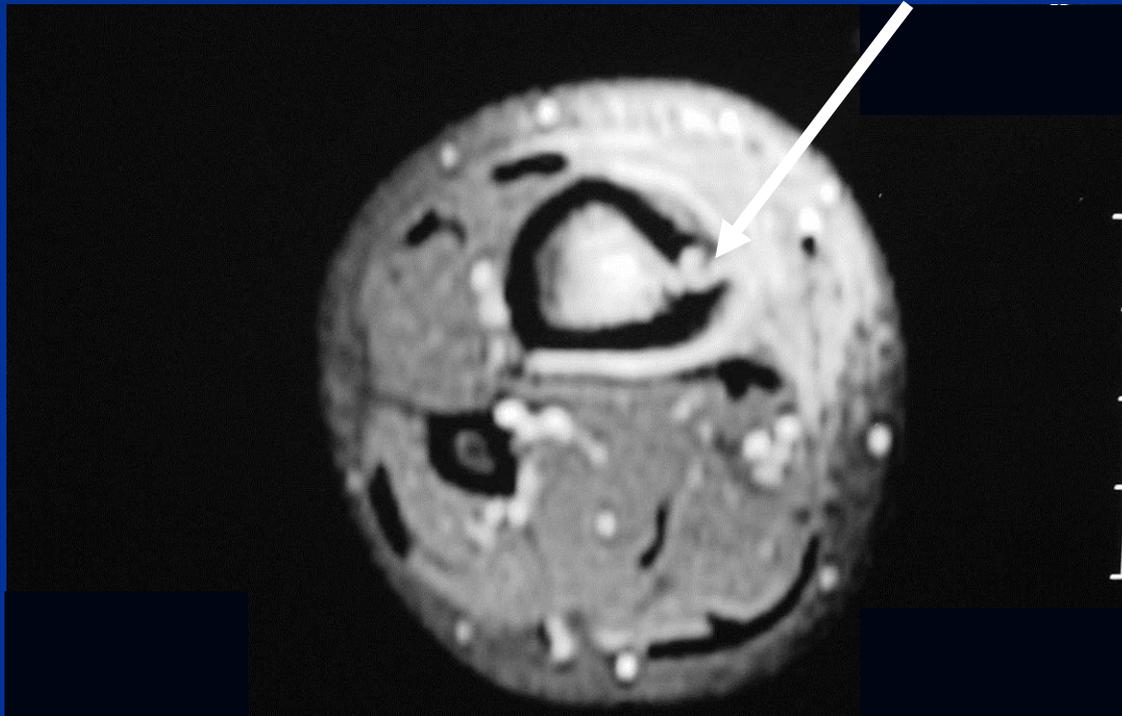


# Brodie's Abscess



# Brodie's Abscess

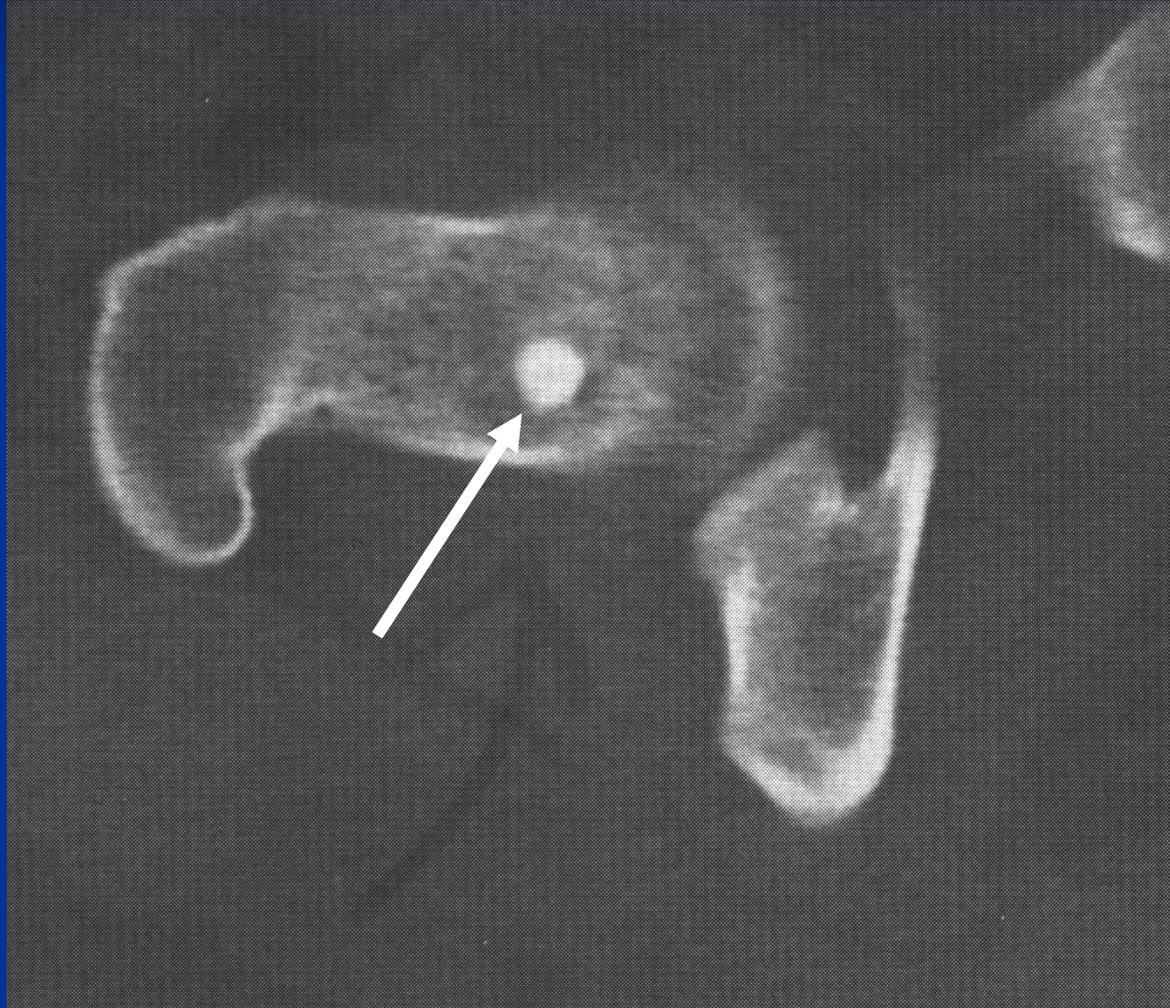
Draining Sinus Tract from Bone



# Stress Fracture

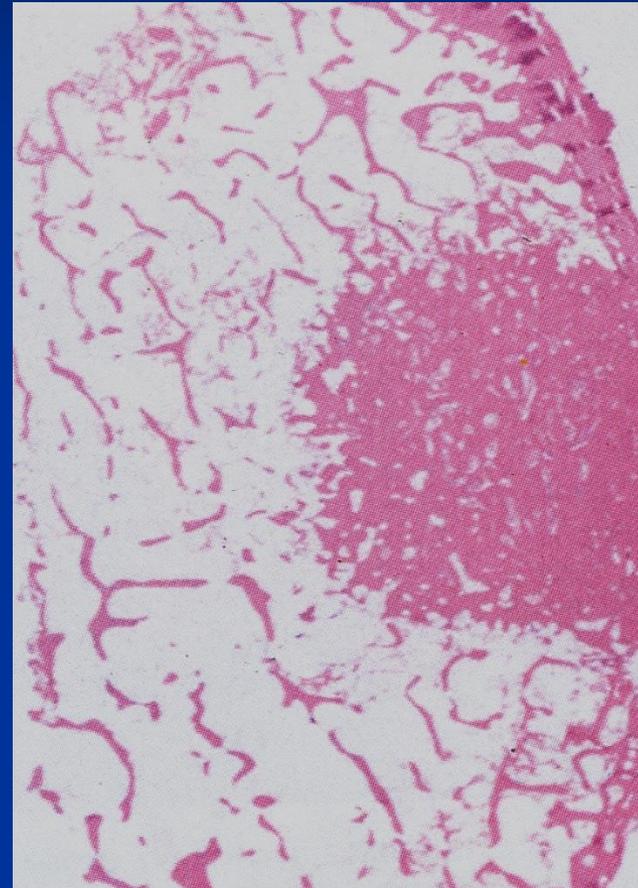


# Bone Island



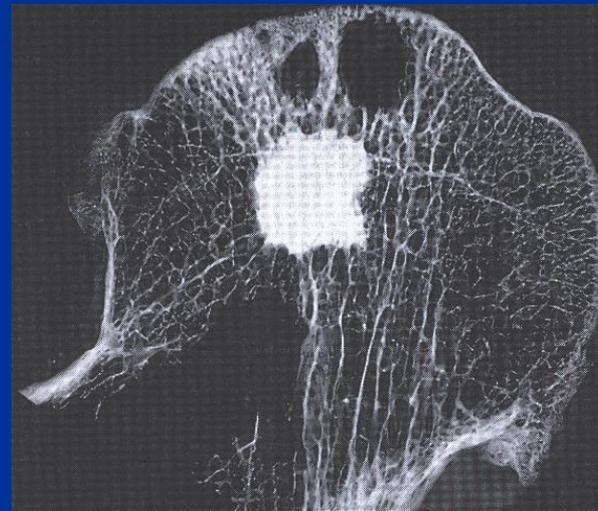
# Bone Island Pathology

- Pathology is same as an osteoma except a bone island occurs within the medullary canal and not on the surface of the bone
- Mature, dense, cortical, compact bone arranged in a lamellar manner around haversian canals
- Sits within medullary canal

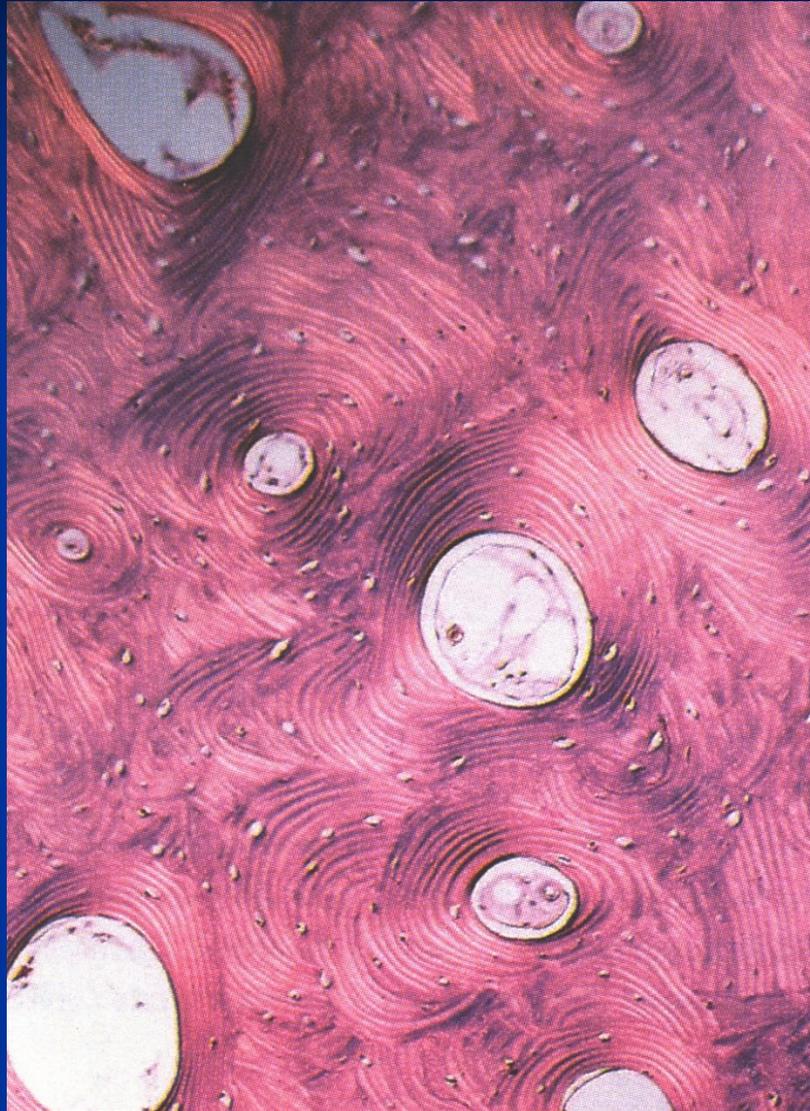


# Bone Island

- The periphery of a bone island extends outward as spicules that blend in with surrounding trabeculae
- CT scan can often demonstrate these spicules



# Pathology of a Bone Island



# Biological Behavior of Osteoid Osteomas

- Osteoid osteomas exhibit limited growth potential and grow to a certain size (rarely grow greater than 1 cm) and then stop growing
- Some tumors may spontaneously regress
- Osteoid osteomas that occur next to joints or intra-articularly may cause the adjacent synovium to become thickened
  - There may be chronic inflammatory cell infiltrates with lymphofollicular features in the synovium that can be mistaken for rheumatoid arthritis
  - Long standing intraarticular tumors can lead to a true arthritis

# Treatment

- CT guided percutaneous radiofrequency ablation (RF Ablation).
  - 90% successful and there are minimal risk
- Some patients may require open surgical excision or “Burr Down Resection” of the osteoid osteoma
  - Mostly for recurrent tumors
- Lesions not accessible surgically or with RF ablation may be treated with chronic NSAIDS
  - Problems with gastritis and renal failure
  - Sometimes spontaneously regress or burn but there are patients who have had osteoid osteomas for years

# Osteoblastoma

# General Information

- Benign osteoblastic neoplasm with aggressive growth pattern (considered a benign aggressive tumor)
  - Histologically it is similar to osteoid osteoma but is a larger size and grows progressively
- Consists of well vascularized connective tissue stroma with interconnecting trabeculae of osteoid and **immature woven bone**
- Constitute about 1% of excised primary bone tumors
- Osteosarcoma is 20x more common and osteoid osteoma is 4x more common than osteoblastoma
- There is a more aggressive form of osteoblastoma in which recurrences are more common. These tumors have a higher rate of recurrence.

# Clinical Presentation

- **Signs/Symptoms:** Pain is the most common presenting symptom
  - Pain is usually less severe and less pronounced at night and may or may not be relieved by aspirin compared to an osteoid osteoma.
  - Spinal lesions may be accompanied by muscle spasms, scoliosis and neurological manifestation
- **Prevalence:** Males: Females 2-3:1
- **Age:**
  - 80% of patients are between 10 and 30 years old
- **Sites:**
  - Spine (40% of cases; usually posterior elements)
  - Long Bones (30%)
    - Most arise from diaphysis or metaphysis
    - Epiphyseal lesions are rare but may occur more often in the tubular bones of the hands or feet

# Radiographic Presentation

- Plain X-rays:
- Geographic, circumscribed lesion usually around 5cm in size.
- Expansion of bone, cortical thinning and cortical breakthrough. A soft tissue mass may accompany this lesion but the soft tissue component is usually contained by the periosteum.
- The periosteum remains intact around the soft tissue component. CT scan useful to detect the subtle calcification (Egg Shell Rim of Calcification) associated with an intact periosteal reaction
- The lesion may be entirely radiolucent but usually shows some degree of mineralization. (CT useful for subtle mineralization)
- Usually less surrounding sclerosis than an osteoid osteoma.

