

# Advances in Musculoskeletal Imaging

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MSK Radiologist



# Disclosure

- I have no commercial or financial interests related to the subject matter of this presentation

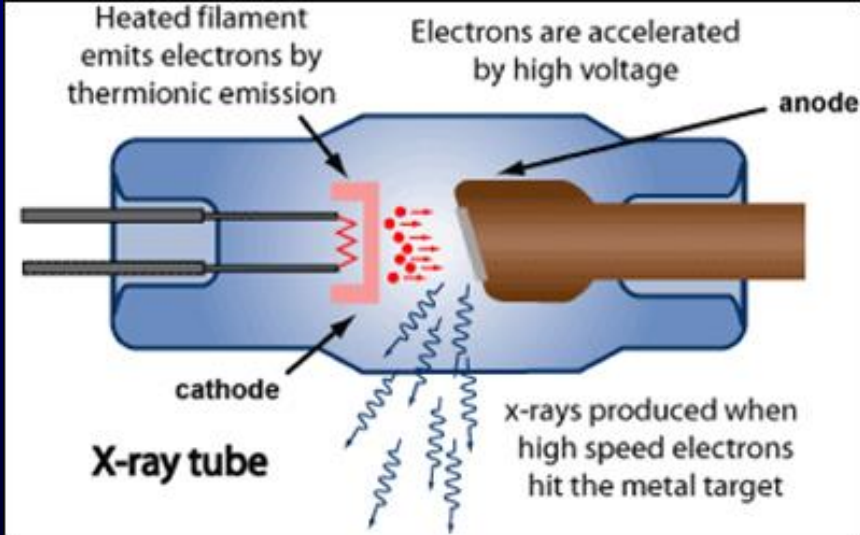
# Objectives

At the end of this presentation, the participant will be able to:

1. Discuss new advances in bone, soft tissue and joint imaging
2. Understand the optimal modality for imaging common musculoskeletal conditions
3. Summarize advanced imaging techniques

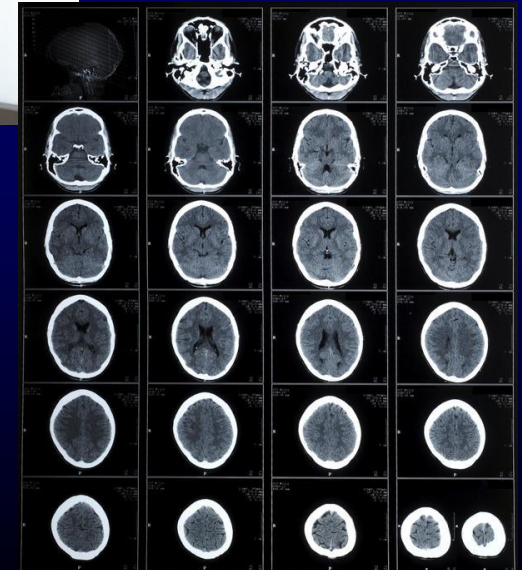


Wilhelm Röntgen



# Radiography

- Film processing
- Computed Radiography (CR)
- Digital Radiography (DR)





# Radiography

- Digital Radiography

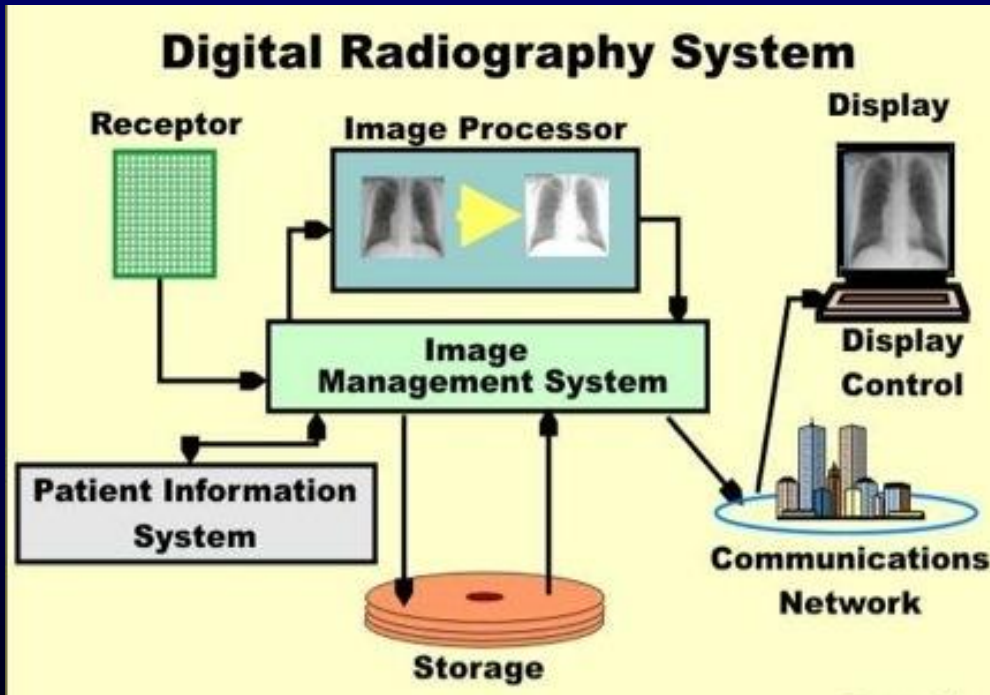
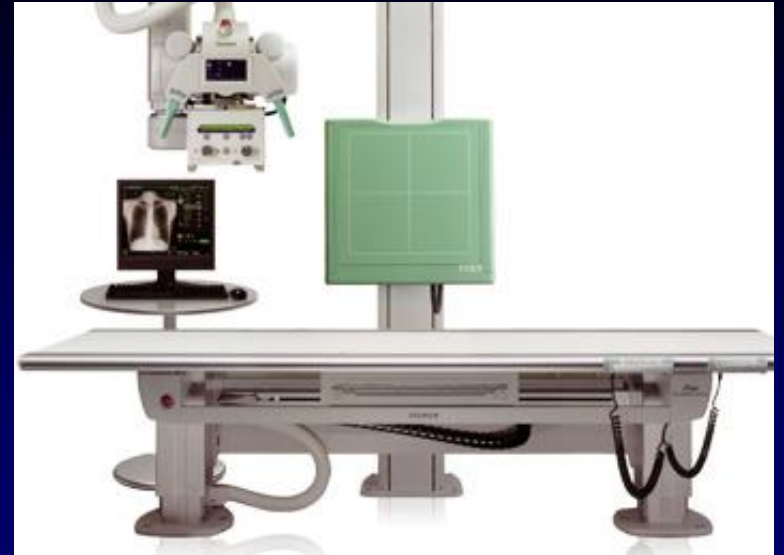






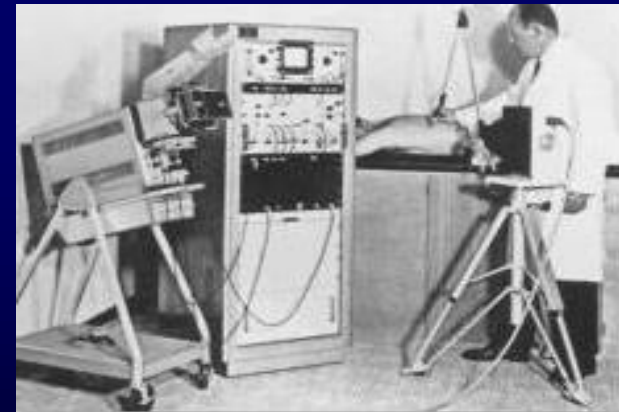
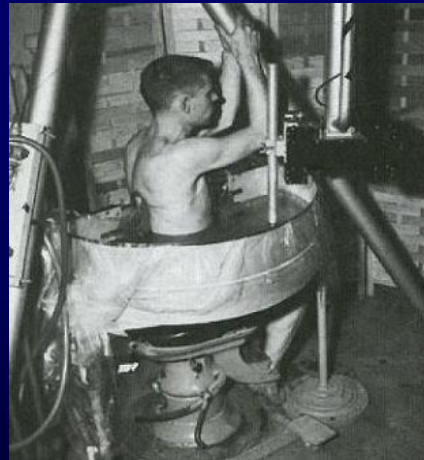
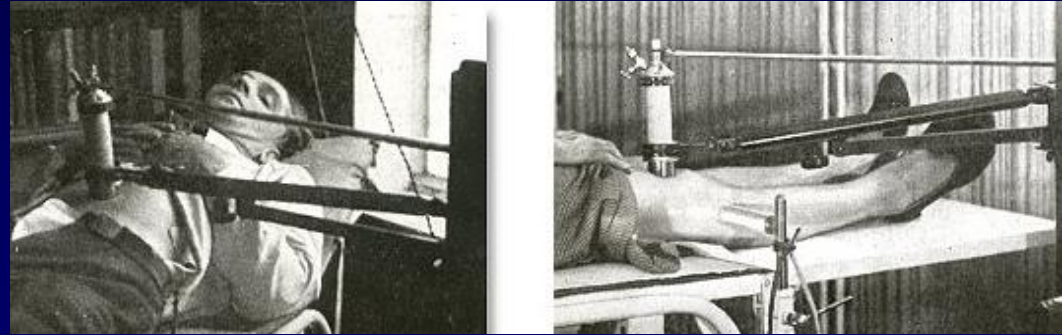
Image Adjustment:  
window & level





