Learning to Be Worried

A Primer in Musculoskeletal Oncology

Josh Lawrenz, MD
Musculoskeletal Oncology
Department of Orthopaedic Surgery
Vanderbilt University Medical Center
Nashville, TN USA

VANDERBILT Orthopaedics

Disclosures

No relevant commercial relationships to disclose.

Objectives

At the conclusion of this session, participants should be able to:

1. To overview the clinical presentation, imaging findings, diagnostic workup and treatment of malignant bone and soft tissue sarcomas.
2. To overview the clinical presentation, imaging findings, diagnostic workup and treatment of selected benign bone and soft tissue tumors.
3. To overview the clinical presentation, imaging findings, diagnostic workup and treatment of metastatic bone disease.

Outline

- Introduction
- Epidemiology
- Bone Tumors
- Soft Tissue Tumors
- Take Home Points

Introduction

- 3 Main Tumor Types
  1. Primary Bone Tumors (Benign/Malignant)
  2. Primary Soft Tissue Tumors (Benign/Malignant)
  3. Metastatic Disease
- Extremities, pelvis, chest wall, spine
- Academic/University/Tertiary Hospitals
  - Around 200 fellowship trained MSK Oncologists in USA (1-3 / major center)

Epidemiology

- Sarcomas account for 1-2% of all cancers
- Soft Tissue Sarcoma: approx. 10,000 new cases / yr in USA
- Bone Sarcoma: approx. 3,000 new cases / yr in USA
- Bone metastases >>>>>> Sarcoma
- All MSKL Tumors: Benign >>> Malignant

Epidemiology

- Rare = Orphan Disease
  - Most orthopaedic providers may only see 1 sarcoma in their career.
- BUT…the consequences of misdiagnosis and – even more so – mistreatment can be significant!
  - Iatrogenic metastases
  - Amputation
  - Morbid resection

Epidemiology

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  - Most orphaedic providers may only see 1 sarcoma in their career.
- BUT…the consequences of misdiagnosis and – even more so – mistreatment can be significant!

  - Iatrogenic metastases

  - Amputation

  - Morbid resection

=> Above Knee Amputation

Epidemiology

- Rare =
  - Most
- BUT...th tment can be

  - Iatrog

  - Ampu

  - Morbid resection

FIRST, MAKE THE DIAGNOSIS!!!

Bone Tumors

- Clinical Presentation
- Imaging
- Diagnostic Workup
- Treatment

Bone Tumors – Clinical Presentation

- Typically painful
  - Night pain
  - Pain with weight bearing
- History of injury can be misleading
- Low energy fracture mechanism with or without antecedent pain
- Depending on etiology can have constitutional symptoms (fevers, weight loss, night sweats)

Bone Tumors – Imaging

Start with Plain Xrays of the ENTIRE BONE

Enneking 4 Questions

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Bone Tumors – Imaging

- Where is it? What bone AND what area of that bone (epiphysis, metaphysis, diaphysis)
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Epiphysis

Metaphysis

Diaphysis

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

- Zone of transition ("geometric")
  - Area where normal bone "transitions" to diseased bone
  - Narrow = Benign
  - Vague = Malignant

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Narrow
Geographic

Dx: aneurysmal bone cyst

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Broad
Nongeographic

Dx: osteosarcoma

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Broad
Nongeographic

Dx: lymphoma

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

- Bone will try to contain the lesion as it grows
  - Sclerotic rim
  - Cortical expansion
  - Codman's triangle
  - Sunburst
  - Onion-skinning
  - Cortical erosion
- Active/aggressive periosteal reaction is always bad (cancer, infection)

Bone Tumors – Imaging

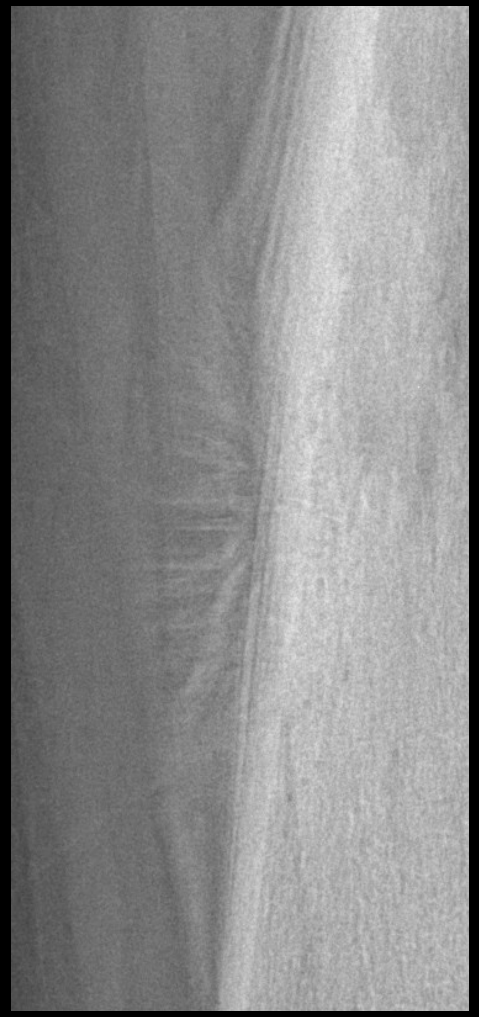
- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Dx: osteosarcoma

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

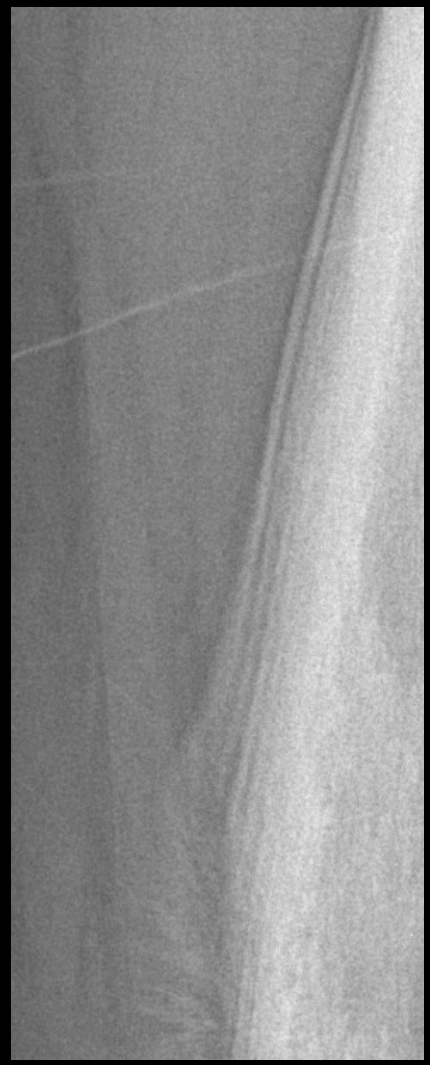
Sunburst
Spiculated



Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

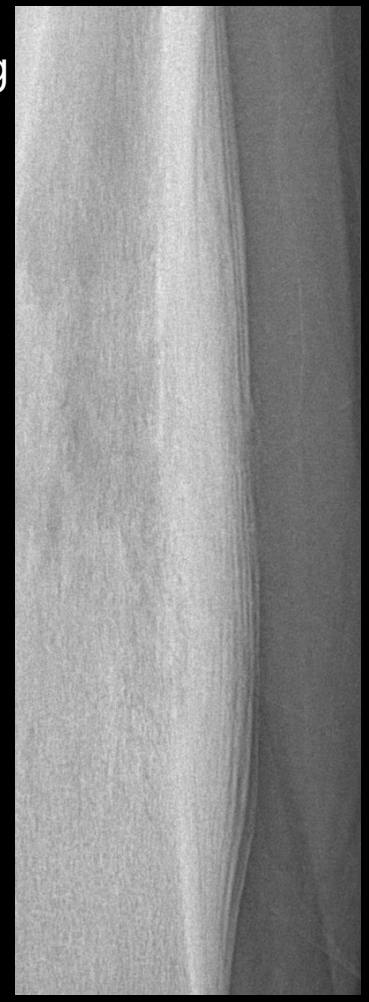
Codman's Triangle



Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Onion-skinning
Lamellated



Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Osteoid (Bone)

