Atrium Health
Levine Cancer Institute
Musculoskeletal Institute

Evaluation and Management of Bone and Soft Tissue Tumors

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May 5th, 2023

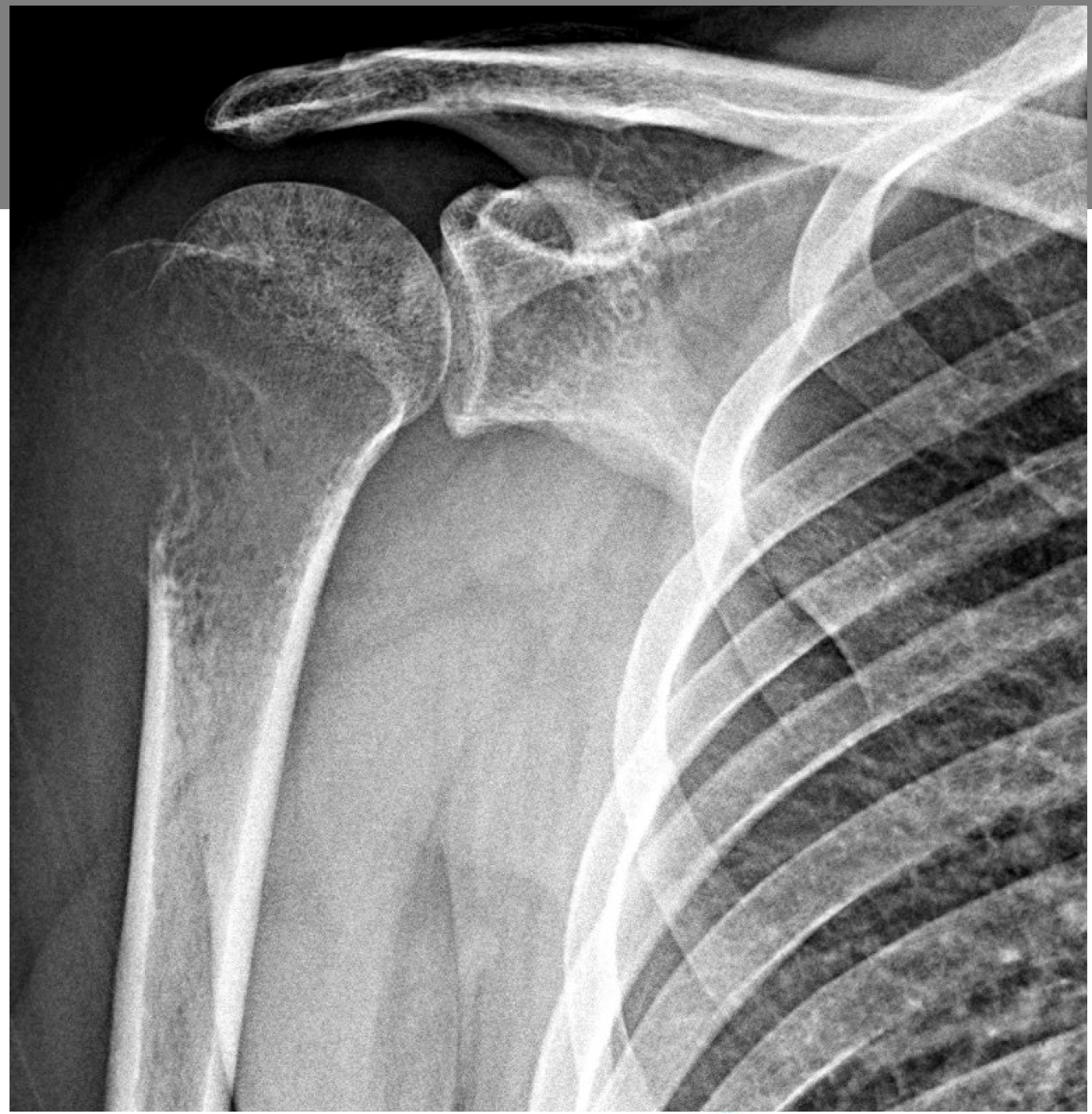
Disclosures

- I have no disclosures to report

Case Review

- HPI: 28 yo M presents w/ 2-3 months of progressively worsening right shoulder pain and weakness. +Night pain. No fevers, chills, night sweats, weight loss.
- PMHx: None
- PSHx: None
- FamHx: No malignancies
- SocHx: No tobacco, rare EtOH. Works for pool construction company

What do you do? What do you tell the patient?



“Tumor Brain Fog”

- Dr. Jeff Kneisl introduced me to this concept
- Decision making in orthopedics is by-and-large straightforward and algorithmic
- Bone and soft tissue tumors are outside of the comfort zone for many providers
- When faced with concerning bone or soft tissue lesion, many struggle to process/act in their normal calculated/reasonable manner
- Why does this occur?

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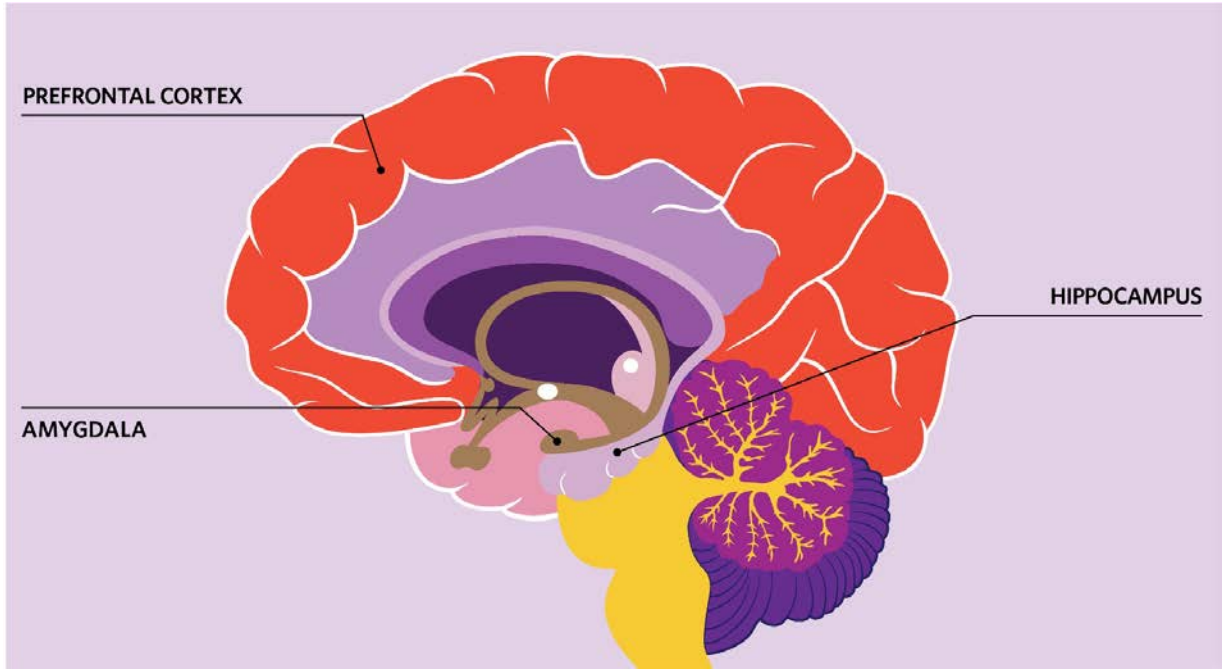
Neuroscience 101

- Amygdala
  - Evolved 250 million years ago with first mammals
  - Integrative center for emotions, emotional behavior, motivation
  - Subconscious, regulates autonomic & endocrine systems
  - Controls “fight or flight” response
  - Evaluates instinct, trustworthiness
- Prefrontal Cortex
  - Most recently evolved brain region
  - Provides for our highest order cognitive abilities
  - Skills: Reasoning, problem solving, comprehension, impulse control, creativity, perseverance



PFC-Amygdala connection

Doubled-Edged Swords in the Biology of Conflict

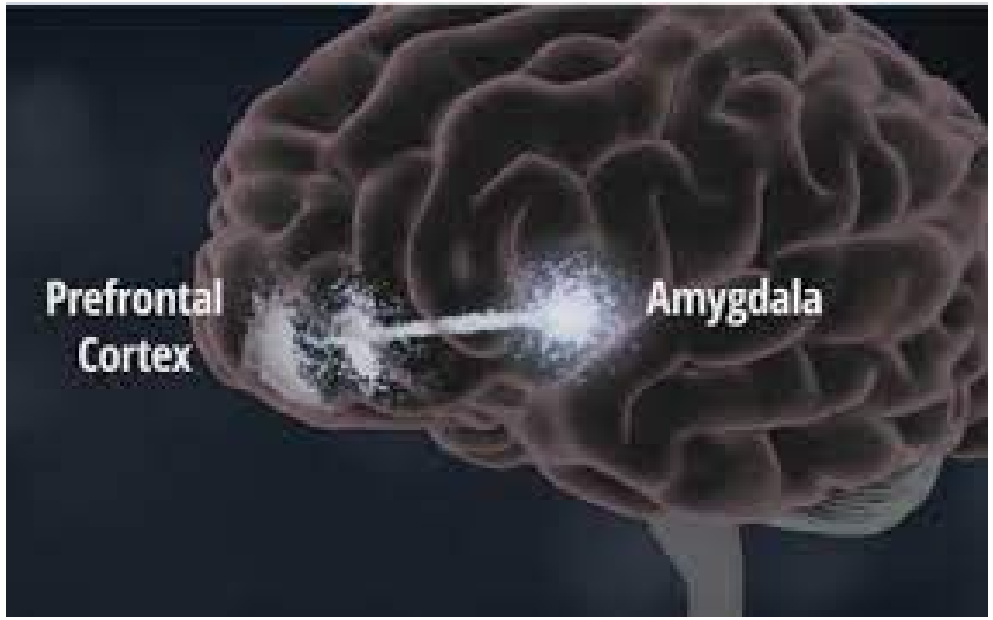
REVIEW
published: 20 December 2018
doi: 10.3389/fpsyg.2018.02625

Robert M. Sapolsky [1,2*]

[1] Gilbert Laboratory MC 5020, Departments of Biology, Neurology and Neurological Sciences, and Neurosurgery, Stanford University, Stanford, CA, United States, [2] Institute of Primate Research, National Museums of Kenya, Nairobi, Kenya

While intense stress decreases the activity of neurons in the frontal cortex, it activates the amygdala, allowing the latter to dominate the former (Roozendaal et al., 2004), thus increasing the odds of impulsive behavior.

Thus, stress makes organisms fearful, more egoistic and less empathic, less likely to think clearly, assess risks accurately, incorporate new data, or to restrain impulses.



Purpose

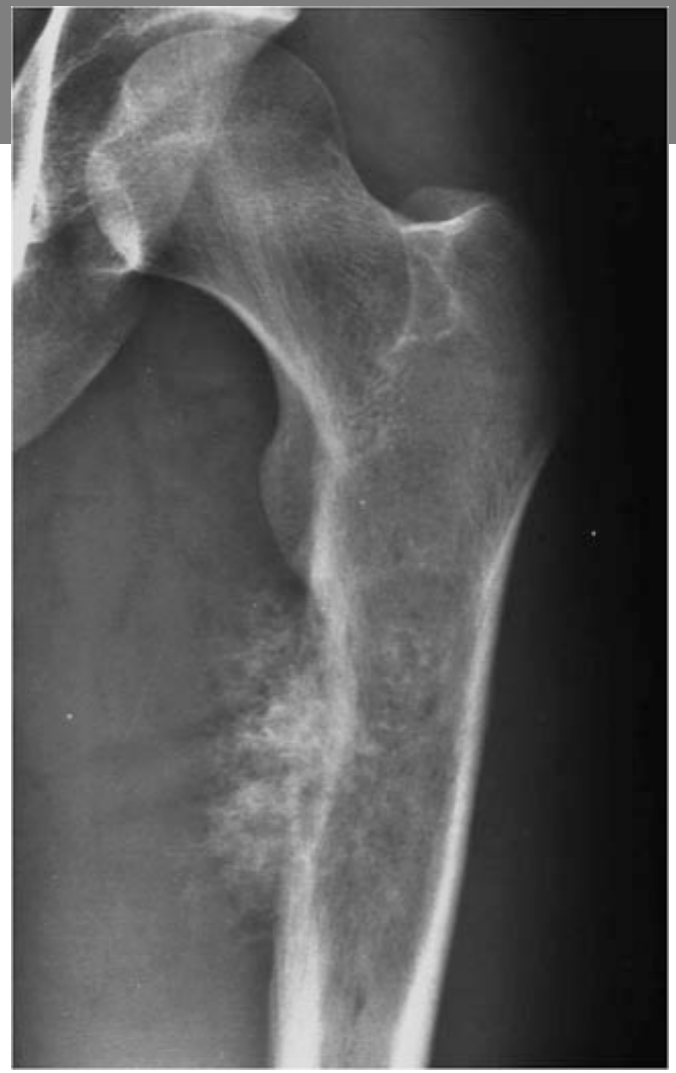
- Review the evaluation and management of bone and soft tissue tumors
- Understand concerning vs. reassuring features
- Provide you with tips/resources to prevent tumor brain fog!!

Outline

- Epidemiology
- Patient Evaluation
- Imaging
- Differential Diagnosis
- Biopsy
- Staging
- Management

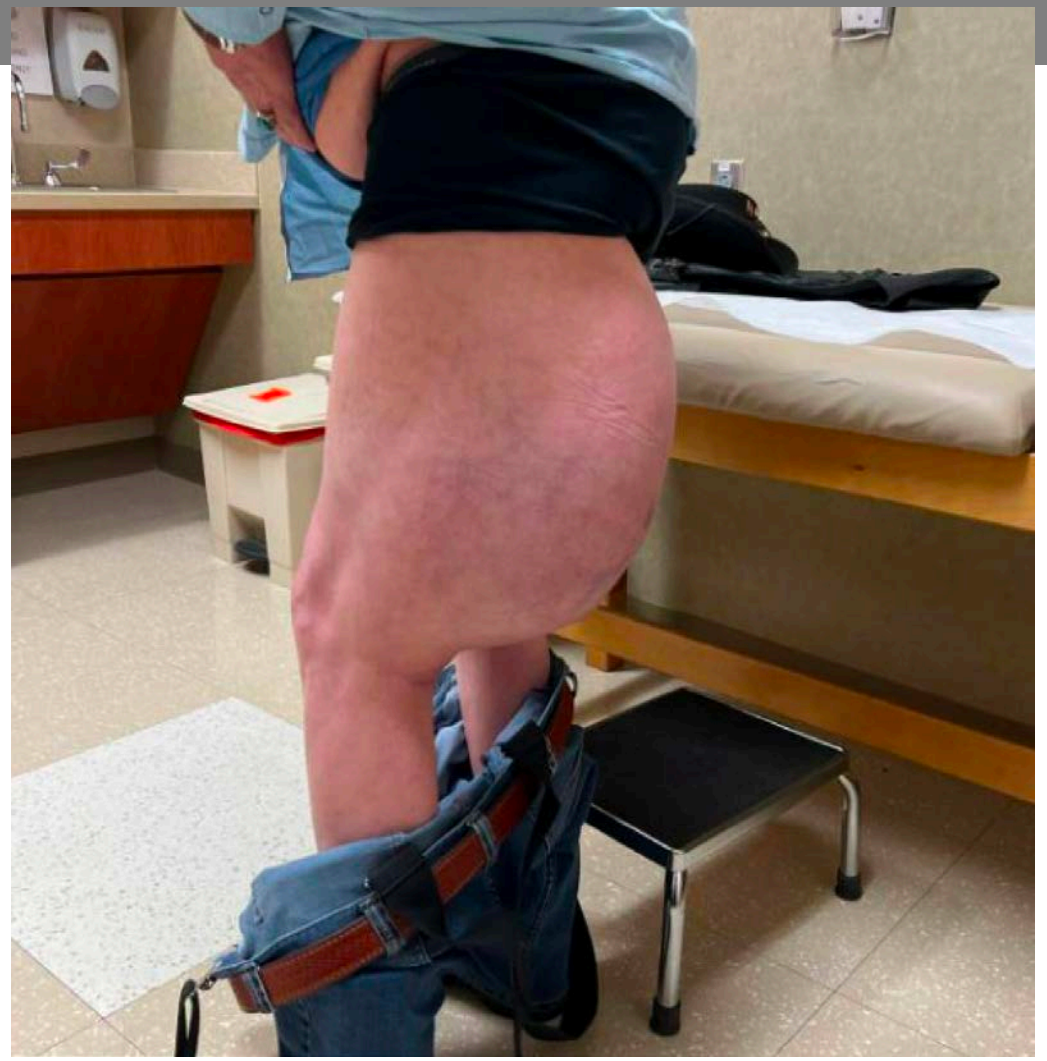
Epidemiology

- Bone tumors
  - Primary bone tumors rare
    - Classified as benign or malignant
    - Benign bone tumors much more common
    - Bone sarcoma account for 0.2% of malignancies in adults
    - Bone sarcomas account for 6% of malignancies in children
    - About 4,000 new bone sarcomas a year in the US
  - Metastasis much more common than primary lesions



Epidemiology

- Soft tissue lesions
  - Classified as benign or malignant
  - Benign much more common than malignant
  - About 13,400 new soft tissue sarcomas a year in the US
  - 30-50% of soft tissue sarcomas are inappropriately biopsied or excised prior to referral
    - The “whoops” procedure or “unplanned excision”



The Royal College of Surgeons of England

HUNTERIAN LECTURE

Ann R Coll Surg Engl 2006; **88**: 519–524
doi 10.1308/003588406X130651

Size matters for sarcomas!

ROBERT J GRIMER

Oncology Service, Royal Orthopaedic Hospital, Birmingham, UK

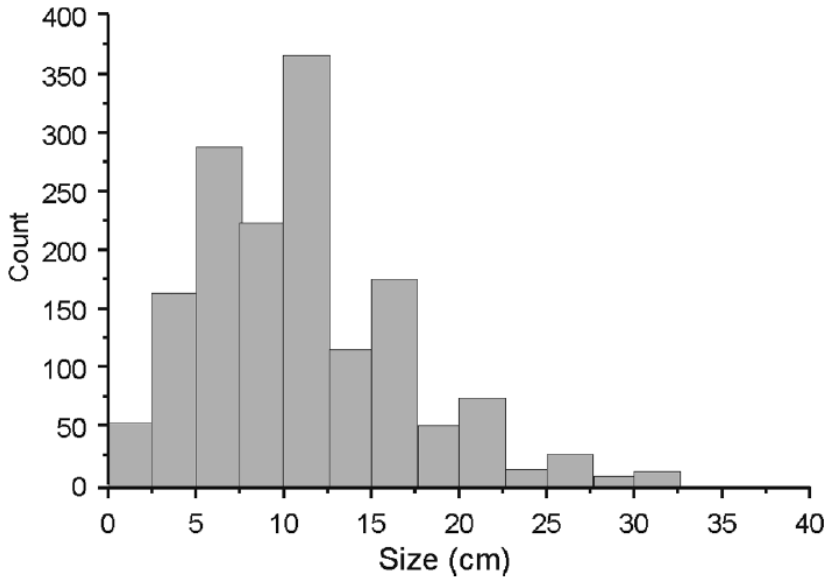


Figure 1 .Size of sarcomas at presentation (n = 1490).

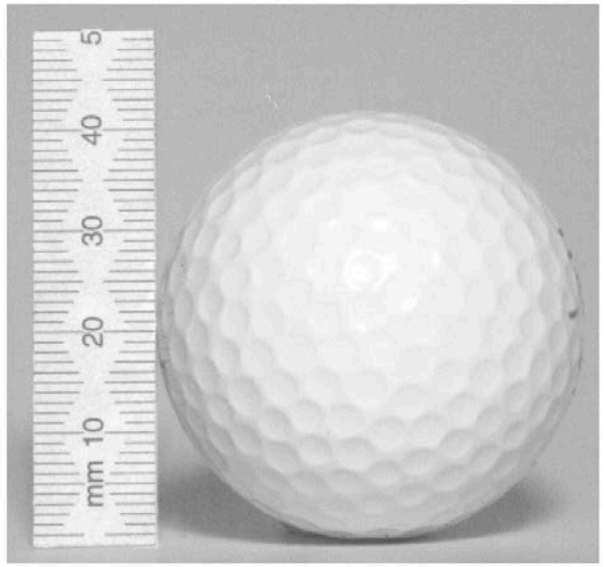


Figure 8 A golf ball measures 42 mm. A useful size to remember – any lump bigger than this should be considered malignant until proved otherwise.