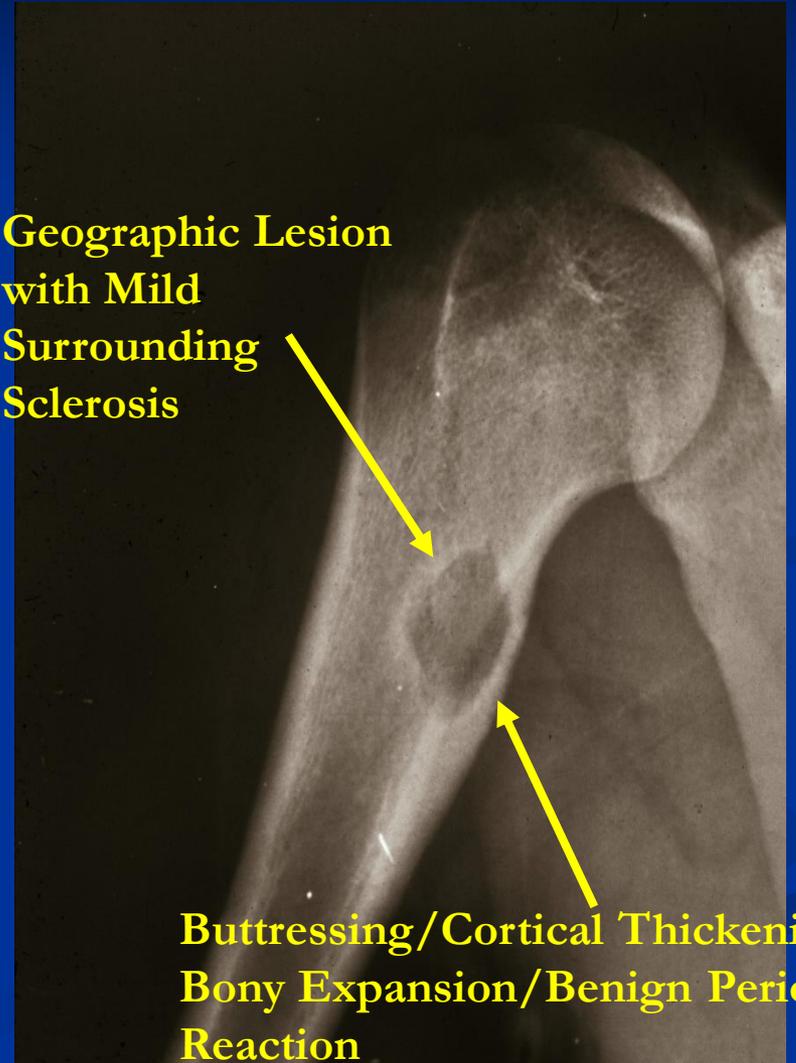
# Radiographic Presentation

- **Bone Scan**: Increased uptake at the site of the lesion
- **CT Scan**: More useful for detecting mineralization and evaluating extent of bone destruction than plain X-ray
- **MRI**: Useful in determining extent
  - There is often extensive **edema** around the tumor in the surrounding bone and soft tissues that can lead to a misdiagnosis of a malignant tumor.

# Plain X-Ray: Osteoblastoma

- Geographic Pattern of Bone Destruction
- Eccentric
- Sclerotic Margin
- Buttressing, Benign Appearing Periosteal Reaction (Cortical Thickening/Bony Expansion)
- No clear mineralization on Xray

**Geographic Lesion  
with Mild  
Surrounding  
Sclerosis**

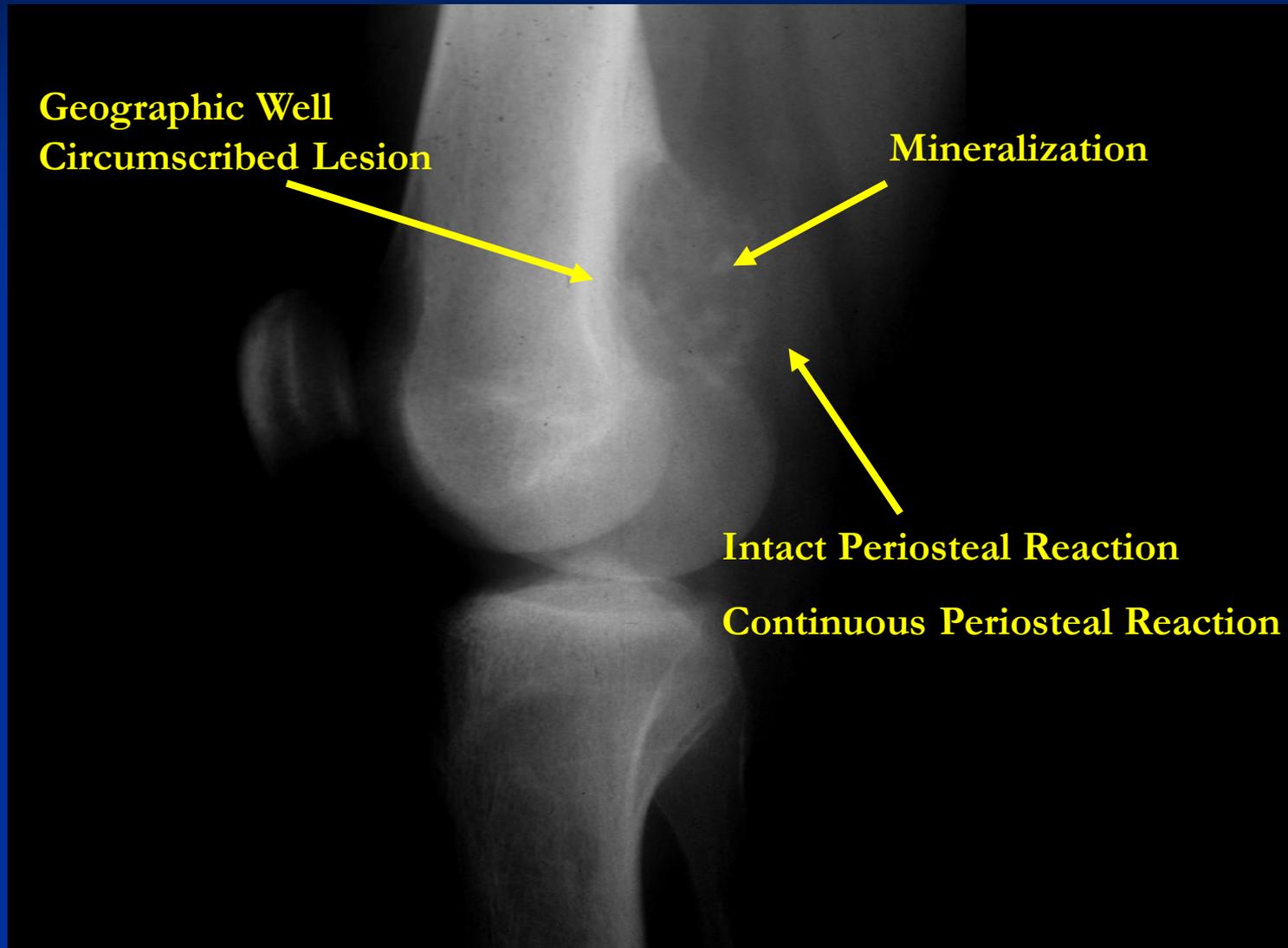


**Buttressing/Cortical Thickening/  
Bony Expansion/Benign Periosteal  
Reaction**

# Plain X-ray: Osteoblastoma of Proximal Humerus



# Plain X-Ray: Osteoblastoma of Distal Femur



# MRI: T1 Weighted Image of Osteoblastoma of Distal Femur

- Geographic Well Circumscribed Lesion
- Intermediate Signal on T1



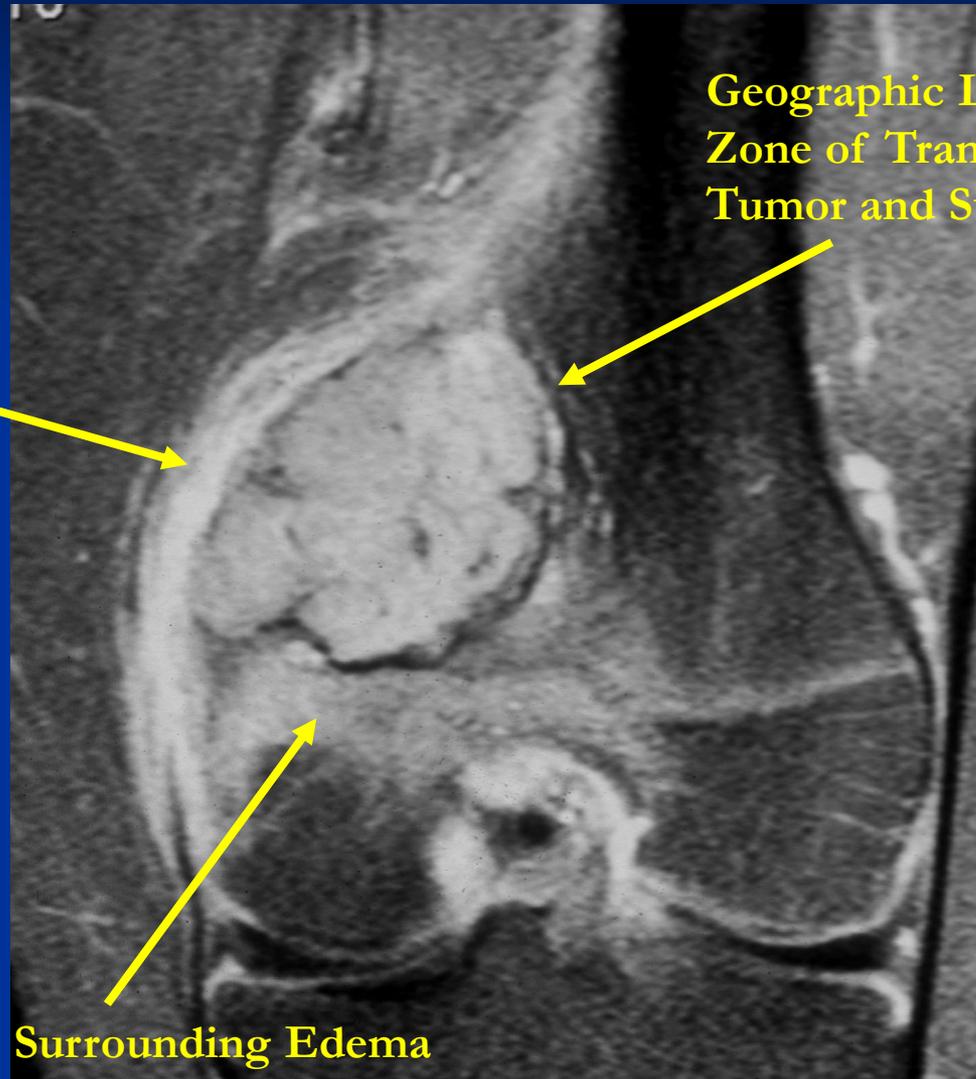
# MRI: T2 Weighted of Osteoblastoma of Distal Femur

- Geographic Lesion
- High signal on T2 with punctate low signal areas consistent with mineralization (Arrows)
- There is extensive edema around the lesion (high signal in medullary canal)



# MRI: T2 Coronal MRI of Osteoblastoma of Distal Femur

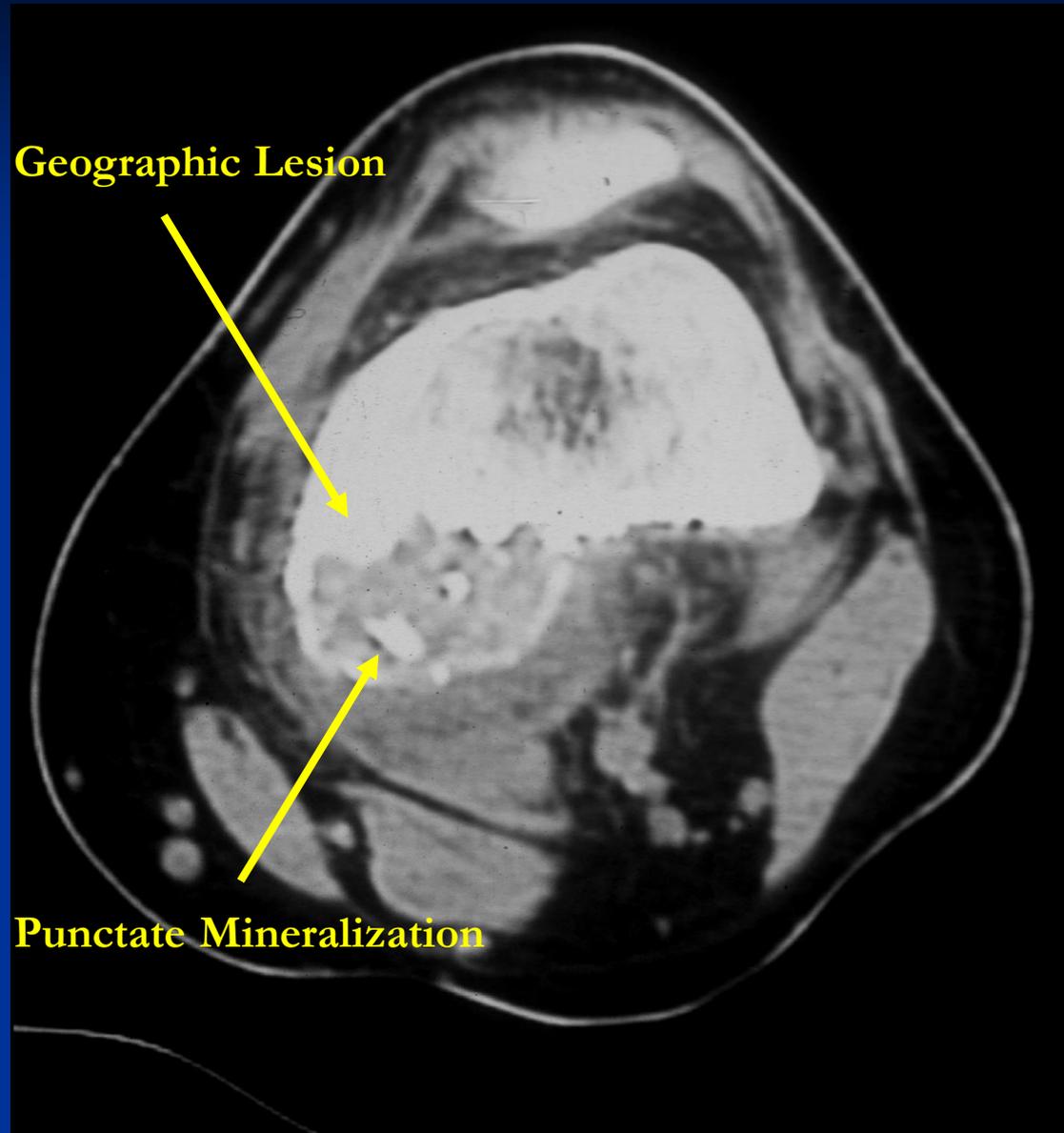
Soft Tissue  
Edema



Geographic Lesion with Narrow  
Zone of Transition between  
Tumor and Surrounding Bone