Chondroid (Cartilage)

Fibrous

Lytic

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Osteoid

Dx: Osteosarcoma

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
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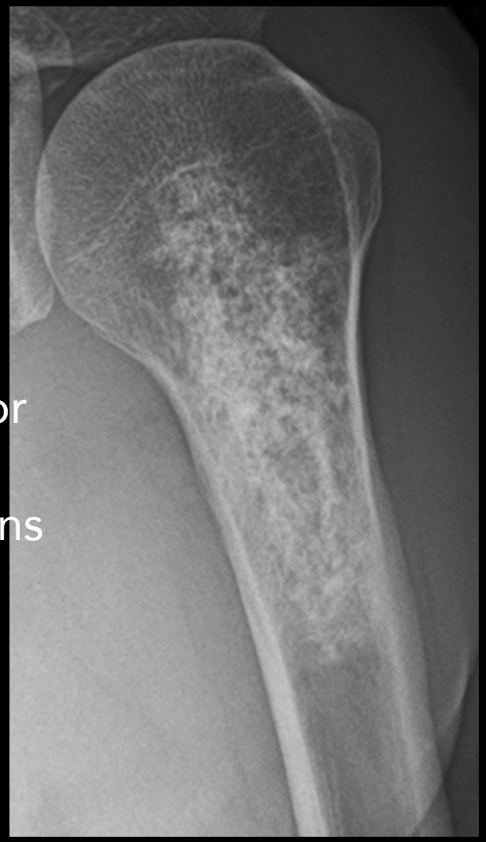
Chondroid



Stippled or speckled calcifications

Dx: benign enchondroma

Bone Tumors – Imaging

- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Fibrous

Ground glass

Dx: fibrous dysplasia

Bone Tumors – Imaging

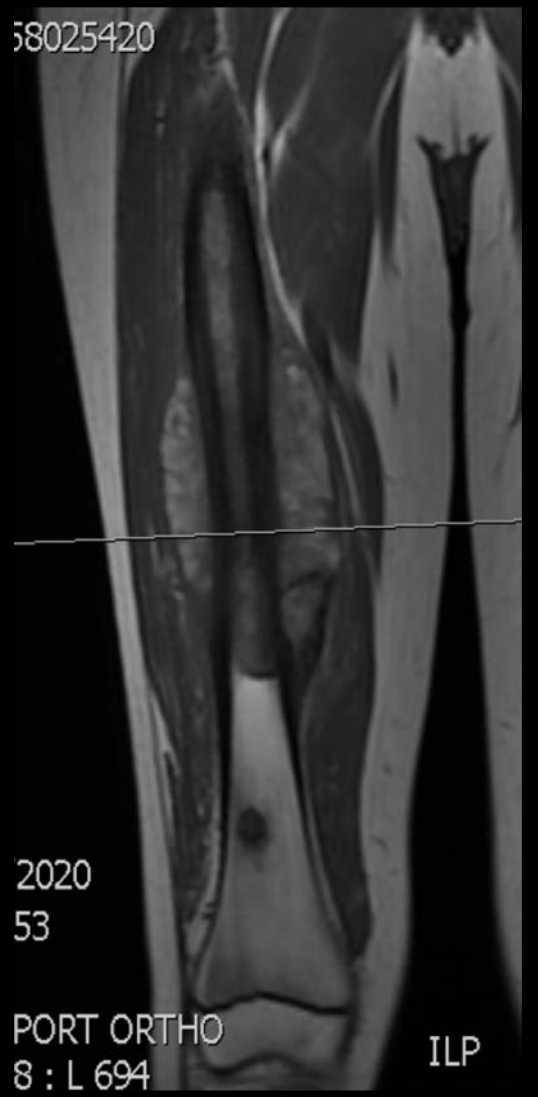
- Where is it?
- What's the tumor doing to the bone?
- What the bone doing to the tumor?
- Matrix to indicate what type?

Lytic

Dx: giant cell tumor of bone

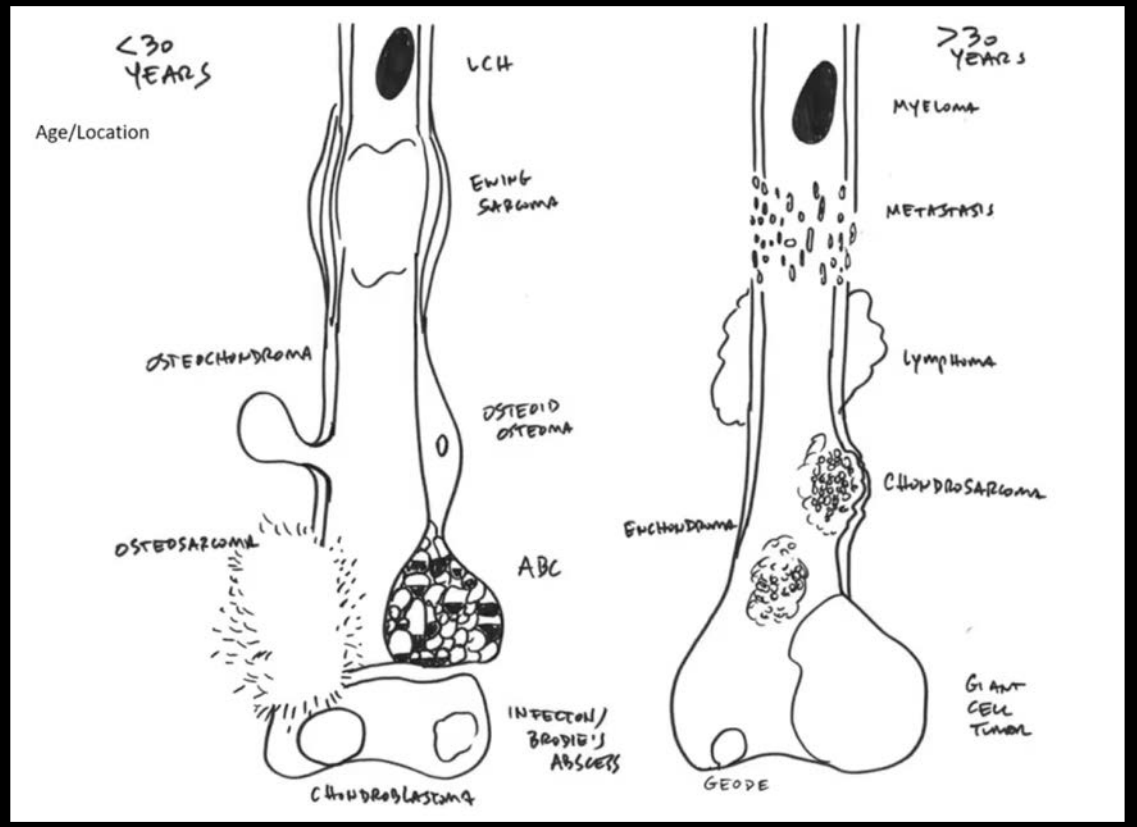
Bone Tumors – Imaging – MRI

- If xrays concerning get MRI WITH and WITHOUT contrast
- Image the WHOLE BONE
  - i.e. Tibia MRI for proximal tibial lesion rather than a knee MRI
  - To assess for skip lesions or bony mets within the same bone (= distant metastasis)
- Dark T1, Bright T2, Enhancing or Heterogeneous w/contrast



Bone Tumors – Making a Diagnosis

- Age is key as well
- <30
  - Malignant: Ewing's sarcoma, Osteosarcoma OR
  - Benign: UBC, ABC, NOF, chondroblastoma, LCH
- >30
  - Malignant: Metastatic disease, Myeloma, Lymphoma, chondrosarcoma OR
  - Benign: Enchondroma, bone infarct, subchondral cysts



Bone Tumors – Making a Diagnosis

- Patient Age +
- Tumor Location (w/in the bone) +
- Aggressive vs. Benign +
- Matrix (bone, cartilage, fibrous, lytic) => Differential