***Any mass larger than a golf ball should be considered a malignancy until proven otherwise!!!

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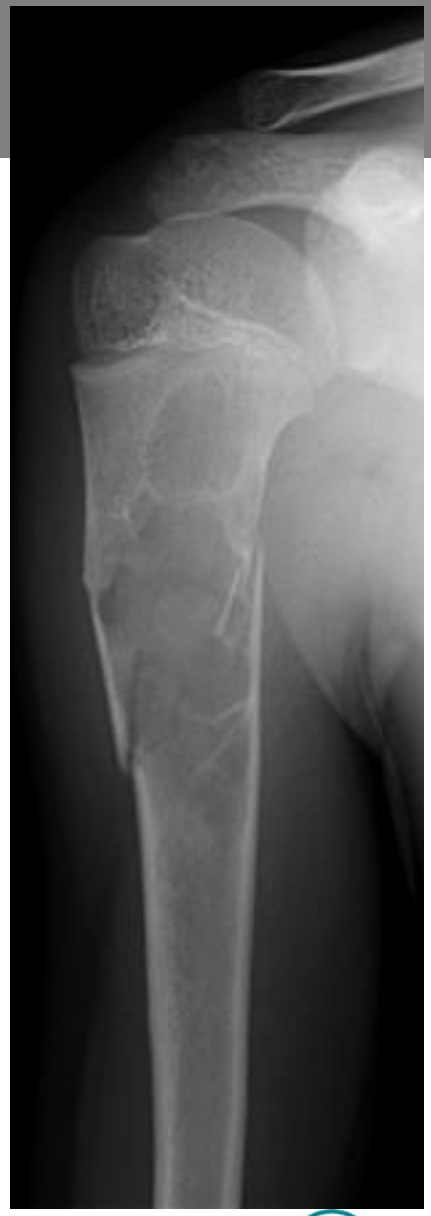
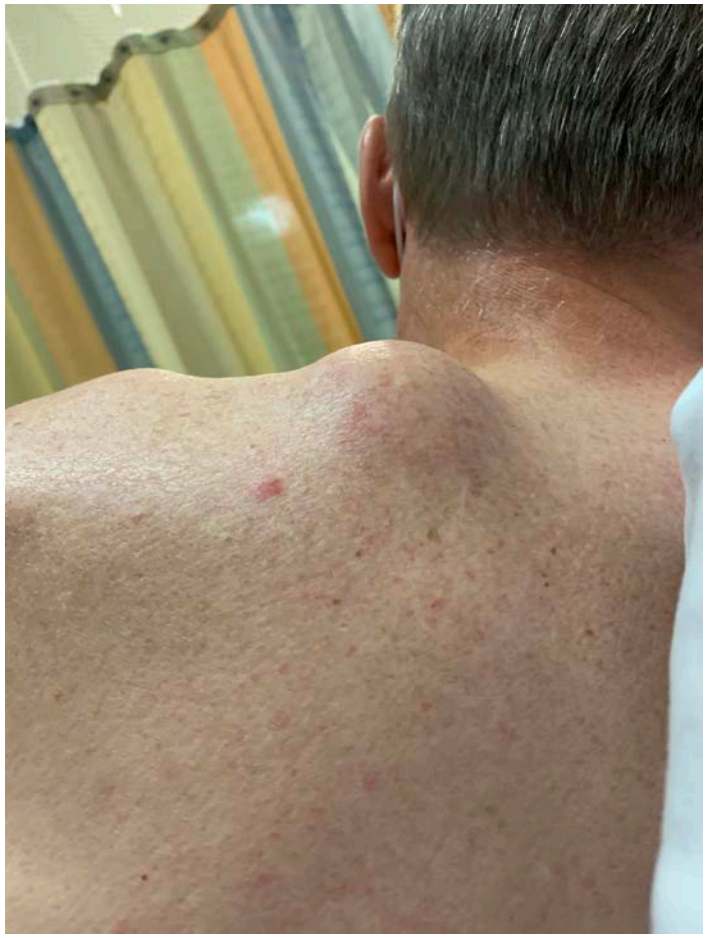
Clinical Presentation

- Bone lesions
  - Often incidental findings
  - Impending/completed pathologic fracture
- Soft tissue lesions
  - Mass or lump



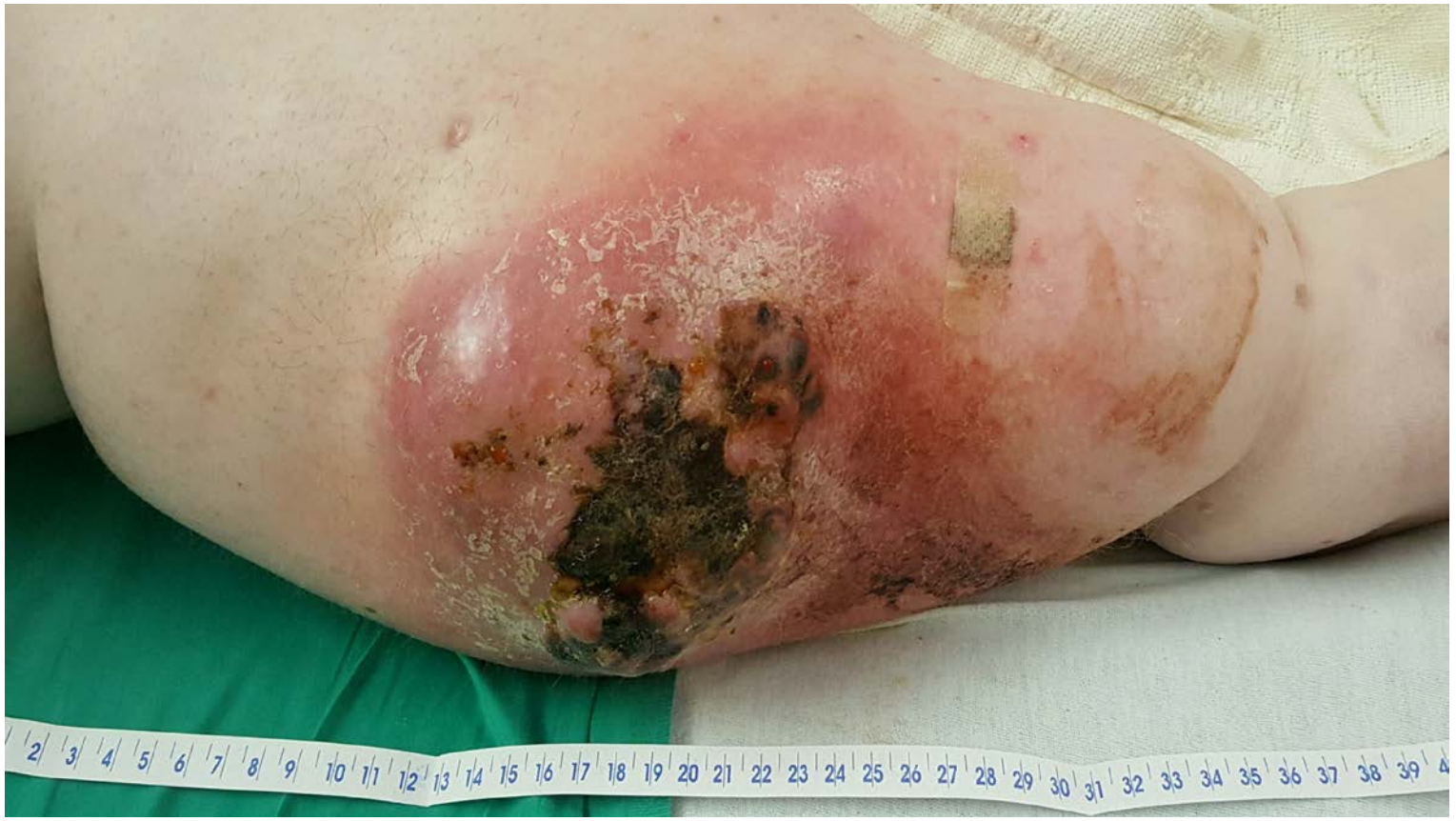
Patient Evaluation

- Order an H&P!!
  - Age, gender
  - Pain?
  - Rapid growth?
  - History of trauma?
  - Prior treatments?
  - ROS
    - Fevers, chills, weight loss, night sweats, night pain
  - FamHx: Malignancy?
  - SocHx: Smoking? Alcohol? Carcinogenic exposures?



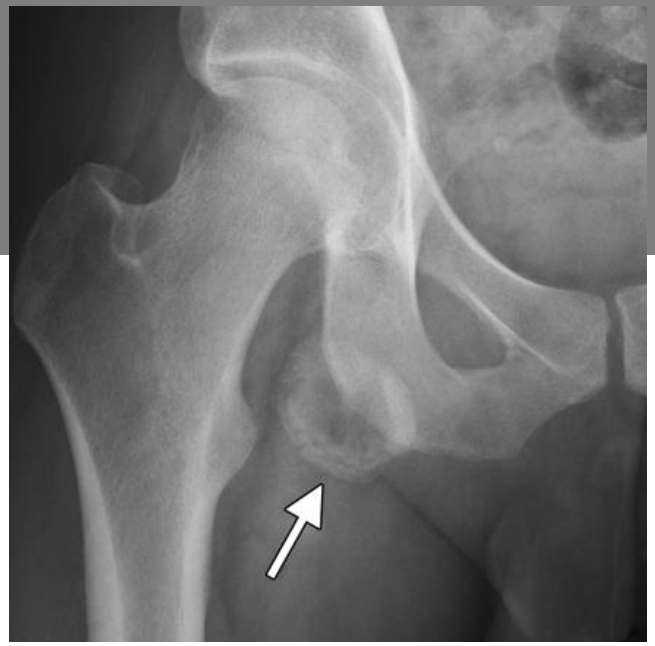
Physical Examination

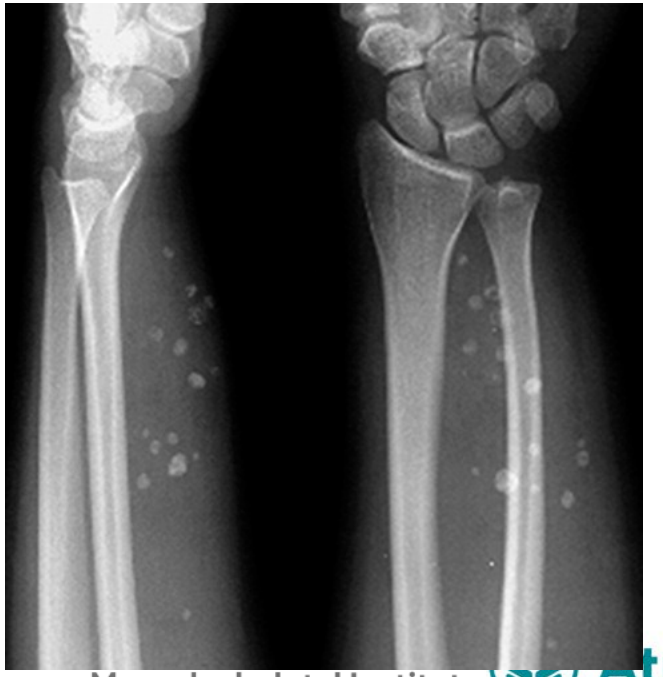
- Size
- Location
- Depth
- Consistency
- Mobility
- Lymph Nodes
- Tinel’s



X-rays

- Extremely important!
  - Pain longer than 6 weeks
  - Pain refractory to conservative measures
  - Red flags
  - History of cancer
- Majority of benign bone lesions can be seen
- Malignant bone lesions often have more subtle findings – more likely to be missed
- Soft tissue calcifications can be informative





How to Read and X-ray

Enneking Questions

1) Where is the lesion?

2) What is the lesion doing to the bone?

3) What is the bone doing to the lesion?

4) Are there any clues that would provide information about the type of tissue within the lesion (e.g. matrix)?

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Enneking Questions

1) Where is the lesion?
2) What is the lesion doing to the bone?
3) What is the bone doing to the lesion?
4) Are there any clues that would provide information about the type of tissue within the lesion (e.g. matrix)?

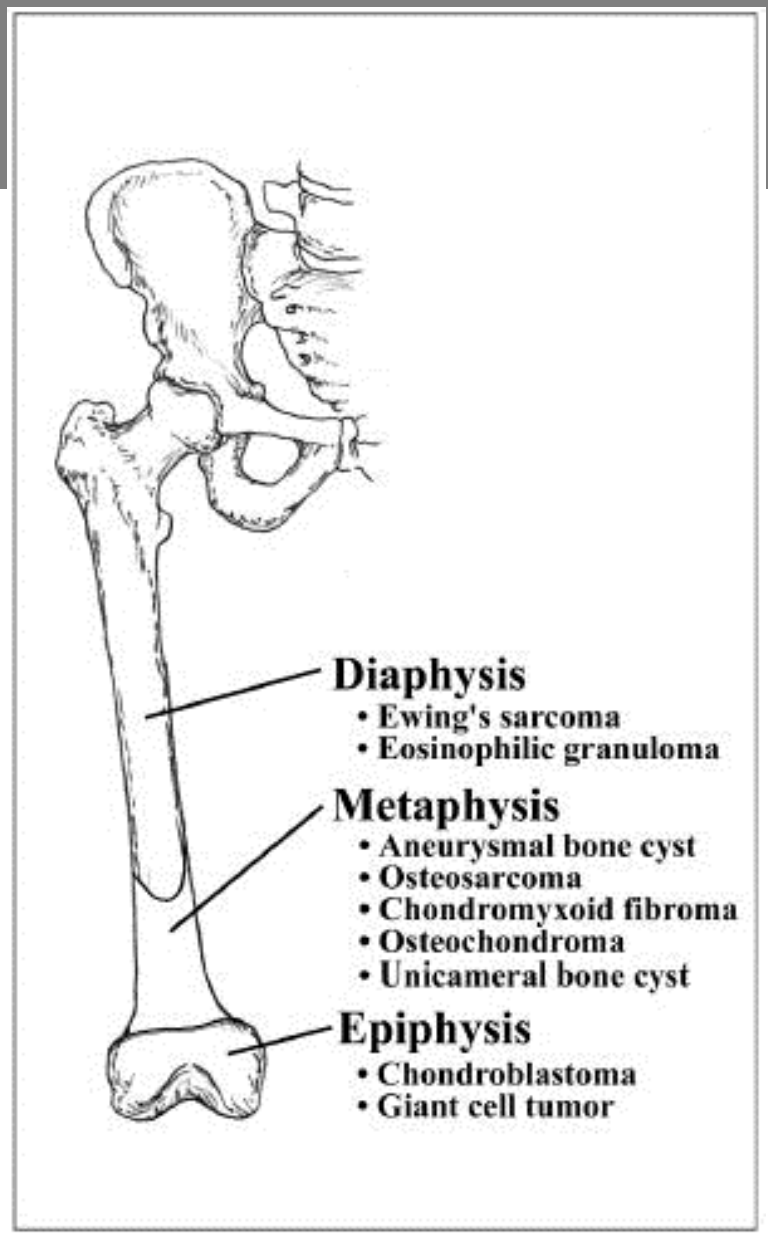
Enneking Questions

1) Where is the lesion?
   a) Epiphyseal, Metaphyseal, Diaphyseal

   b) Axial vs. Appendicular skeleton

   c) Central, Eccentric, Cortically-based, Juxtacortical, Peri-articular

   d) Multiple lesions?



Enneking Questions

1) Where is the lesion?
2) What is the lesion doing to the bone?
3) What is the bone doing to the lesion?
4) Are there any clues that would provide information about the type of tissue within the lesion (e.g. matrix)?

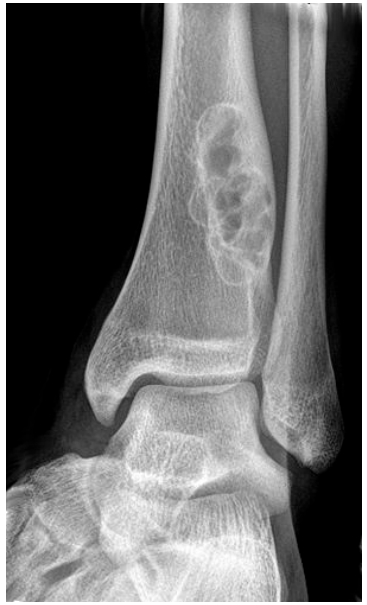
Enneking Questions

1. Where is the lesion?
2. What is the lesion doing to the bone?
   a) Size (>5 cm more likely bad)
   b) Cortical expansion
   c) Endosteal scalloping
   d) Cortical Erosion/breakthrough
   e) Destructive changes
   f) Pathologic fracture
3. What is the bone doing to the lesion?
4. Are there any clues that would provide information about the type of tissue within the lesion (e.g. matrix)?

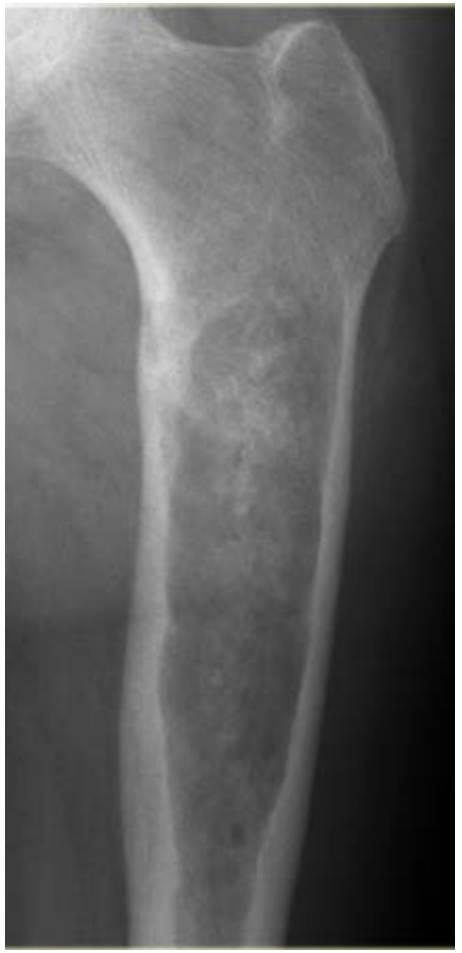
Cortical expansion

- Generally implies slow growth
  - Think of Wolff's law
  - Benign lesions generally do not violate the cortex

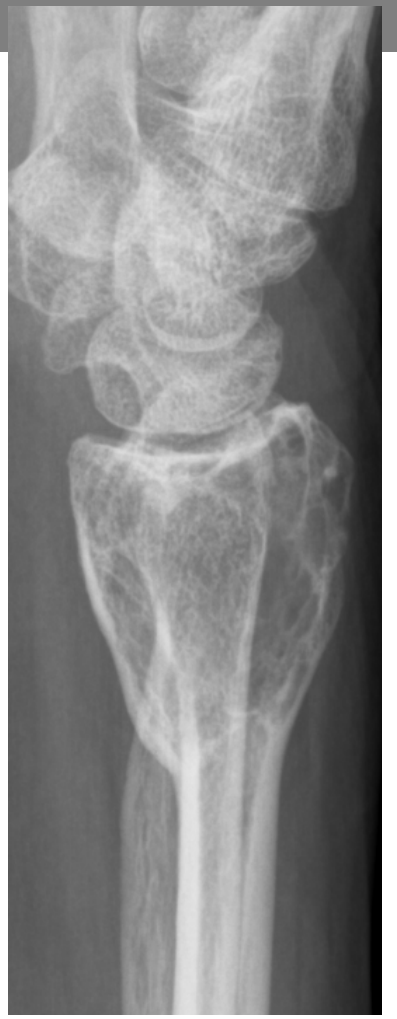
- Mild
  - NOF, FD
- Moderate
  - UBC, ABC
  - Chondroid lesions
- Severe
  - ABC, GCT, Mets



Non-ossifying fibroma



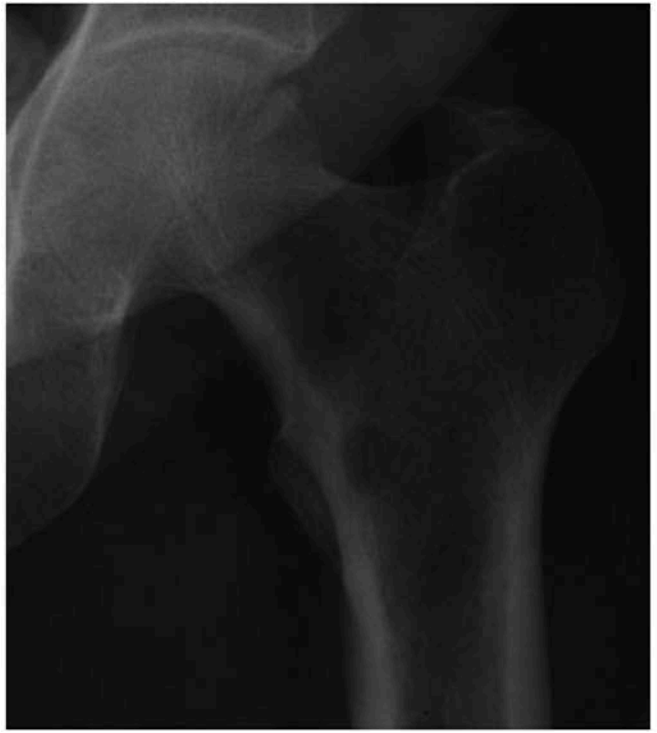
Enchondroma

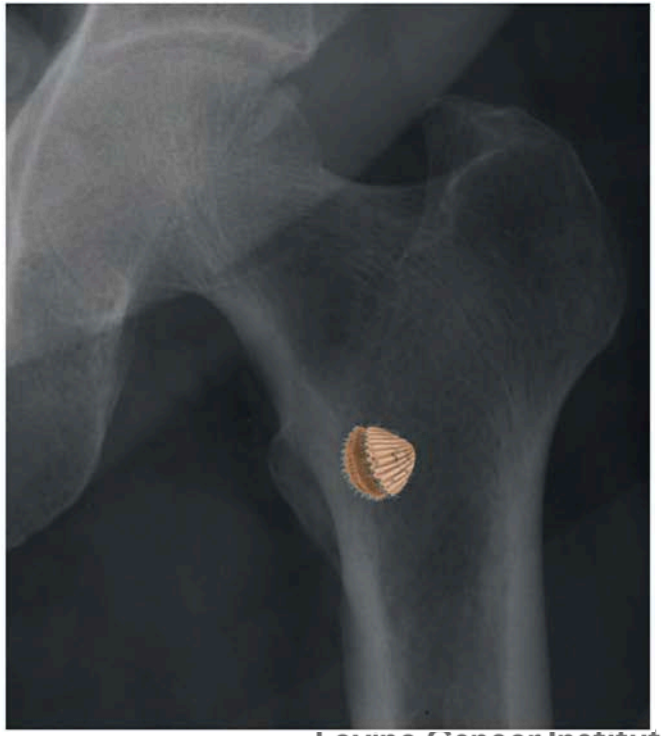


Giant cell tumor

Endosteal scalloping

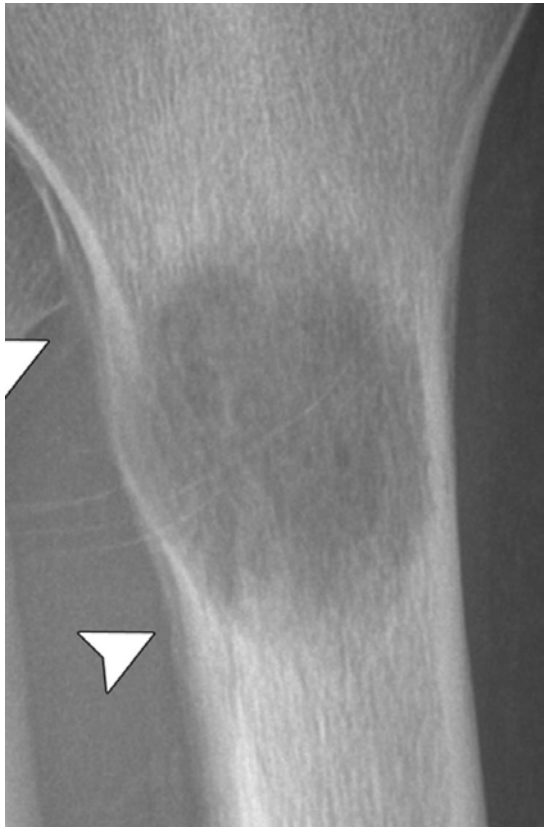
- Erosion of inner surface of cortex due to medullary bone lesion
  - Can be benign (often seen in enchondroma) or malignant (mets, myeloma)