Surrounding Edema

# CT Scan of Distal Femur Osteoblastoma

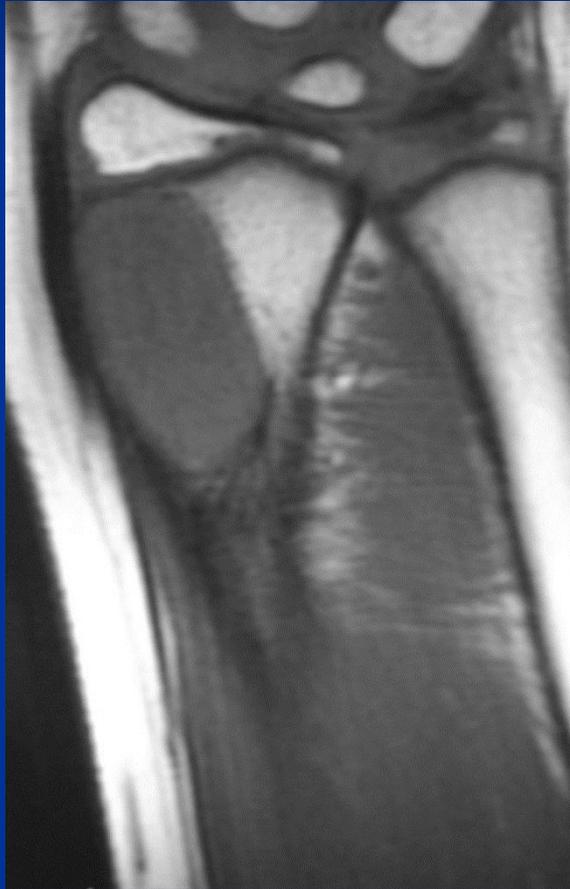


# X-ray: Osteoblastoma of Distal Radius

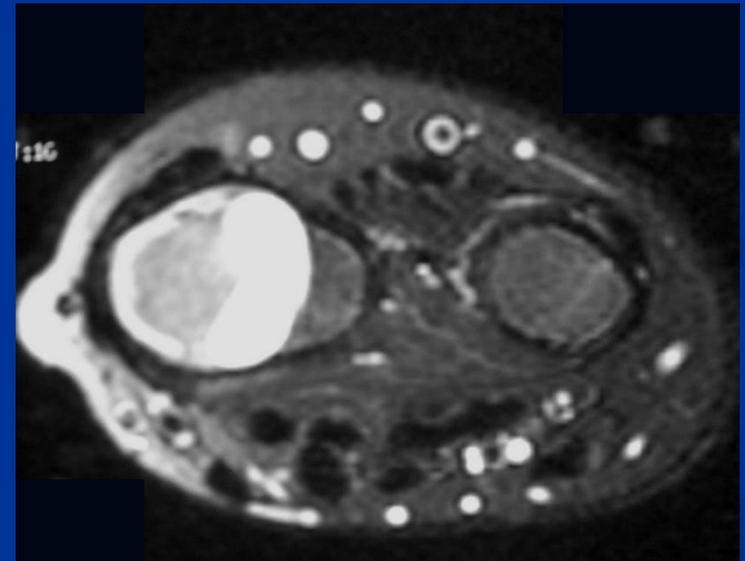
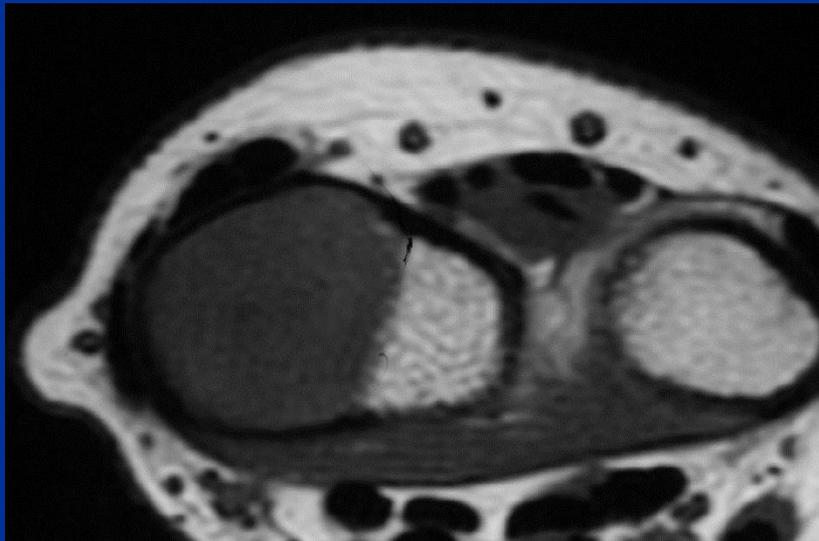
- Geographic Lesion
- Well Circumscribed
- Mineralization may not be detectable on a plain radiograph



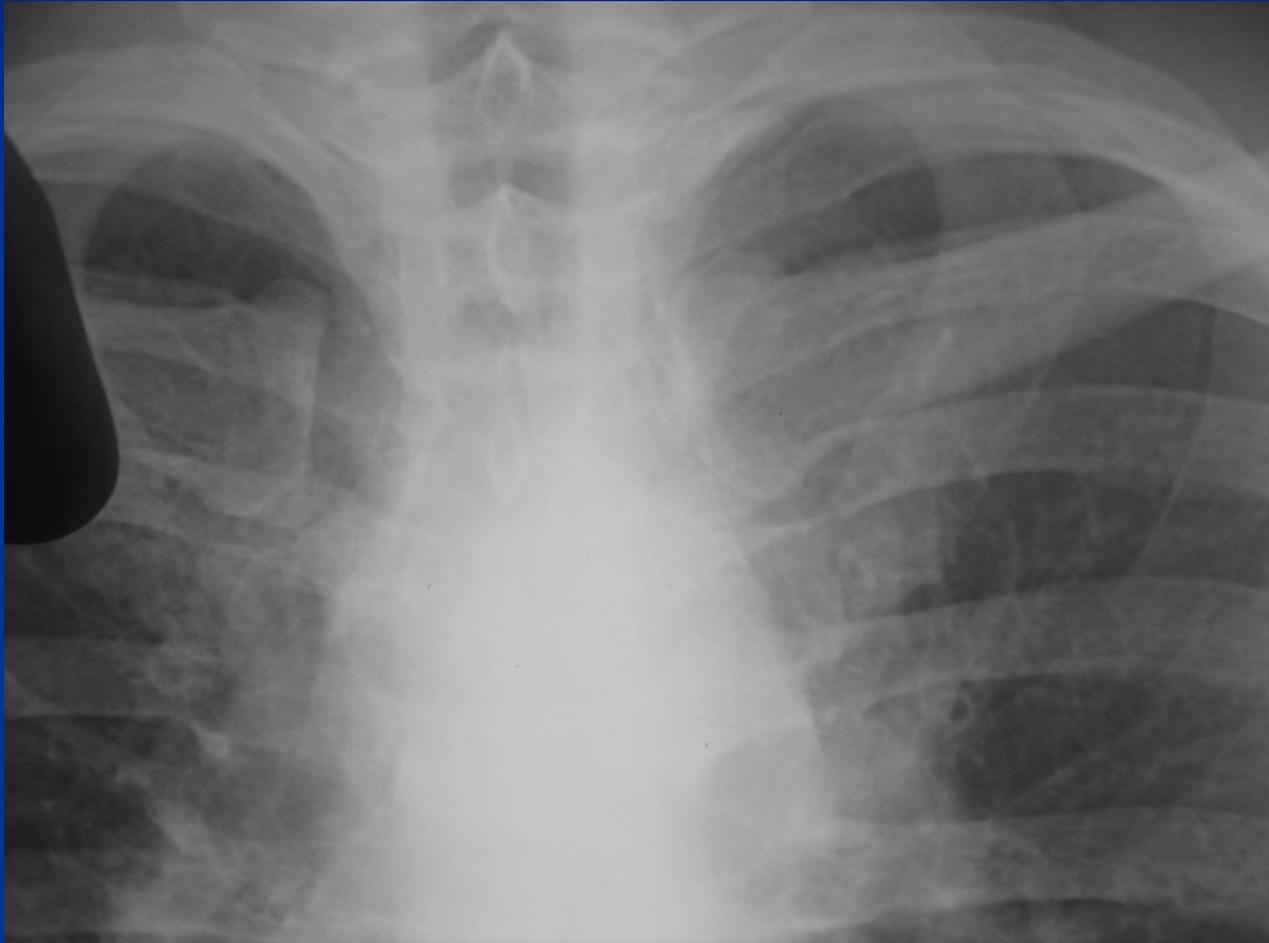
# MRI: Osteoblastoma of Distal Radius



# MRI: Osteoblastoma of Distal Radius

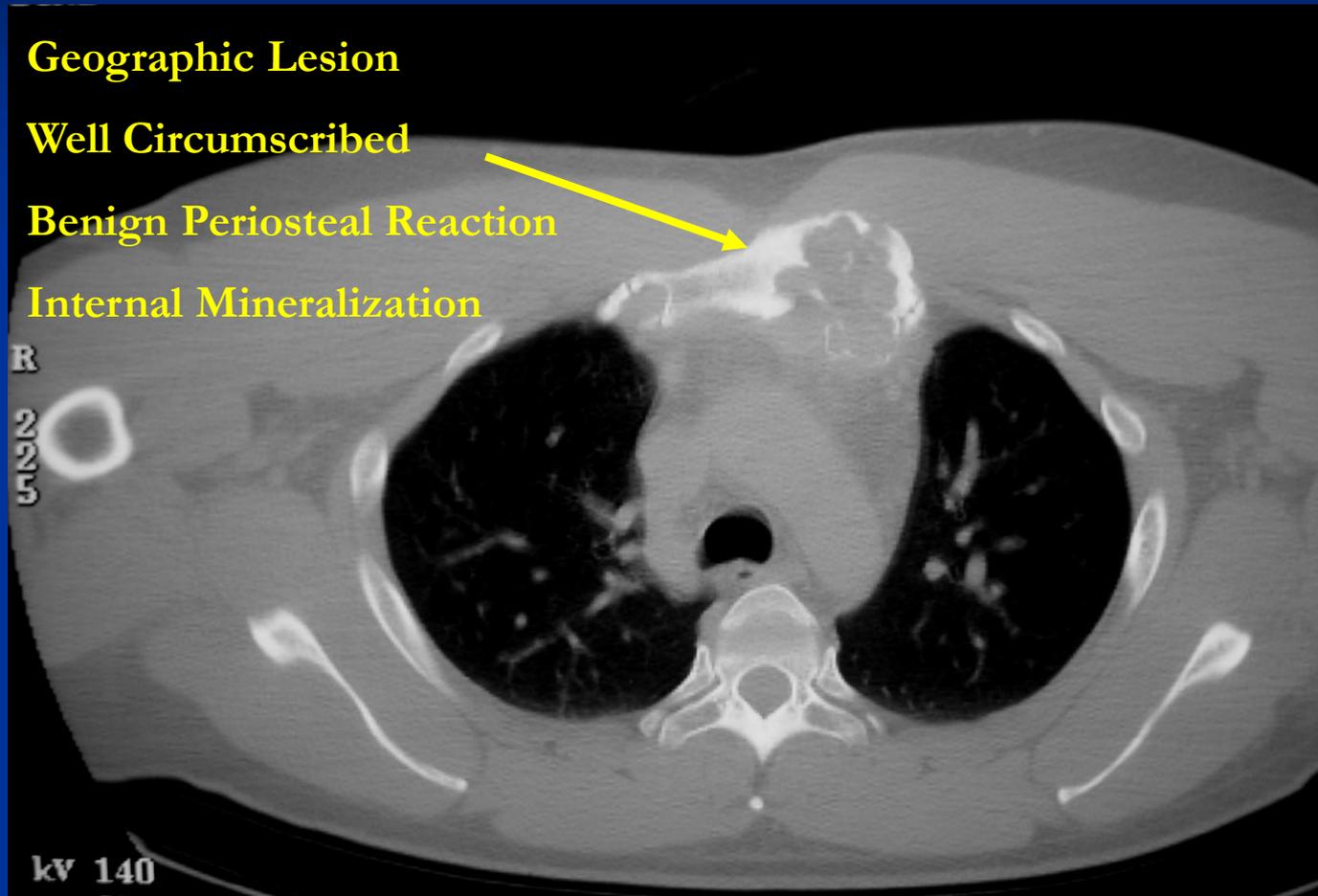


# Plain X-Ray: Osteoblastoma of Sternum



# CT Scan: Osteoblastoma of Sternum

## Axial Section



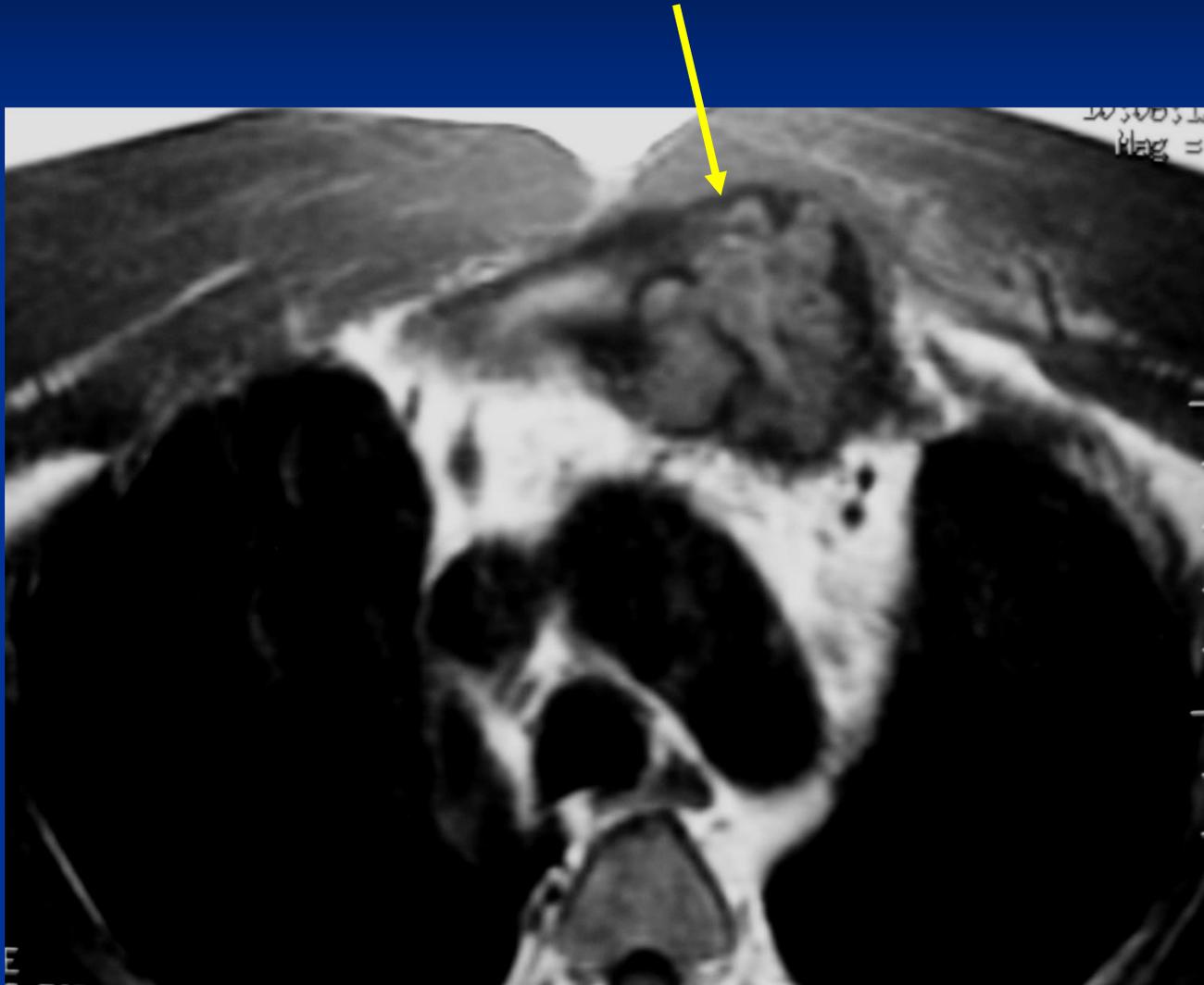
# CT Scan Osteoblastoma of Sternum Coronal Section