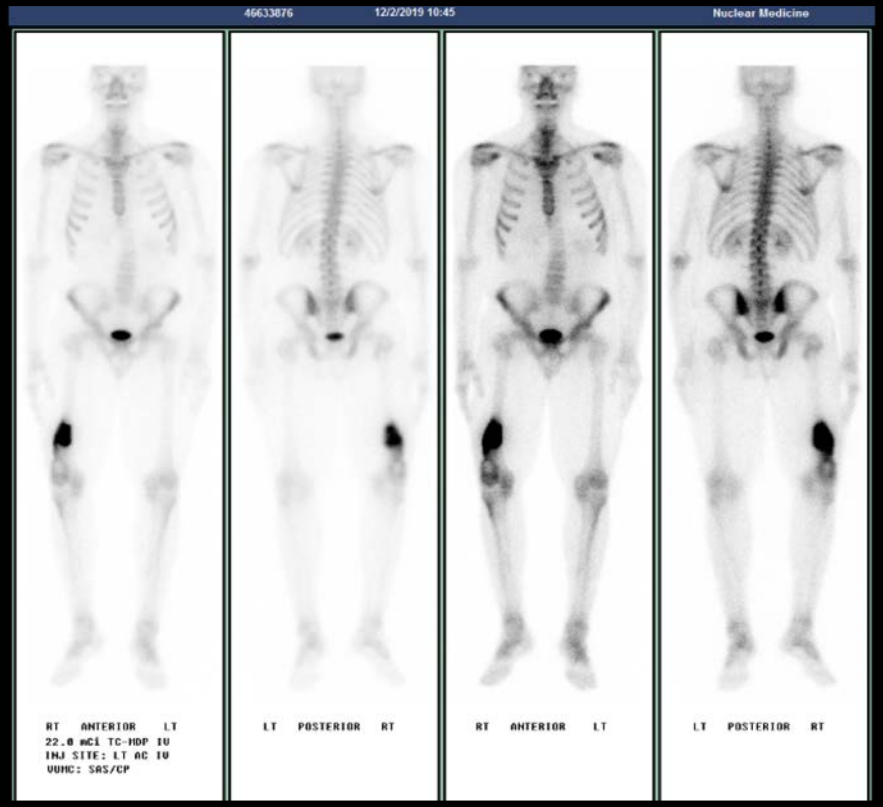
- Use time to aid your diagnosis
  - If still unsure, have patient return with repeat xrays over a short interval (2-3 months) to see if lesion is changing

- *The goal does not always have to be to make a firm diagnosis, but to know when you should be worried enough to look deeper or refer*

Bone Tumors – Diagnostic Workup

Staging Studies

- Primary Malignancy
  - XR entire bone
  - Chest XR
  - MRI w contrast whole bone
  - CT chest wo contrast
  - WBBS
- Secondary Malignancy
  - As above +
  - Labs – CBC/CMP, SPEP/UPEP, TSH, PSA
  - CT A/P



Bone Tumors – Treatment

3 BUCKETS

- Observation
- Intralesional resection +/- stabilization
- Wide (negative margin) resection +/- reconstruction

Bone Tumors – Treatment

3 BUCKETS

- Observation = Benign, asymptomatic or self limiting
- Intralesional resection +/- stabilization = Benign, symptomatic, locally aggressive
- Wide (negative margin) resection +/- reconstruction = Malignant (sarcoma)

Bone Tumors – Treatment

3 BUCKETS

- Observation = Benign, asymptomatic or self limiting
  - Nonossifying fibroma (NOF), Enchondroma
- Intralesional resection +/- stabilization = Benign, symptomatic, locally aggressive
- Wide (negative margin) resection +/- reconstruction = Malignant (sarcoma)

Bone Tumors – Treatment

17M with mild leg pain

Dx: non ossifying fibroma

Bone Tumors – Treatment

3 BUCKETS

- Observation = Benign, asymptomatic or self limiting
  - Nonossifying fibroma (NOF), Enchondroma
- Intralesional resection +/- stabilization = Benign, symptomatic and/or locally aggressive
  - Giant Cell Tumor of Bone (GCT), Aneurysmal bone cyst (ABC), Low grade chondrosarcoma, Metastatic disease
- Wide (negative margin) resection +/- reconstruction = Malignant (sarcoma)

Bone Tumors – Treatment

15F with weightbearing R ankle pain

Dx: chondroblastoma

Bone Tumors – Treatment

15F with weightbearing R ankle pain

Dx: chondroblastoma

Bone Tumors – Treatment

59F with persistent R upper arm pain

Dx: low grade chondrosarcoma

Bone Tumors – Treatment

59F with persistent R upper arm pain

Dx: low grade chondrosarcoma

Bone Tumors – Treatment

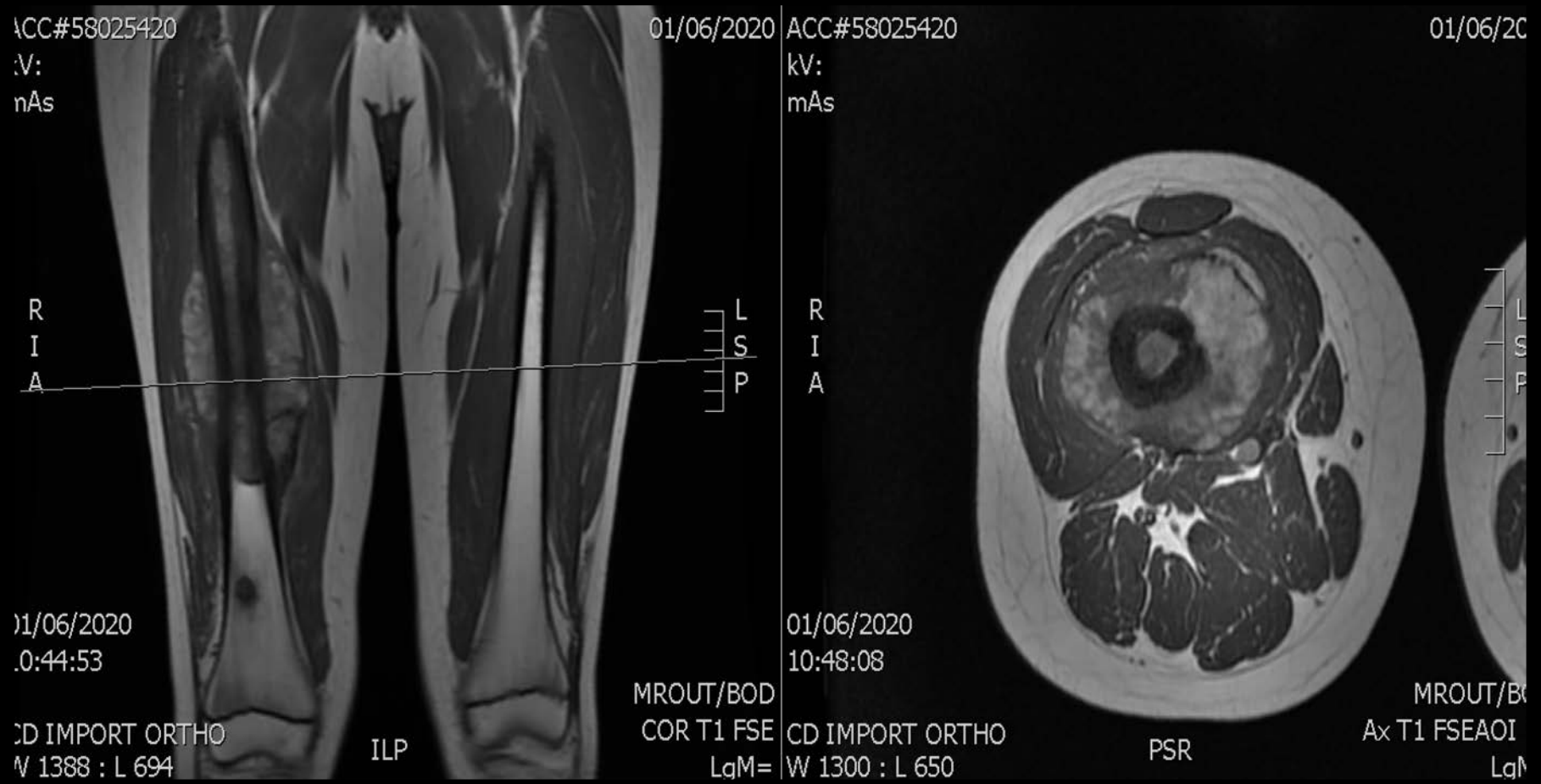
3 BUCKETS

- Observation = Benign, asymptomatic or self limiting
  - Nonossifying fibroma (NOF), Enchondroma
- Intralesional resection +/- stabilization = Benign, symptomatic and/or locally aggressive
  - Giant Cell Tumor of Bone (GCT), Aneurysmal bone cyst (ABC), Low grade chondrosarcoma, Metastatic disease
- **Wide (negative margin) resection +/- reconstruction** = Malignant (sarcoma)