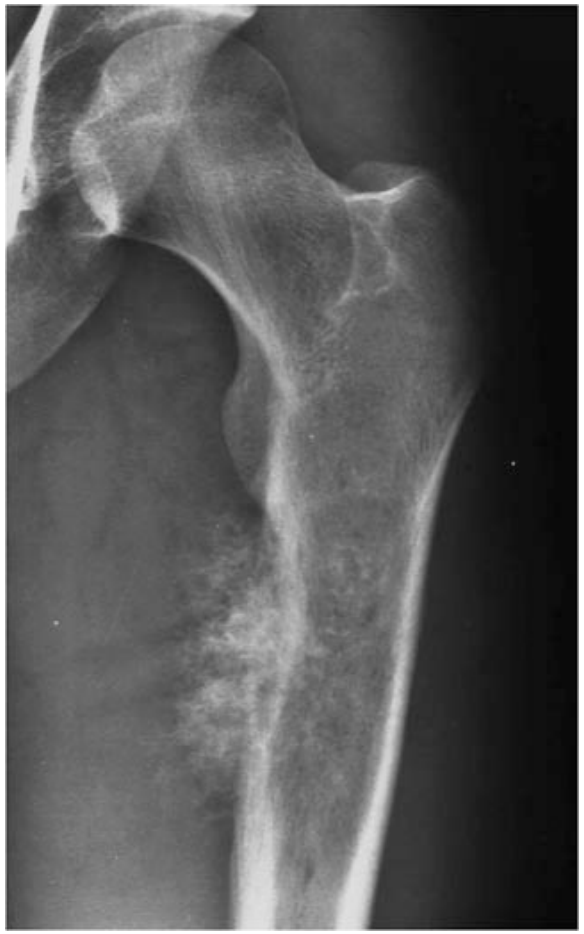


Cortical Erosion/Breakthrough

- More aggressive finding

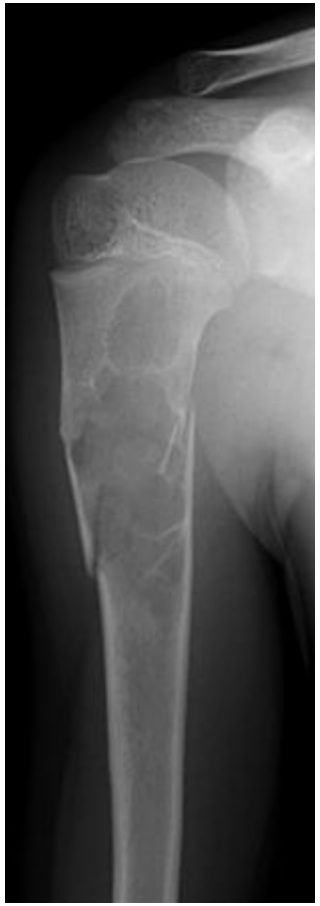


Met

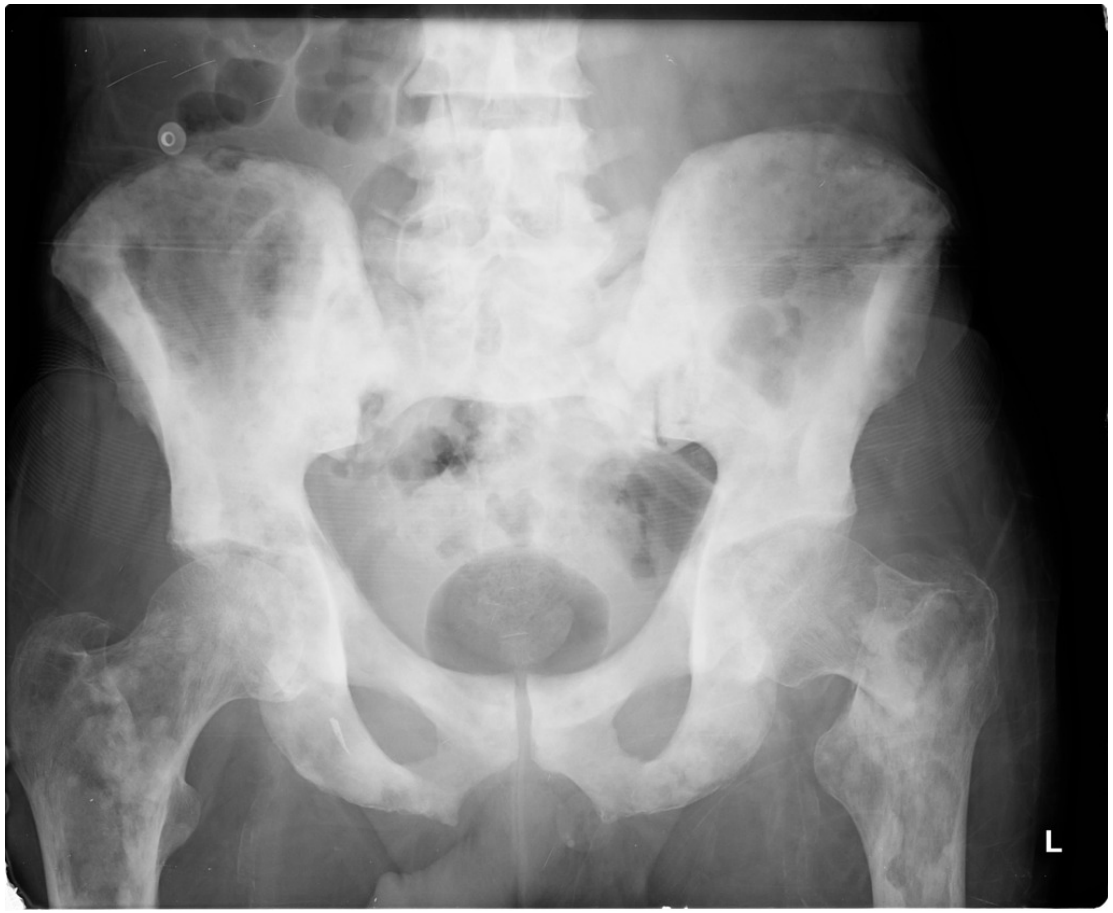


High Grade CS

Pathologic Fracture



UBC



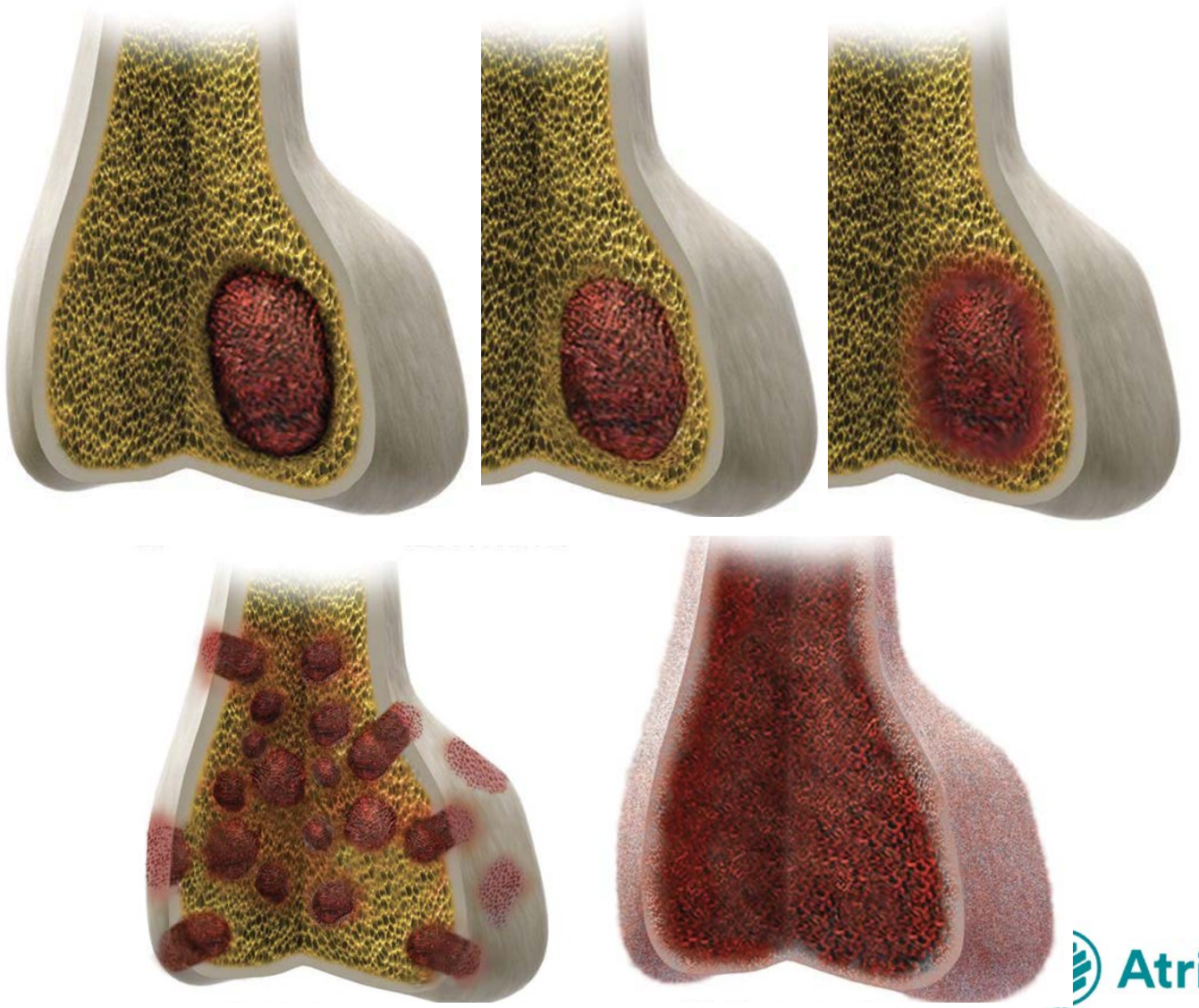
Prostate Ca Mets

Enneking Questions

1. Where is the lesion?
2. What is the lesion doing to the bone?
3. What is the bone doing to the lesion?
   a) Margins
   b) Periosteal reaction
4. Are there any clues that would provide information about the type of tissue within the lesion (e.g. matrix)?

Lodwick Classification (Margins)

- Geographic
  - Sclerotic (IA)
  - Non-sclerotic (IB)
  - Ill-defined (IC)
- Non-Geographic
  - Moth Eaten (II)
  - Permeative (III)

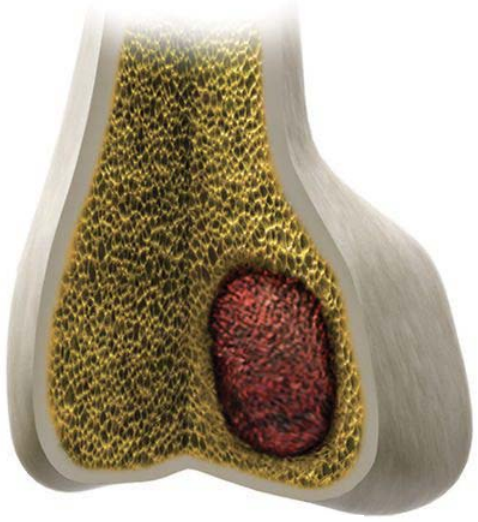


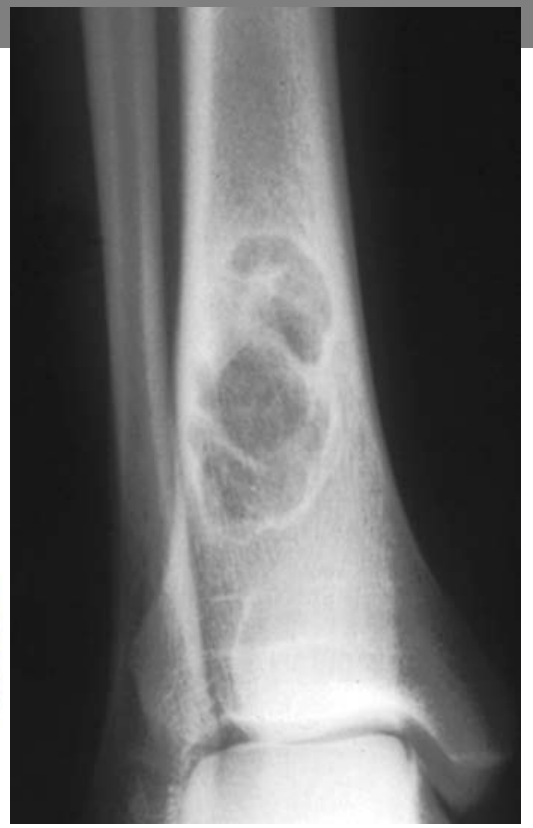
Atrium Health

Geographic IA

- Narrow zone of transition
- Rim of reactive bone
- 99% benign

- Examples:
  - Non-ossifying Fibroma
  - Osteoid osteoma
  - Fibrous dysplasia
  - LCH, ABC, UBC
  - Brodie's abscess



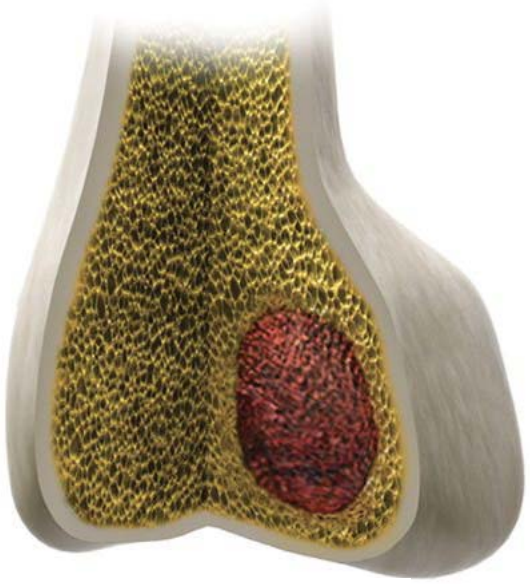


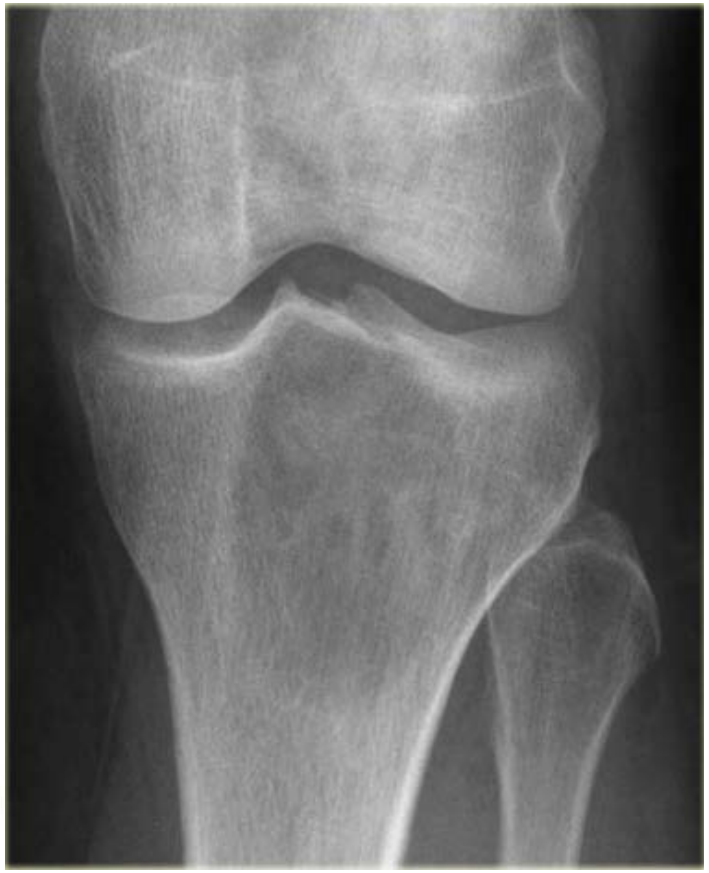
Non-ossifying fibroma

Geographic IB

- Narrow zone of transition
- No rim of reactive bone
- Benign or aggressive

- Examples:
  - GCT, ABC
  - Osteoblastoma
  - Chondroblastoma
  - Chondromyxoid fibroma
  - Metastasis
  - Myeloma



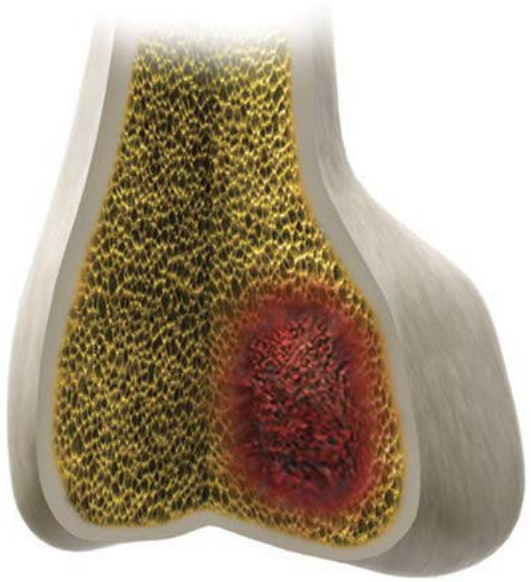


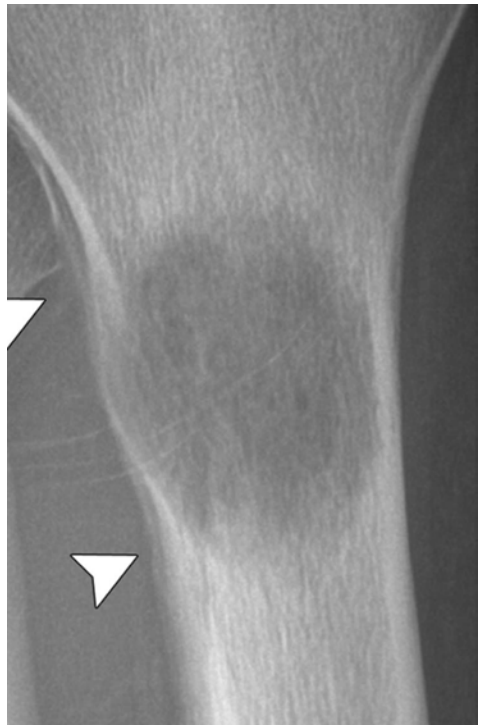
Giant cell tumor

Geographic IC

- Wide zone of transition
- No rim of reactive bone
- Aggressive

- Examples:
  - Osteosarcoma (early)
  - Chondrosarcoma (early)
  - GCT
  - Brown tumor
  - LCH
  - Osteomyelitis
  - Metastasis
  - Myeloma

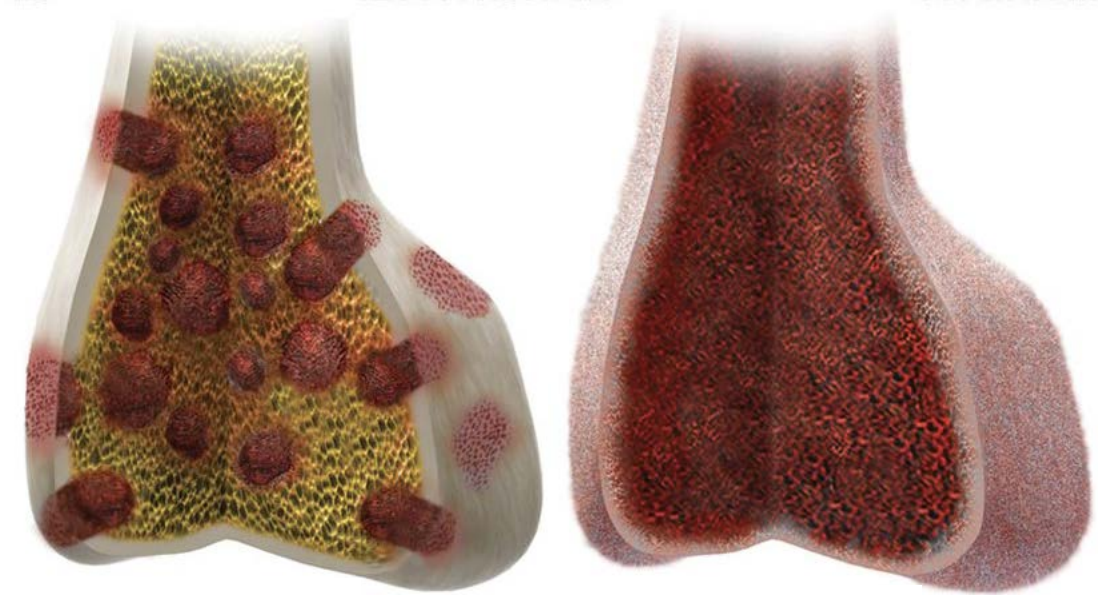


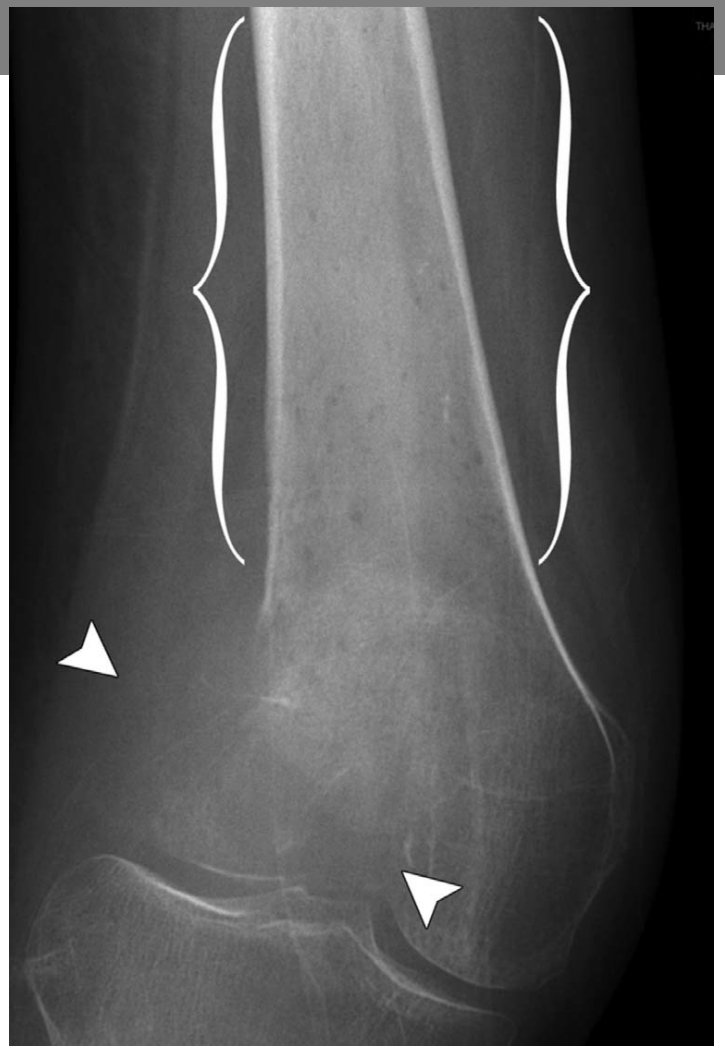


Met

Non-geographic margins (II & III)