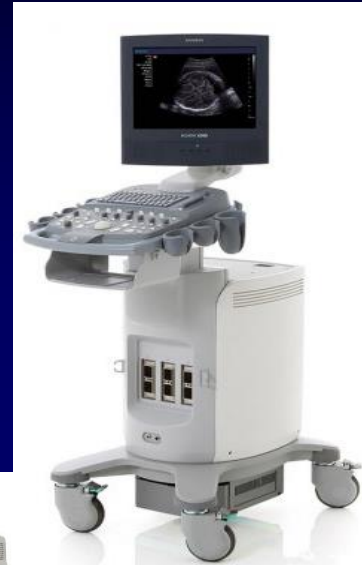
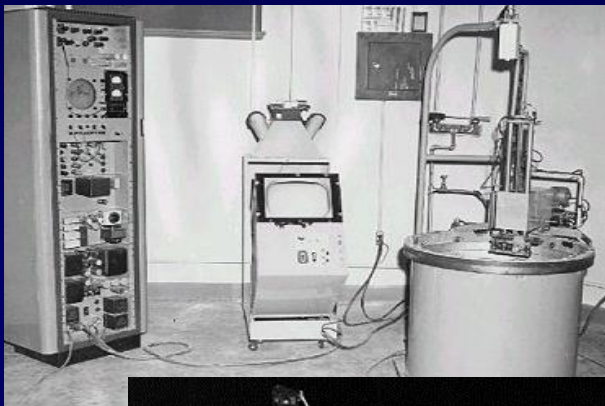
# Ultrasound

- 1940's used for therapy using heat & disruptive effects
- Developed as a diagnostic tool in saline
- Direct contact transducer



Woo J. A short History of the development of Ultrasound in Obstetrics and Gynecology. [www.ob-ultrasound.net/history1](http://www.ob-ultrasound.net/history1)

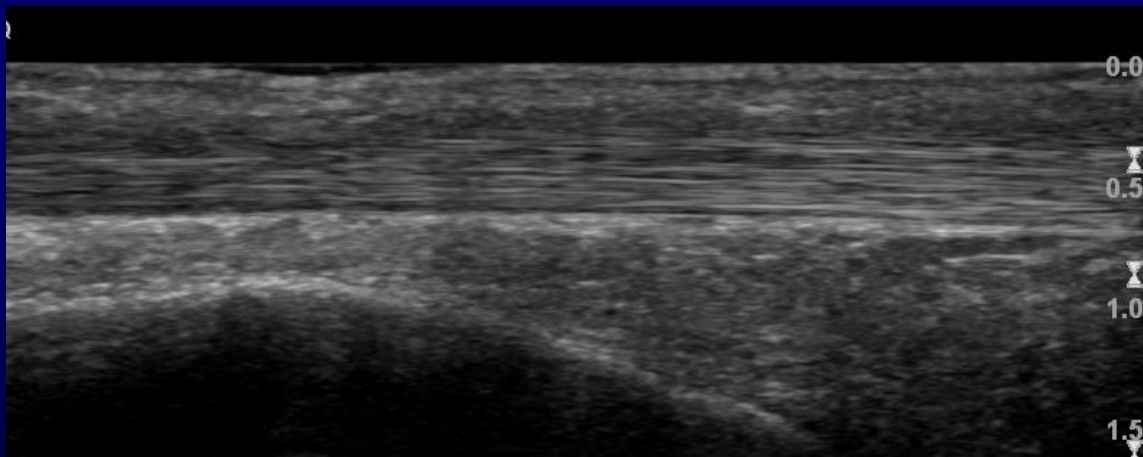
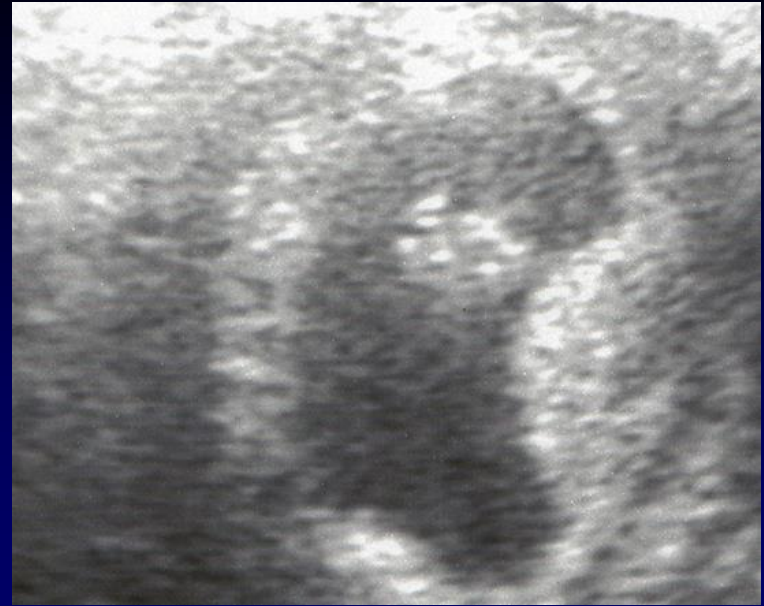
# Ultrasound



# Ultrasound



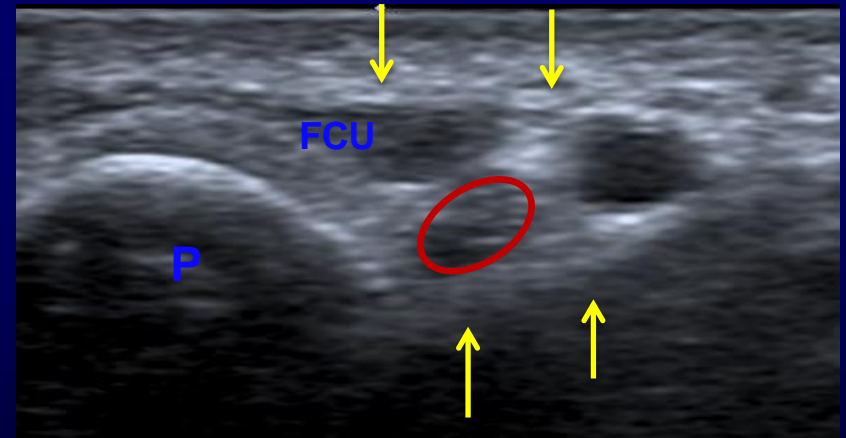
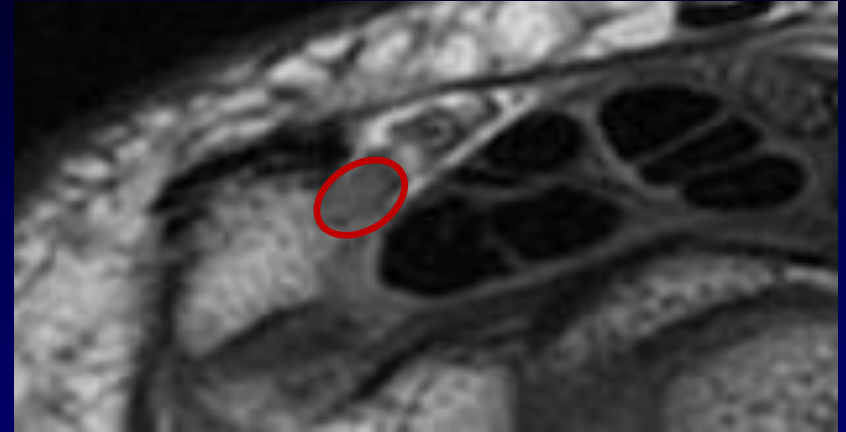
# Ultrasound