Bone Tumors – Treatment

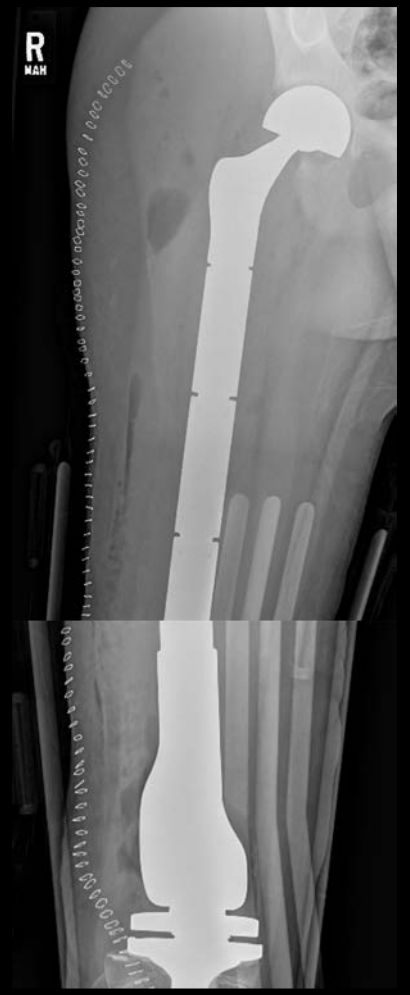
12M football player with two months thigh swelling and pain

Bone Tumors – Treatment



Bone Tumors – Treatment

Underwent total femur resection with total femur growing prosthesis reconstruction



Dx: osteosarcoma

Bone Tumors – Treatment – Adjuvant Therapy

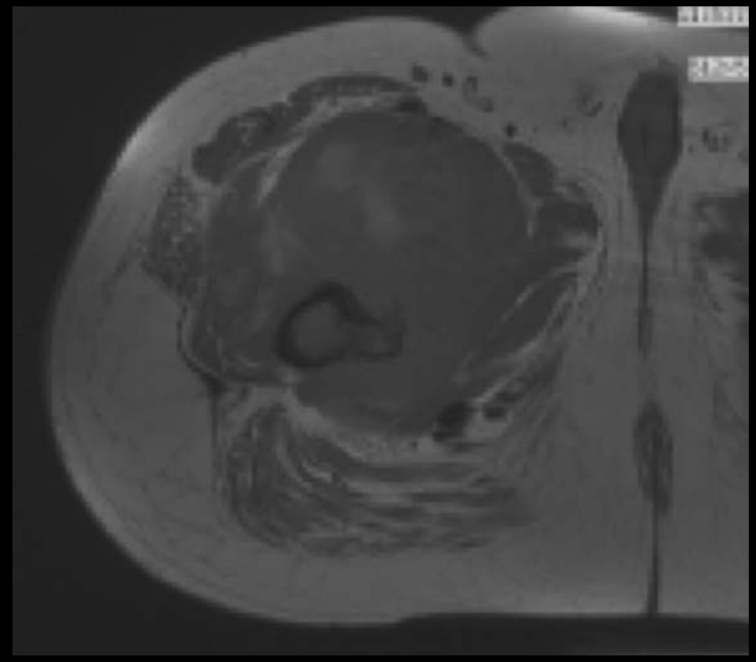
- **Local adjuvants** are often used for intralesional resections – High speed burr, peroxide, argon laser

- Pre and post operative **chemotherapy** is standard of care for primary bone sarcomas except for chondrosarcoma, chordoma, low grade osteosarcoma

- **Radiation**
    - Metastatic disease
    - Soft Tissue Sarcoma
    - Unresectable bone sarcomas, especially Ewing's

Top 4 Malignant Bone Tumors

- Osteosarcoma
- Ewing Sarcoma
- Chondrosarcoma
- Metastatic Disease

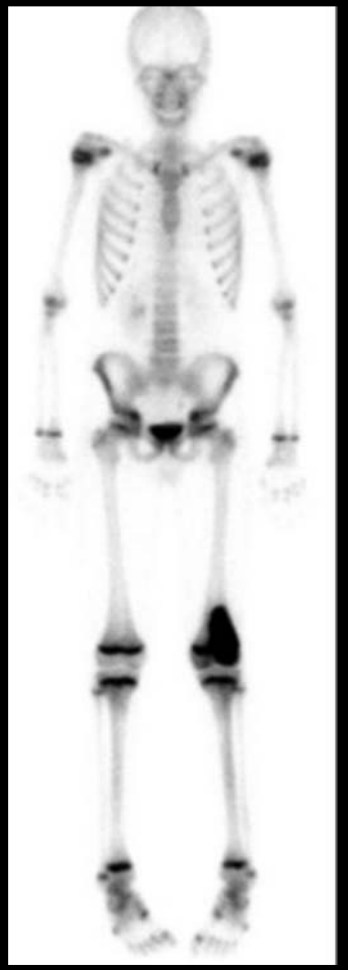


Dx: lymphoma

Osteosarcoma

- Most common primary bone sarcoma
- Bimodal: adolescent and elderly
- Metaphyseal
- 50% around the knee
- Bone forming tumor; bright/sclerotic appearance on xray
- Tx: Chemo (2 cycles) + Surgery + Chemo (4 cycles); 7-8 months treatment