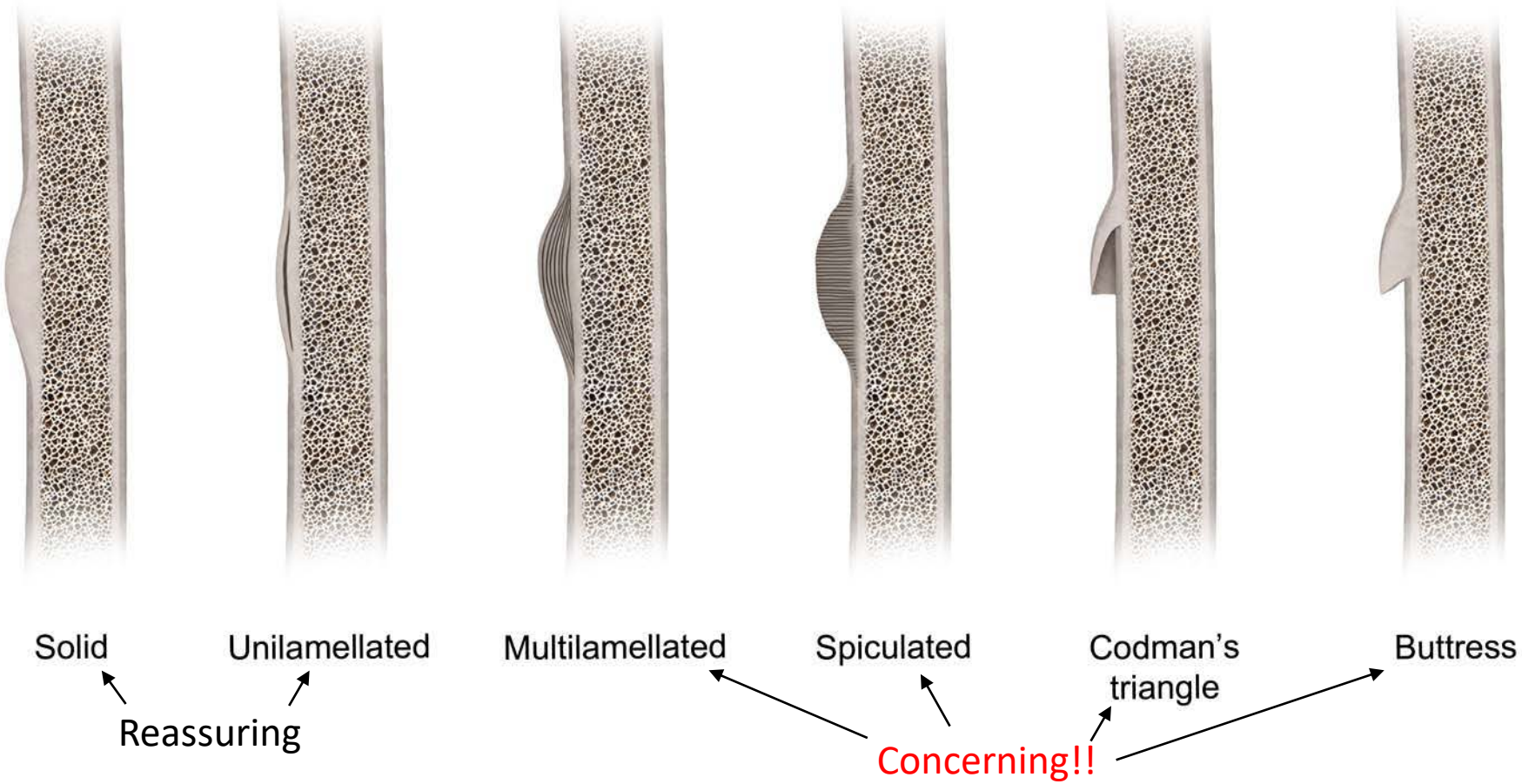
- Moth eaten (II)
- Permeative (III)
- Ill-defined areas of bone destruction
- AGGRESSIVE



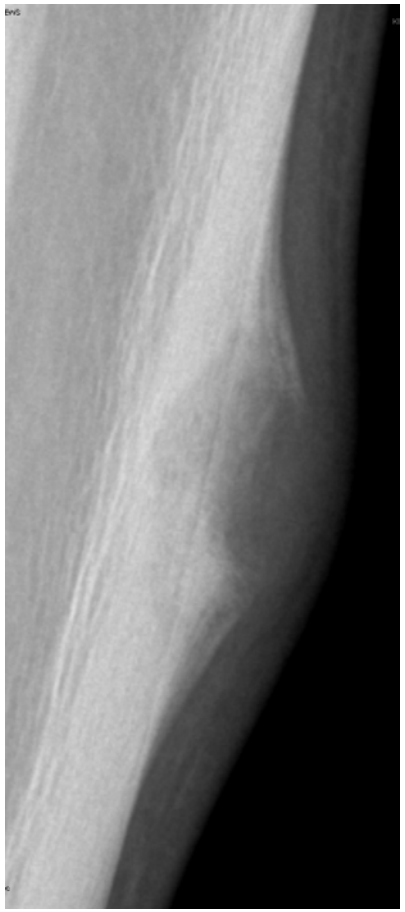


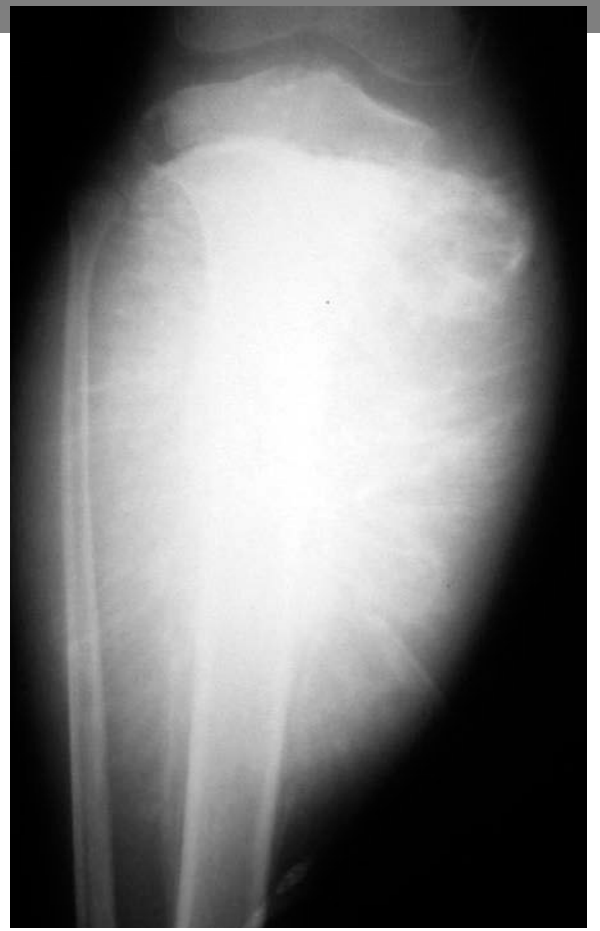
Lymphoma

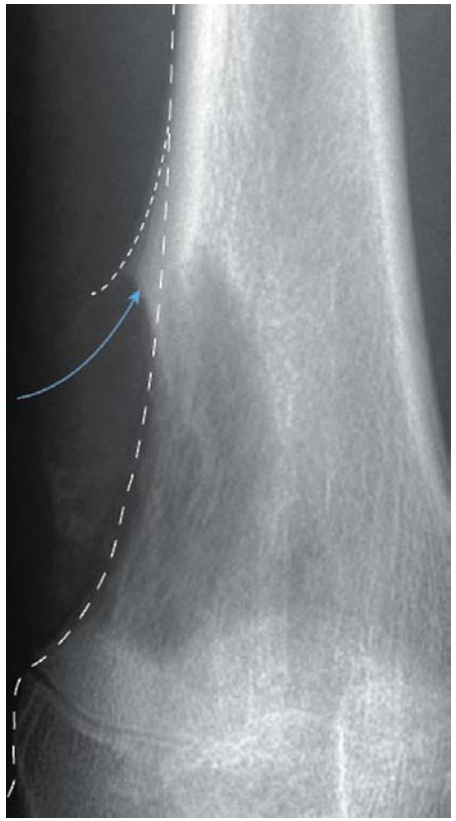
Periosteal reaction



Periosteal reaction





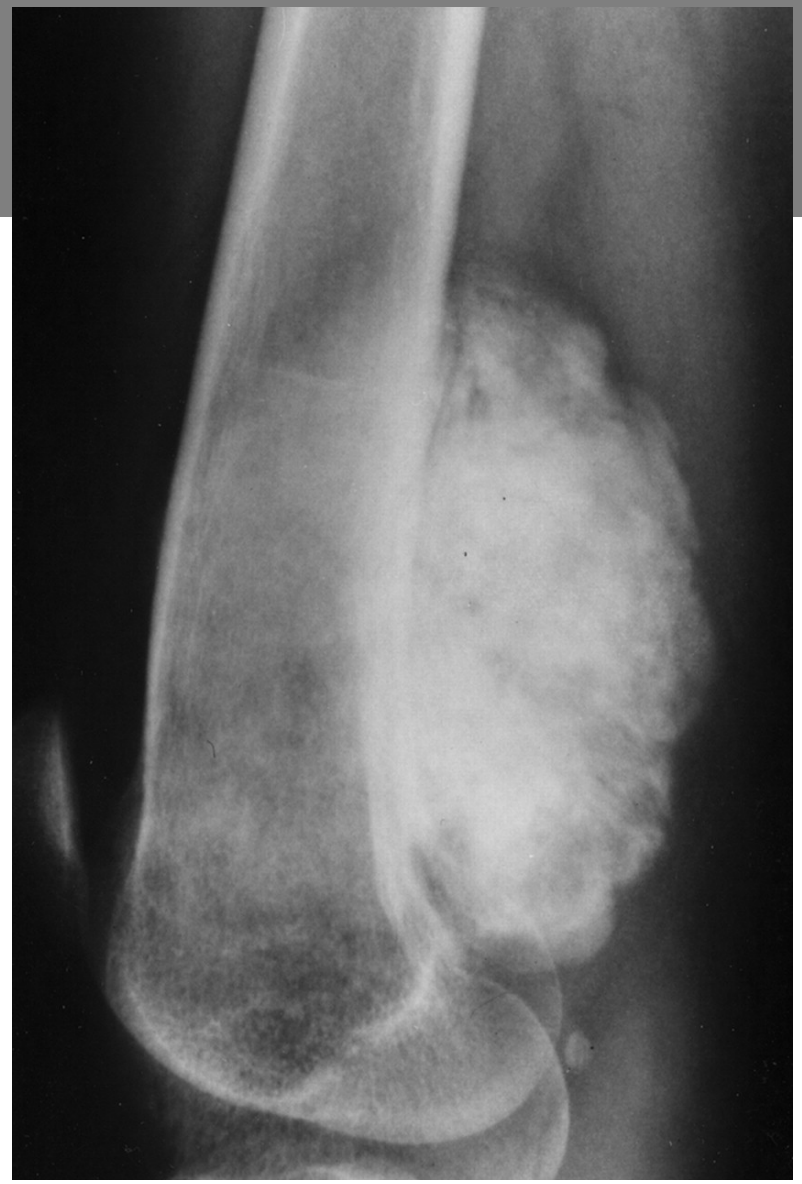


Enneking Questions

1. Where is the lesion?
2. What is the lesion doing to the bone?
3. What is the bone doing to the lesion?
4. Are there any clues that would provide information about the type of tissue within the lesion (e.g. matrix)?
   a) Osteoid
   b) Chondroid
   c) Fibrous