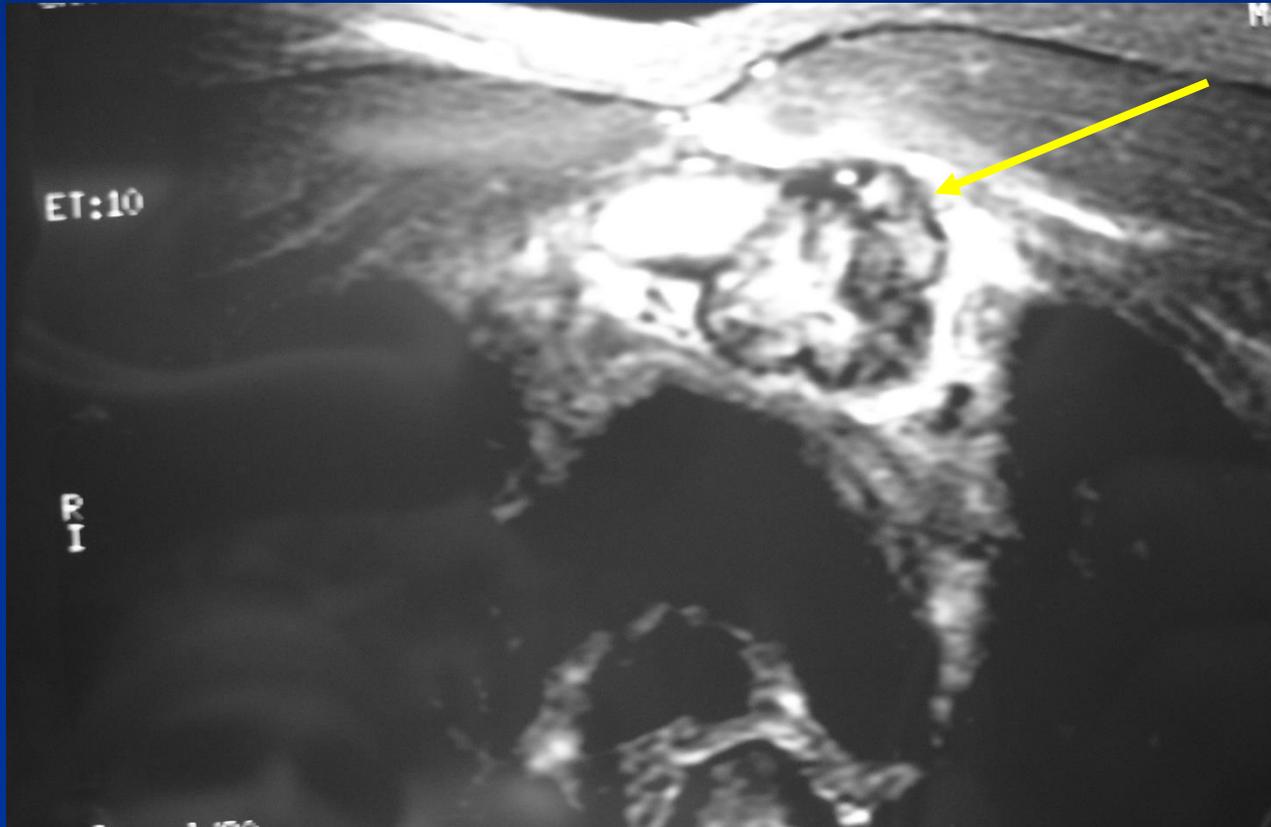
# CT Scan Osteoblastoma of Sternum Sagittal Section



# MRI: T1 Weighted Image Osteoblastoma of Sternum



# MRI: T2 Weighted Image of Osteoblastoma of Sternum with Surrounding Edema



# X-ray: Osteoblastoma of Proximal Phalanx



Geographic Lesion

Cortex Expansile

Mineralization not  
always detected on x-ray

# Osteoblastoma

- **Radiology of Spine Lesions:**

- Well defined, expansile, geographic, osteolytic lesion that is partially or extensively calcified or ossified
- Posterior elements alone (>60% of cases)
- Posterior elements with extension into vertebral body (25%)
- Vertebral body alone (15%)
- More likely to contain ossification and a soft tissue mass
- Sclerosis less likely than long bones
- Scoliosis less characteristic than osteoid osteoma

# Osteoblastoma of Spine

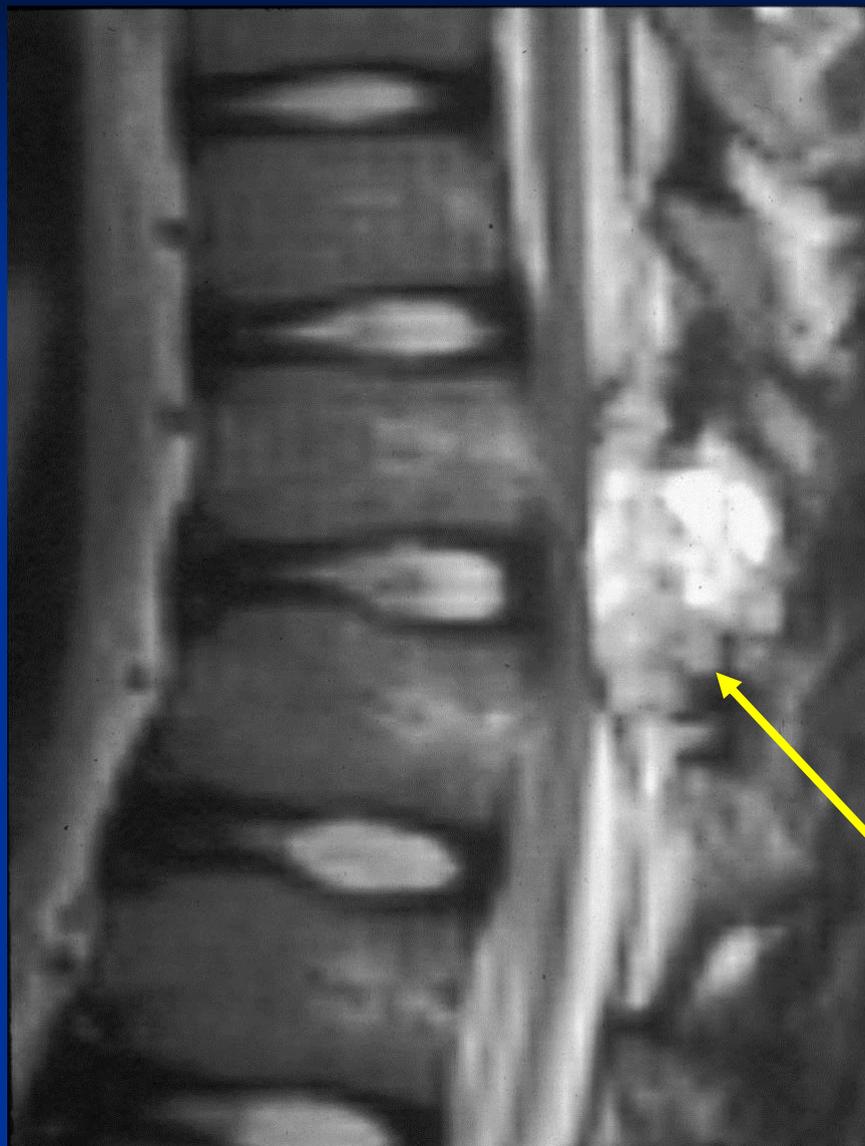
- Geographic Lesion
- Posterior Elements of Spine
- Bone is Expanded
- The lesion (soft tissue component) is surrounded by an “Egg Shell” rim of calcification indicating the periosteum is intact
- Mineralization present in lesion



# Osteoblastoma of Spine

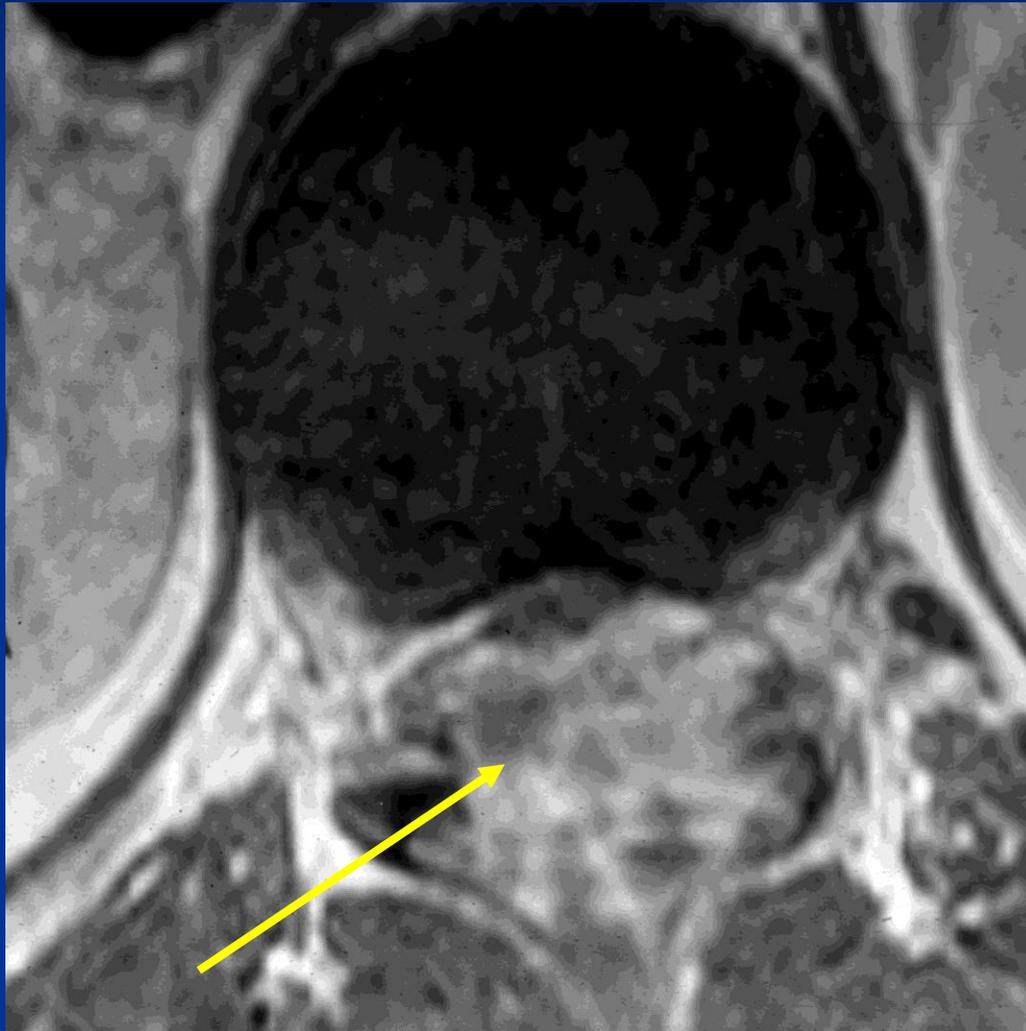


# MRI: Osteoblastoma of Spine Posterior Elements



Osteoblastoma

# MRI: Osteoblastoma of Spine Posterior Elements



# CT Scan Osteoblastoma of Spine Posterior Elements



# Osteoblastoma

- **Differential between Osteoid Osteoma and Osteoblastoma**
  - Osteoblastoma
    - Size: >1.5-2cm
    - Growth: Benign Aggressive Lesion: Continues to grow and destroy bone (osteoid osteoma has a limited growth potential--indolent)
    - Soft Tissue Mass with an Osteoblastoma
    - Scoliosis and classical pain symptoms absent with Osteoblastoma
    - Matrix is multifocal in an osteoblastoma and not central