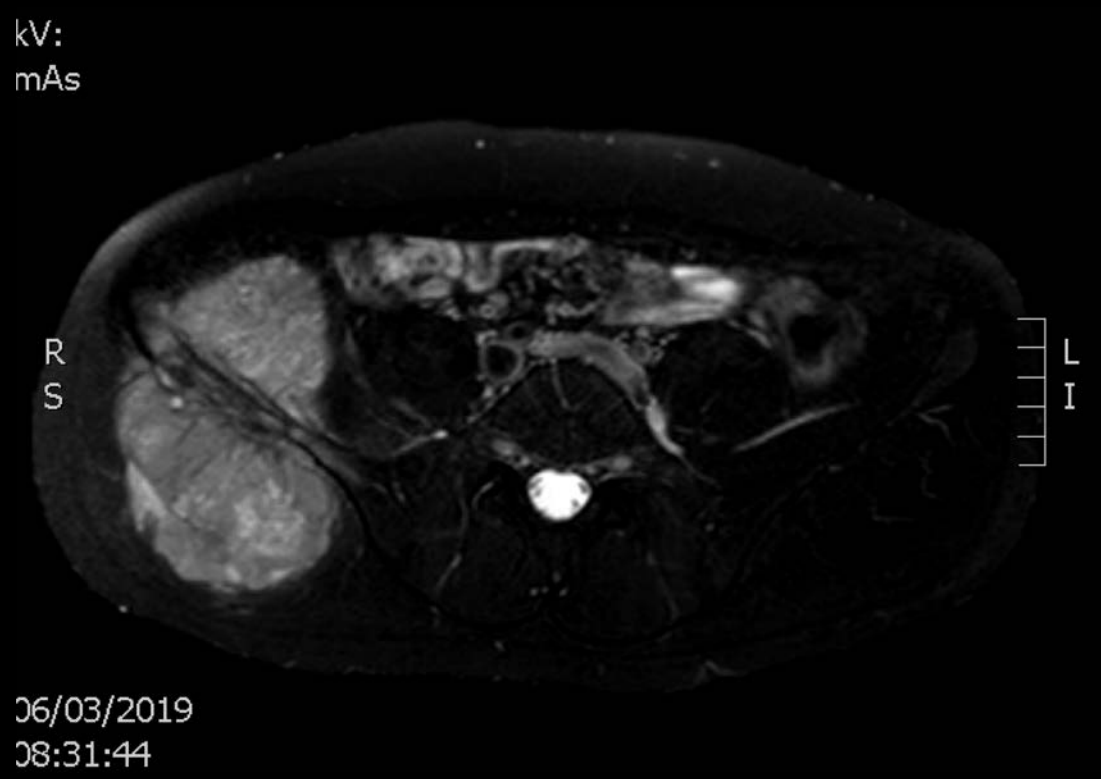
Osteosarcoma



Ewing Sarcoma

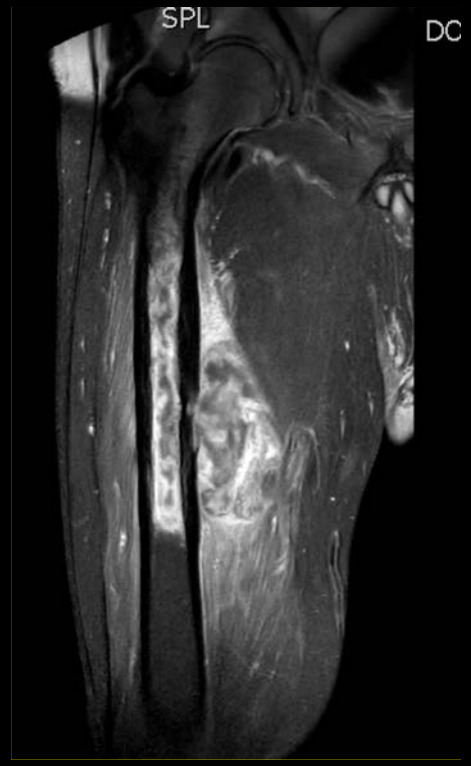
- 3rd most common primary bone sarcoma (2nd most common in children)
- Age 5-30
- Diaphyseal
- Often subtle xray findings and very large soft tissue mass
- Can present with fever, chills, weight loss, elevated ESR/CRP (can mimic an infection!)
- Tx: Chemo (6 cycles) + Surgery + Chemo (8 cycles); 7-8 months treatment

Ewing Sarcoma



Chondrosarcoma

- 2nd most common primary bone sarcoma (most common in adults or >40 yrs)
- Cartilage forming tumor
  - Speckled calcifications, arcs/rings
- Tx: Surgery only (ex. mesenchymal and possibly dediff)



Chondrosarcoma

Enchondroma

-Cartilage matrix
-No cortical disruption
-No expansile change
-No aggressive features
-Often NO pain

Chondrosarcoma

-Cartilage matrix
- Cortical thinning
-Expansile change
-Aggressive features
-PAIN!

Metastatic Disease

- Most common malignant bone tumor
- Lytic/moth eaten on xray
- Lytic lesion >40 years old: Metastatic disease, Myeloma, Lymphoma! (then much less common is chondrosarcoma)
- Carcinoma or adenocarcinoma, not sarcoma
- 5 Most Common Sites of Origin
  - "BLT and a Kosher Pickle" – Breast, Lung, Thyroid, Kidney, Prostate

Metastatic Disease

- Just because someone has a history of cancer does not guarantee that is where the lesion is coming from!
- Must do full staging workup (MRI lesion, CT CAP to look for primary cancer, WBBS)
  - Must get a biopsy of bone lesion to prove it is metastatic carcinoma and not a sarcoma!

Soft Tissue Tumors

- Clinical Presentation
- Imaging
- Diagnostic Workup
- Treatment

Soft Tissue Tumors – Clinical Presentation

- Swelling, lump/bump, mass
- Typically painless (esp. soft tissue sarcomas)
- Rate of growth (10 yrs vs. 2 months)
- Soft, mobile, superficial = benign VS
  Firm, fixed, deep = malignant
- Warning signs (think sarcoma/malignant):
  - >5cm
  - Deep (immobile)
  - Rapidly enlarging
- Incidence: Benign >>>>>> Malignant

Soft Tissue Tumors – Imaging

- XR: limited diagnostic utility, but the right place to start
- MRI: best lesional and anatomic data
  - Size
  - Surrounding anatomy, i.e. proximity to vital structures
  - Internal characteristics
- CT: least helpful due to limited soft tissue data
- US: user dependent; size, proximity to vessels, solid vs cystic

Soft Tissue Tumors – Diagnostic Workup

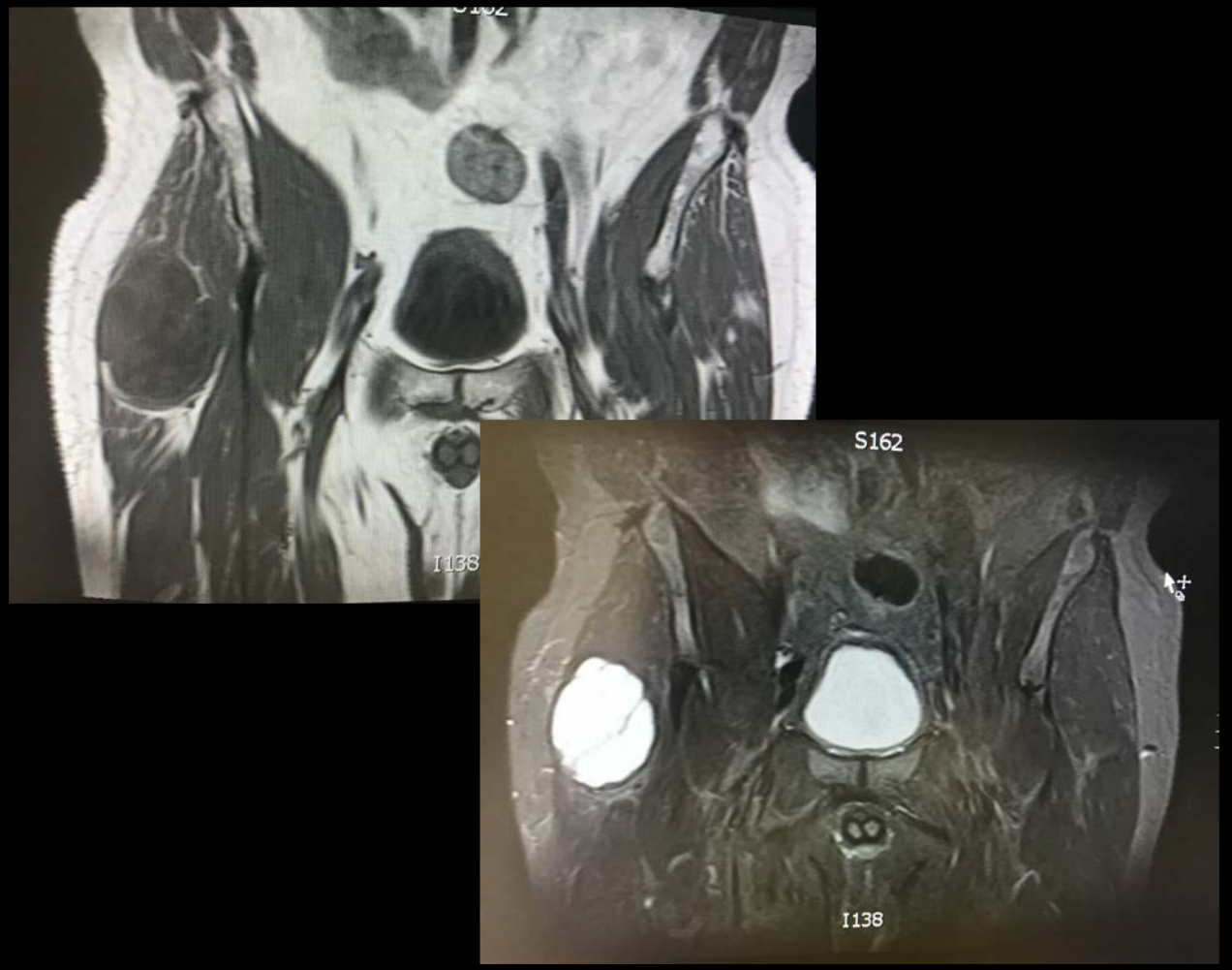
- Due to the wide variety of soft tissue lesions, imaging is rarely if ever sufficient to make a firm diagnosis
  - ➢ Few exceptions:
  - Lipomas – isointense with fat on all sequences
  - Ganglion cysts – peripherally enhancing with direct continuity to joint
  - Myositis ossificans – progressive, smooth peripheral calcification pattern
  - Schwannoma – entering and exiting nerve
- Tissue is often required to make a definitive diagnosis
- Biopsy should ALWAYS be obtained by the surgeon and facility that will definitively treat the lesion