Tendon:  
Fibrillar, linear pattern

# Ultrasound

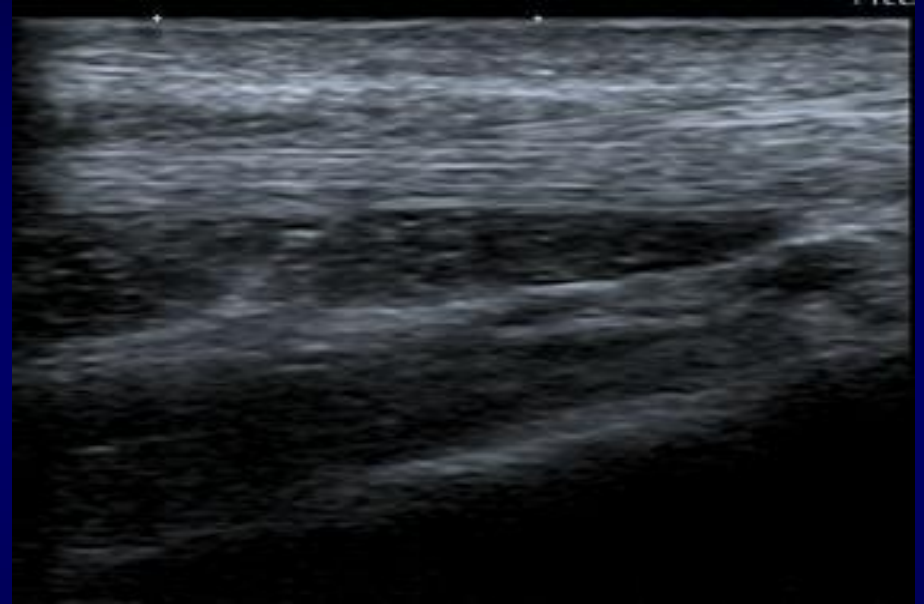
- Readily available
- Safe
- Anatomy





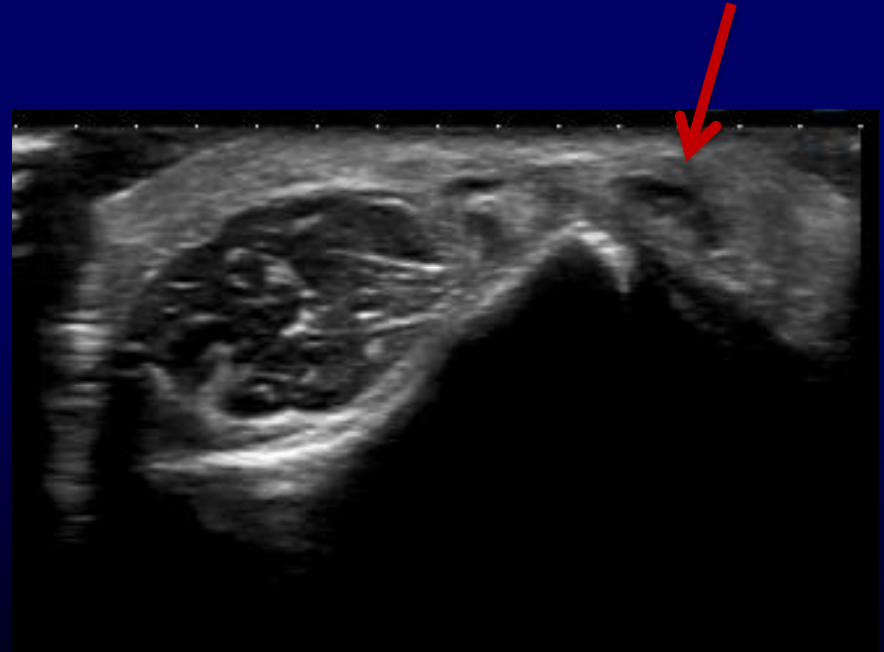
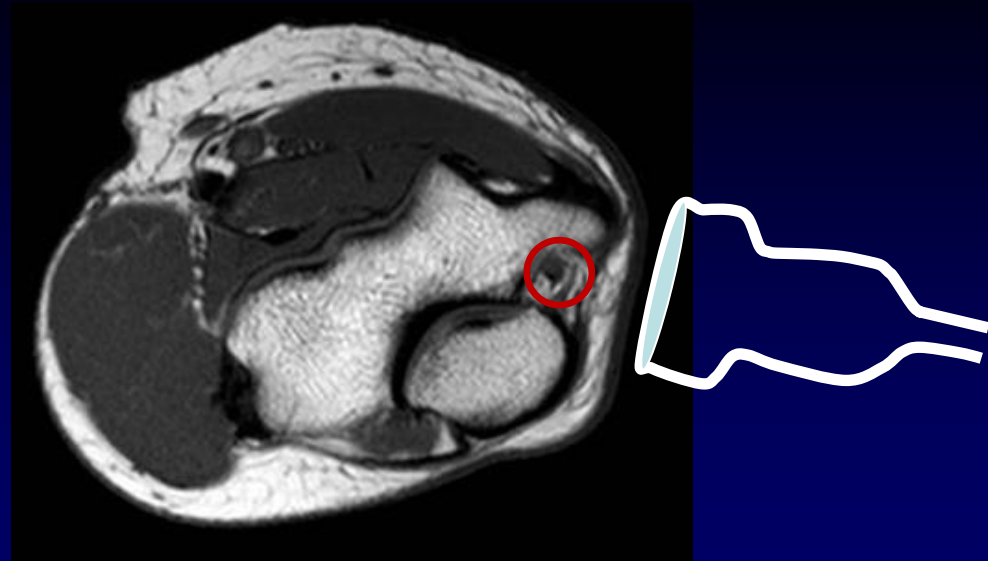
# Ultrasound

- Good spatial resolution:
- 0.3 – 3 mm (XR, CT, MRI 1 mm)
- Compare other side
- Communicate with pt.
- Dynamic



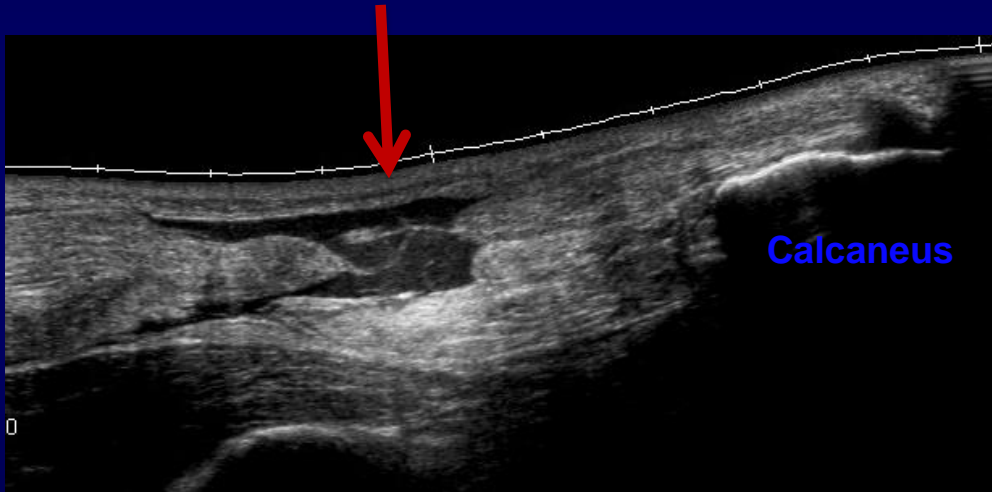
# Ultrasound

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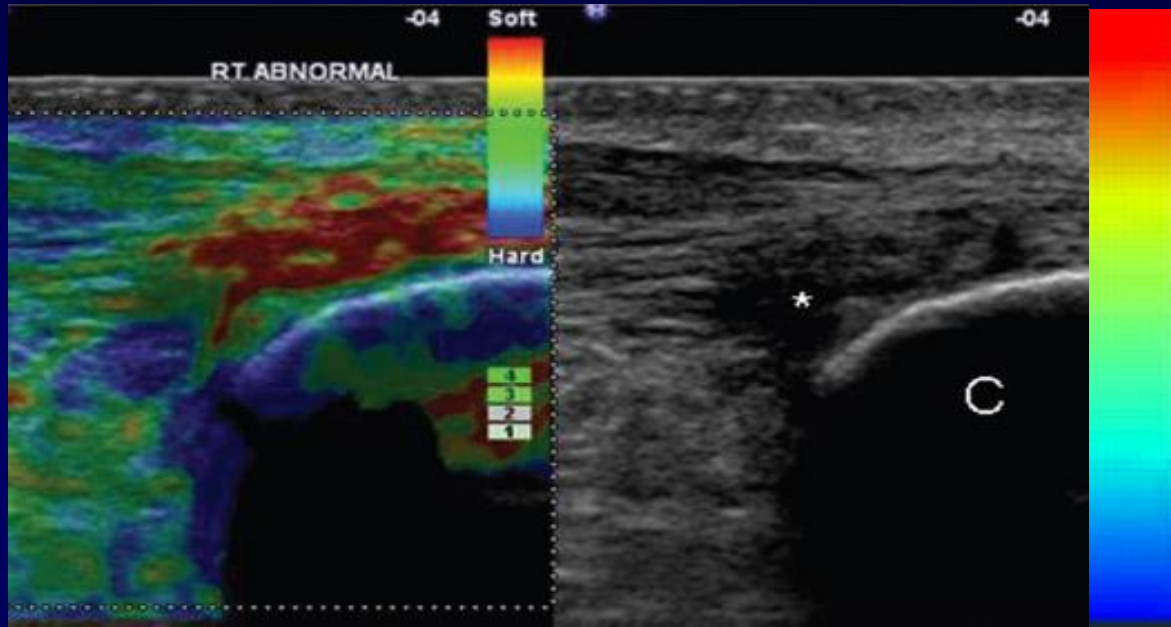
# Ultrasound

- Achilles tear



# Ultrasound

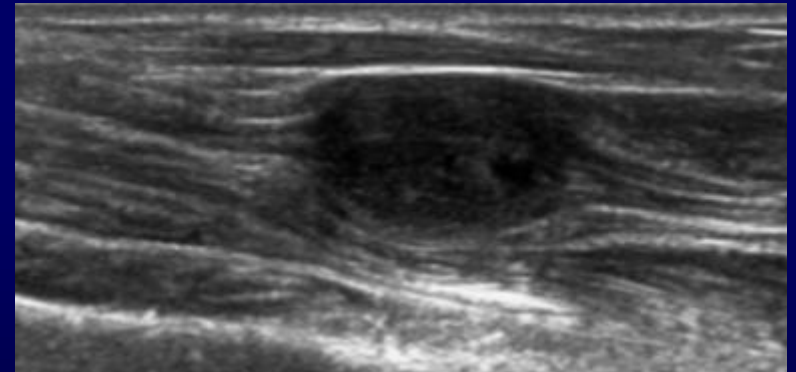
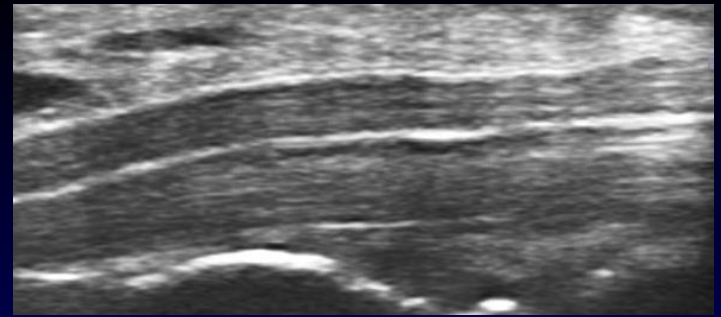
- Function:
  - blood flow
  - tissue perfusion
  - tissue stiffness
- Shear wave



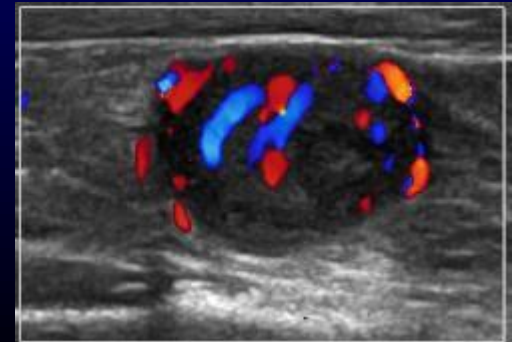
Drakonaki EE, Allen GM, Wilson DJ, Ultrasound elastography for musculoskeletal applications. BJR, 85(2012), 1435-1445

# Structure

- Nerves
  - Multiple axons bundled together in fascicles
  - Surrounded by echogenic perineurium