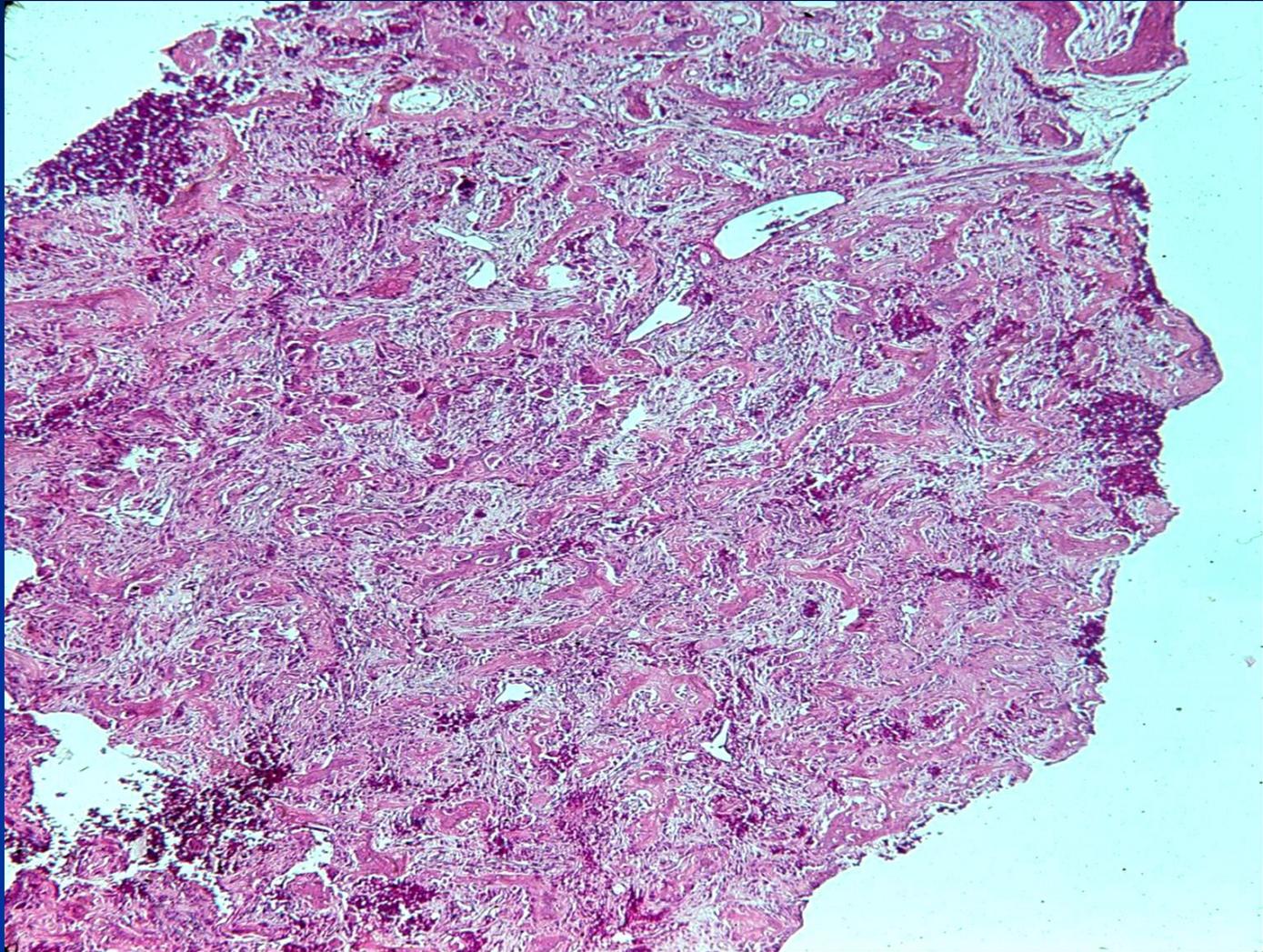
# Gross Pathology

- Indistinguishable from an osteoid osteoma except larger
- Nidus is well demarcated
  - Granular, friable, reddish hemorrhagic tissue
  - May bleed significantly when curetted
- Cortex is thinned, possibly destroyed

# Microscopic Pathology

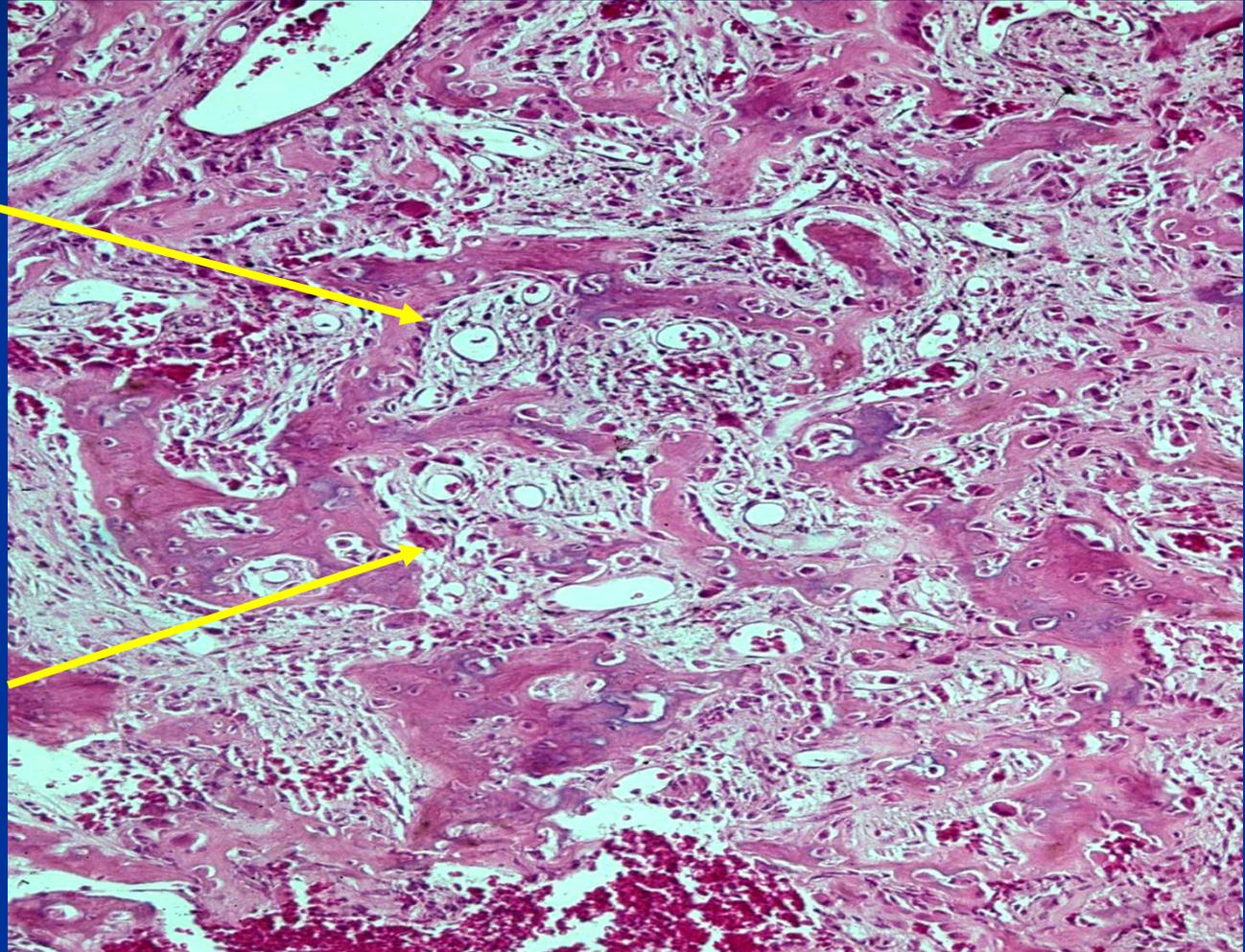
- Interlacing network of bone trabeculae in a loose fibrovascular stroma
  - Prominent vessels
- Osteoblasts are plump, active, scattered mitotic figures
- Osteoblasts line up around periphery of trabeculae (Osteoblastic Rimming)
- Soft tissue component usually surrounded by shell of reactive bone or periosteum (Egg Shell Rim of Calcification)
- No cartilage production (as opposed to osteosarcomas that may contain areas of cartilage)