Soft Tissue Tumors – Diagnostic Workup

- Incomplete Excision "Whoops" Procedures: QUITE COMMON!
- Don't just cut it out. There are consequences.

Top 5 Soft Tissue Tumors

- Lipoma
- Ganglion cyst
- Myositis ossificans
- Schwannoma
- Soft Tissue Sarcoma



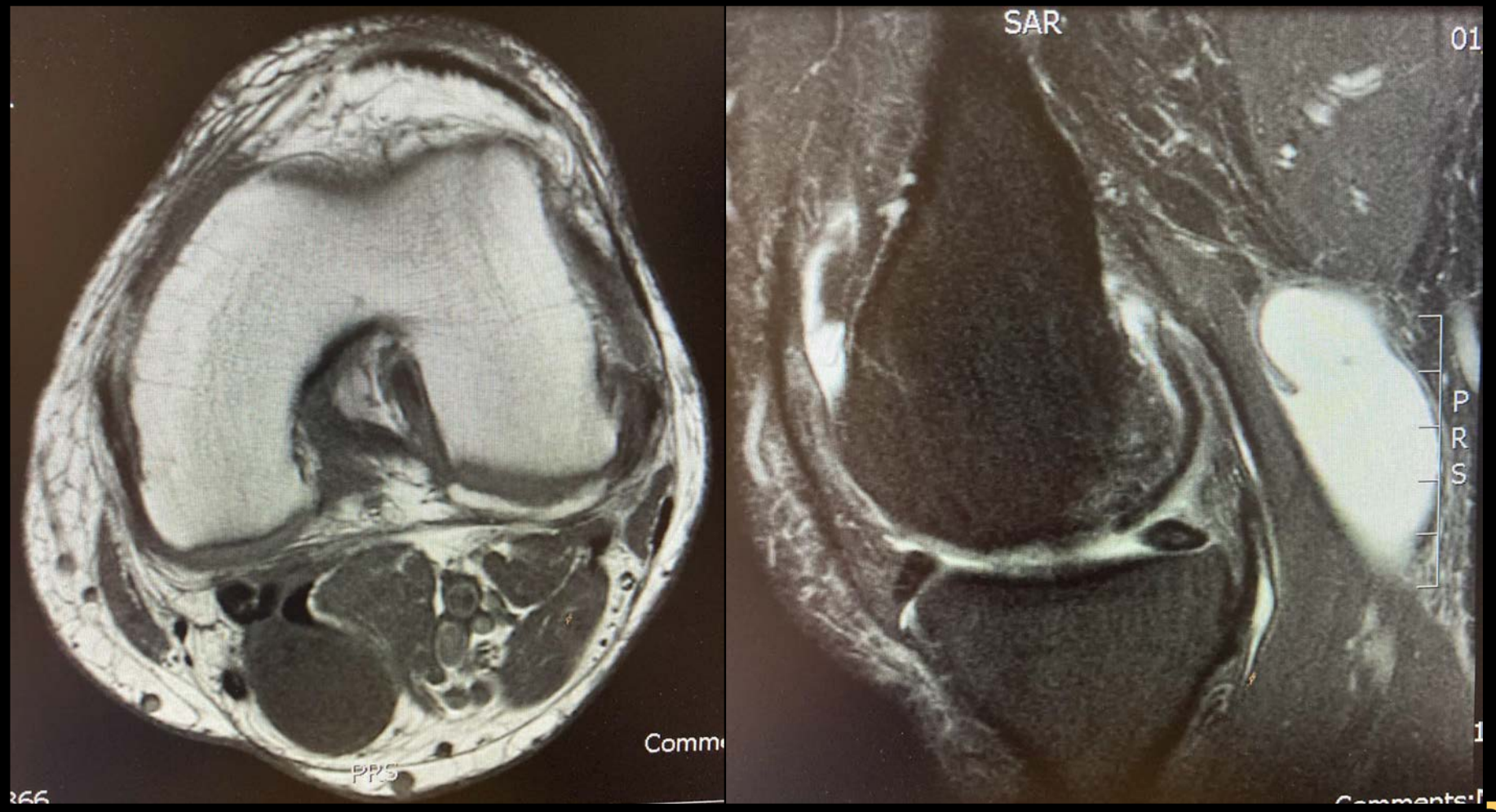
Top 5 Soft Tissue Tumors

45F with right hip mass slowly growing over 5 years

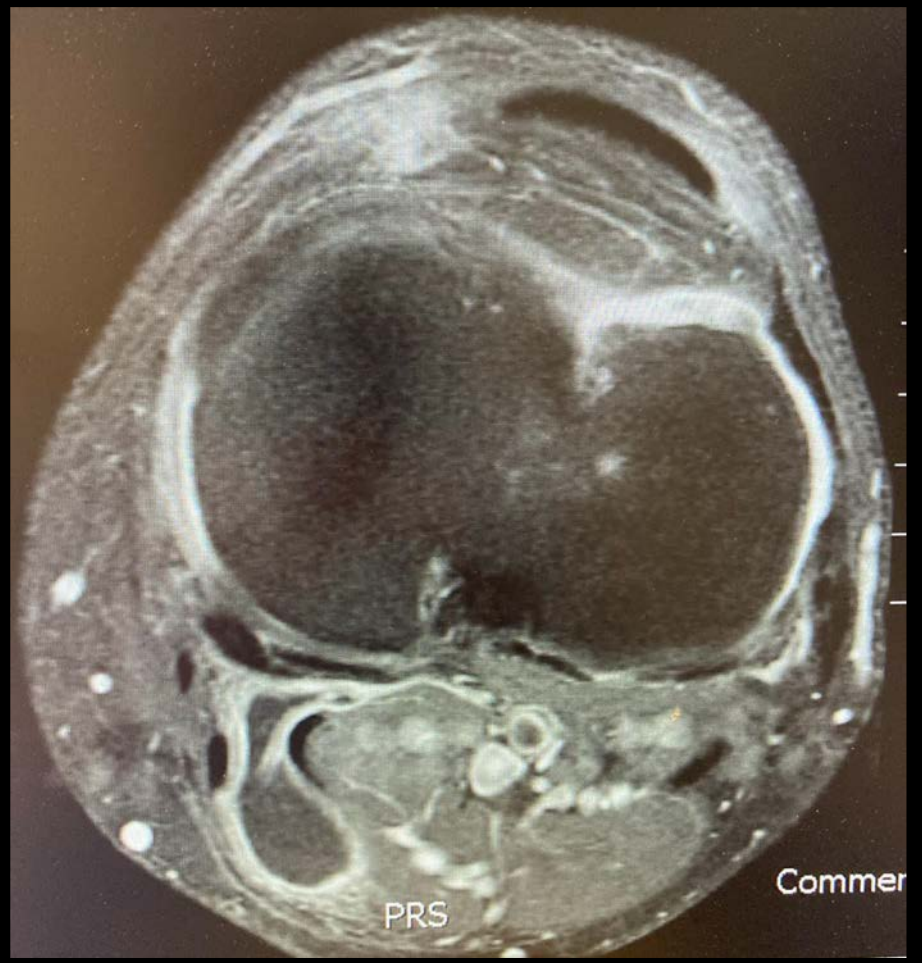
Dx: benign lipoma

Top 5 Soft Tissue Tumors

35M with chronic medial knee pain and lump in back of knee



Top 5 Soft Tissue Tumors



Dx: Baker (ganglion) cyst

Top 5 Soft Tissue Tumors

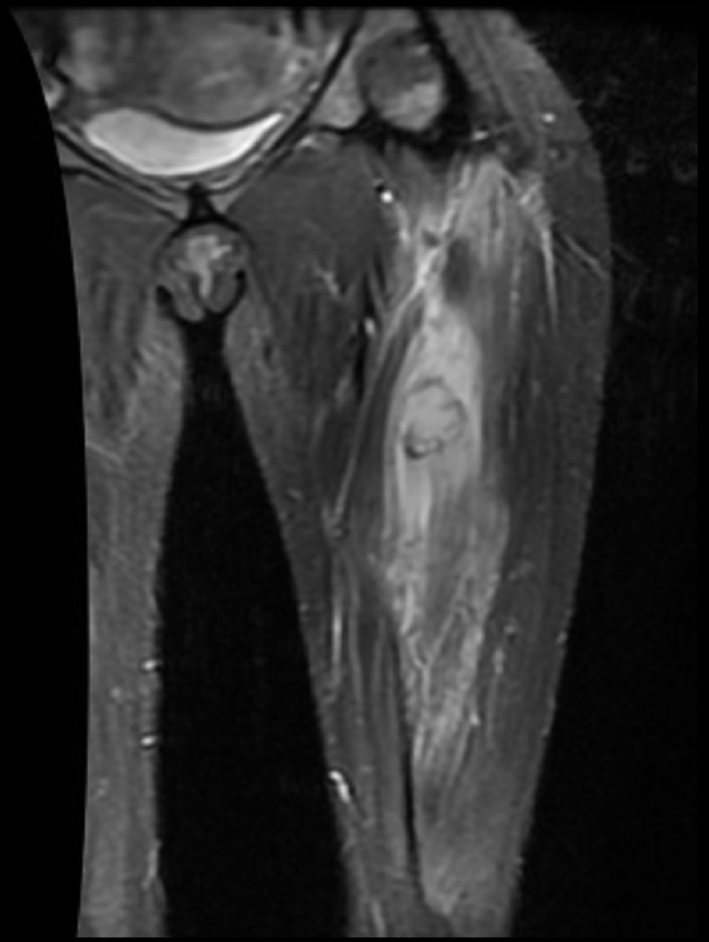
16M with 1 month of thigh pain after getting hit playing football

Top 5 Soft Tissue Tumors

Look closer…

Top 5 Soft Tissue Tumors