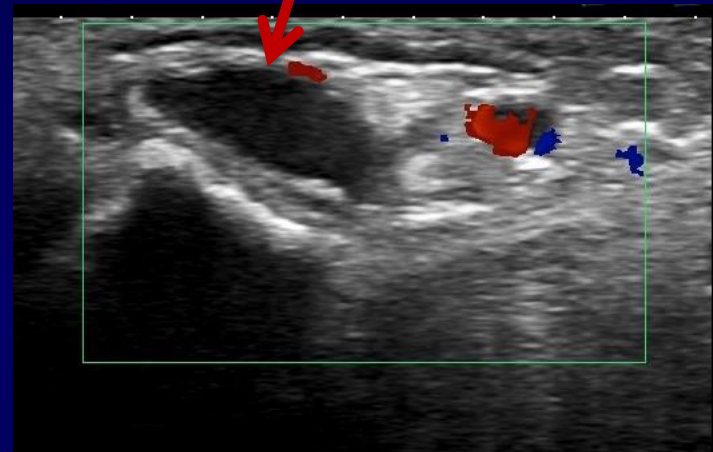
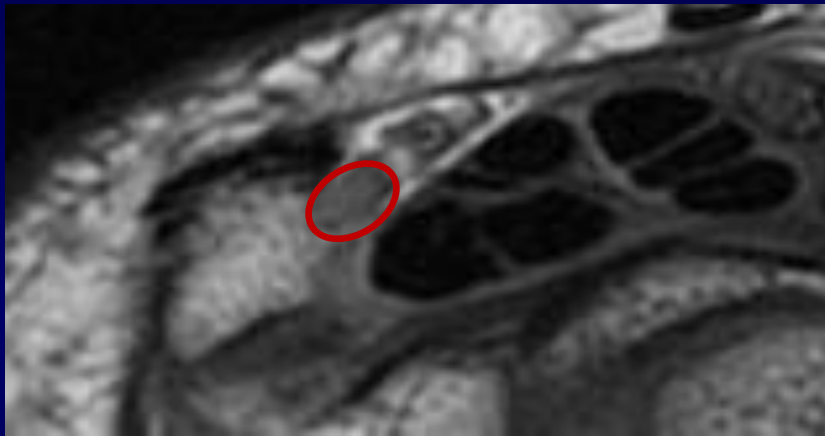


Nerve Sheath  
Tumour



# Neuropathy – Ulnar Nerve

- Guyon's canal

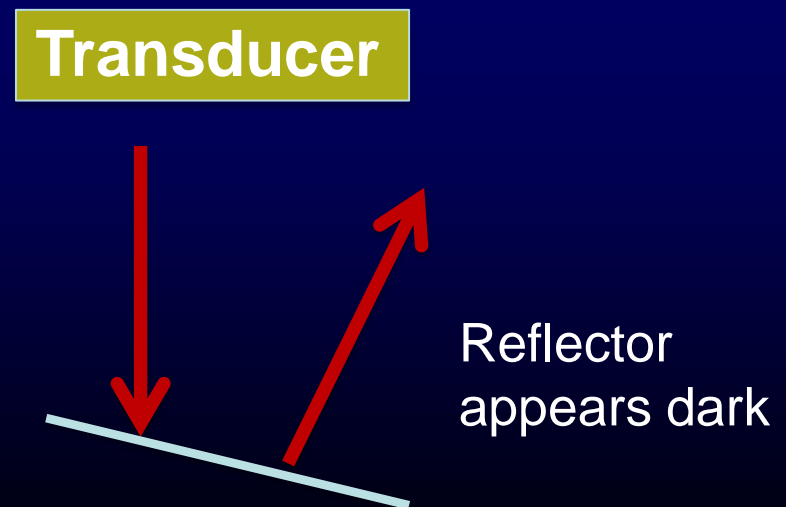
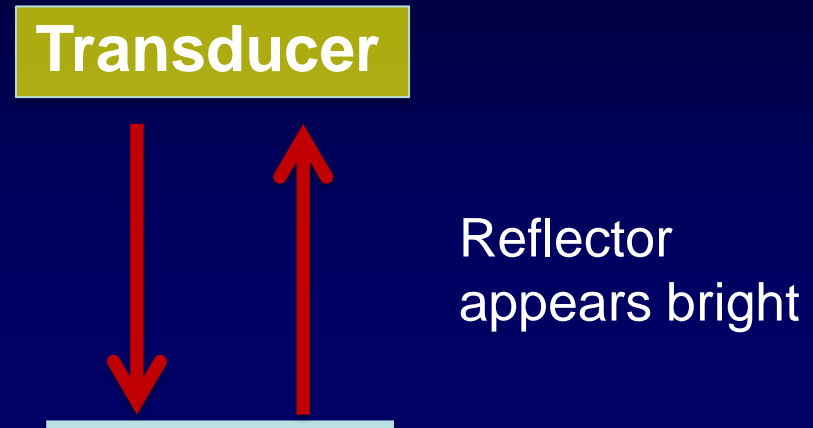


Ganglion cyst compressing the ulnar nerve



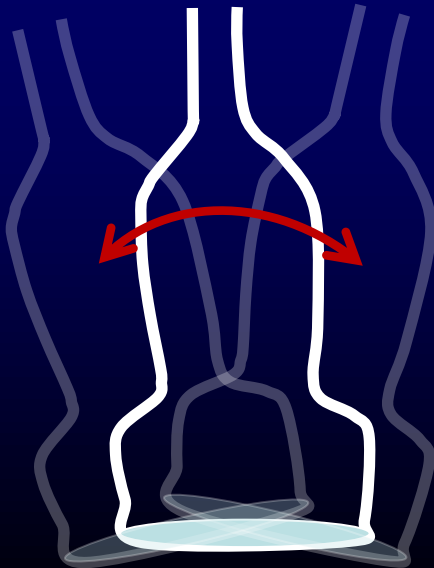
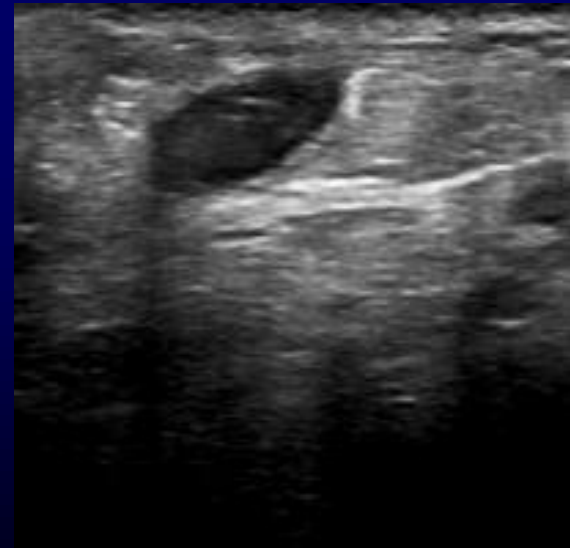
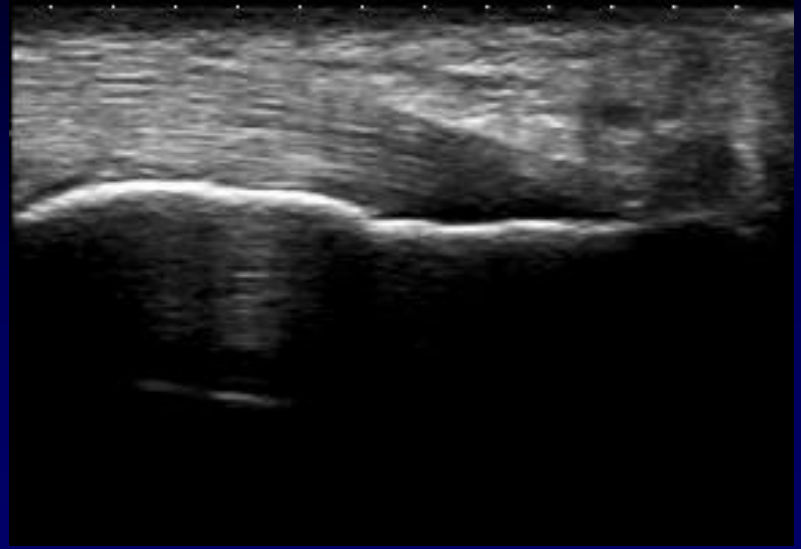
# Pitfall - Anisotropy

- Beam reflected away from transducer if probe not perpendicular to the structure
- Appears hypoechoic



# Pitfall - Anisotropy

- Solution
  - Heel toe transducer in longitudinal
  - Rock transducer in transverse

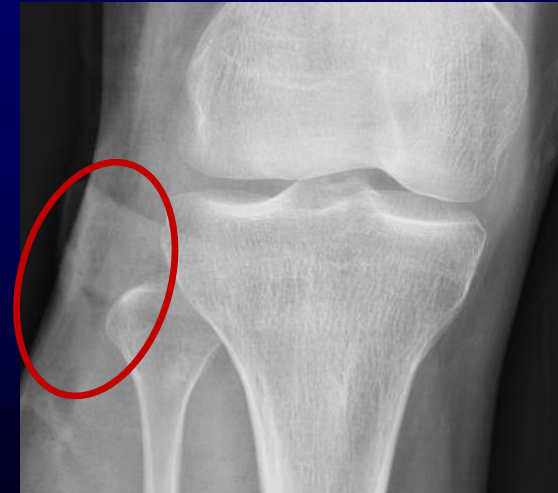
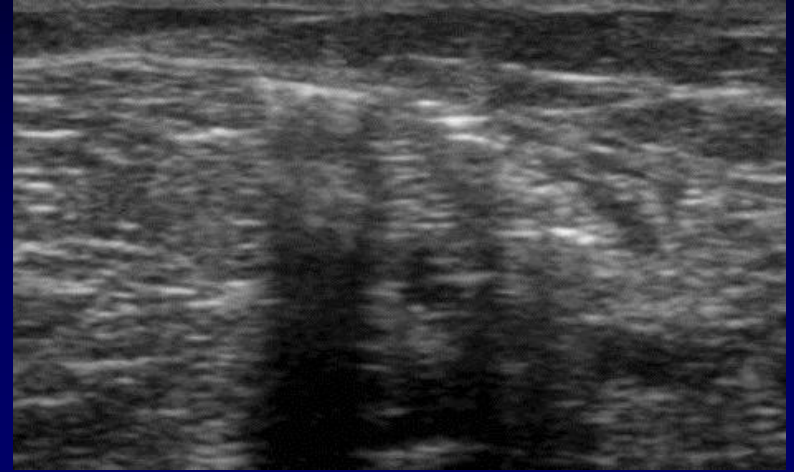