# Osteoblastoma



# Osteoblastoma

Trabeculae of  
Woven Bone Lined  
by Osteoblasts

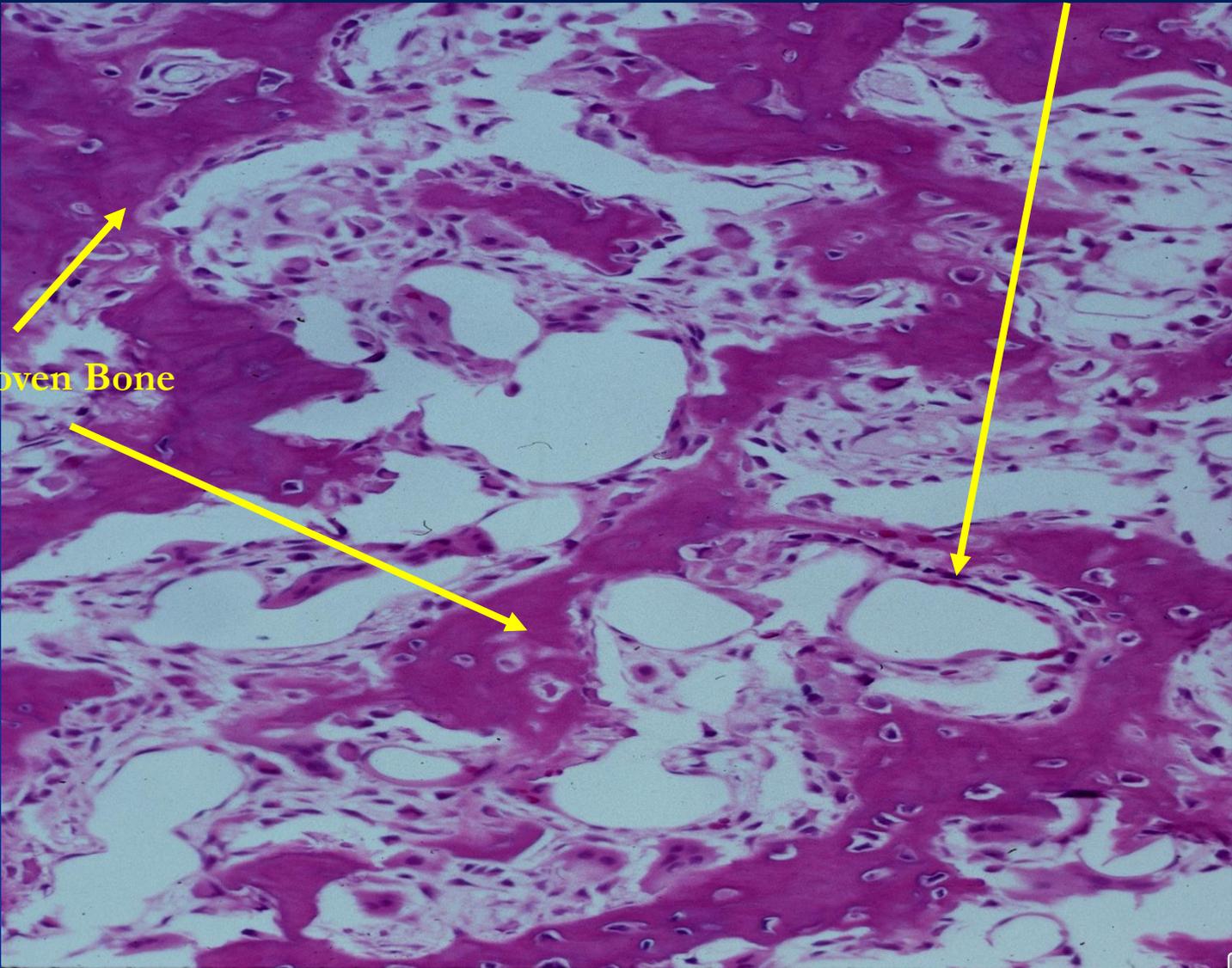


Fibrovascular Stroma



# Osteoblastoma

Osteoblasts Line  
Trabeculae



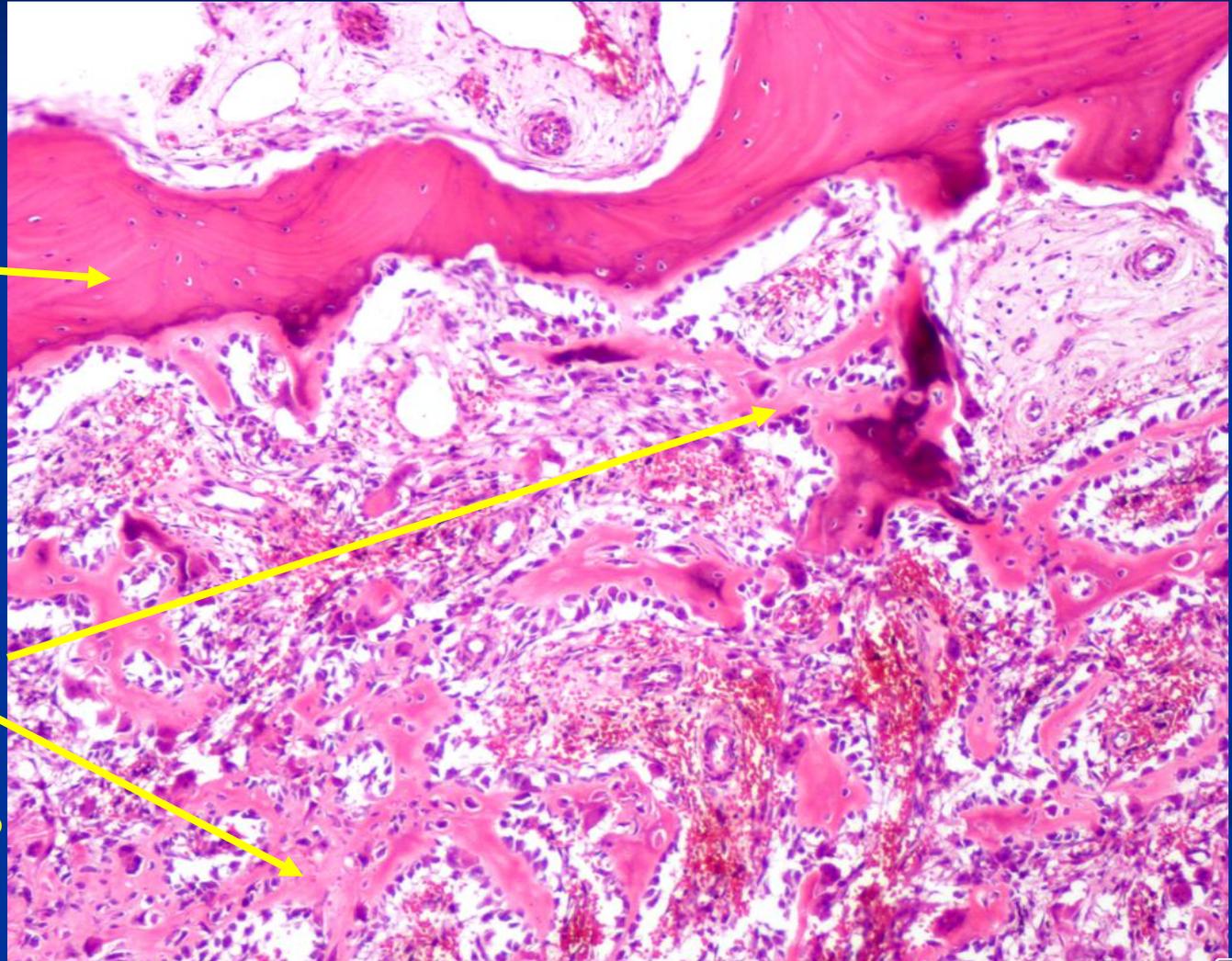
Trabeculae of Woven Bone



# Osteoblastoma

Thickened  
Reactive  
Surrounding  
Bone

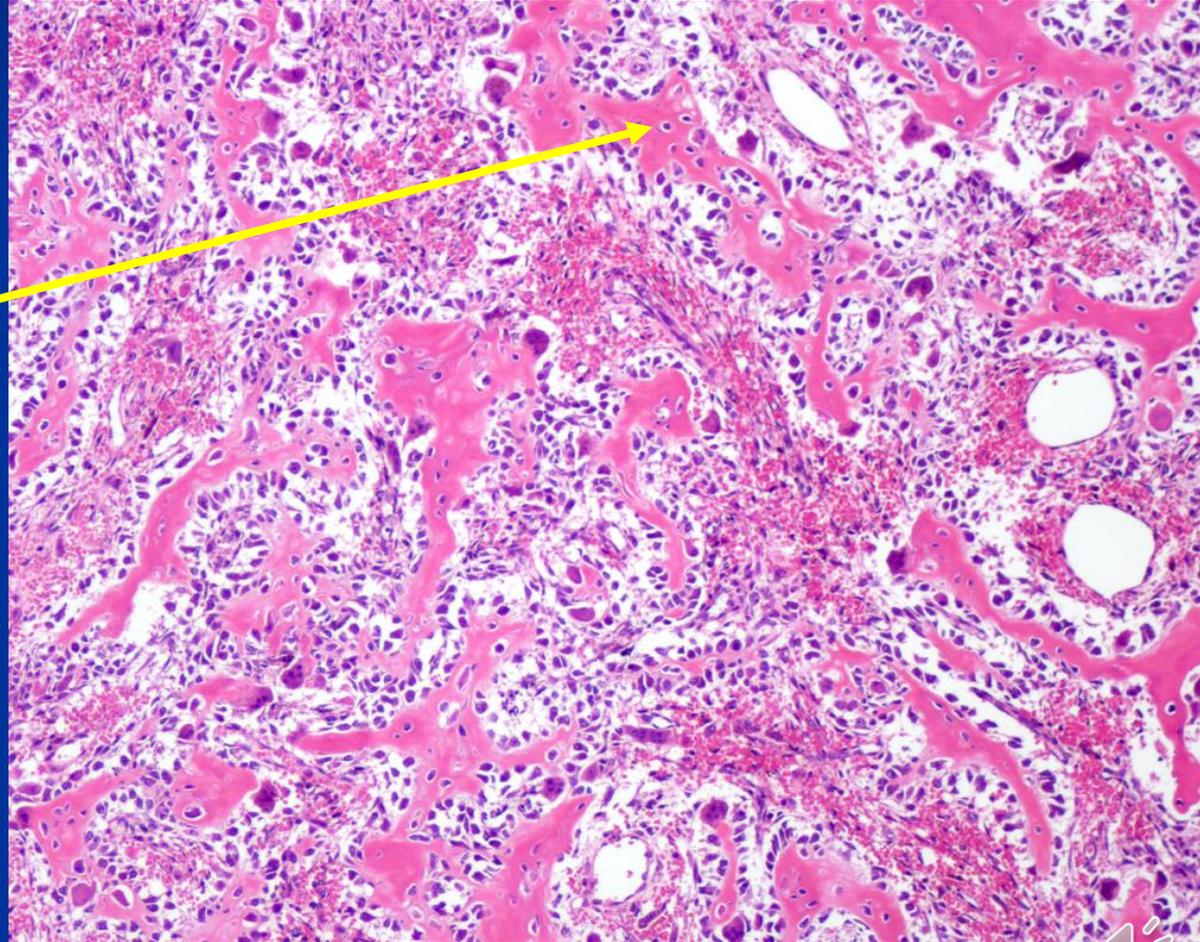
Immature  
Trabeculae of  
Woven Bone  
Lined by Plump  
Osteoblasts