Look closer…



Top 5 Soft Tissue Tumors

6 months goes by…
lesion maturation

Dx: myositis ossificans

Top 5 Soft Tissue Tumors

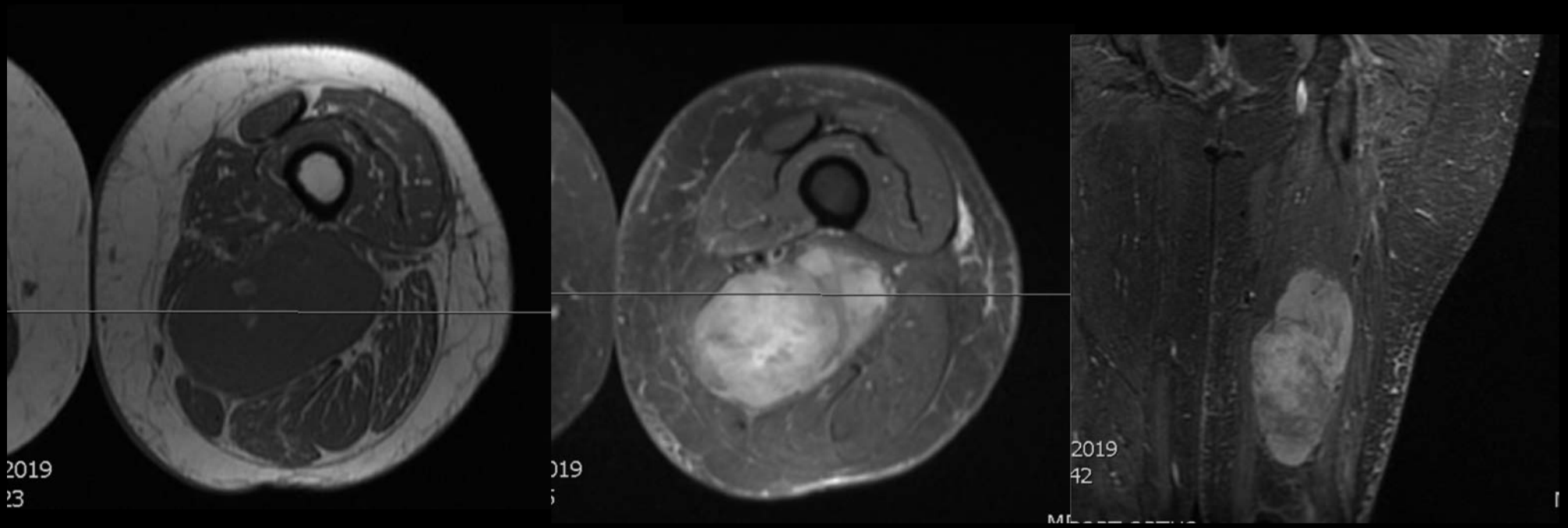
32F with posterior knee swelling, stiffness and shooting pains/numbness into foot

Top 5 Soft Tissue Tumors

Dx: schwannoma

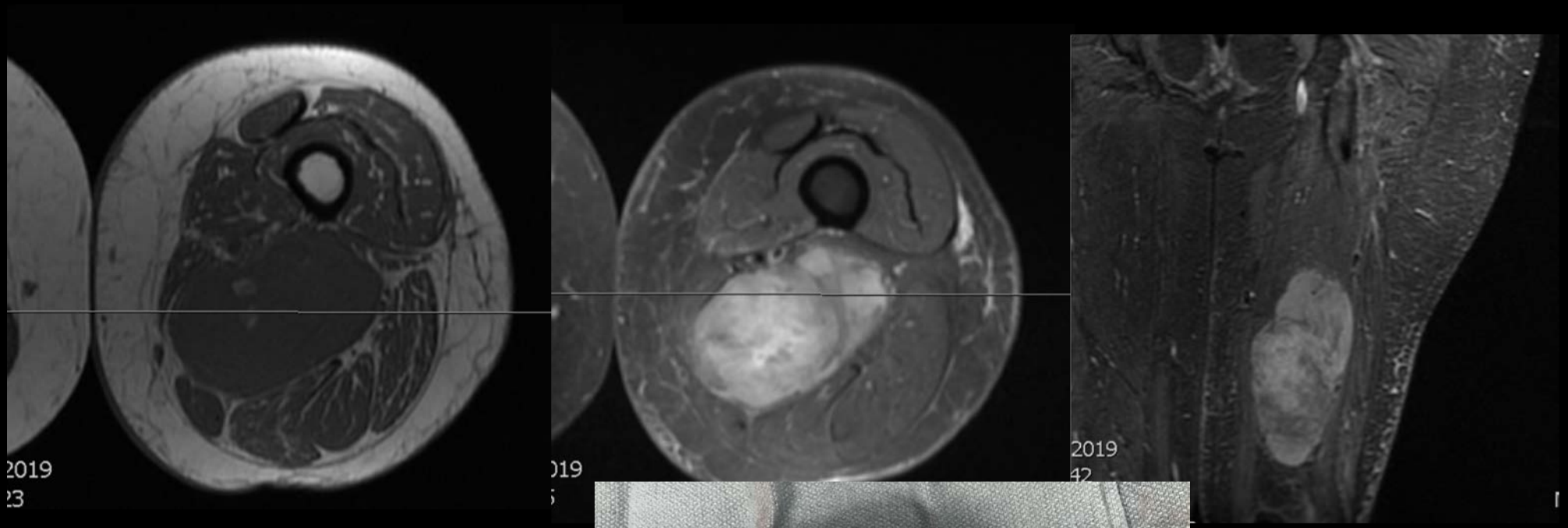
Top 5 Soft Tissue Tumors

72F thigh swelling; painless; getting bigger over few months



Top 5 Soft Tissue Tumors

72F thigh swelling; painless; getting bigger over few months



Dx: soft tissue sarcoma

Soft Tissue Tumors – Diagnostic Workup

Staging Studies

- Xray of involved body segment
- Chest xray
- MRI area of interest (wide enough for entire mass)
- CT chest wo contrast
- On occasion: PET/CT or whole body MRI