Osteoid

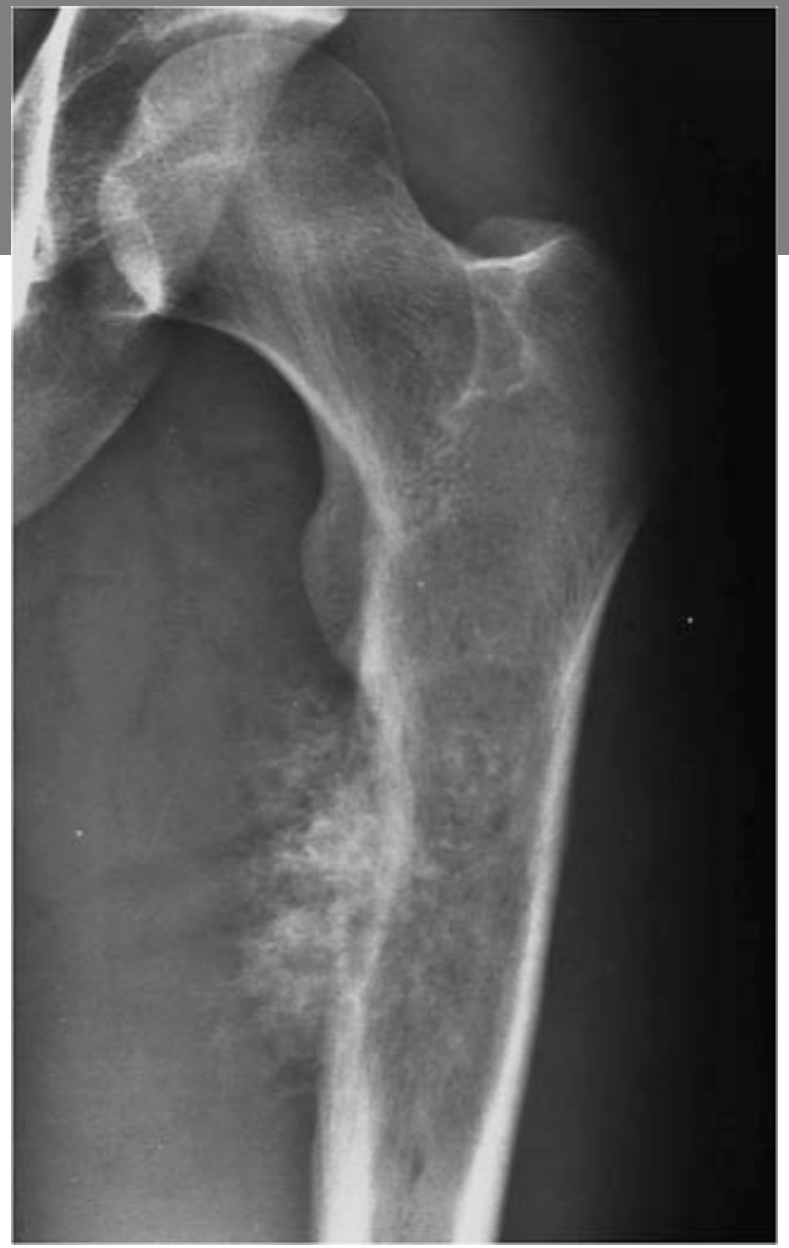
- Fluffy, cloud-like
- Ivory, dense



Parosteal osteosarcoma

Chondroid

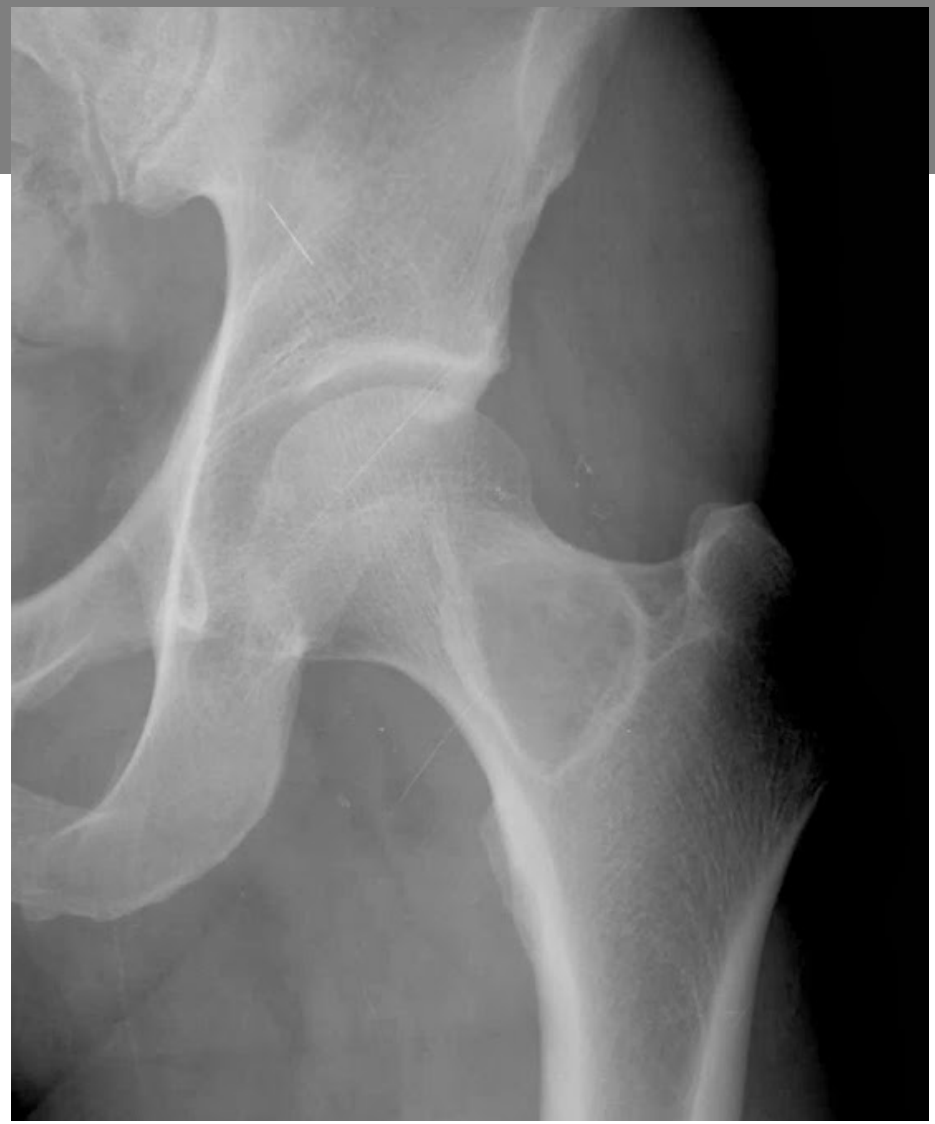
- Stippled
- Rings & arcs



High grade chondrosarcoma

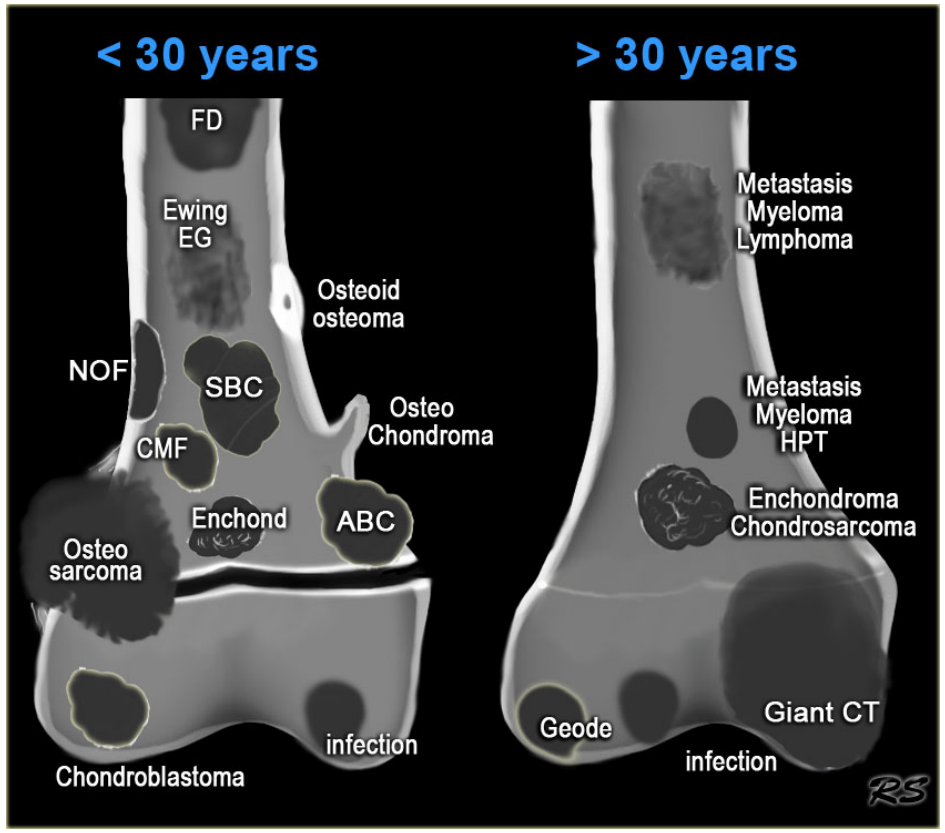
Fibrous

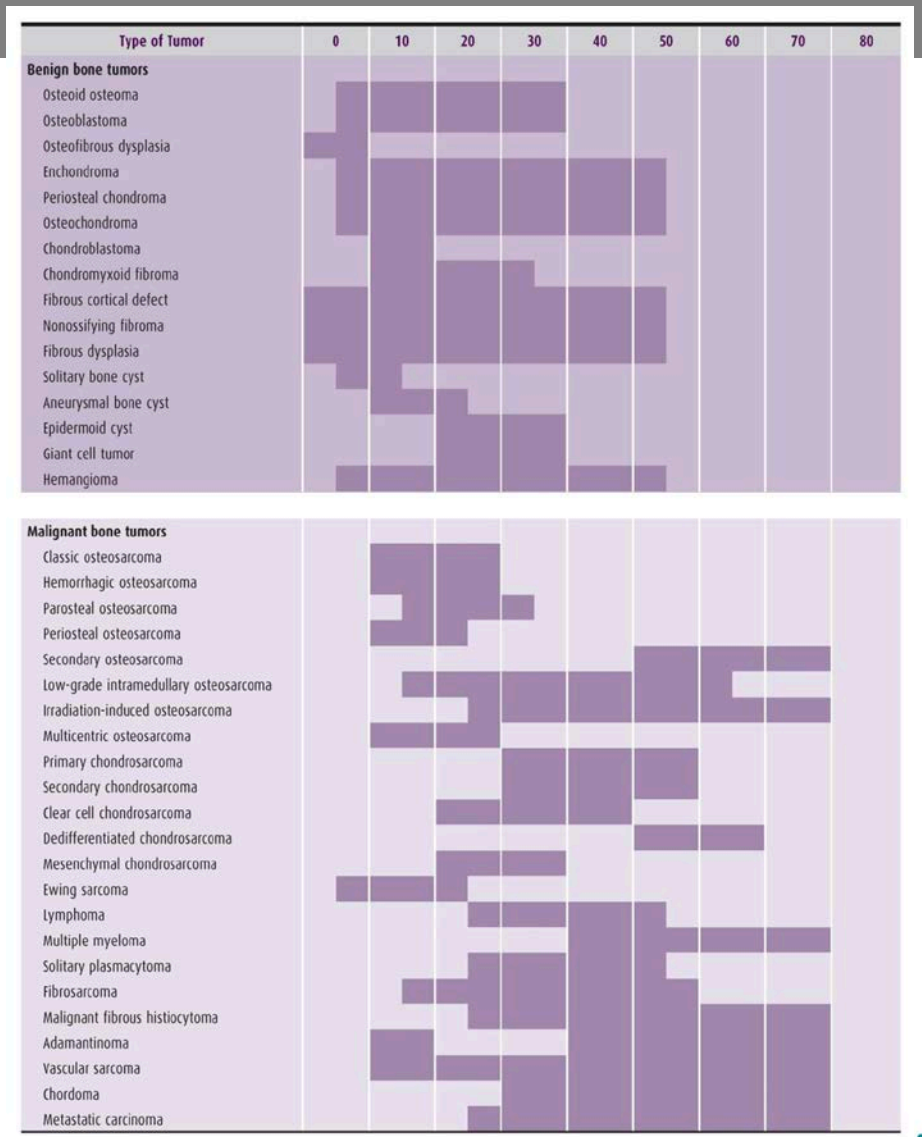
- Ground glass



Fibrous dysplasia

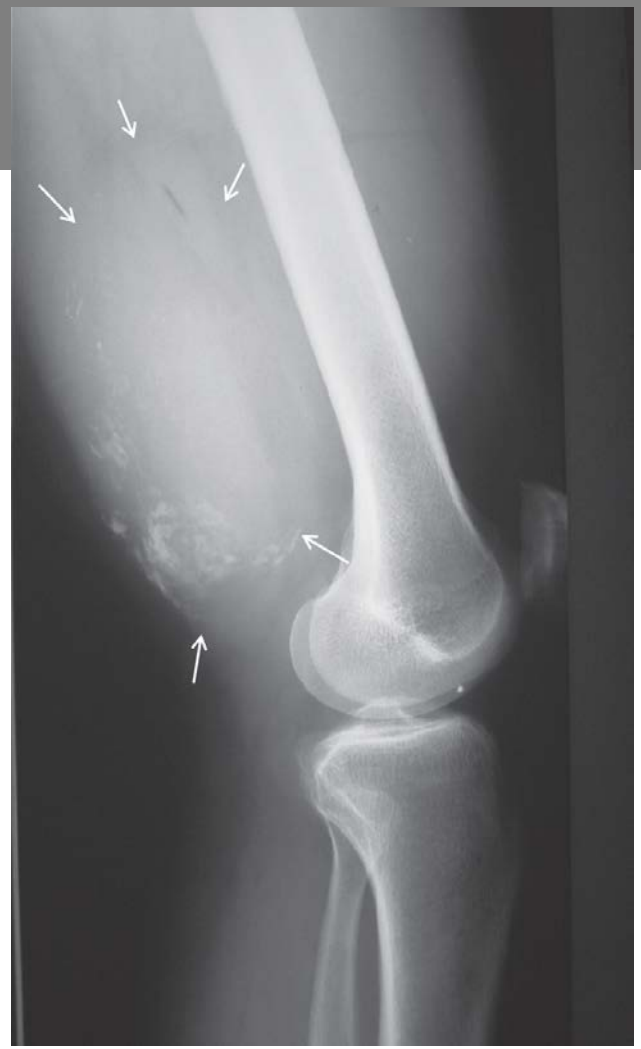
Age + Location + Radiography = Differential Diagnosis





Work up

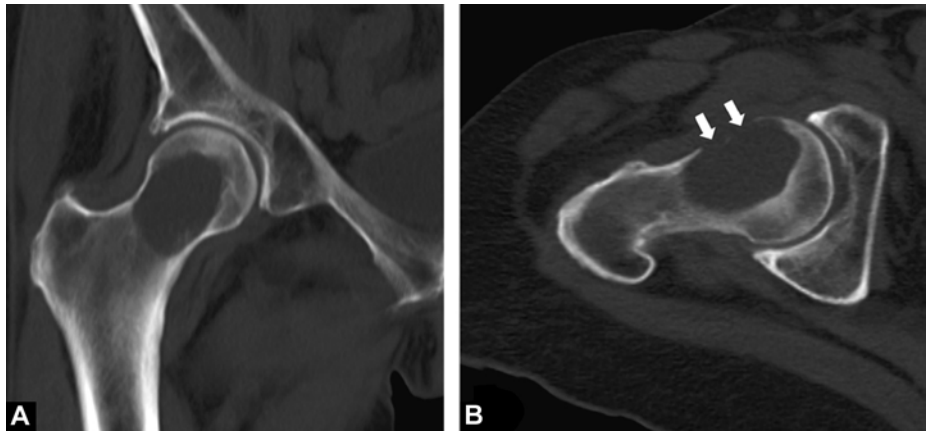
- If x-rays demonstrate anything concerning, okay to stop here and refer the patient
- Would not fault you for obtaining advanced imaging
  - Appreciate additional information, however sometimes the imaging study is insufficient
  - e.g. MRI w/o contrast

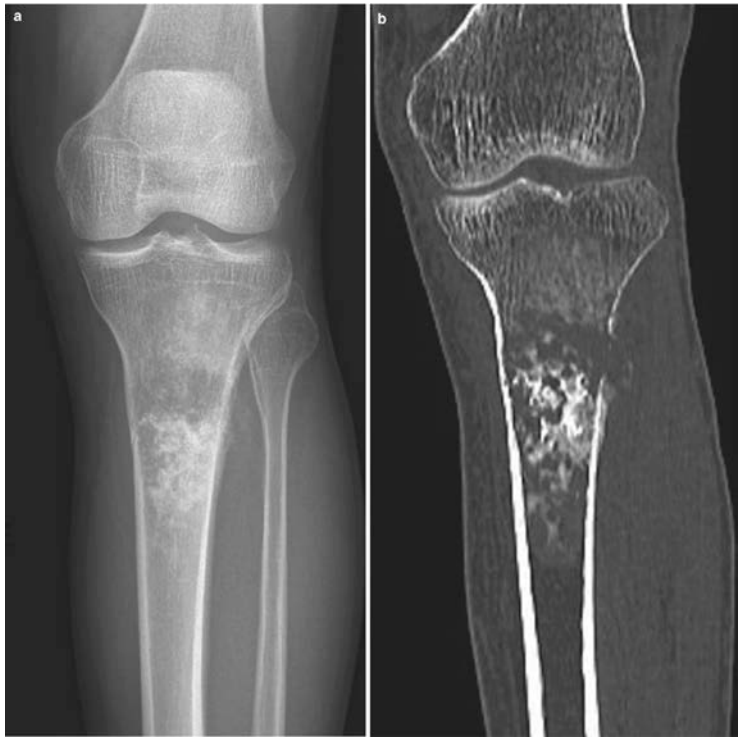


Synovial sarcoma

CT Scan

- Optimal visualization of bony anatomy
- Especially useful for cartilaginous neoplasms
- Demonstrates extra-osseous extension

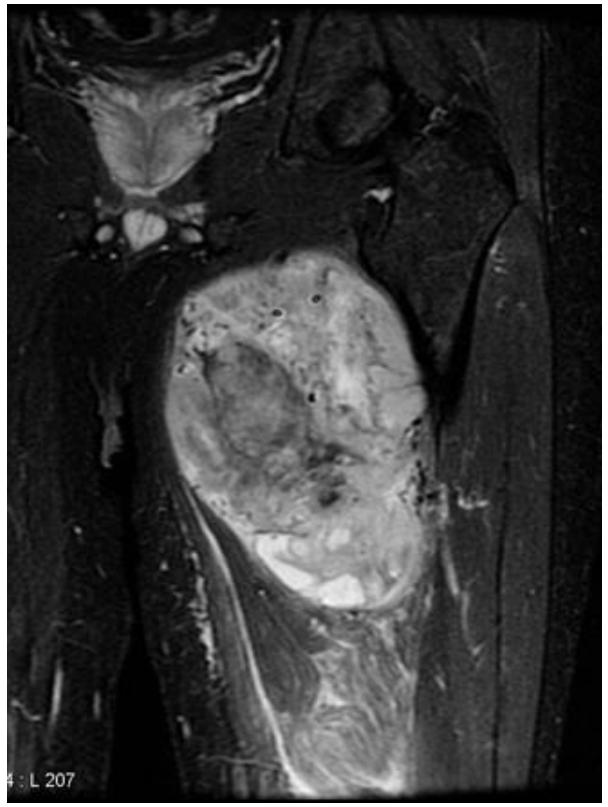




Low grade chondrosarcoma

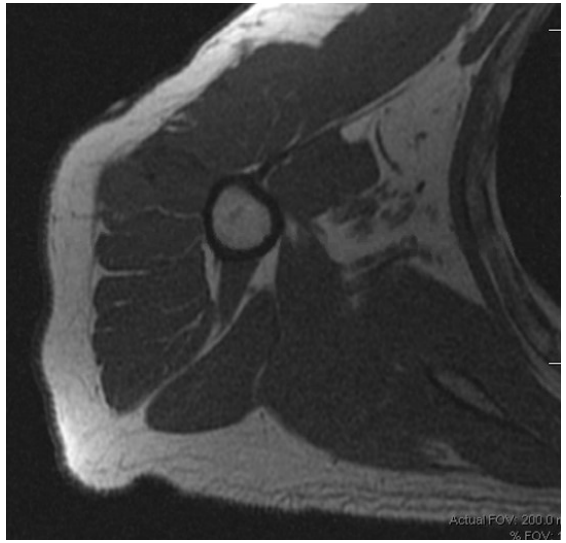
MRI

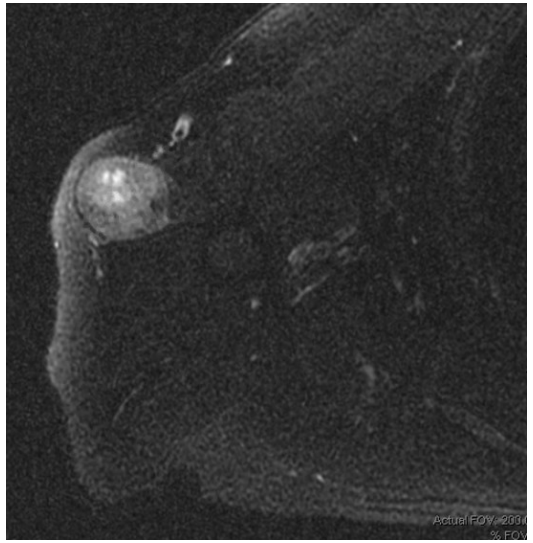
- Best study for evaluation of soft tissue lesions
- Obtain with and without contrast!!
- Sequences
  - T1
    - Water – intermediate
    - Fat – bright
    - Bone/collagen – dark
  - T2
    - Water – bright
    - Fat – intermediate
    - Bone/collagen – dark
  - Gadolinium
    - Cellularly active tissues

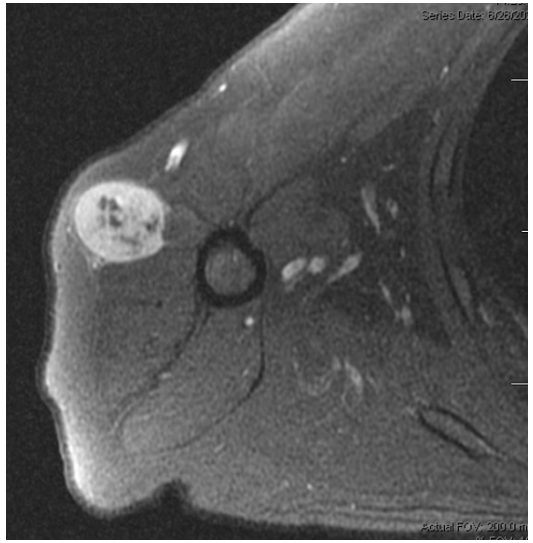


MRI

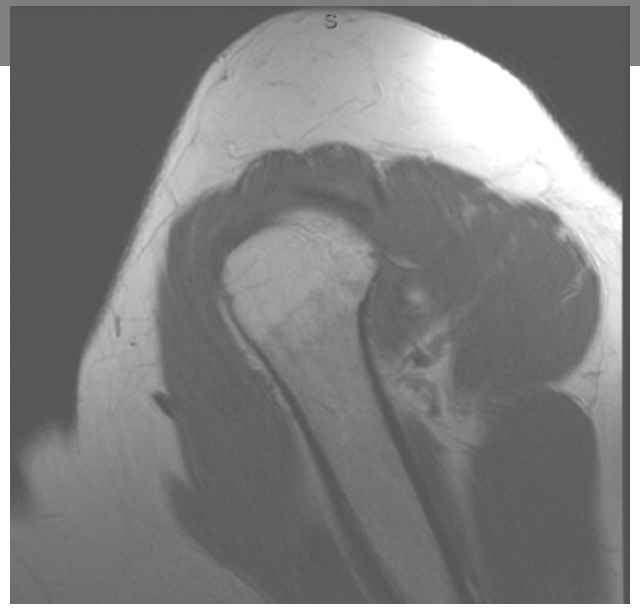
- Most sarcomas are:
  - Isointense to muscle on T1
    - Liposarcomas and hemorrhagic tumors may have focal increased T1 signal
  - Bright on T2 (+/- surrounding edema)
  - Avidly contrast enhancing (+/- internal necrosis)

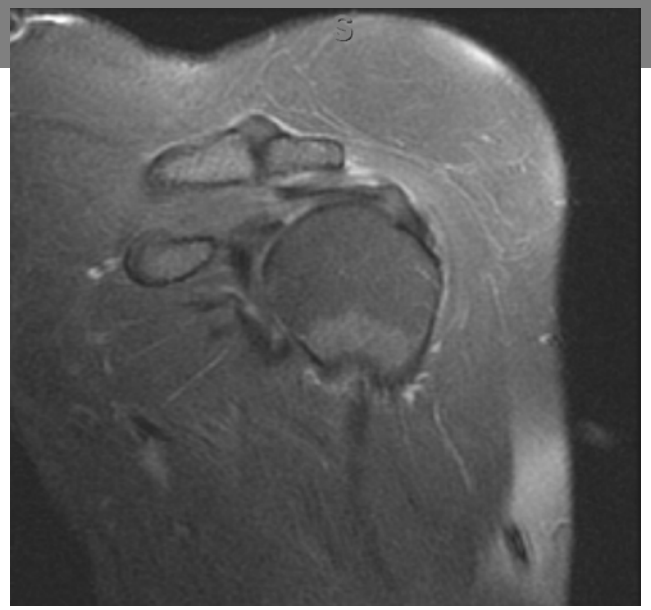


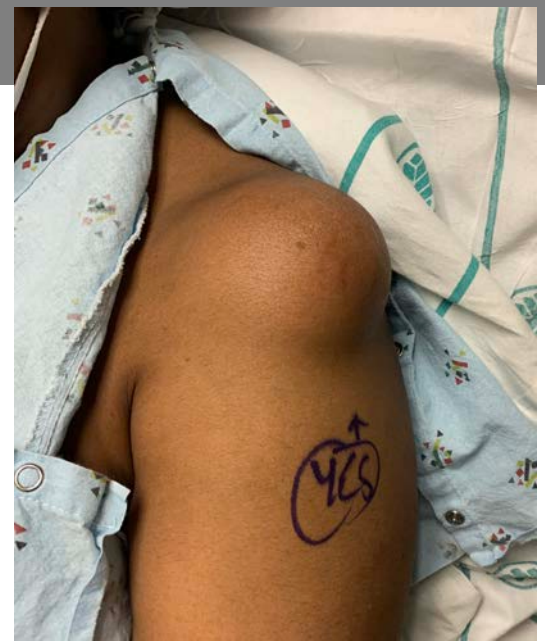


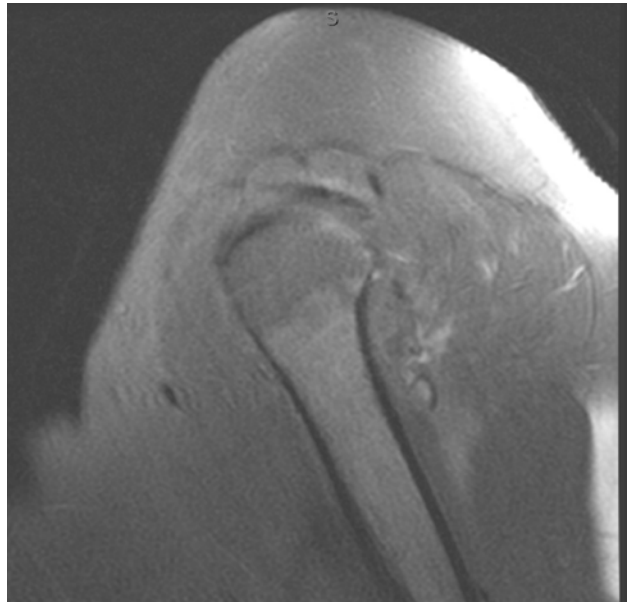


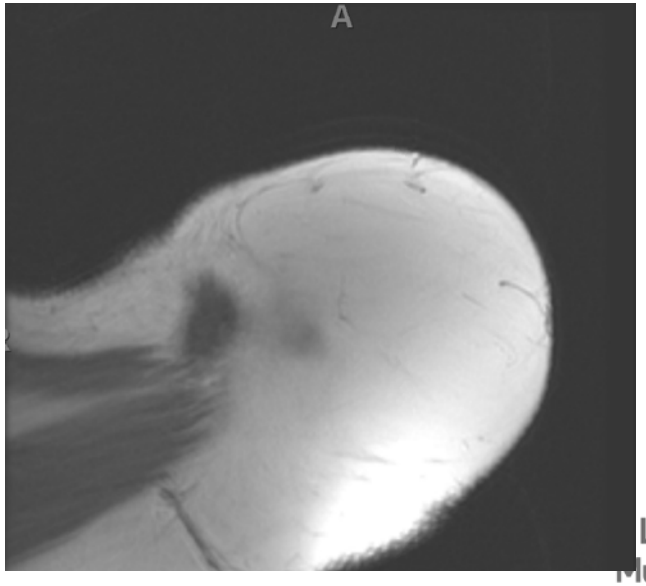
MRI of a lipoma = identical to fat on ALL sequences

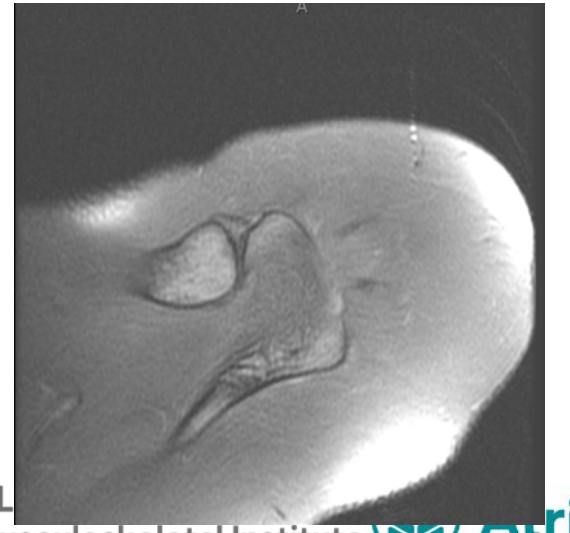






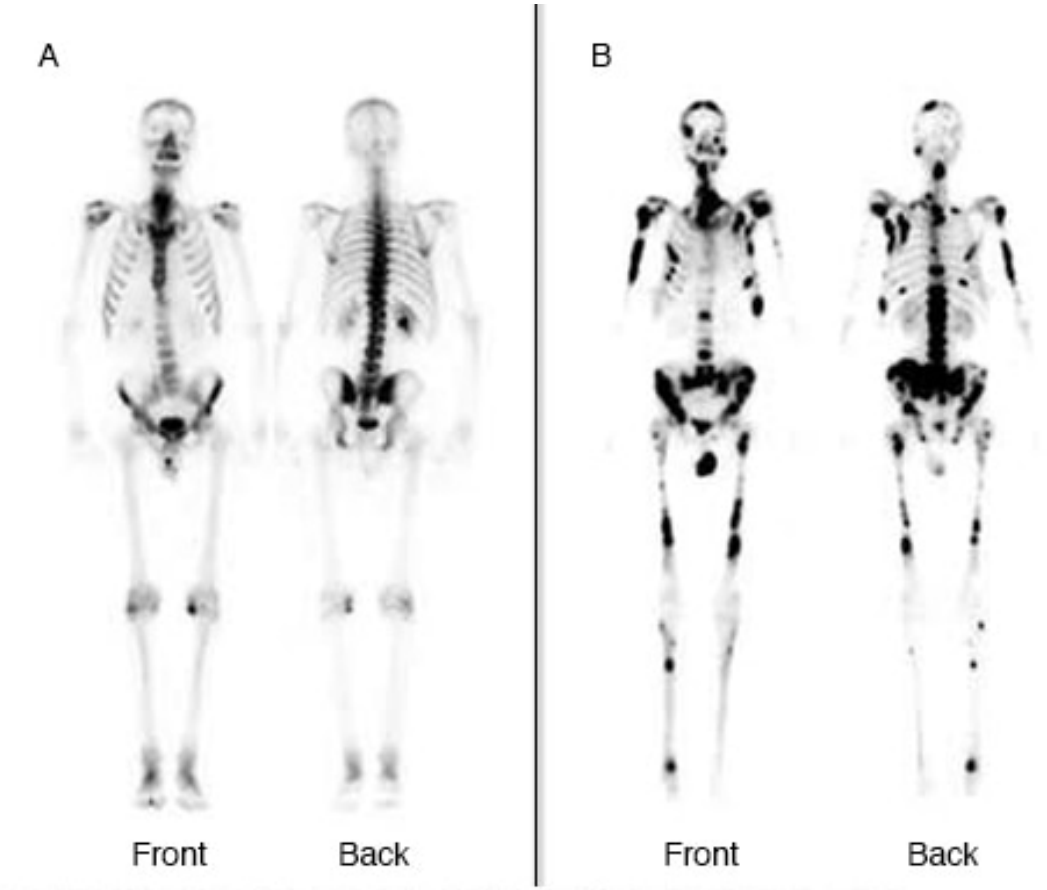






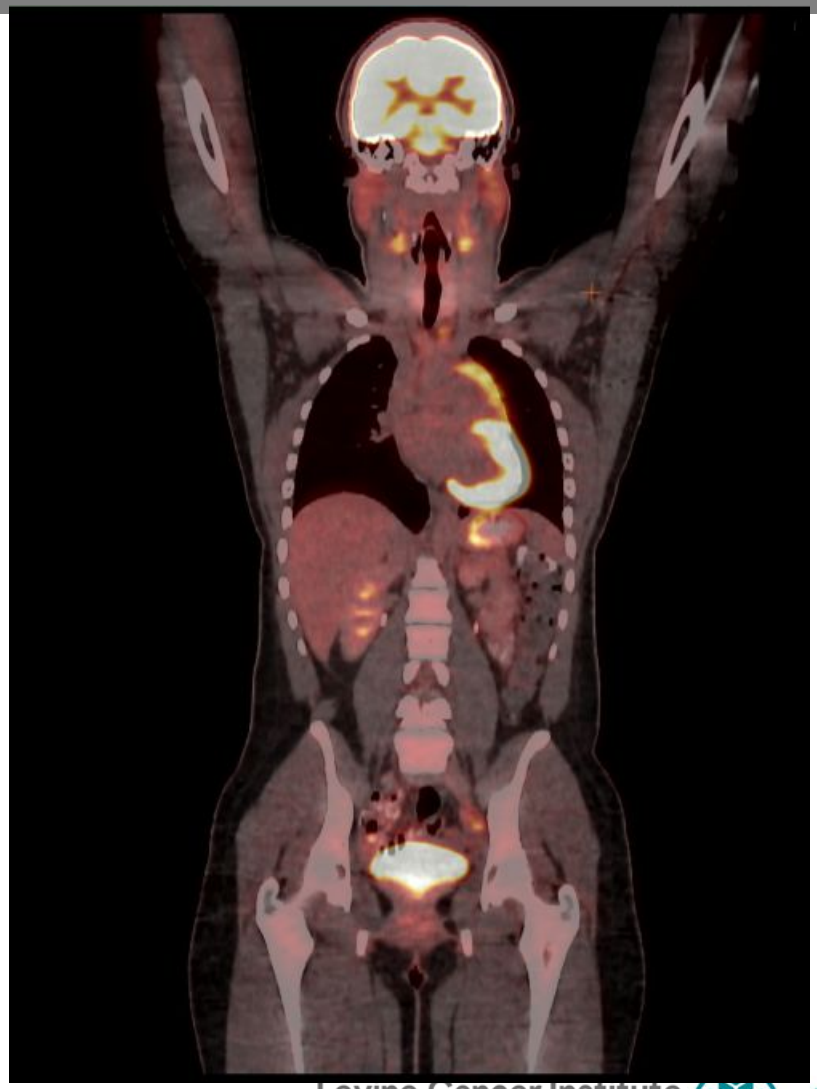
Advanced imaging

- Bone scan
  - Shows areas of bone turnover
  - Evaluate for unifocal vs. multifocal disease
  - Helpful for most bone tumors
  - Bone benign and malignant lesions can be seen
  - Multiple myeloma typically cold -> Skeletal survey