# Osteoblastoma

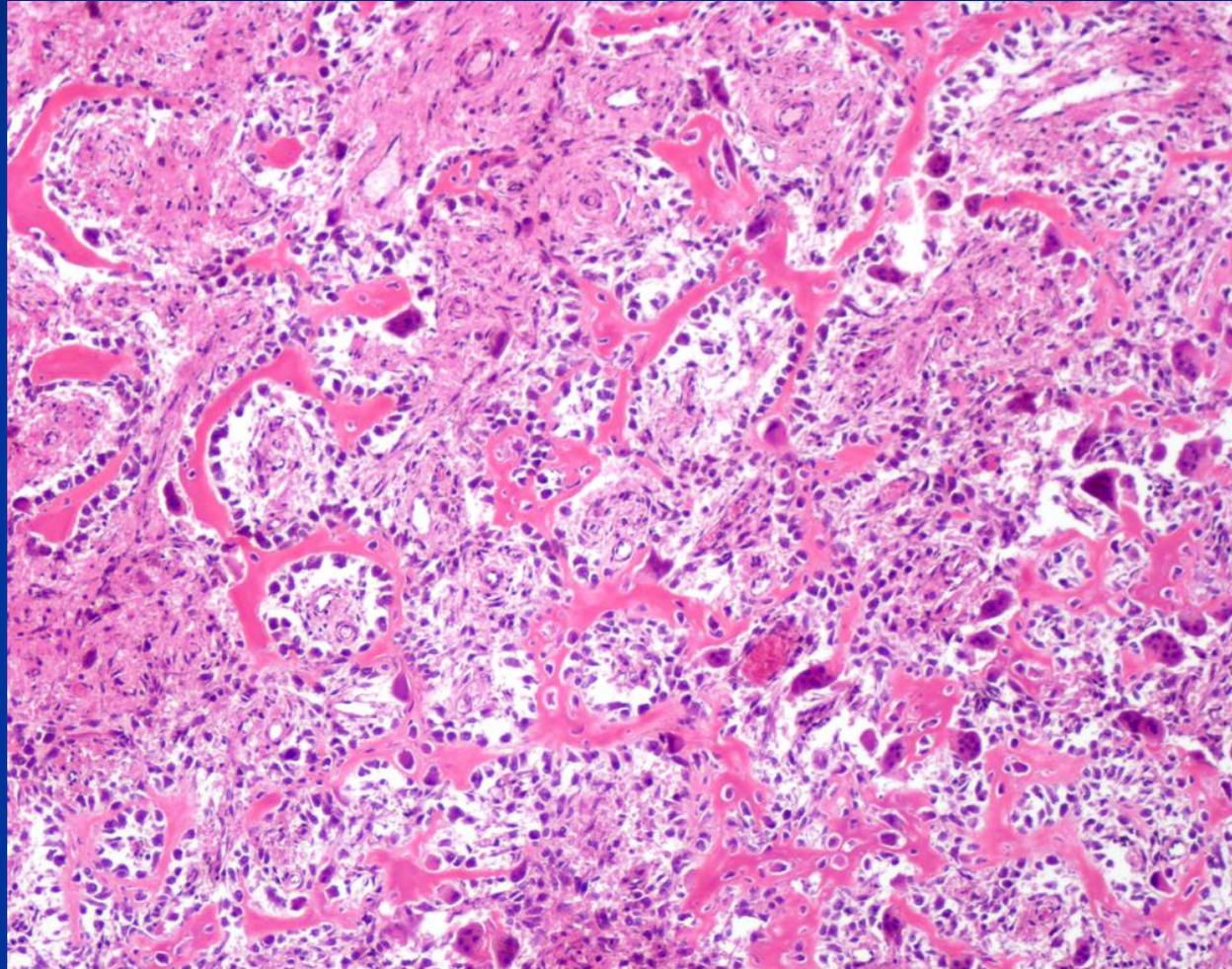
## Low Power View

Trabeculae of  
Immature Woven  
Bone Lined by  
Osteoblasts

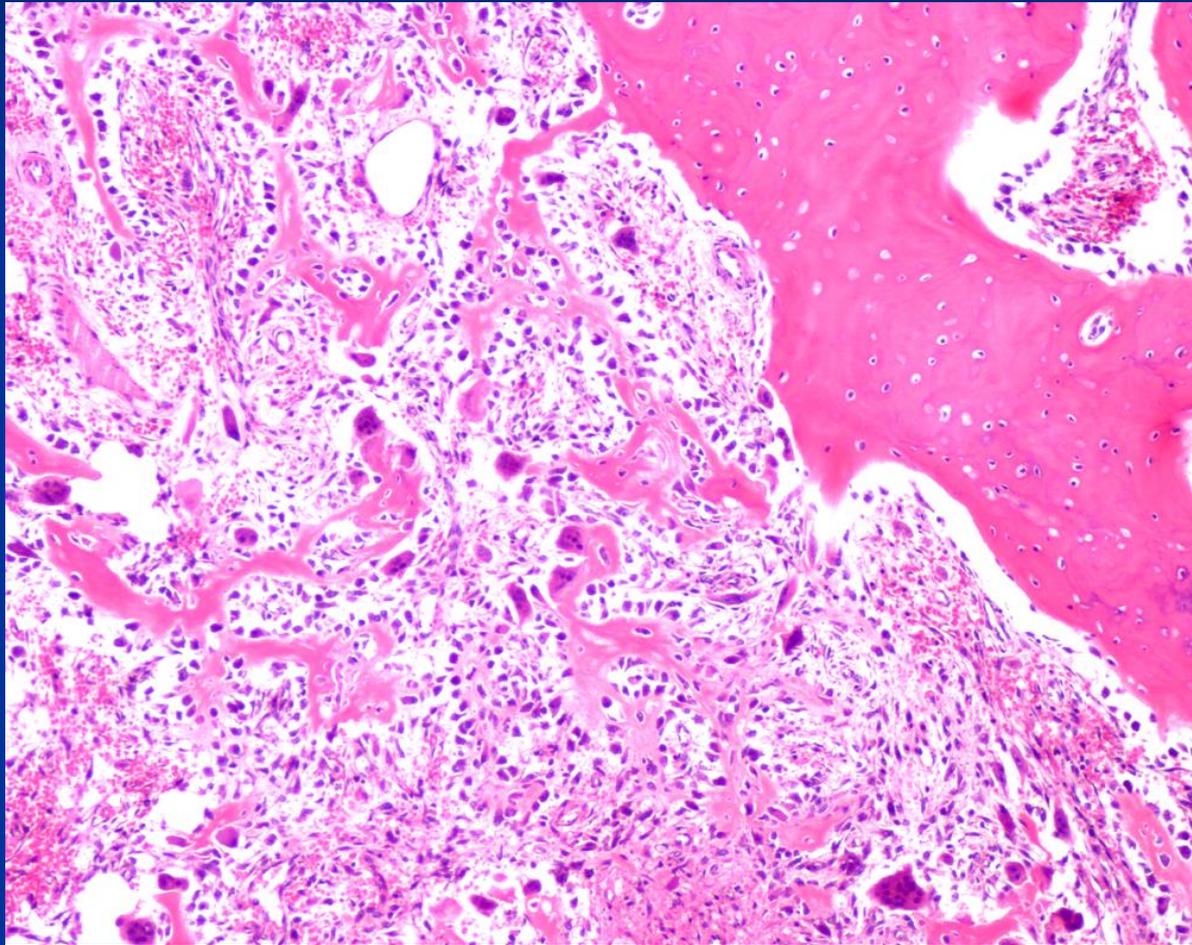


# Osteoblastoma

## Low Power View



# Osteoblastoma



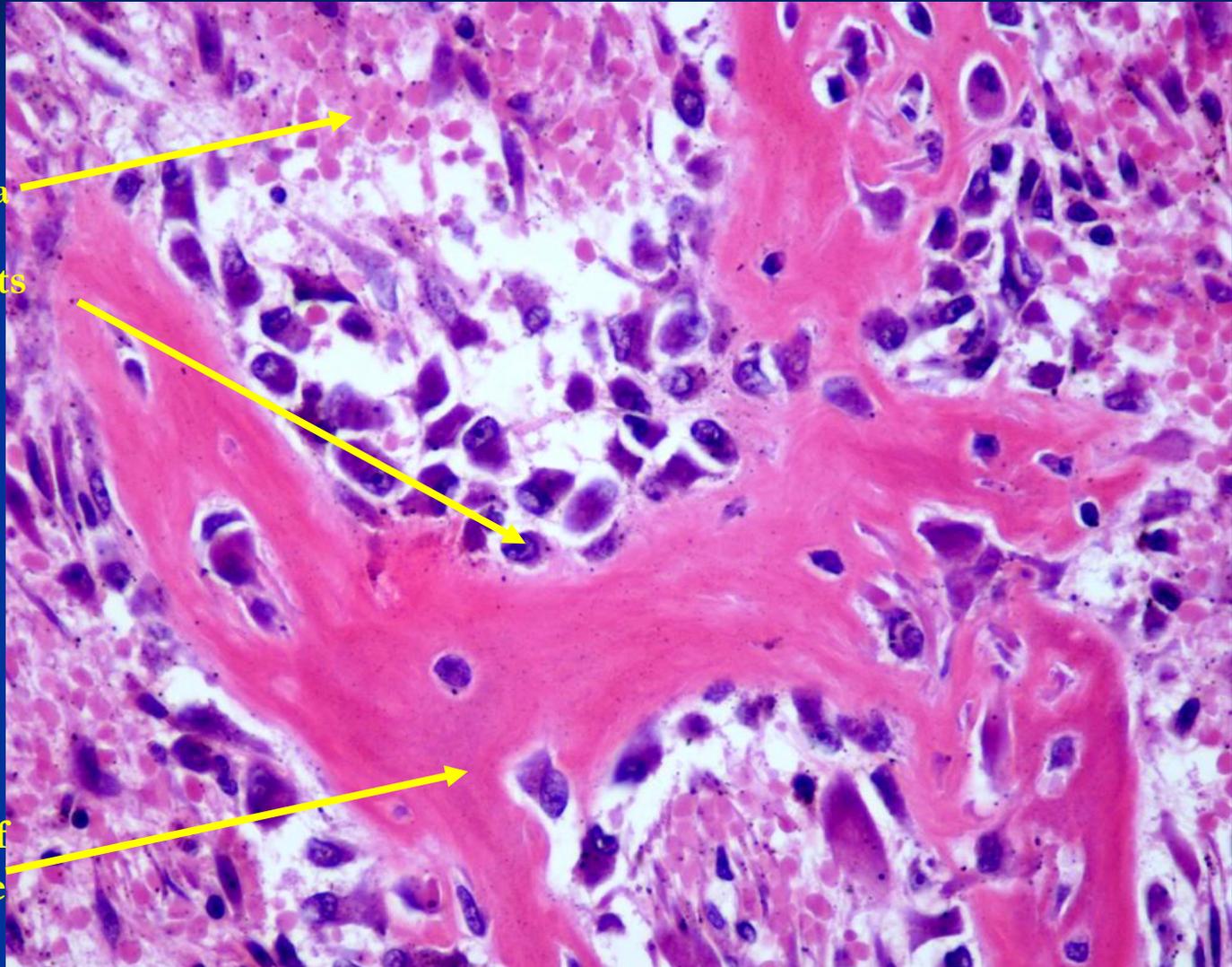
# Osteoblastoma

## High Power View

Fibrovascular Stroma

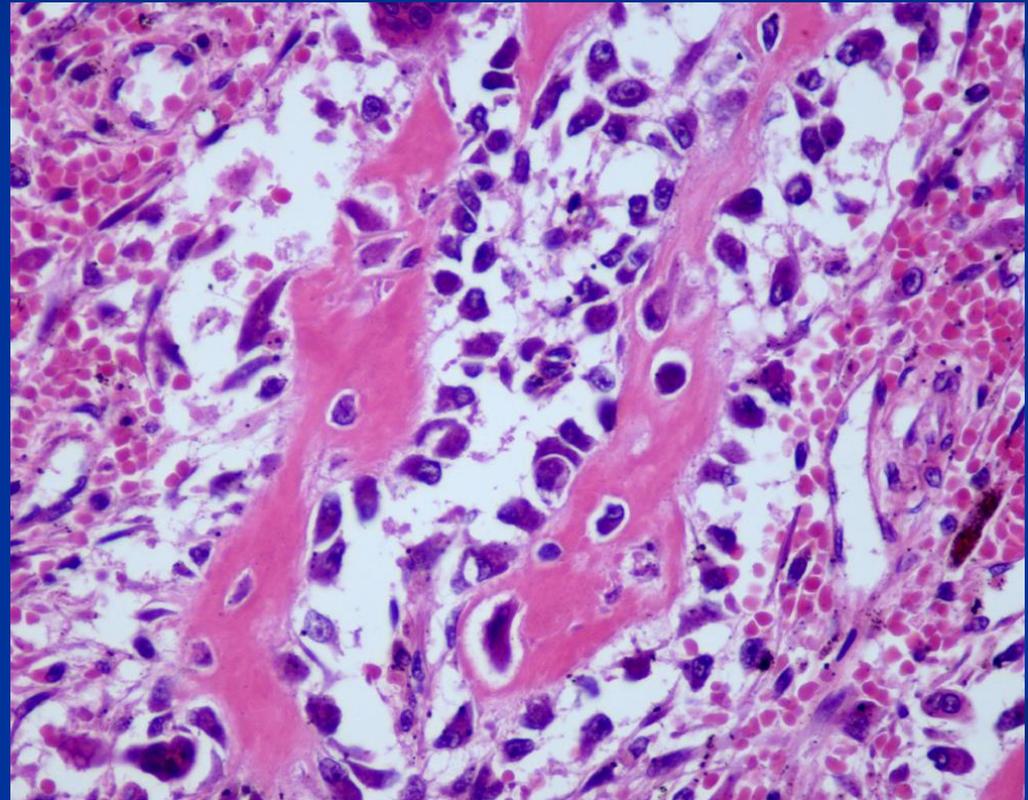
Plump Osteoblasts  
Line Trabeculae

Trabecula of  
Woven Bone



# Osteoblastoma

- Trabeculae of Immature, Woven Bone
- Osteoblasts Line Trabeculae (Osteoblastic Rimming)
- Fibrovascular Stroma



# Aggressive Osteoblastoma

- Aggressive osteoblastoma has much more aggressive local behavior than a conventional osteoblastoma. They have a higher chance for local recurrence after removal.
- There has been controversy about the true existence of this type of tumor and whether these tumors are actually low grade osteosarcomas.
- They have a similar appearance microscopically as a conventional osteoblastoma except the osteoblasts are twice as large and have an epithelioid quality with abundant eosinophilic cytoplasm (**Epithelioid Osteoblasts**).
- Aggressive osteoblastoma is a borderline lesion between osteoblastoma and osteosarcoma. It is not a precursor to osteosarcoma. It does not metastasize.

# Aggressive Osteoblastoma

- Older age group than conventional osteoblastoma. Most patients are older than age 30.
- Affects a broad variety of bones.
- Usually larger than a conventional osteoblastoma and have been reported to be up to 8.5 cm in diameter.
- Most have a similar radiographic appearance as a conventional osteoblastoma and have well defined margins, variable amounts of mineralization and peritumoral sclerosis. They occasionally have radiographic characteristics consistent with malignancy.

# Plain X-Ray: Aggressive Osteoblastoma of a Hand Metacarpal

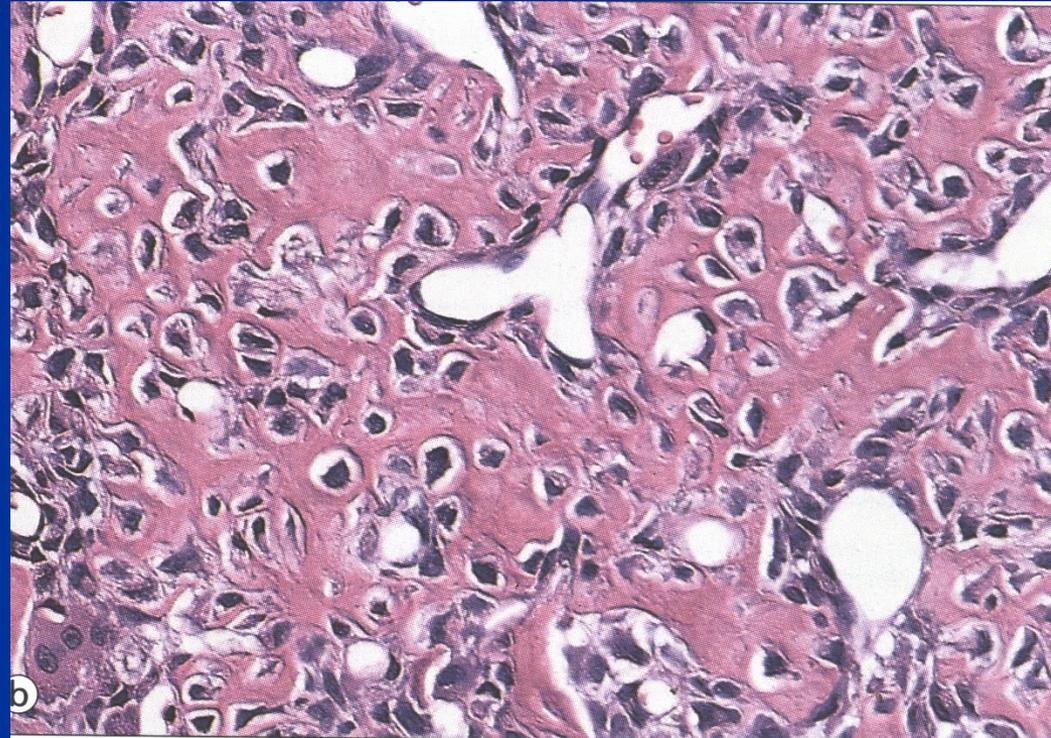


Mineralization within tumor

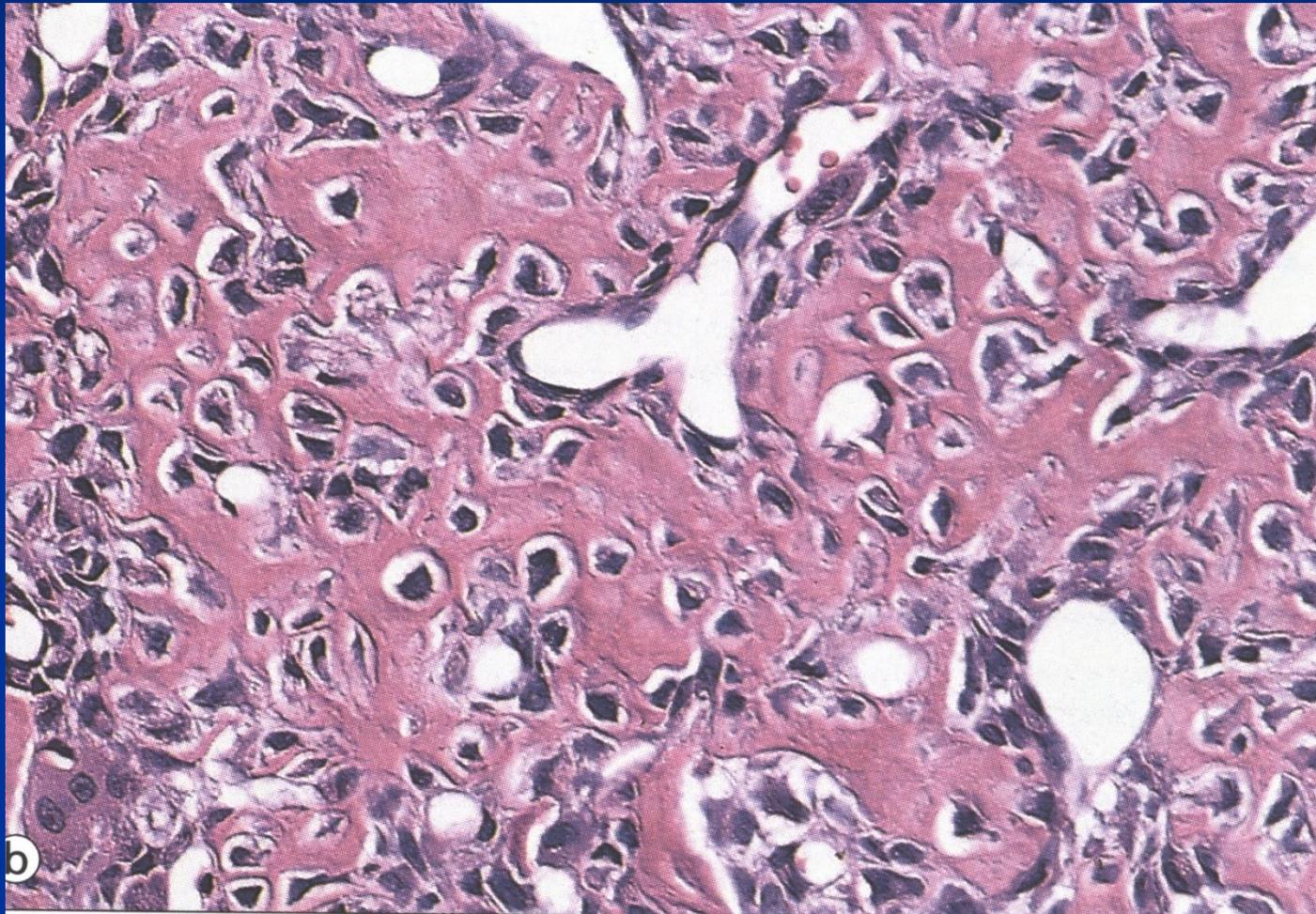
Expansile large lesion with  
soft tissue component

# Pathology of Aggressive Osteoblastoma

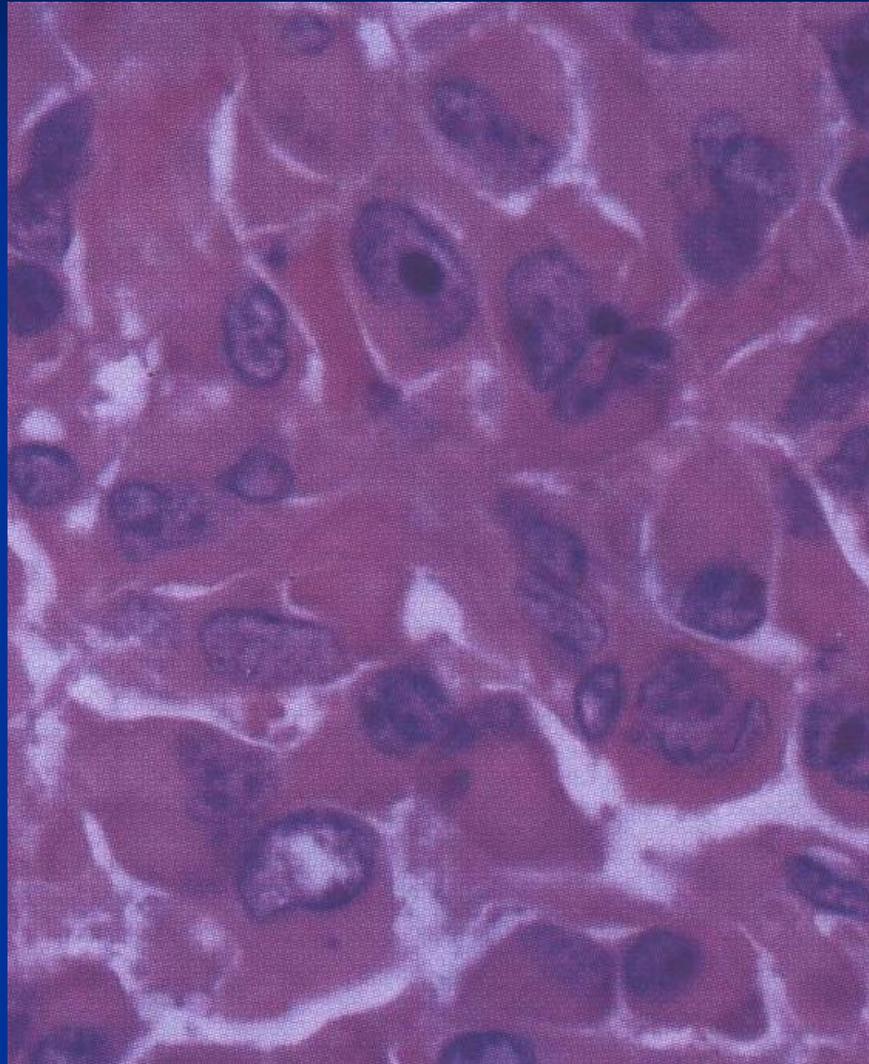
- Osteoblast cells are uniform
- Cells line trabeculae
- Trabeculae are usually more thickened than conventional osteoblastoma
- Osteoblasts are larger than normal osteoblasts and have an epithelioid shape (Epithelioid Osteoblasts)