# Ultrasound

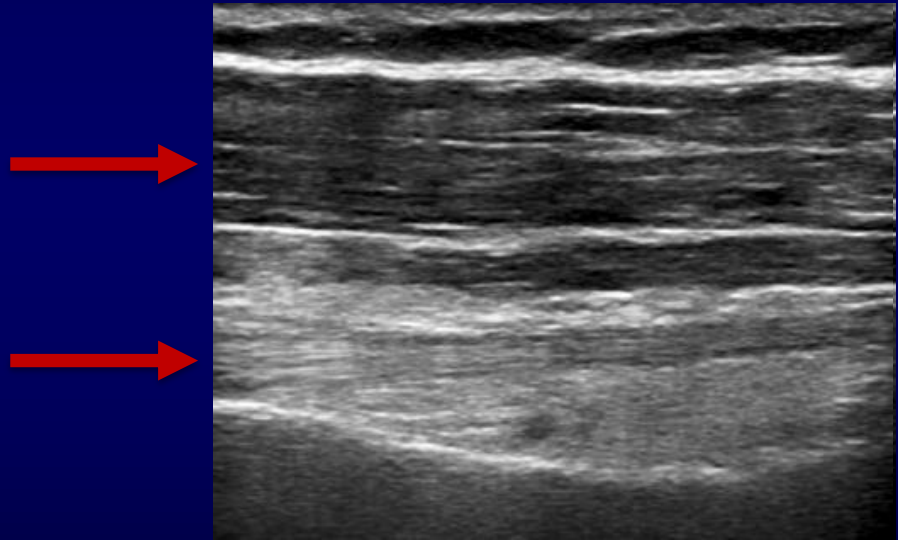
## Limitations:

- Deep structures hard to penetrate or obscured
- Body habitus
- Air



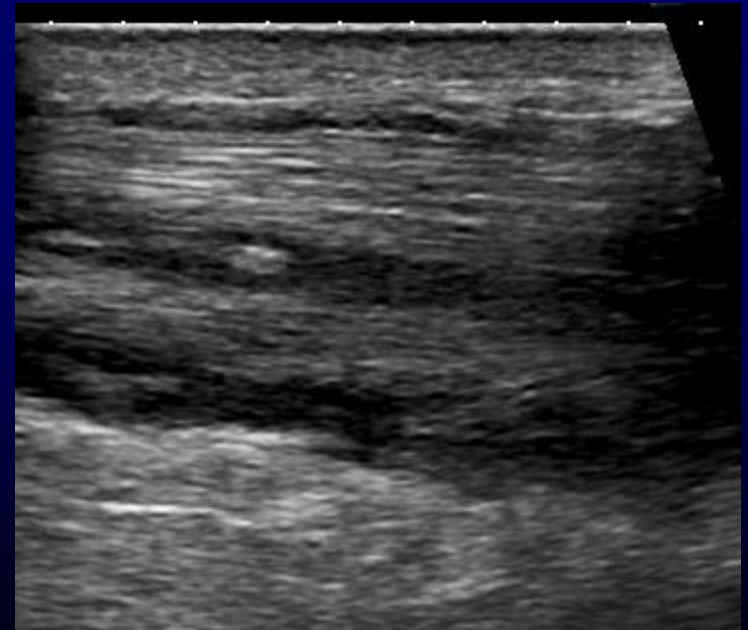
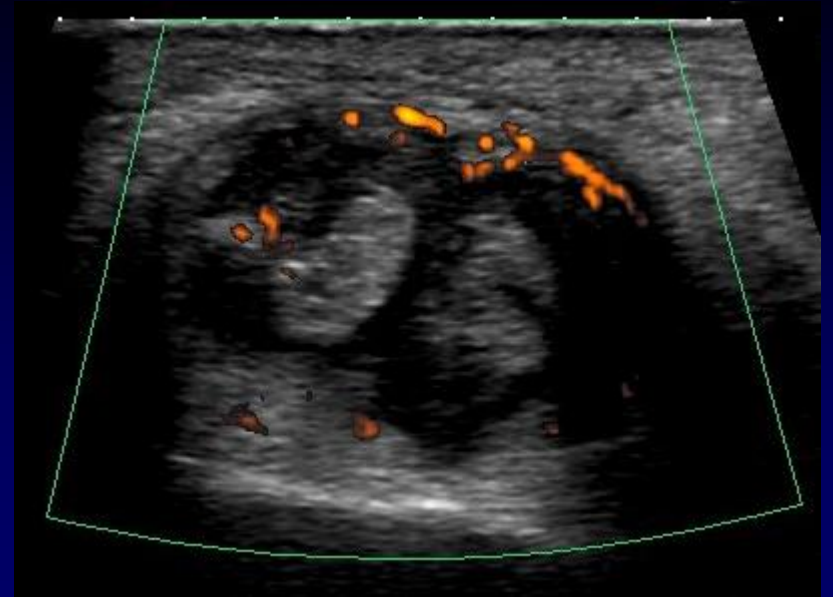
# Ultrasound

- Focal Zone Adjustment



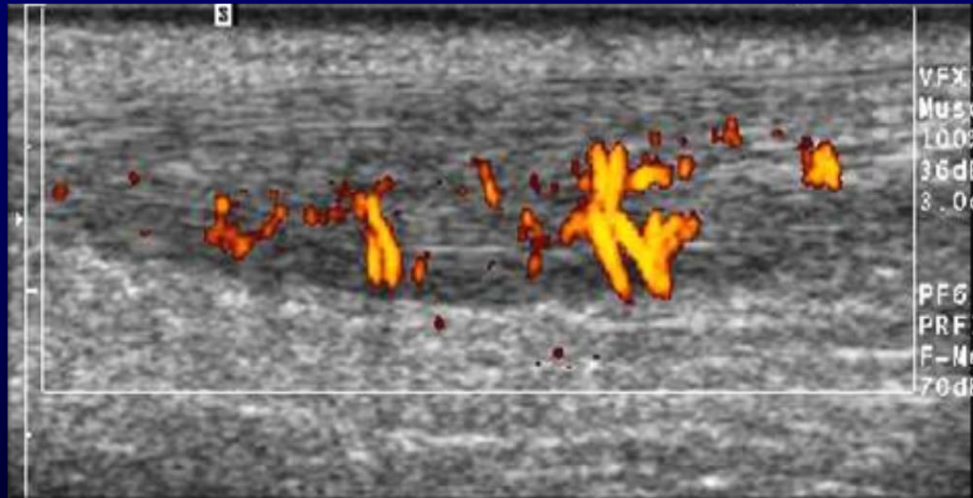
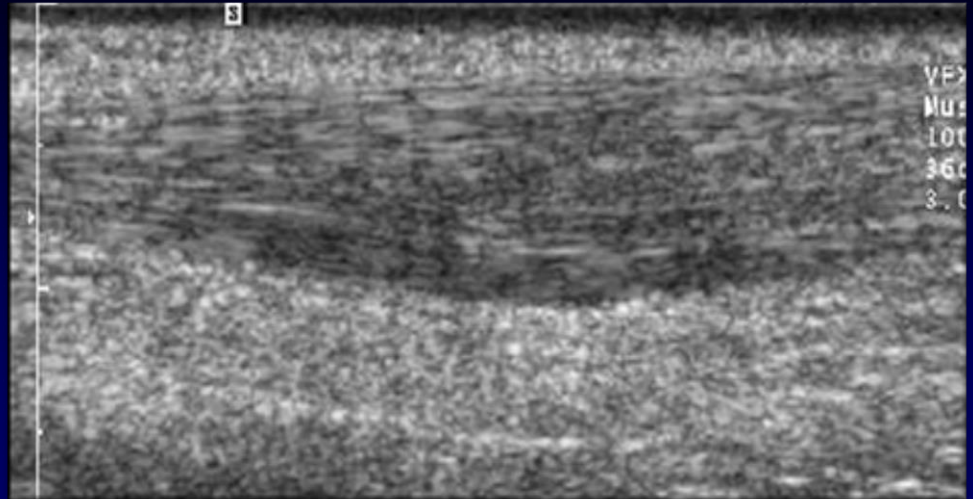
# Tenosynovitis

- Distention of tendon sheath with fluid or synovial hypertrophy
- +/- hyperemia



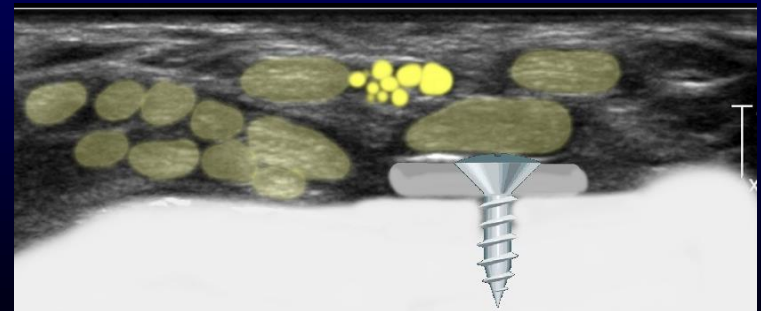
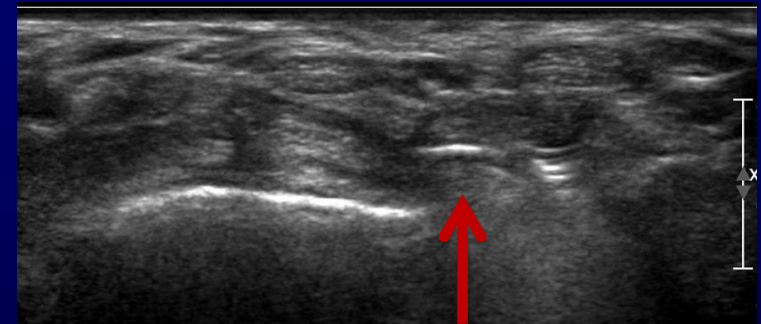
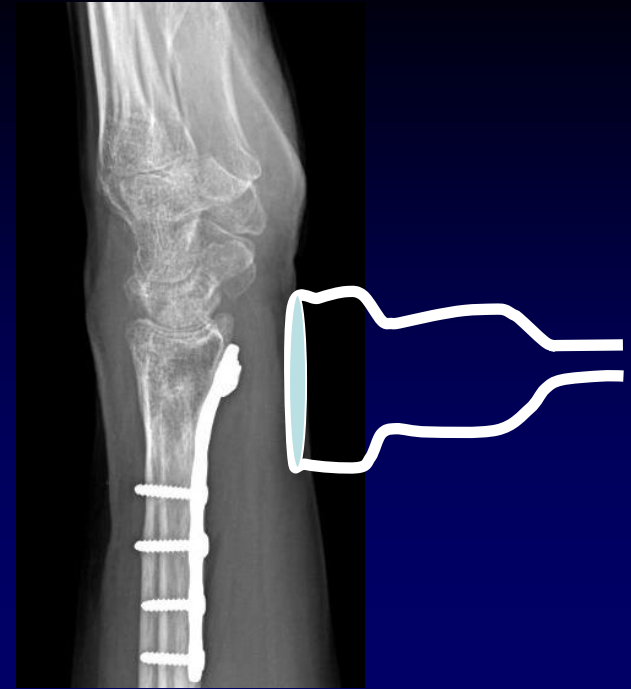
# Tendinosis