Soft Tissue Tumors – Treatment

3 BUCKETS

- Observation = Benign, asymptomatic or self limiting
- Marginal resection = Benign, symptomatic (lipoma, schwannoma)
- Wide (negative margin) resection +/- reconstruction = Malignant (sarcoma)

Soft Tissue Tumors – Treatment

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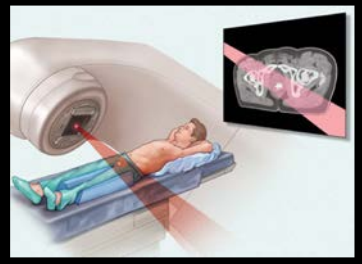
Soft Tissue Tumors – Treatment

- ***Radiation*** is a vital adjuvant therapy to decrease the risk for local recurrence, either pre or post operatively



- ***Chemotherapy*** is reserved for younger patients, sensitive subtypes or metastatic disease

Take Home Points

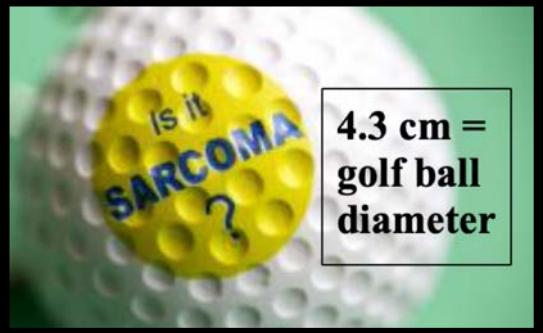
Bone Tumors

- Bone malignancy, typically painful
- Sarcomas = Children/adolescents
- Metastatic disease/lymphoma/myeloma = Adults
- Xray entire bone, and be critical of images
- If pain is not explained by xrays OR

  xrays are concerning => obtain MRI wwo contrast

Soft Tissue Tumors

- Soft tissue malignancy, typically painless
- Adults
- Start with xrays
- Soft tissue tumor that is…
  - Deep
  - Growing
  - Larger than golf ball
  - ✓ Think sarcoma



- ➢ Make a diagnosis before initiating treatment!
- ➢ Refer to Ortho Oncology Center. Let them do the biopsy.
- ➢ Never hesitate to call or email your regional orthopaedic oncologist.

References

- Brennan MF, Antonescu CR, Moraco N, Singer S. Lessons learned from the study of 10,000 patients with soft tissue sarcoma. *Ann Surg*. 2014;260(3):416-422.
- Cetin K, Christiansen CF, Jacobsen JB, Nørgaard M, Sørensen HT. Bone metastasis, skeletal-related events, and mortality in lung cancer patients: A Danish population-based cohort study. *Lung Cancer*. 2014;86(2):247-254.
- Chandrasekar CR, Wafa H, Grimer RJ, Carter SR, Tillman RM, Abudu A. The effect of an unplanned excision of a soft-tissue sarcoma on prognosis. *J Bone Jt Surg - Br Vol*. 2008;90-B(2):203-208.
- Datir A, James SLJ, Ali K, Lee J, Ahmad M, Saifuddin A. MRI of soft-tissue masses: the relationship between lesion size, depth, and diagnosis. *Clin Radiol*. 2008;63(4):373-378.
- Dyrop HB, Vedsted P, Safwat A, et al. Alarm symptoms of soft-tissue and bone sarcoma in patients referred to a specialist center. *Acta Orthop*. 2014;85(6):657-662.
- George A, Grimer RJ. Early symptoms of bone and soft tissue sarcomas: could they be diagnosed earlier? *Ann R Coll Surg Engl*. 2012;94:261-266.
- Grimer RJ. Size matters for sarcomas! *Ann R Coll Surg Engl*. 2006;88(6):519-524.
- Henderson ER, Groundland JS, Pala E, et al. Failure mode classification for tumor endoprostheses: Retrospective review of five institutions and a literature review. *J Bone Jt Surg - Ser A*. 2011;93(5):418-429.
- Honoré C, Méeus P, Stoeckle E, Bonvalot S. Soft tissue sarcoma in France in 2015: Epidemiology, classification and organization of clinical care. *J Visc Surg*. 2015;152(4):223-230.
- Jensen AT, Jacobsen JB, Nørgaard M, Yong M, Fryzek JP, Sørensen HT. Incidence of bone metastases and skeletal-related events in breast cancer patients: A population-based cohort study in Denmark. *BMC Cancer*. 2011;11(1):29.
- Jernigan EW, Esther RJ. Soft Tissue Masses for the General Orthopedic Surgeon. *Orthop Clin North Am*. 2015;46(3):417-428.
- Kransdorf MJ. Benign soft-tissue tumors in a large referral population: Distribution of specific diagnoses by age, sex, and location. *Am J Roentgenol*. 1995;164(2):395-402.
- Kransdorf MJ. Malignant Tumors in a Large Referral Population: Distribution of Diagnoses and Location by Age , Sex and Location. *Am J Roentgenol*. 1995;(164):129-134.

References

- Landis SH, Murray T, Bolden S, Wingo PA. Cancer statistics, 1999. *CA Cancer J Clin*. 2008;49(1):8-31.
- Mankin HJ, Lange TA, Spanier SS. The hazards of biopsy in patients with malignant primary bone and soft-tissue tumors. *Clin Orthop Relat Res*. 1982;64:1121-1127.
- Mastrangelo G, Fadda E, Cegolon L, et al. A European project on incidence, treatment, and outcome of sarcoma. *BMC Public Health*. 2010;10(i).
- Myhre-Jensen O. A consecutive 7-year series of 1331 benign soft tissue tumours: Clinicopathologic data. Comparison with sarcomas. *Acta Orthop*. 1981;52(3):287-293.
- Simon MA, Aschliman MA, Thomas N, Mankin HJ. Limb-salvage treatment versus amputation for osteosarcoma of the distal end of the femur. *J Bone Jt Surg - Ser A*. 1986;68(9):1331-1337.
- Smith GM, Johnson GD, Grimer RJ, Wilson S. Trends in presentation of bone and soft tissue sarcomas over 25 years: Little evidence of earlier diagnosis. *Ann R Coll Surg Engl*. 2011;93(7):542-547.
- Steffner RJ, Jang ES. Staging of Bone and Soft-tissue Sarcomas. *J Am Acad Orthop Surg*. 2018;26(13):e269-e278.
- Stiller CA, Trama A, Serraino D, et al. Descriptive epidemiology of sarcomas in Europe: Report from the RARECARE project. *Eur J Cancer*. 2013;49(3):684-695.
- Stojadinovic A, Leung DHY, Hoos A, Jaques DP. Analysis of the Prognostic Significance of Microscopic Margins in 2,084 Localized Primary Adult Soft Tissue Sarcomas.
- Toro JR, Travis LB, Hongyu JW, Zhu K, Fletcher CDM, Devesa SS. Incidence patterns of soft tissue sarcomas, regardless of primary site, in the Surveillance, Epidemiology and End Results program, 1978-2001: An analysis of 26,758 cases. *Int J Cancer*. 2006;119(12):2922-2930.
- Ward WG, Rougraff B, Quinn R, et al. Tumors masquerading as hematomas. *Clin Orthop Relat Res*. 2007;(465):232-240.

Questions? Email me.
Joshua.Lawrenz@vumc.org

Thank you

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