Advanced Imaging

- PET Scan
  - FDG tracer
  - Can replace bone scan
  - Increasingly utilized
  - Extended whole body vs. “eyes to thighs”



Differential Diagnosis

- Trauma: Foreign body, heterotopic ossification, myositis
- Infection: Abscess
- Vascular: Hemangioma, hematoma
- Metabolic: Gout
- Inflammatory: Rheumatoid nodule
- Congenital/Developmental
- “It’s a Tumor”

Biopsy

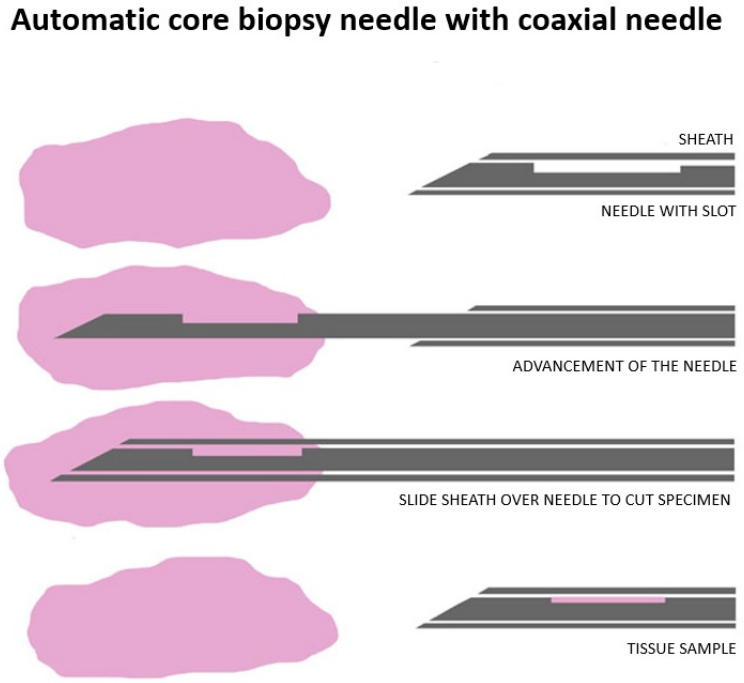
- Gold standard to obtain diagnosis

- Simple Technical Skill
- Complex Cognitive Skill

Biopsy

- Indications:
  - Soft tissue masses >5 cm
  - Aggressive appearing soft tissue lesions
  - Unclear diagnosis in symptomatic patient
- When biopsy can be avoided
  - Soft tissue lesion with diagnostic imaging (ie lipoma, hemangioma)
  - Smaller (<5 cm) less-concerning lesions with likely diagnosis of benign entity
- Types
  - Fine needle aspiration
  - Core needle biopsy
  - Incisional biopsy
  - Excisional biopsy

Hard to determine without an MRI

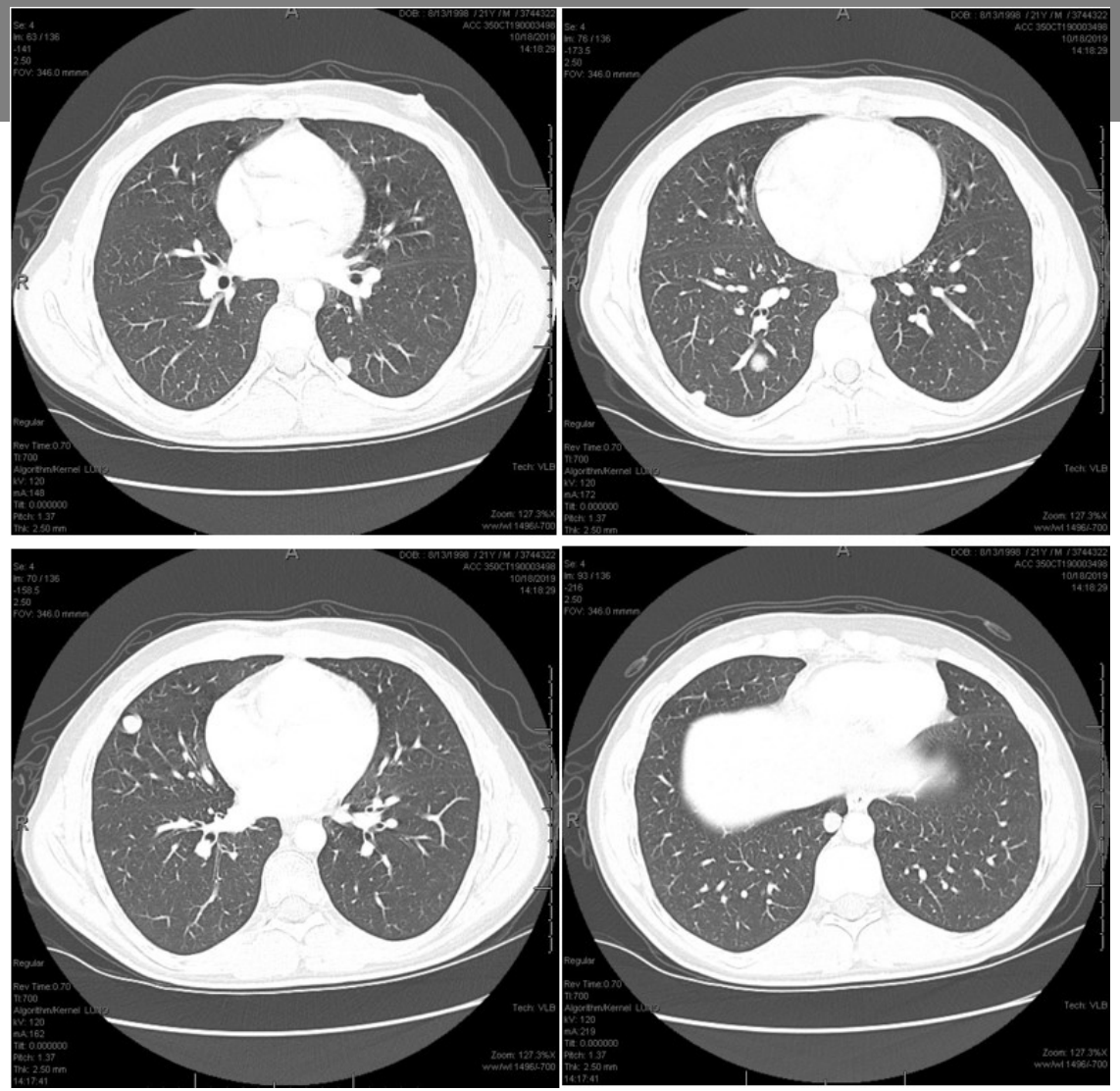


Biopsy principles

- Incision
  - Longitudinal, not Transverse!
  - Allows for extension if needed
- Approach
  - Do not expose NV structures -> contamination
  - Directly through muscle is ideal
  - Avoid elevating flaps
- Closure
  - Obtain meticulous hemostasis
  - Make any drain hole in line with incision
- Inappropriate biopsy can alter treatment and affect outcomes
- If unsure -> REFER!!

Staging

- Process of determining extent of disease
- Provides prognostic information and aids in treatment decision making
- Soft tissue sarcomas:
  - X-rays
  - MRI w/ & w/o contrast
  - CT Chest +/- Abdomen/Pelvis
  - Labs (CBC w/ diff, CMP, Coags)
- Bone Sarcomas
  - X-rays (whole bone)
  - MRI w/ & w/o contrast (whole bone)
  - CT Chest
  - Labs (CBC w/ diff, CMP, LDH, Coags)



The Hazards of the Biopsy, Revisited

FOR THE MEMBERS OF THE MUSCULOSKELETAL TUMOR SOCIETY*

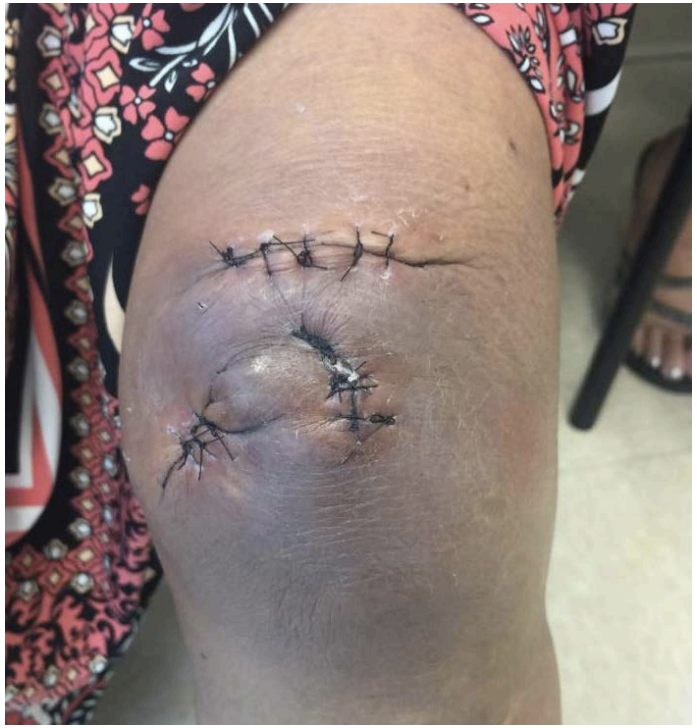
BY HENRY J. MANKIN, M.D.†, CAROLE J. MANKIN, M.S.L.S.†, AND MICHAEL A. SIMON, M.D.‡, BOSTON, MASSACHUSETTS

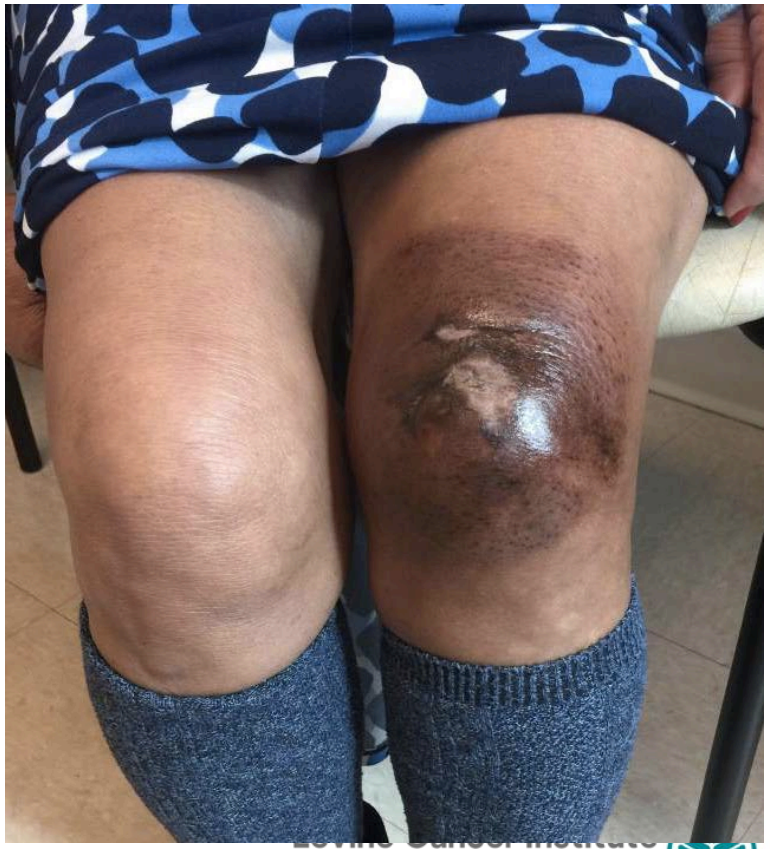
- Study to determine rates of complications, errors, morbidity related to inappropriate biopsies
  - 17.8% Diagnostic error
  - 19.3% Biopsy caused more complex surgery
  - 10.1% Change in patient outcome (Disability, loss of function, local recurrence, death)
  - 3.0% Unnecessary amputation

- Errors, complications, changes in course of outcome were 2-12x ($p < 0.001$) greater when biopsy was performed at referring institution

What not to do…

- “Whoops”



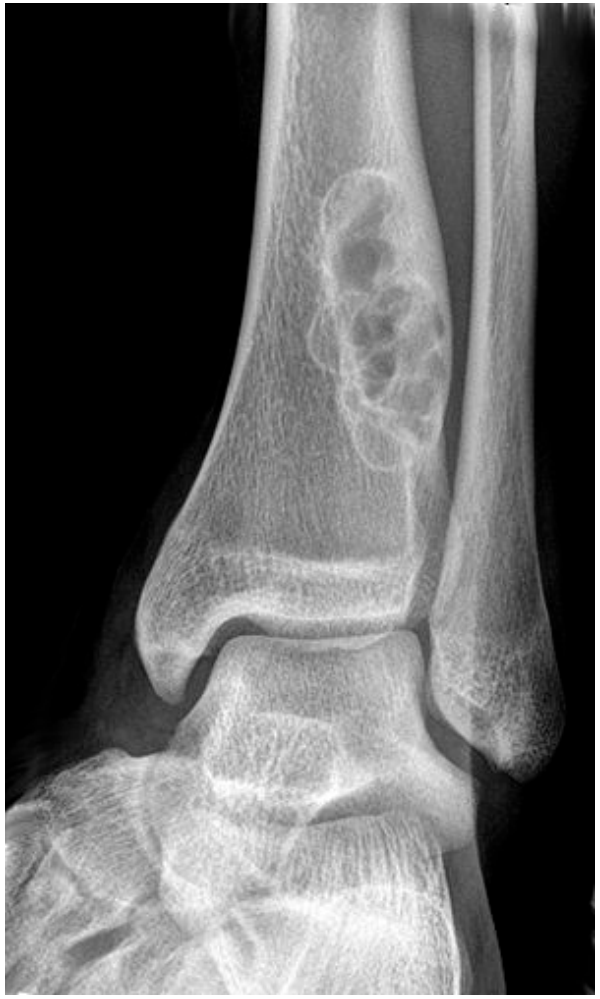


Management Scenarios

- Benign appearing bone lesion
- Concerning bone lesion
- Small superficial soft tissue lesion
- Concerning soft tissue lesion

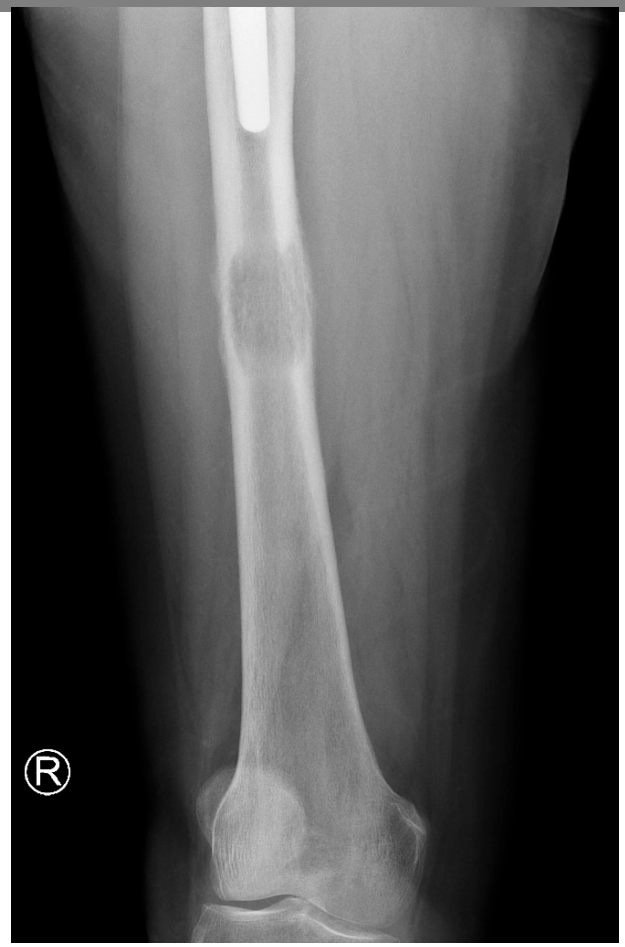
Management

- Benign appearing bone lesion
  - Often incidental
  - Well circumscribed w/ rim of reactive bone is >95% benign
- Obtain thorough H&P
- We will gladly review imaging and let you know if referral is indicated
- Please try not to scare them



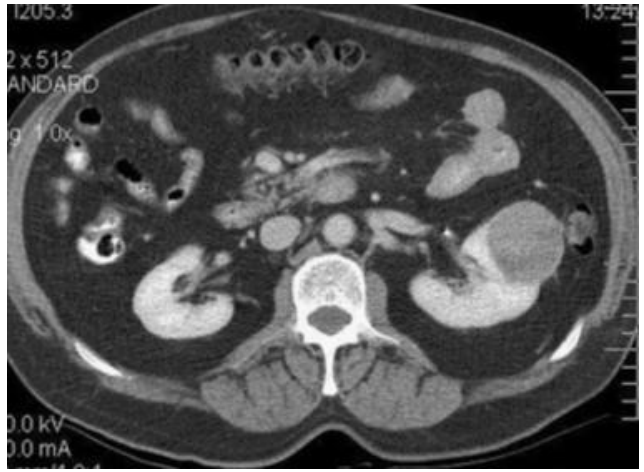
Management

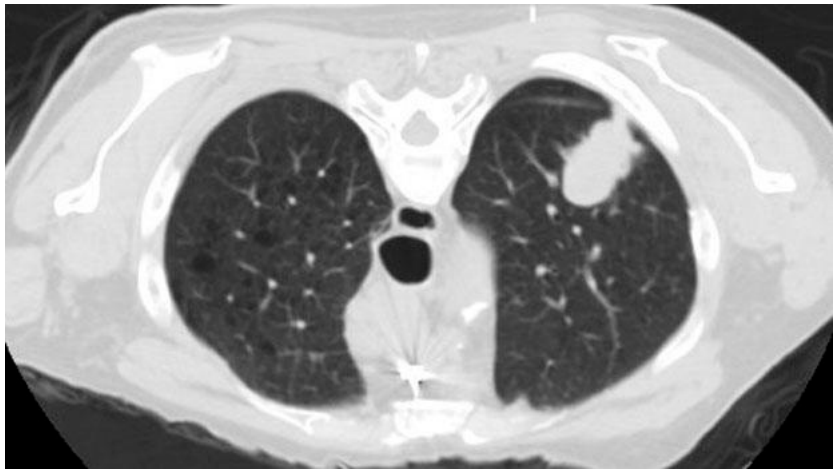
- Concerning bone lesion
  - Obtain thorough H&P
  - In adult -> think met!
    - Consider work up for primary of unknown origin
  - In child, may be benign or malignant
  - Urgent referral
  - Feel free to call us