- Degeneration of the collagen
- US
  - Hypoechoic tendon enlargement
  - +/- hyperemia



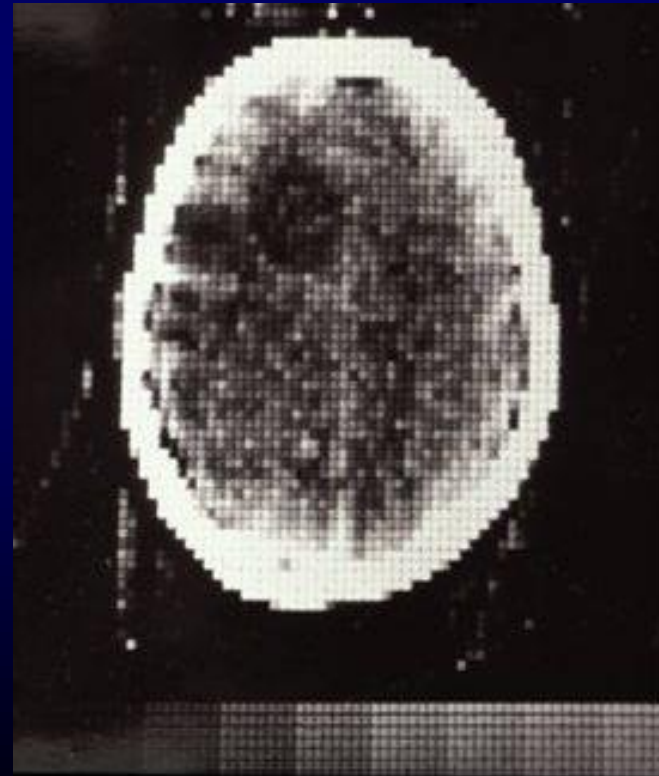
# Screw Impingement

- Metalwork can impinge upon nerves and tendons
- Dynamic assessment helpful

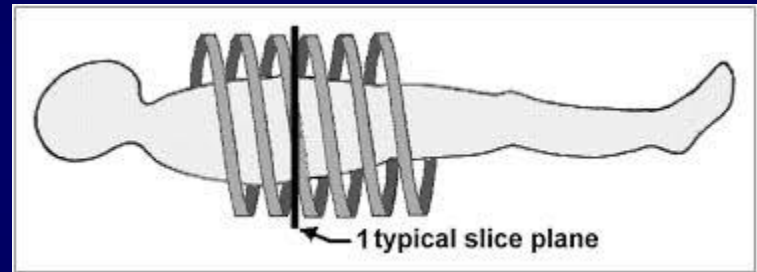
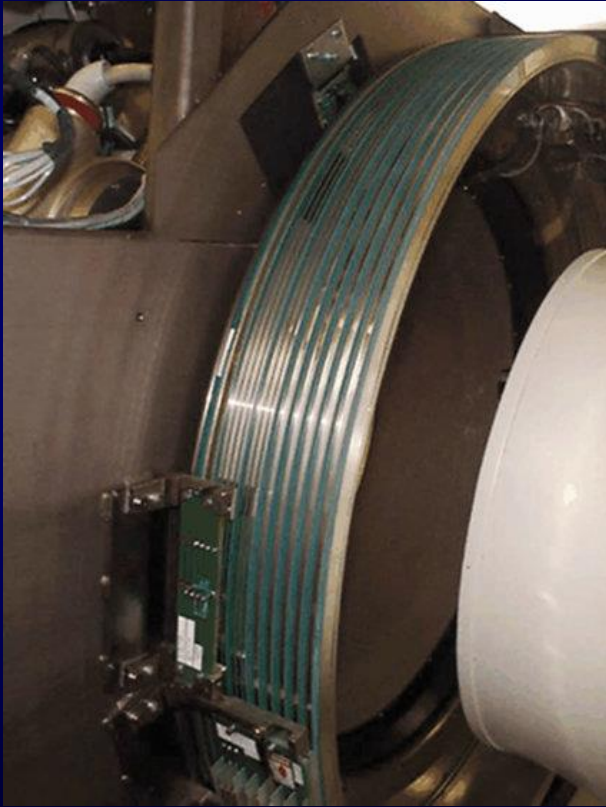


# CT

- 1971 – Godfrey Hounsfield developed CT scanning and first successful scan of cerebral cyst