# Pathology of Aggressive Osteoblastoma



# Epithelioid Osteoblasts



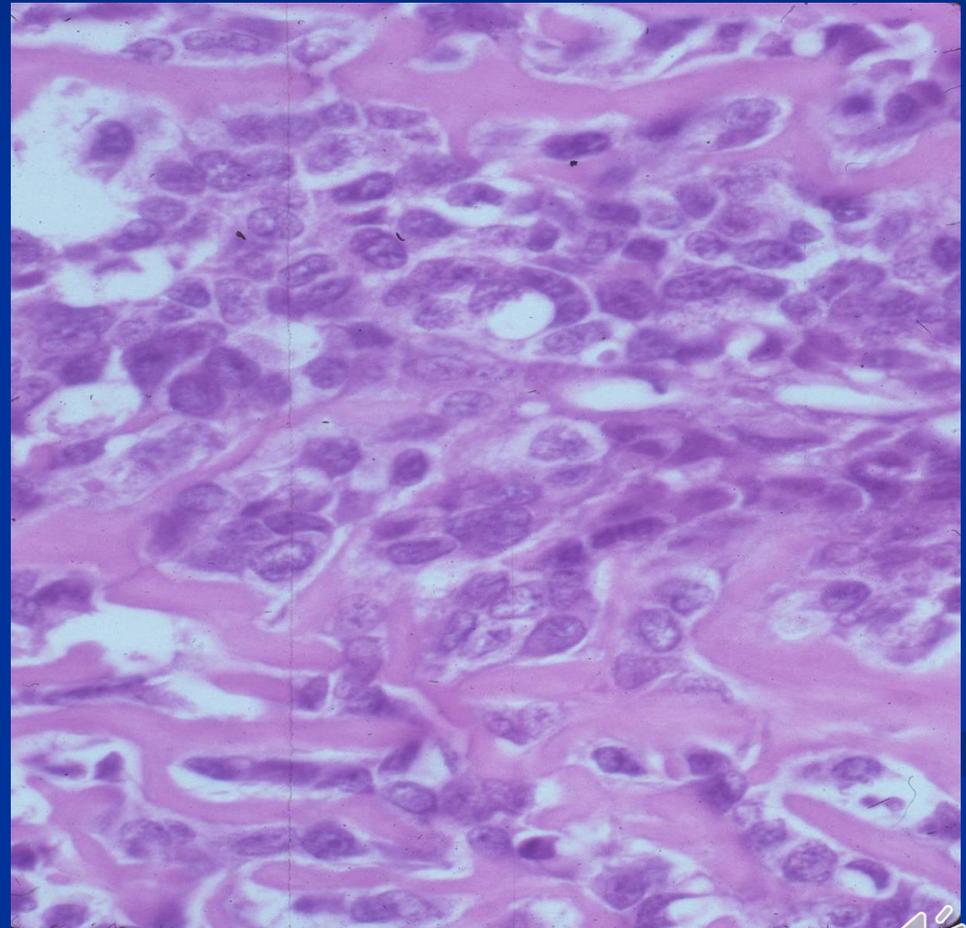
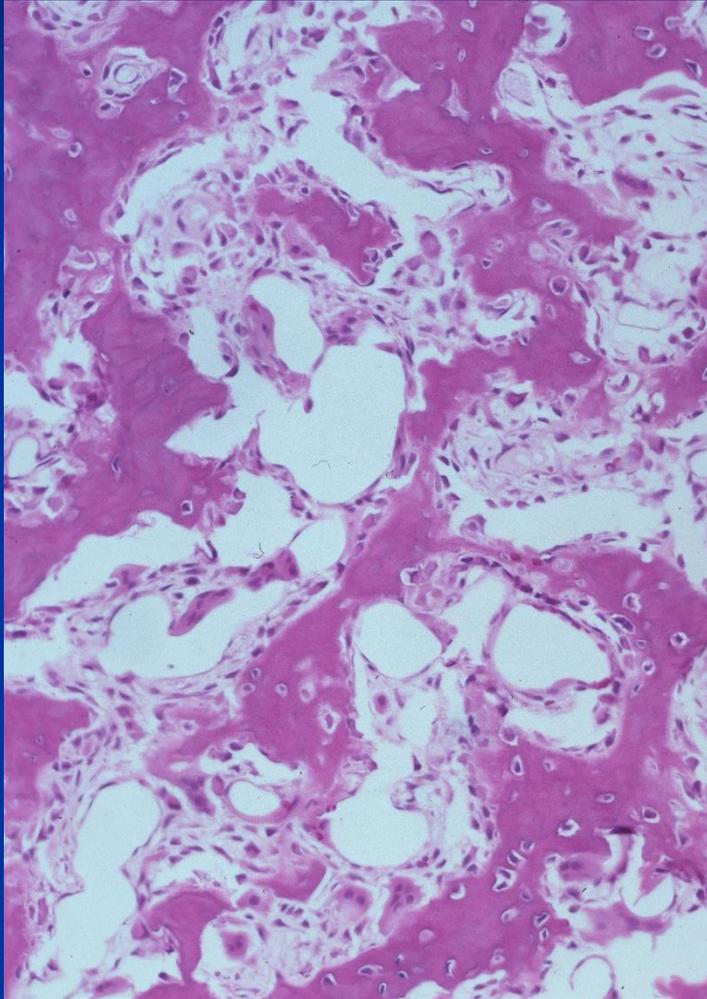
# Aggressive Osteoblastoma

- **Differential Diagnosis:**
  - Osteoid Osteoma
  - Conventional Osteoblastoma
  - Osteosarcoma
- The differential between osteoid osteoma, conventional osteoblastoma and aggressive osteoblastoma is based on size and the presence of epithelioid osteoblasts. Can have epithelioid osteoblasts in osteoid osteoma and conventional osteoblastoma but they do not occur in cohesive sheets that fill intertrabecular spaces

# Osteoblastoma

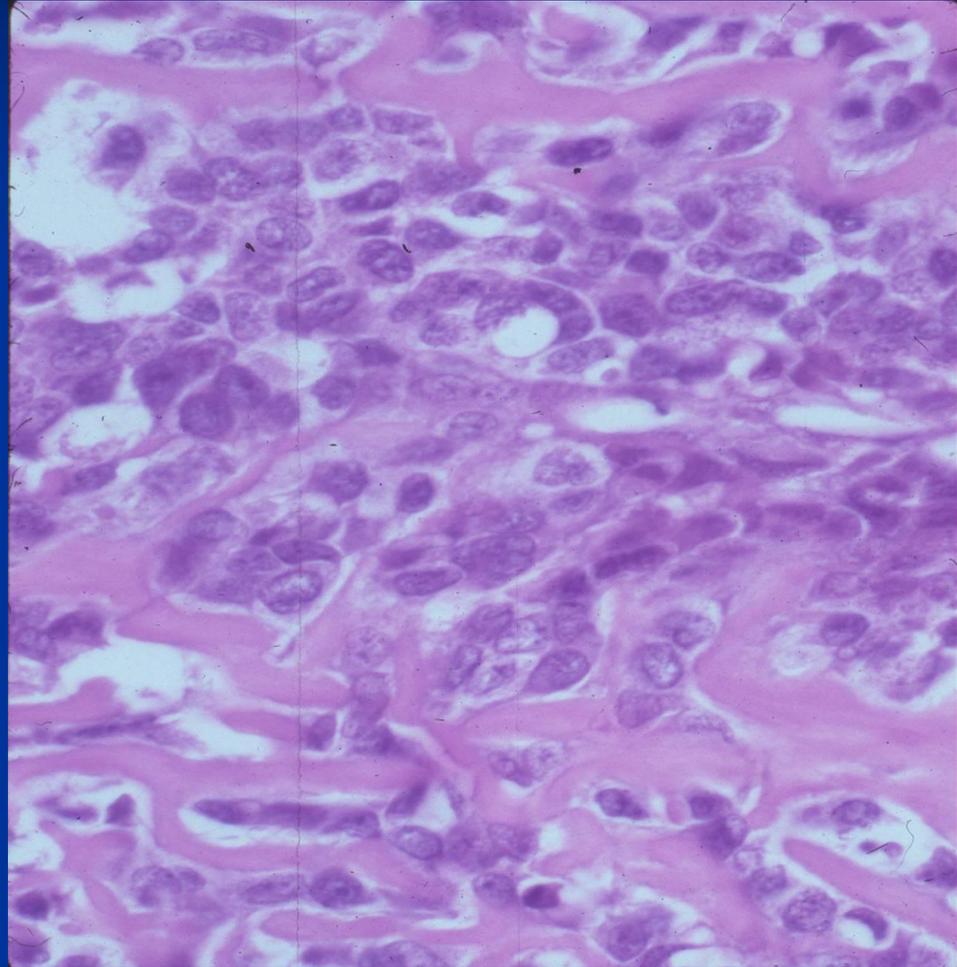
- **Pathology:**
- Differentiation from osteosarcoma
  - Osteoblastomas that are greater than 4 cm and that show prominent periosteal new bone formation may present problems in differentiation from osteosarcoma
  - May have foci of lace-like osteoid, high cellularity and more than a few scattered mitotic figures but these characteristics usually occur independently in an osteoblastoma vs all these atypical characteristics being present in an osteosarcoma

# Osteoblastoma vs. Osteosarcoma



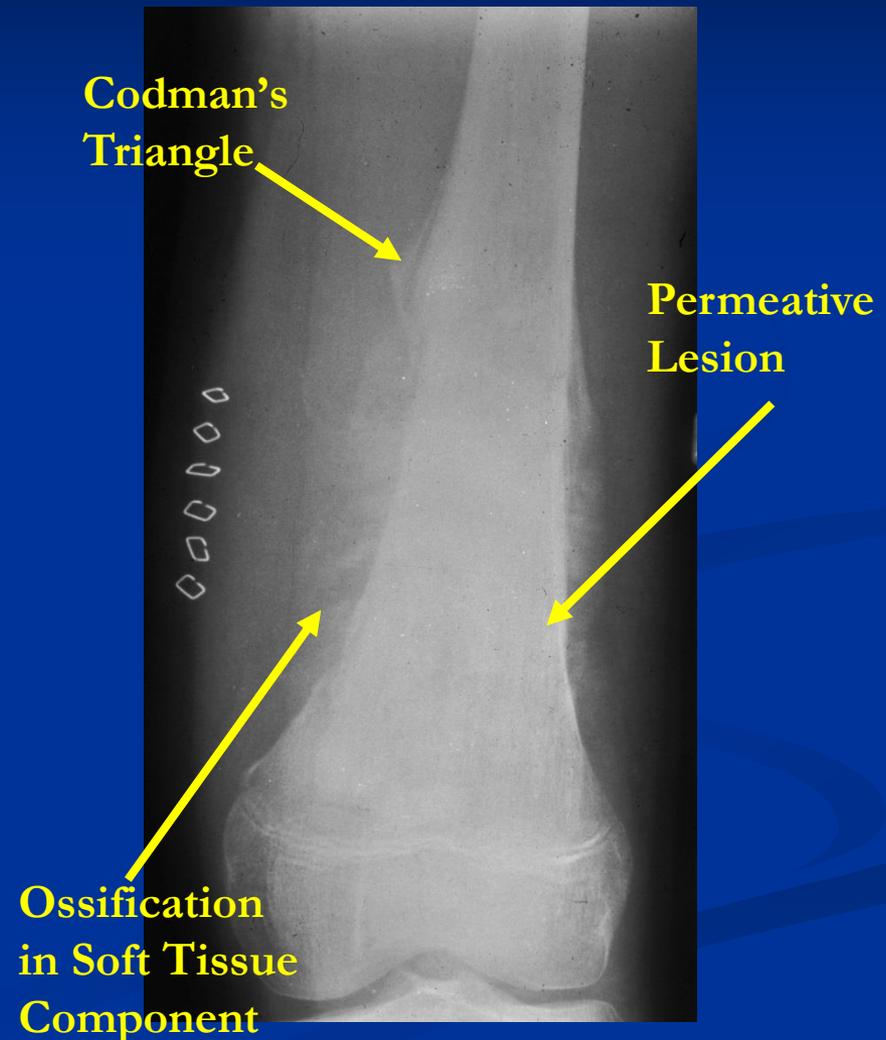
# Osteosarcoma

- Lace-like Osteoid laid down in between cells
- No trabeculae
- Cells are crowded
- High degree of cellular pleomorphism
- Cells do not resemble osteoblasts
- High mitotic rate with atypical mitoses



# Xray: Conventional Osteosarcoma of Distal Femur

- Classic radiographic example of a conventional osteosarcoma of the distal femur
- Distal Femur is most common site for a conventional osteosarcoma
- Permeative lesion with mixed lysis and sclerosis (sclerosis is calcified osteoid)
- Metaphyseal Origin
- There is a Codman's triangle interrupted type of periosteal reaction
- Tumor extends into soft tissue and the soft tissue component is ossified

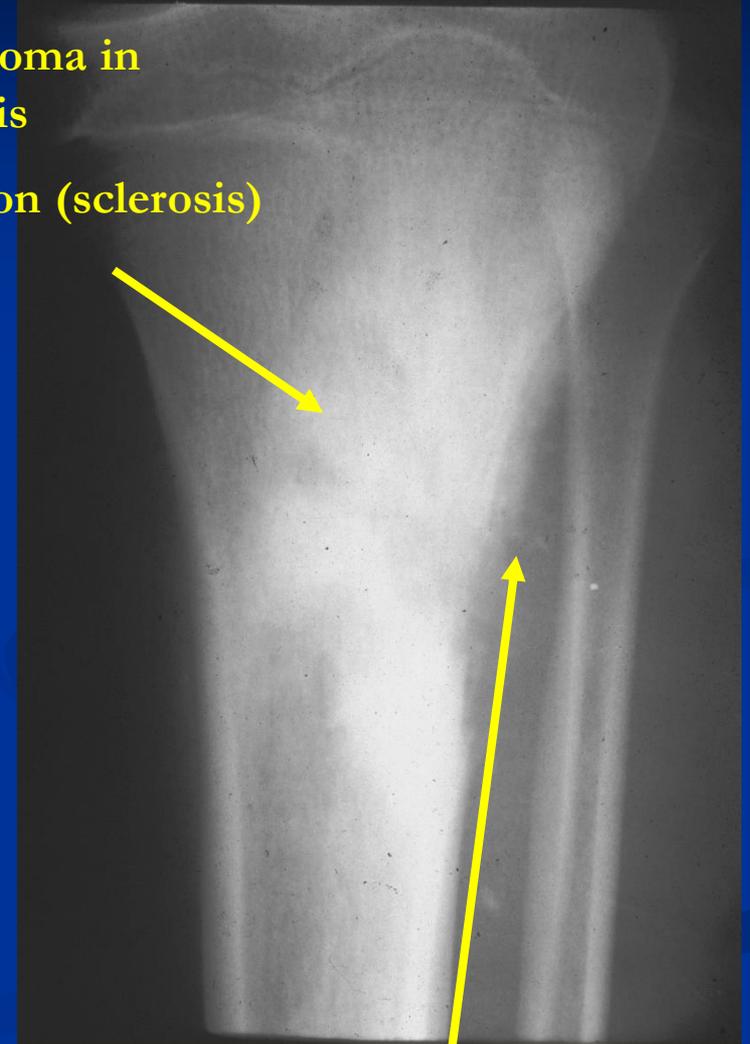


# Xray: Osteosarcoma of Proximal Tibia

- Proximal tibia is second most common site for conventional osteosarcoma
- Permeative lesion with mixed lysis and sclerosis (ossification)
- Metaphyseal origin
- Soft tissue extension
- Hair on End periosteal reaction

Osteosarcoma in Metaphysis

Ossification (sclerosis) and lysis



Hair on End Periosteal Reaction

# Osteoblastoma

- **Natural History**
- Benign, aggressive tumors
  - Propensity for local recurrence
  - Grow locally within the bone and destroy bone as they grow
  - Grow slowly and do not metastasize

# Treatment

- Extremity Lesions:
  - Intralesional Curettage Resection and Cement Fixation vs. Bone Grafting
    - Local adjuvant may be considered such as cryosurgery to reduce the risk of local recurrence
  - En-bloc excision for massive tumors
- Spine lesions:
  - En-bloc resection (recurrence may be as high as 25%)
  - Radiotherapy may be recommended after inadequate removal particularly for spine lesions
  - Rarely—malignant transformation after radiation

# Prognosis

- Majority of patients are cured by initial therapy
- Recurrences usually occur within 2 years from initial surgery from regrowth of microscopic cells
  - Recurrences after 2 years is very rare
- Recurrences in spine are more common and occur in approximately 25% of cases

**Thank You**