Work for primary of unknown origin

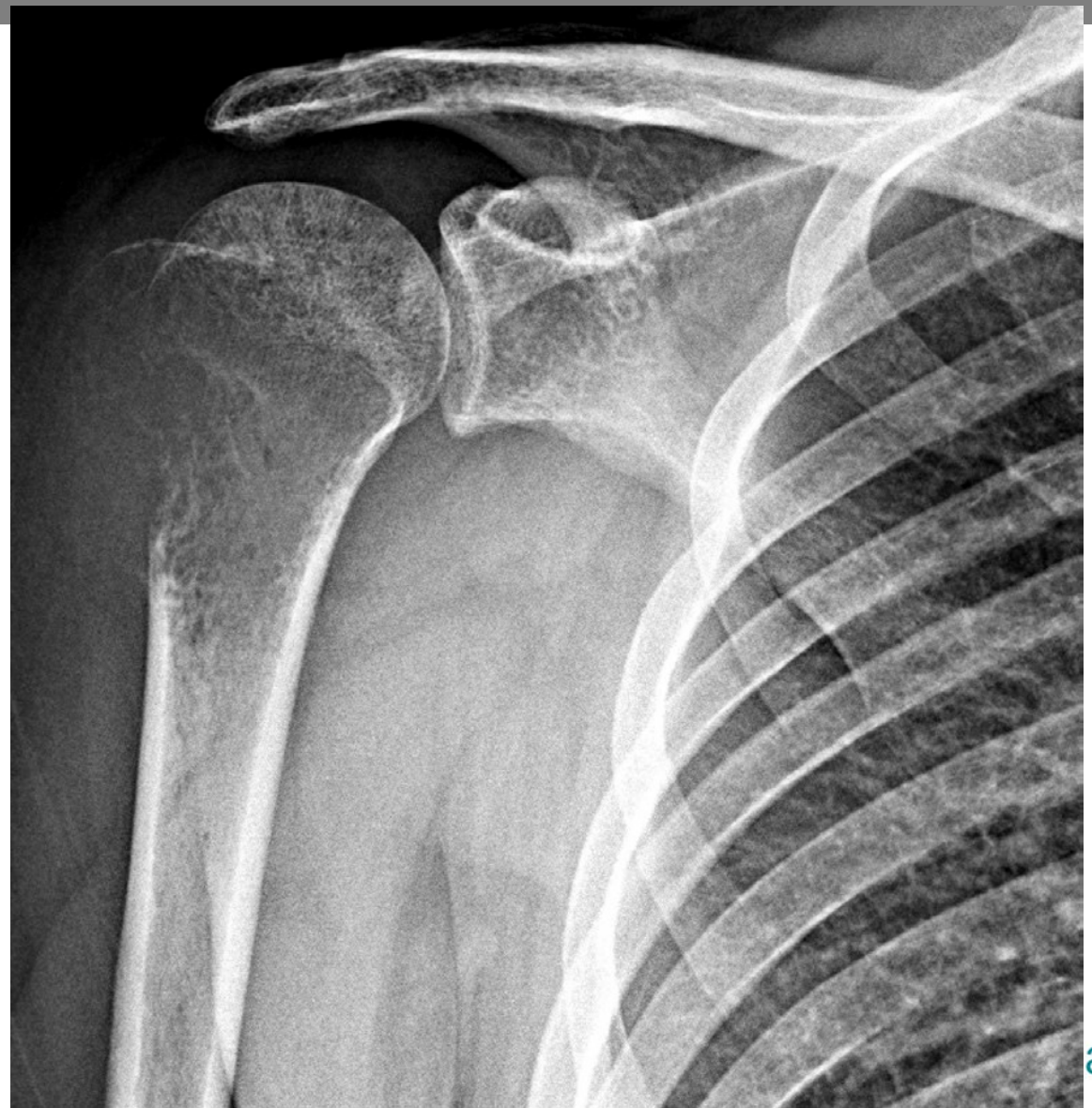
- CT C/A/P
  - Captures location of most common malignancies that metastasize to bone:
    - Breast, Lung, Kidney, Thyroid, Prostate, GI
- Bone Scan
- Labs
  - Patient > 40: CBC w/diff, CMP, ESR/CRP, SPEP/UPEP, (PSA, Thyroid studies)
  - Patient < 40: CBC w/diff, BMP, ESR/CRP, (Alk Phos, LDH)





Case: Concerning bony lesion

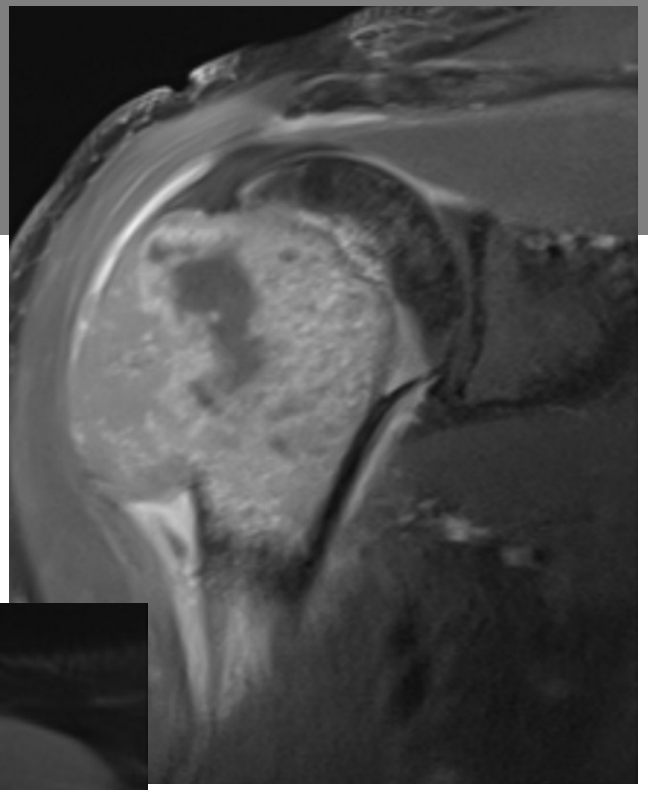
- HPI: 28 yo M presents w/ 2-3 months of progressively worsening right shoulder pain and weakness. +Night pain. No fevers, chills, night sweats, weight loss.
- PMHx: None
- PSHx: None
- FamHx: No malignancies
- SocHx: No tobacco, rare EtOH. Works for pool construction company

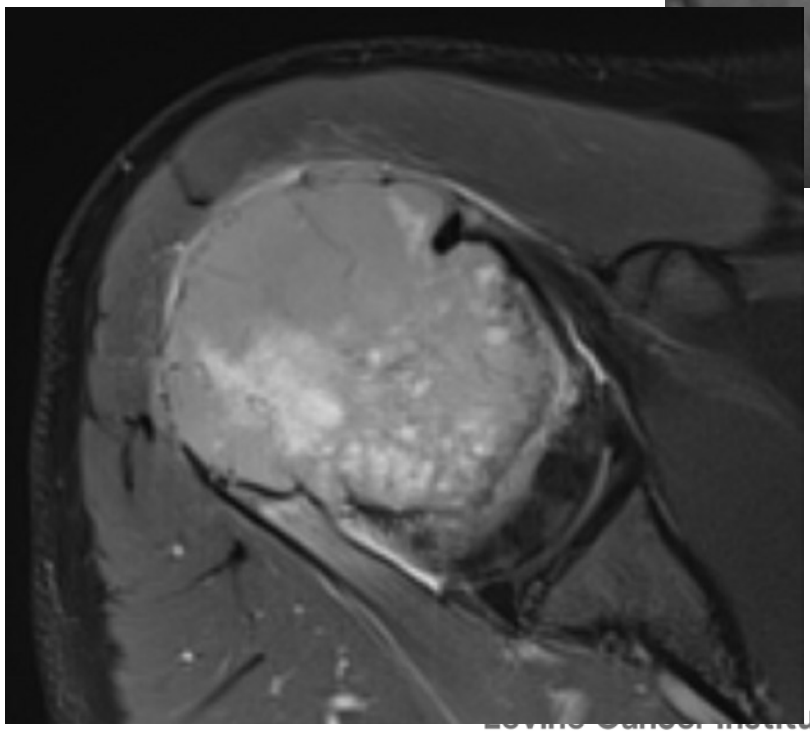


alth

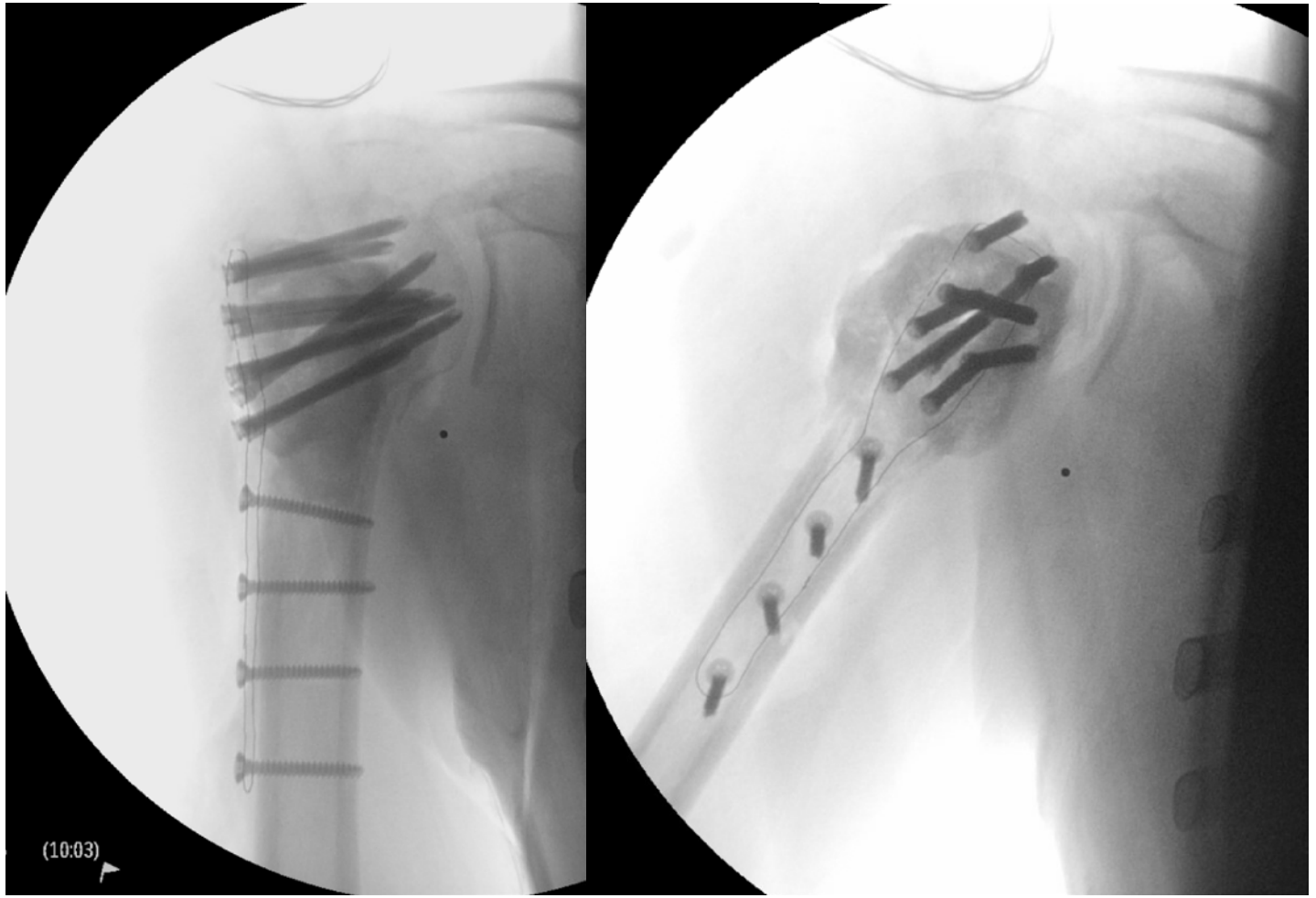
Work up

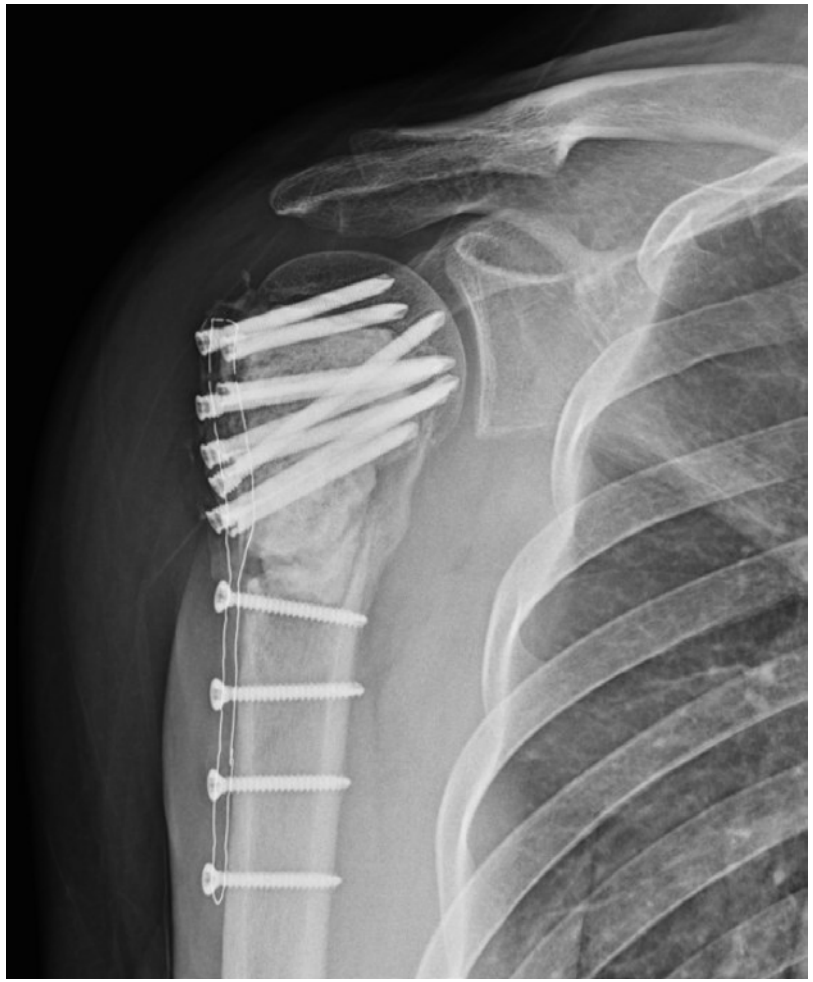
- CT Chest negative for evidence of pulmonary nodules
- MRI with and without contrast obtained
- CT guided biopsy: Giant cell tumor of bone





Treatment



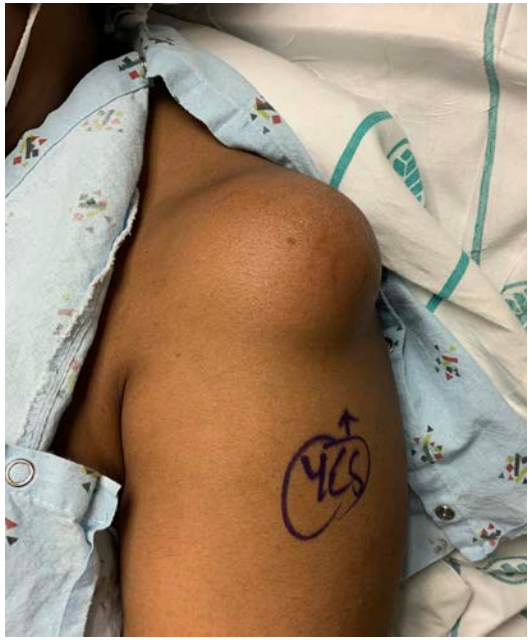


8 months post-op

Levine Cancer Institute
Musculoskeletal Institute
Atrium Health

Management

- Small superficial soft tissue mass
  - Obtain thorough H&P
  - Consider axial imaging prior to any biopsy/excision
  - Remember principles of biopsy
  - We are available to discuss

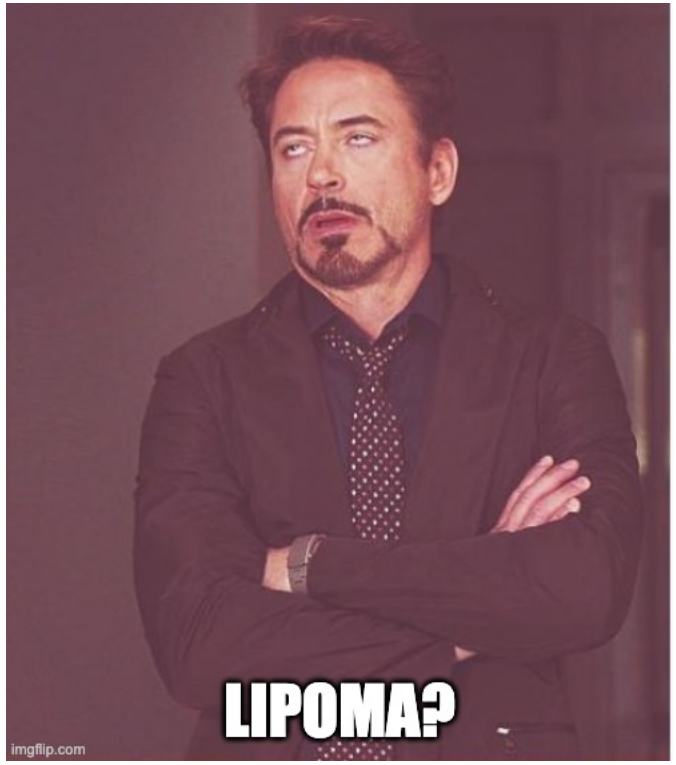


Case: Small superficial soft tissue mass

- CC: Left shoulder mass

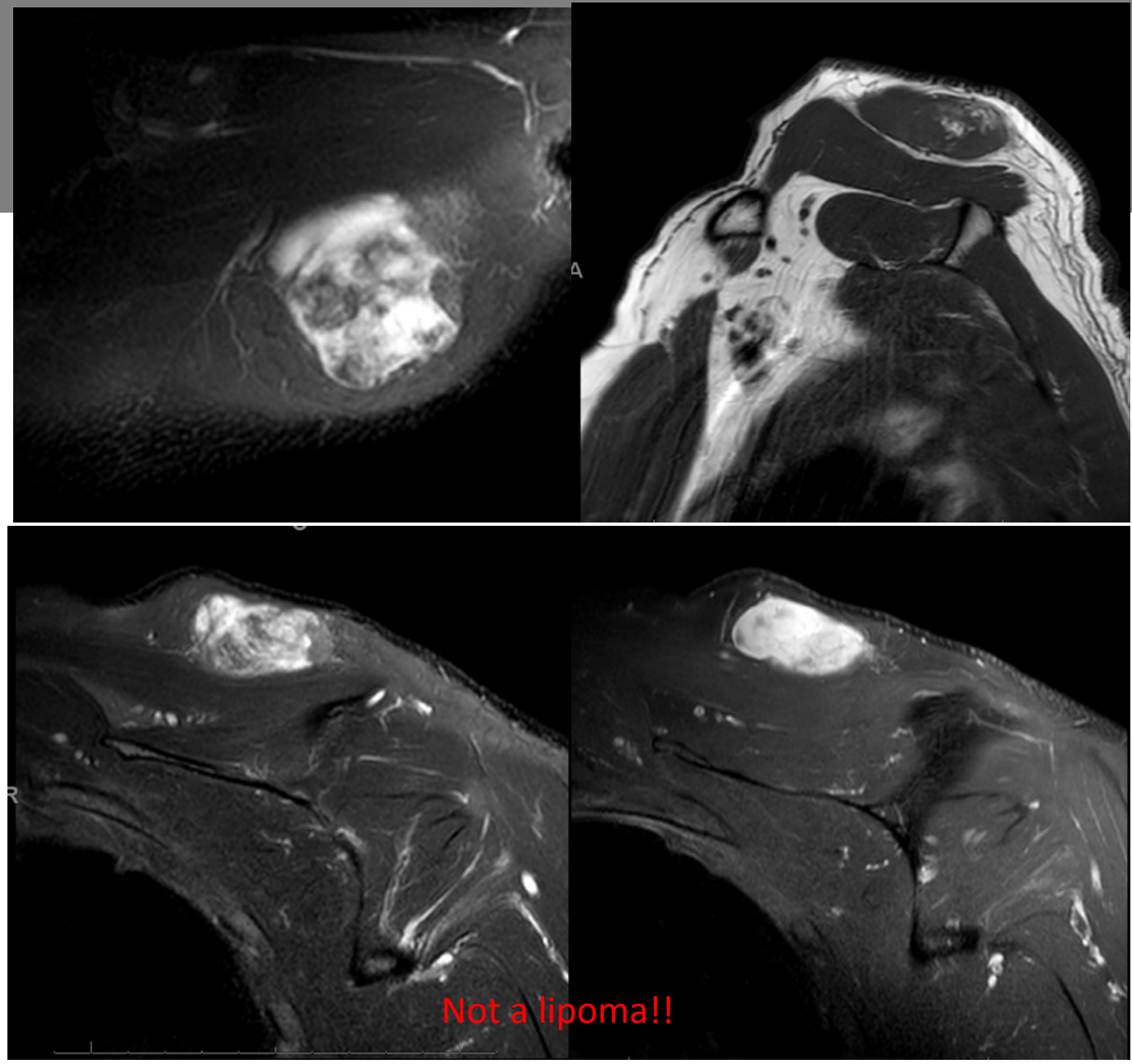
- HPI: RB is a 69 yo M with a five-year history of left posterior shoulder mass. Previously told by three separate providers that it was a lipoma and not to worry about it. Recently growing larger.

- PMHx: None
- PSurgHx: None
- Meds: None
- Social History: Works as truck driver, no tobacco/EtOH



Exam and MRI

- Soft, rubbery mass approximately 5 cm in size arising from posterior superior shoulder overlying trapezius, mobile relative to fascia, non-tender to palpation



Core needle biopsy

Histology

Surgical Pathology Report

Case Number: S21-25143

Date of Service:	4/19/2021
Date Received:	4/19/2021
Date Resulted:	4/21/2021
Ordering Physician:	COLIN J ANDERSON

Final Pathologic Diagnosis

SOFT TISSUE, ADJACENT TO LEFT SHOULDER, CORE BIOPSY:

LOW-GRADE MYXOID LESION (SEE COMMENT).