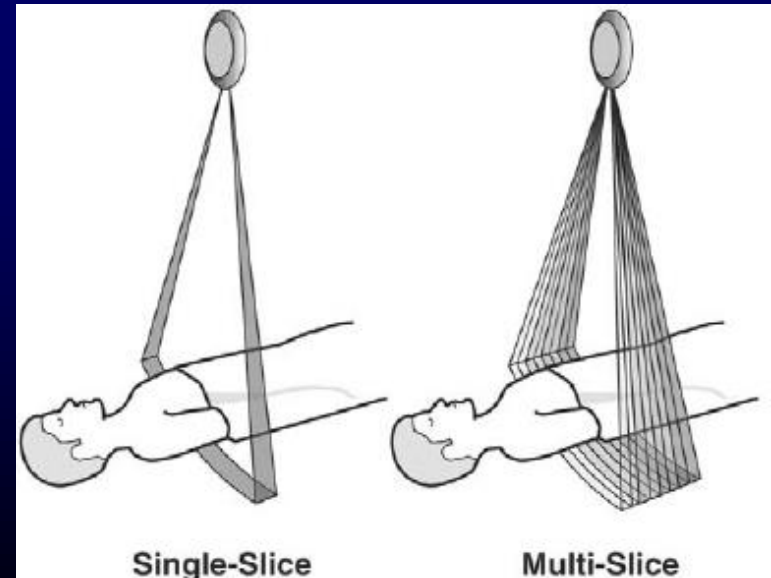


# CT



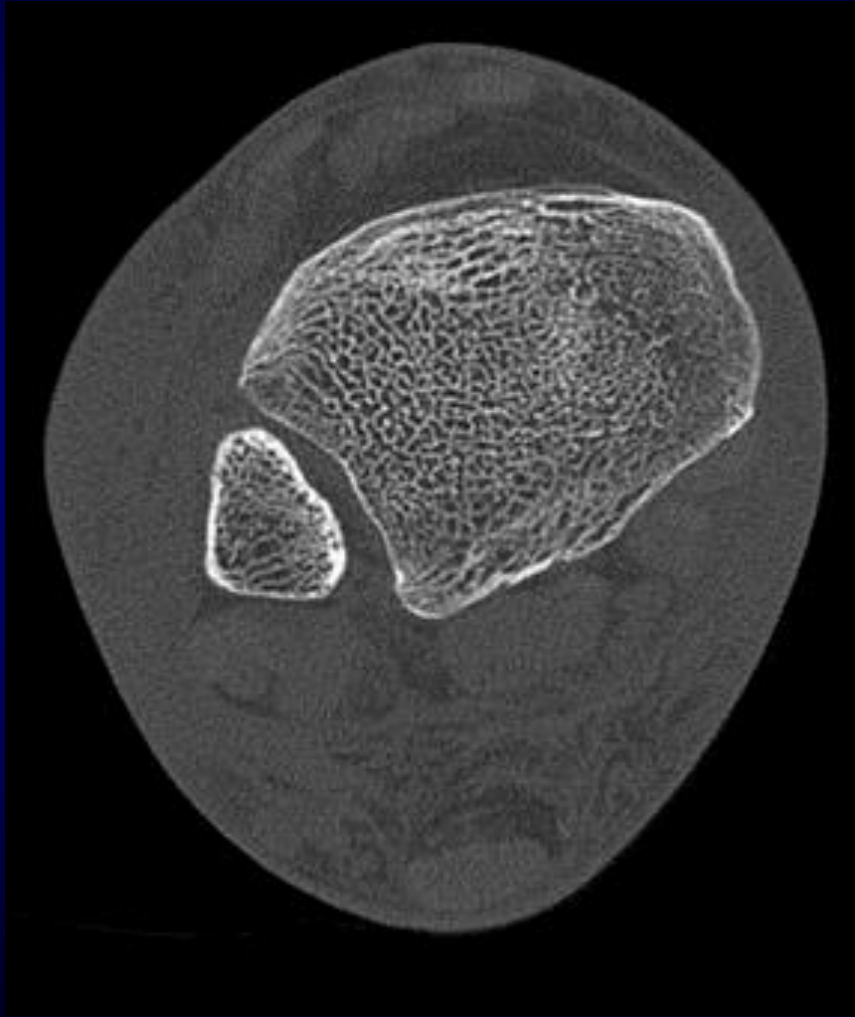
# CT

- Single detector
- Multi detector

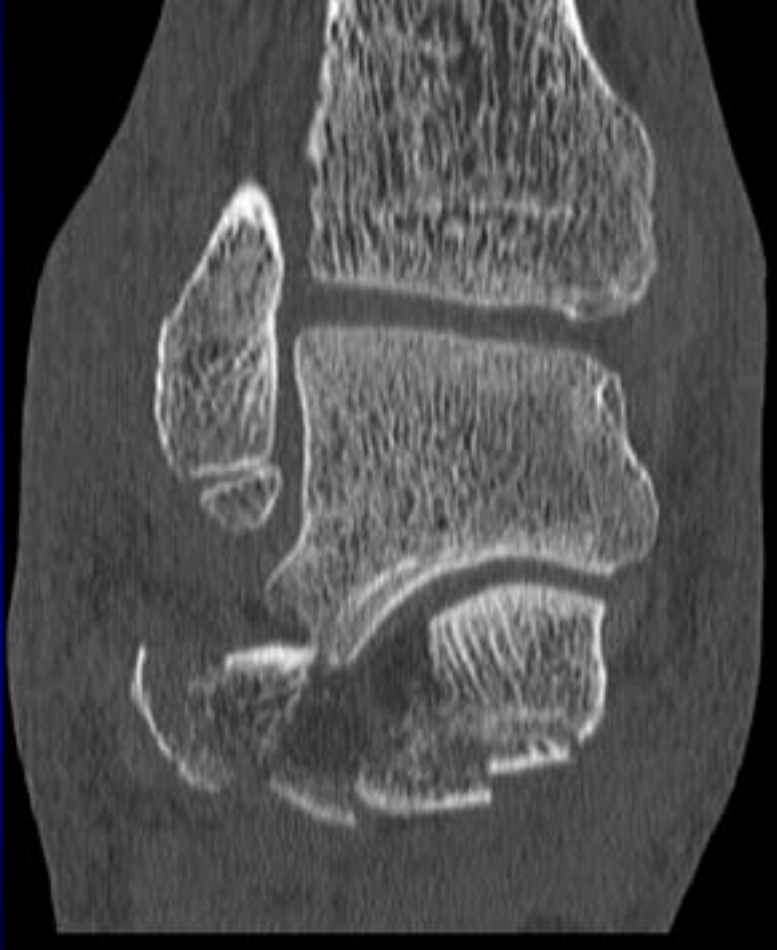




CT

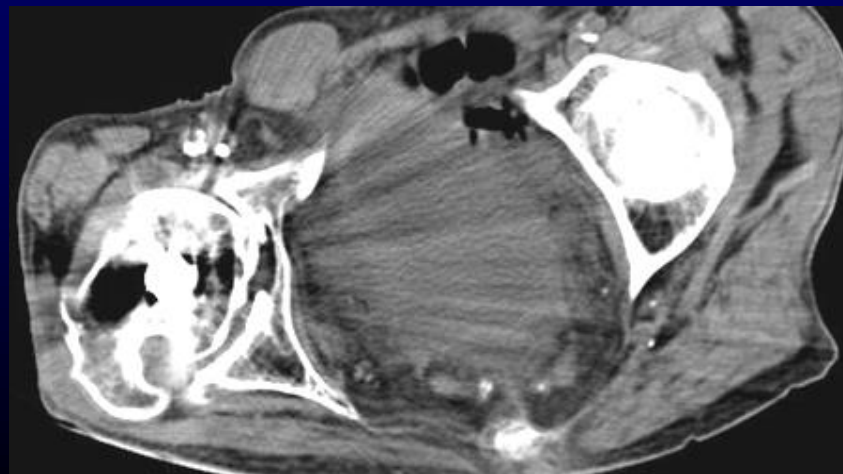
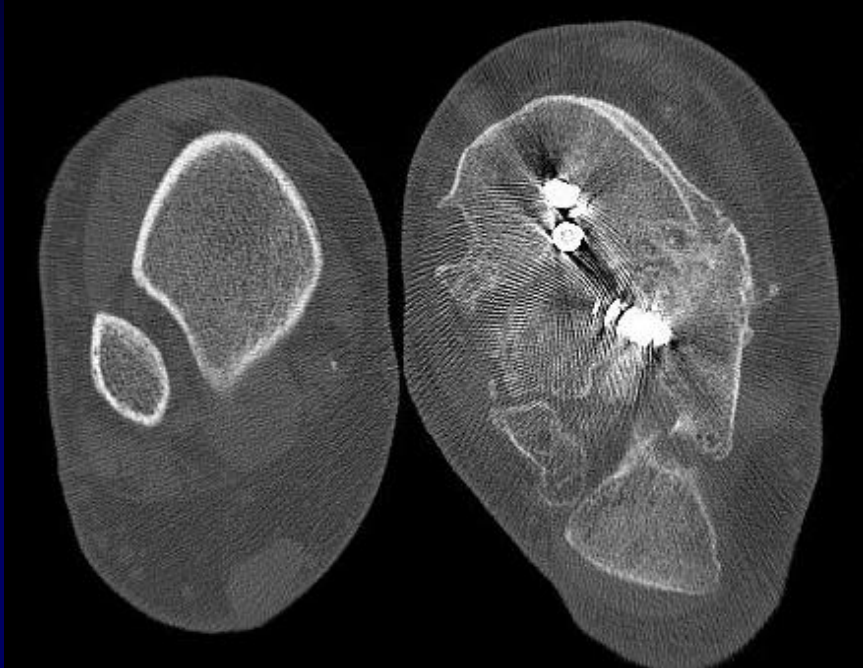


CT



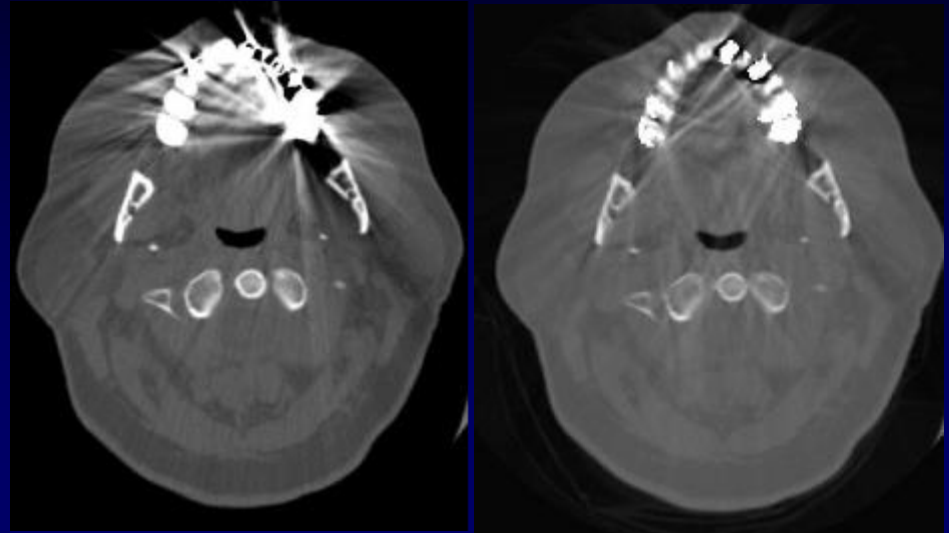
coronal and sagittal reformatting

# CT

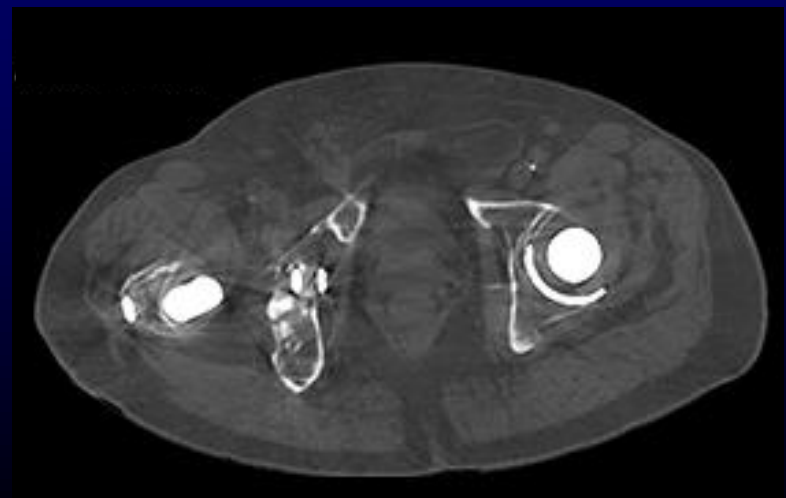
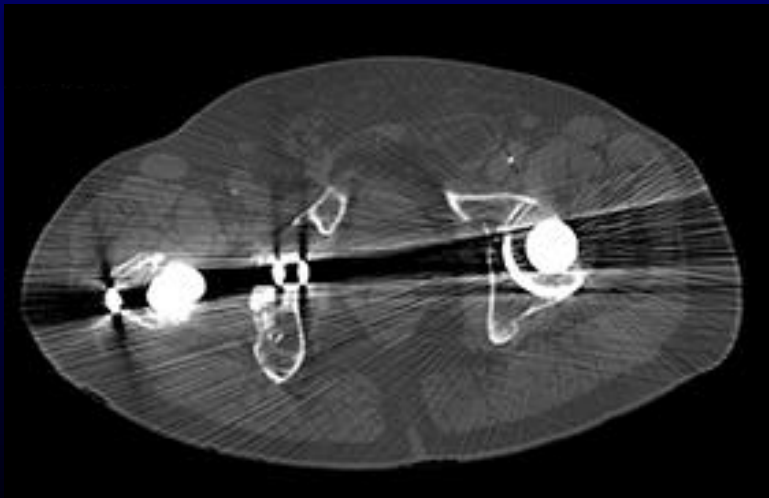