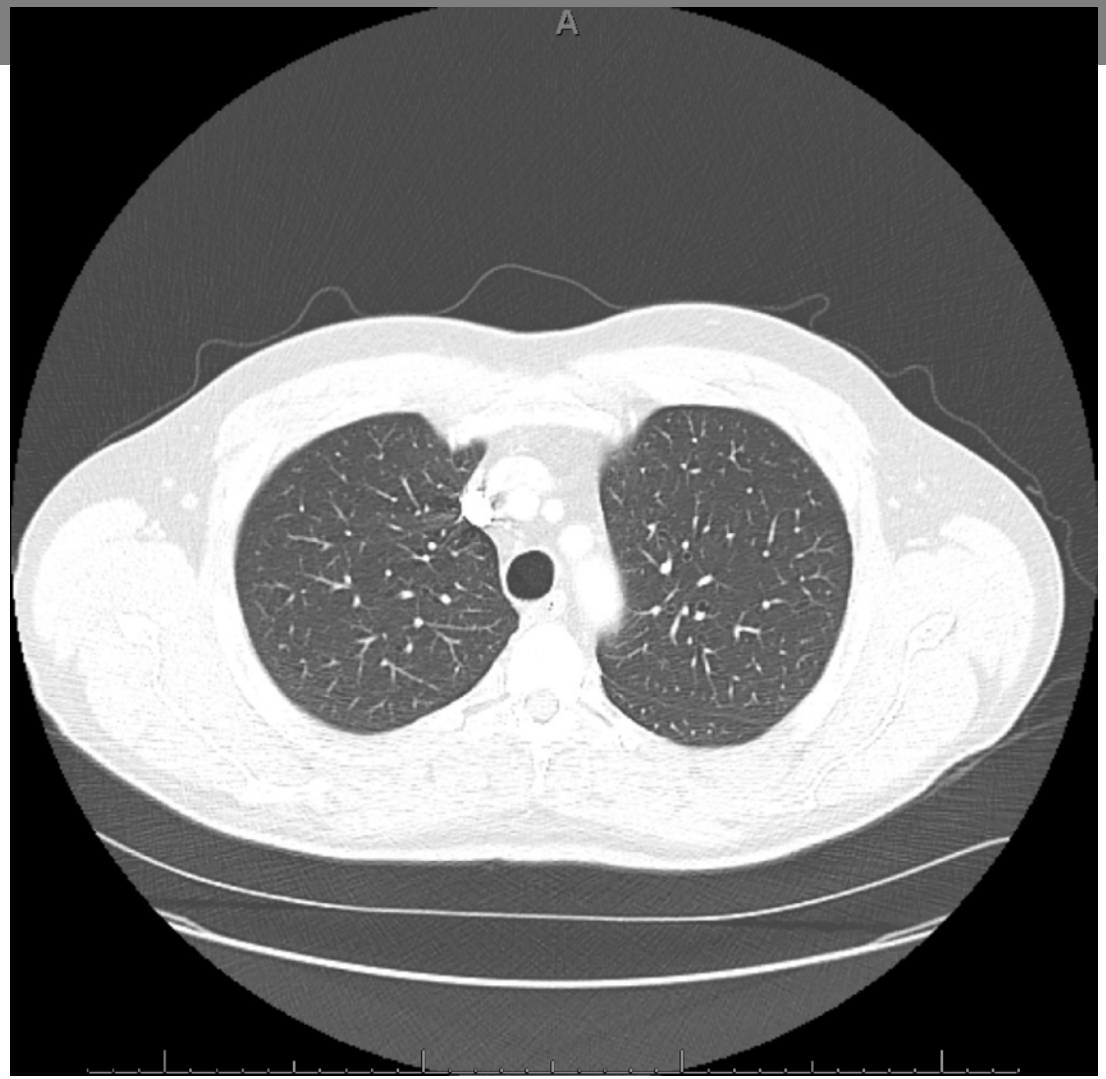
Comment

The biopsy contains fragments of loose fibrous tissue with a low-grade myxoid lesion populated by bland spindled cells. Focal nuclear hyperchromasia is seen. An immunostain for CD34 highlights spindled cells. An S-100 immunostain is negative.

The findings in the biopsy would invoke low-grade myxoid neoplasms, both benign (myxoid variant of spindle cell lipoma) and malignant in the differential diagnosis.

Staging Chest CT

- No evidence of metastasis



Surgery

- Wide excision of mass

Final pathology

- Low grade myxoid sarcoma
  - Negative margins

- Plan:
  - Wide excision was curative
  - No indication for radiation or chemotherapy for low grade lesions
  - Will proceed with surveillance including routine examination and chest imaging

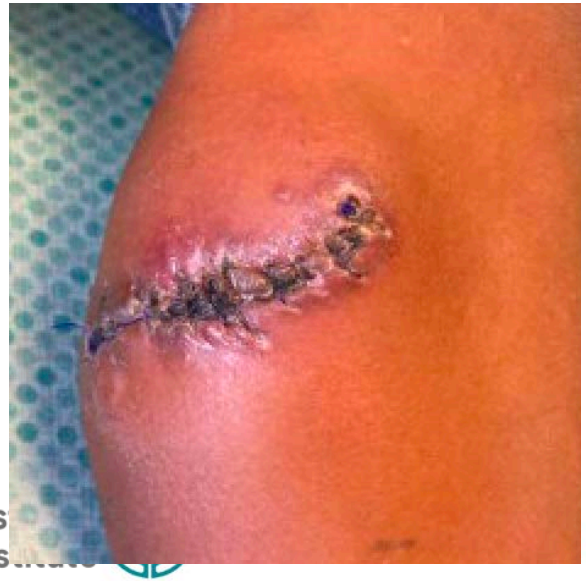
- Take home lessons:
  - Not everything is a lipoma
  - Get advanced imaging!

Management

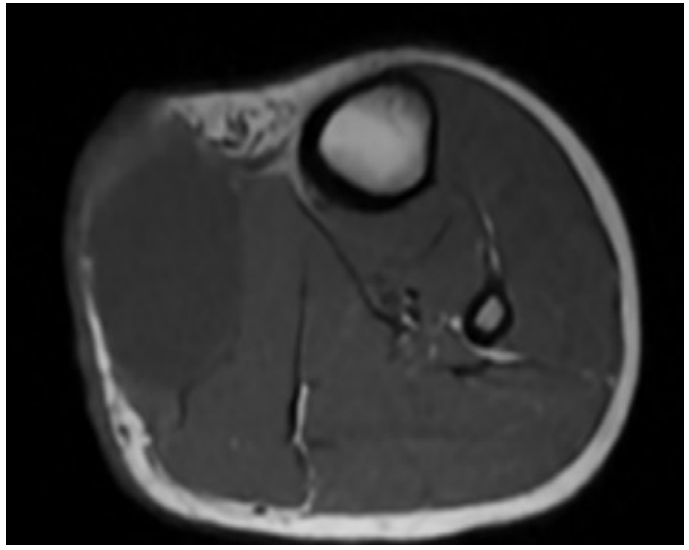
- Concerning soft tissue mass
  - Obtain thorough H&P
  - >5 cm, deep
  - Obtain axial imaging
  - Exercise caution with biopsy or treatment
  - Urgent referral

Case: Concerning soft tissue mass

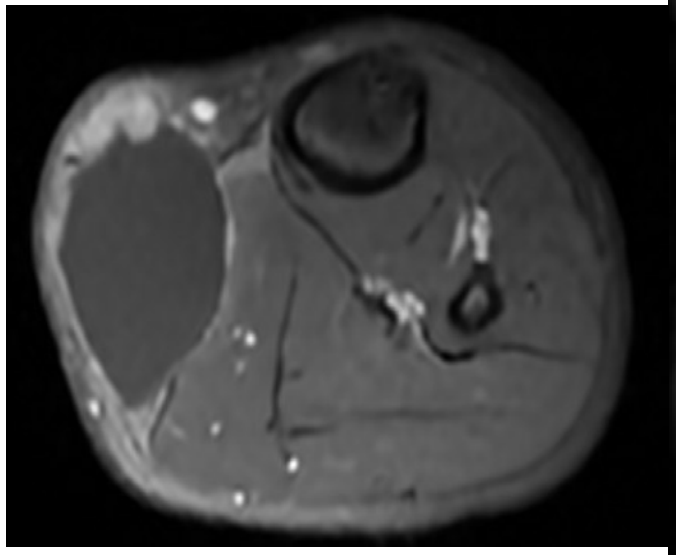
- HPI:
  - MM 6 yo M w/ growing left medial leg mass for 11 months
  - Incision and aspiration performed – bloody material obtained -> AVM? No pathology sent
  - MRI obtained “concerning for sarcoma, not c/w AVM”
  - Excisional biopsy performed, closed with running locked prolene
  - Final pathology with desmoplastic small round cell tumor
  - New MRI w/ residual tumor and large hematoma
  - Unsuccessful suture removal in clinic
- PMHx: None
- FamHx: No malignancy
- Exam: 5 x 7 superficial medial calf mass with transverse incision closed with running locked suture with necrotic skin edges, firm nodularity proximal and distal in wound bed, antalgic gait, distally NVI



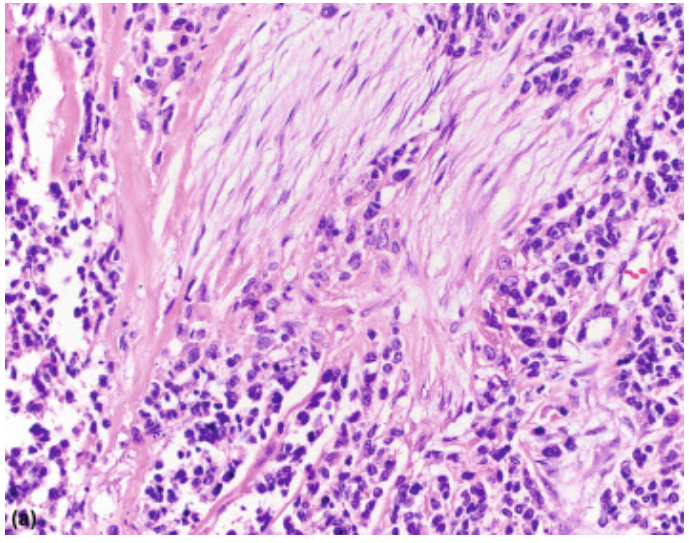
Imaging and Pathology



T1

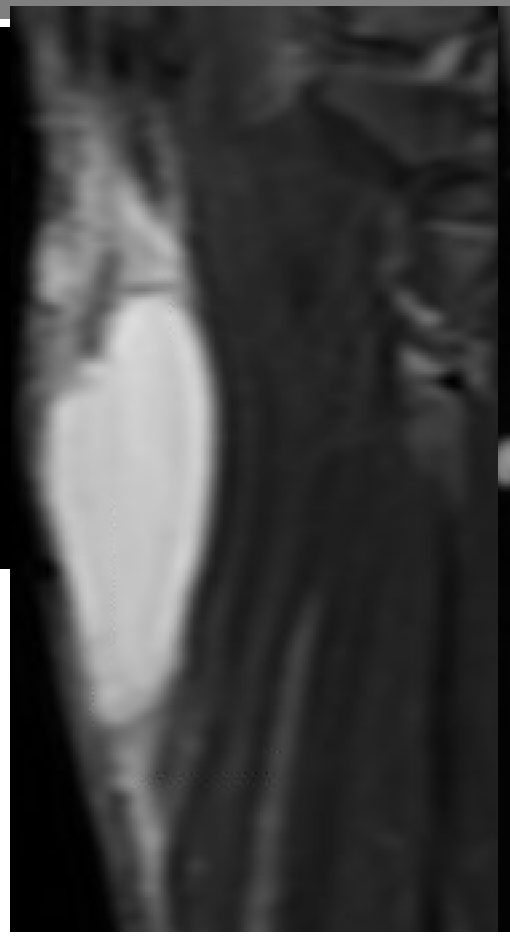


T1FS+c

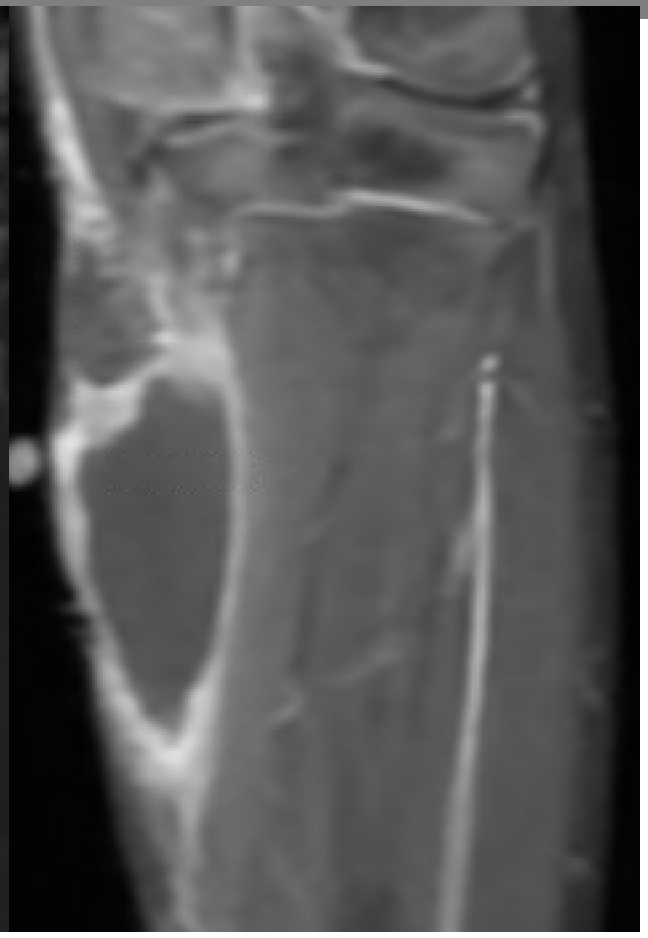


DSRCT:

- Relatively uniform cells
- Highly cellular
- Hyperchromatic nuclei
- Mitotic figures



T2FS



T1FS+c

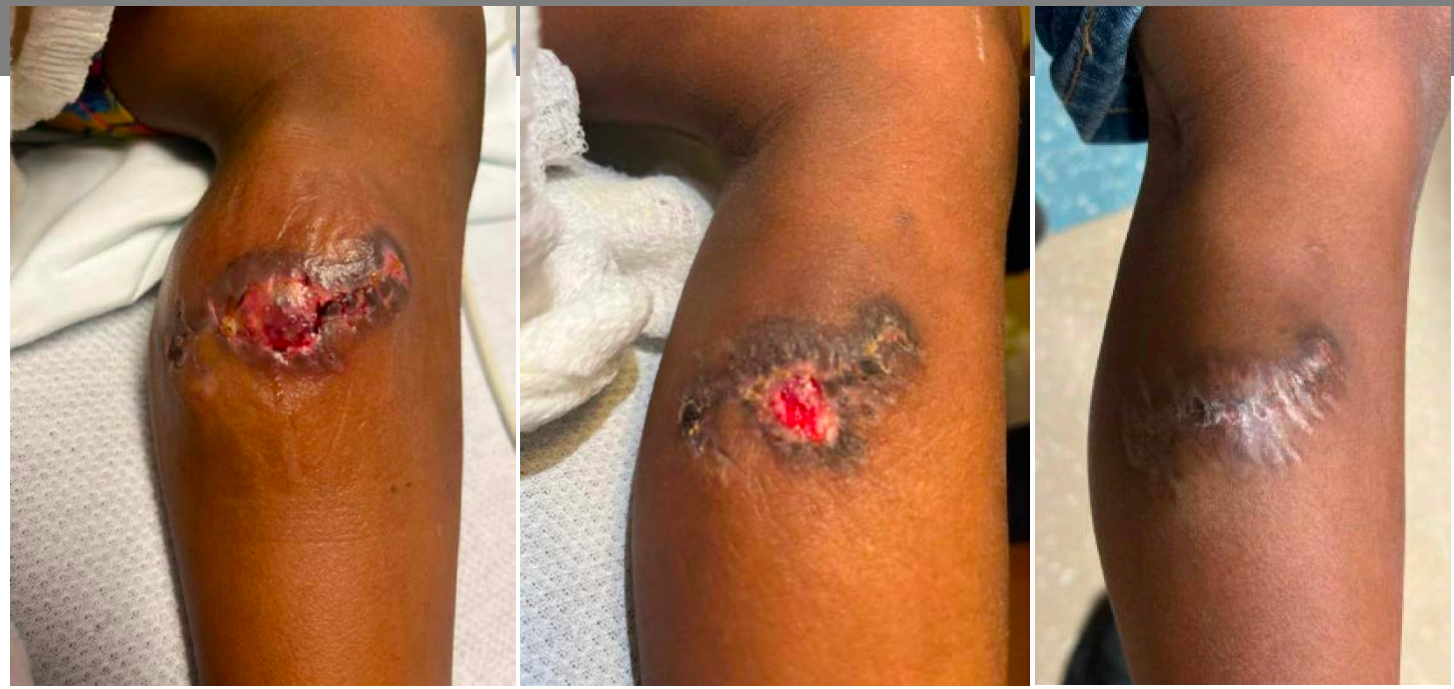
Levine Cancer Institute
Musculoskeletal Institute
Atrium Health

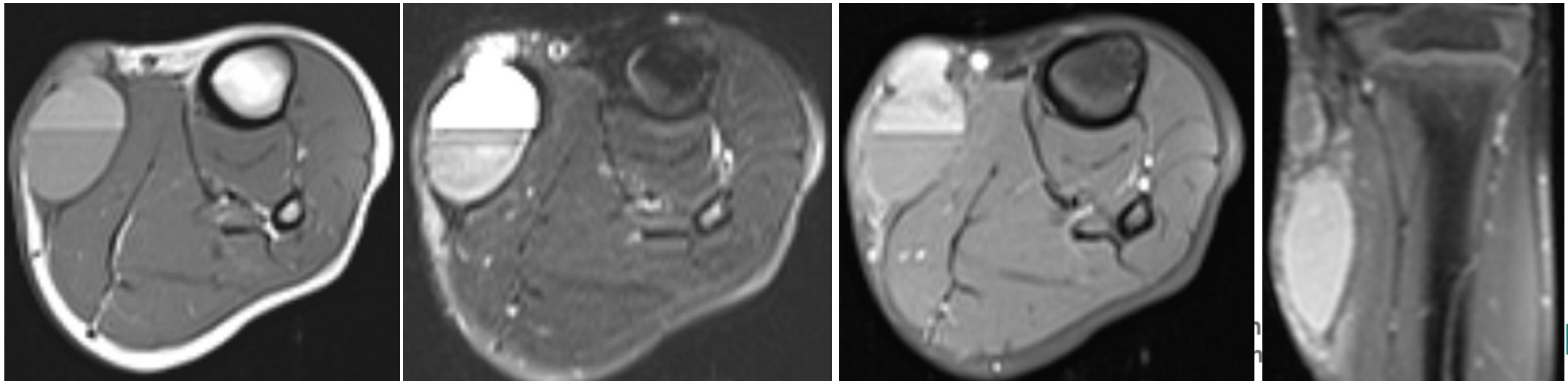
Staging and plan

- PET scan negative
- Stage IIIA (T2, N0, M0, G3)
- BSTTG review:
  - Negative margins may not be possible d/t hematoma
  - RT not ideal in young patient
  - Decision for neoadjuvant chemo and reevaluation
- Sutures removed @ port placement

Treatment

- Pt received 2 cycles of VIDE
- Wound progressively healed
- New MRI with mild interval decrease in size of fluid collection, persistent nodular enhancing lesions
- BSTTG re-review: Proceed w/ resection. If margins positive, RT will likely be recommended



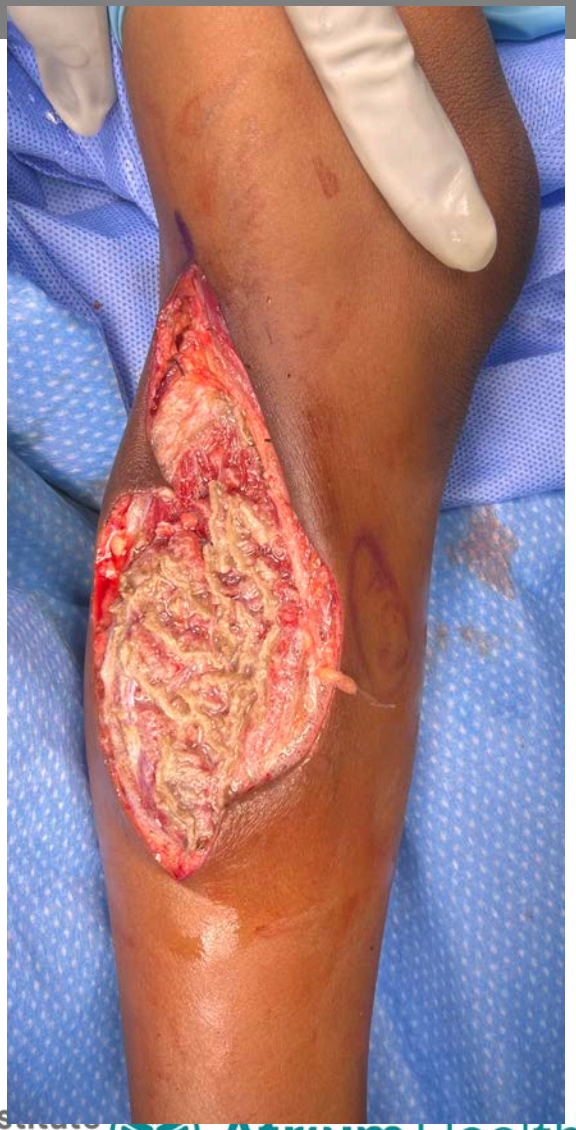


Surgery

- Plan: Proceed with resection, maintain medial gastroc as deep margin, possible wound vac, possible STSG
  - Wound was able to be closed primarily

- Final pathology:
  - Desmoplastic small round cell tumor (G3)
  - Viability: 50%
  - Margins: Negative!!!!

- Follow up
  - Wound healed nicely
  - Patient continuing with adjuvant chemotherapy



Take Home Messages

- Any mass larger than golf ball is malignant until proven otherwise
- Not everything is a lipoma
- Be on the lookout for red flags!
- Please get x-rays
- Consider advanced imaging
- We’re happy to review cases with you

Atrium Health
Levine Cancer Institute

We ask that you please **do not** share the Levine Cancer Institute (LCI) New Patient (NP) referral number with patients as it is not intended for patient use. Please have patients call **980-442-2000** if they need assistance.

LCI New Patient Referral Center

Hours:
Monday through Friday, 8 a.m. to 5 p.m.
Phone: 980-442-2900
Fax: 704-446-4396
Email:
LCIReferralCoordination@AtriumHealth.org

- Practices can submit referrals to Levine Cancer Institute via phone, fax or email.
- Referring practices are responsible for obtaining prior authorization before submitting referral.
- LCI New Patient Referral Coordinators will be responsible for conducting a Real Time Eligibility Check before scheduling the appointment.

1. Referring physician, nurse practitioner or physician assistant orders referral to Levine Cancer Institute.
2. Referring Office Referral Coordinator formally submits referral to LCI New Patient Referral Center via phone, fax or email. If the referral is called in or sent via email, referring practice must fax patient records same day to ensure accuracy of the scheduled appointment/location.
3. LCI NP Referral Coordinator will use section-specific referral guidelines to determine the most appropriate appointment date/location.
4. If the referral is called in, the LCI NP Referral Coordinator will make every effort to schedule the appointment while on the phone. If further clinical evaluation is necessary, the referral will be passed along to the appropriate Referral Coordinator to schedule within 24 to 48 hours.
5. Once the appointment has been scheduled, the LCI Referral Coordinator will contact the patient to inform them of the date, time and location.
6. Lastly, the LCI Referral Coordinator will contact referring practice to inform them of the patient appointment date/time. If the patient contacts the referring office to reschedule the appointment, please direct them to call 980-442-2000.

***For Urgent referrals, call Dr. Kneisl, Dr. Patt, or Dr. Anderson

Questions?

Levine Cancer Institute
Musculoskeletal Institute
Atrium Health