# CT

- Metal reduction

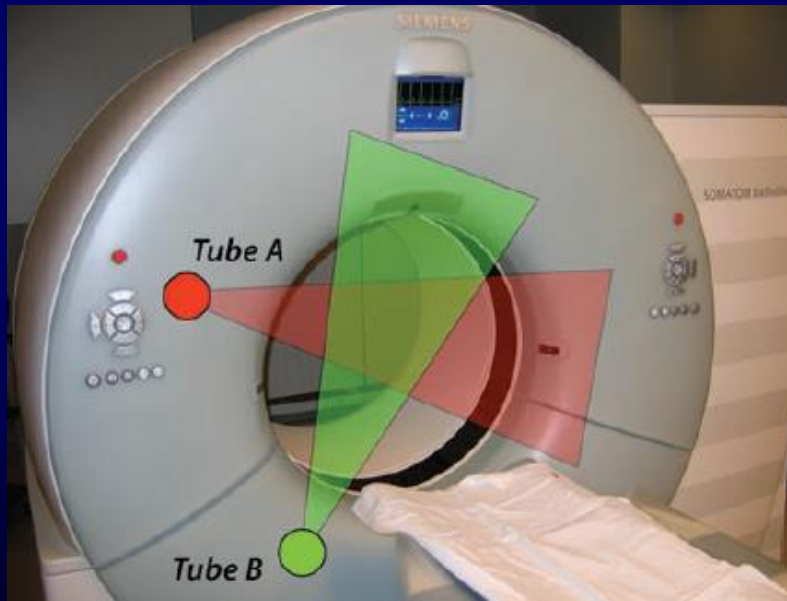


Ki B. Dual-Energy CT with Fast-kVp Switching and it's applications in Orthopedics. OMICS J Radiology 2013;2:137



# CT

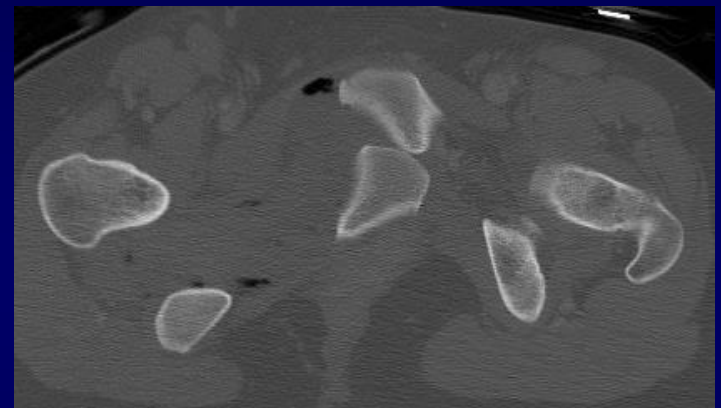
- Dual energy



Nicolaou S, Yong-Hing CJ, Galea-Soler, et. al. Dual-Energy CT as a Potential New Diagnostic Tool in the Management of Gout in the Acute Setting. AJR 2010; 194: 1072-1078

# CT

- Fracture imaging
- Axial images
- 2D & 3D reformats



# MRI

Press Release:

2003 Nobel Prize

October 6, 2003

The Nobel Assembly at Karolinska  
Institutet has today decided to  
award The Nobel Prize in  
Physiology or Medicine for 2003  
jointly to:

Paul Lauterbur

&

Peter Mansfield

“For their discoveries concerning  
Magnetic Resonance Imaging”



# MRI

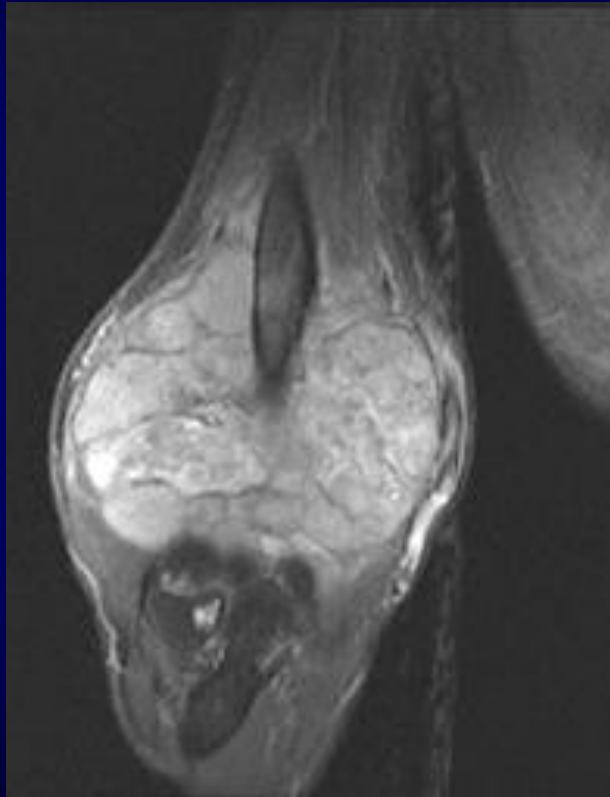
- patient in a strong magnetic field
- multiplanar imaging
- excellent soft tissue contrast
- ideally suited for MSK



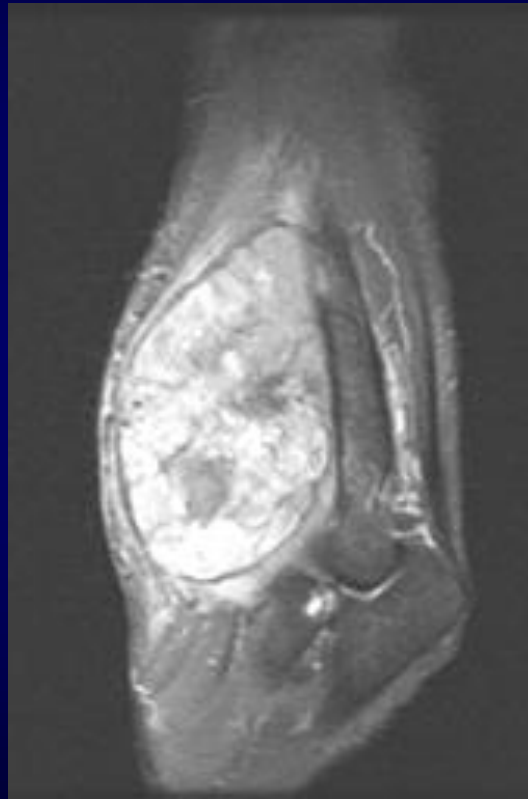


# MRI

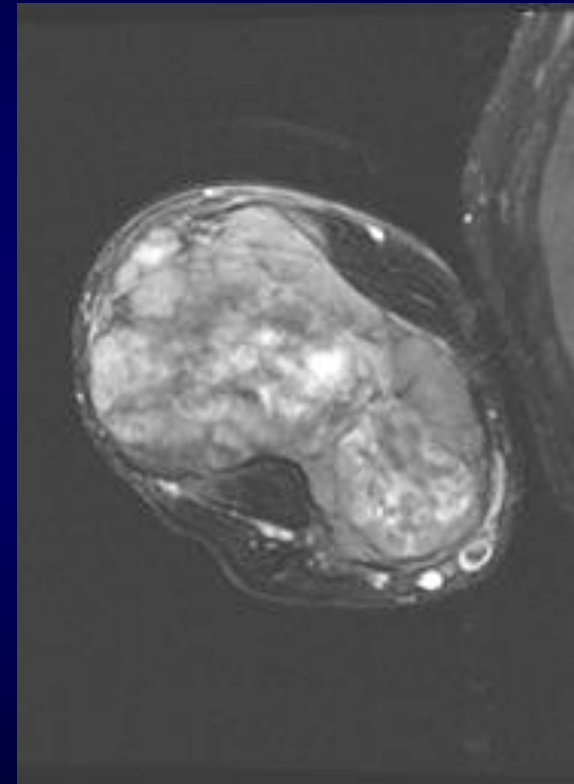
coronal



sagittal



axial

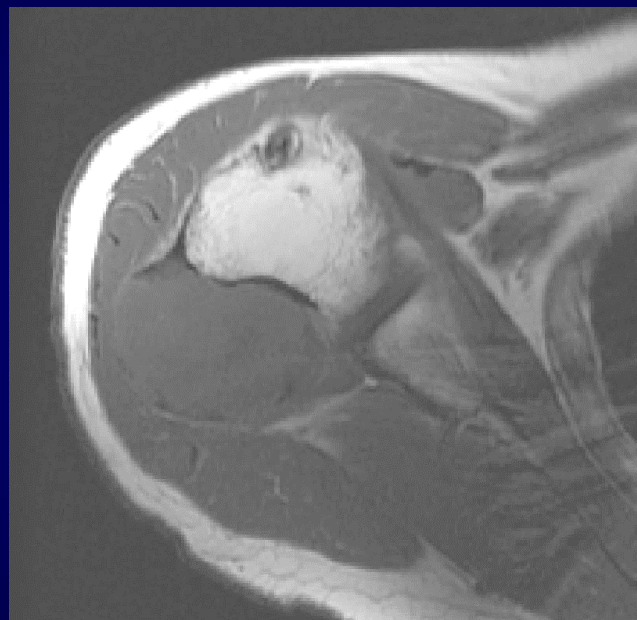


# MRI

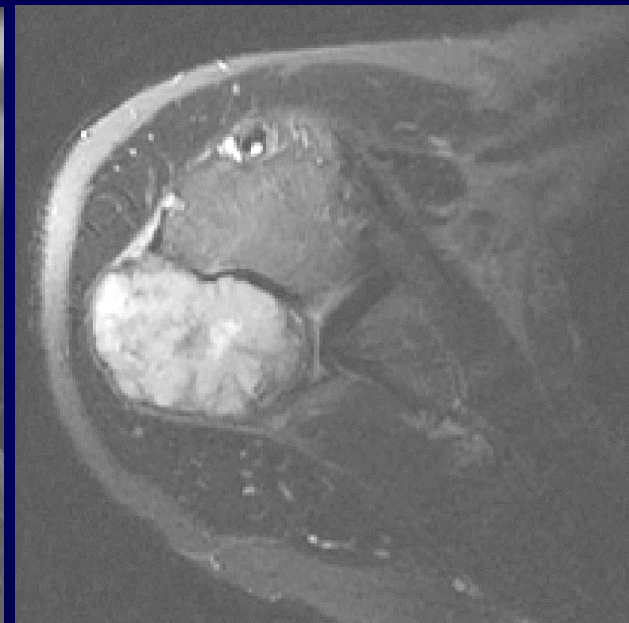
CT



MRI T1

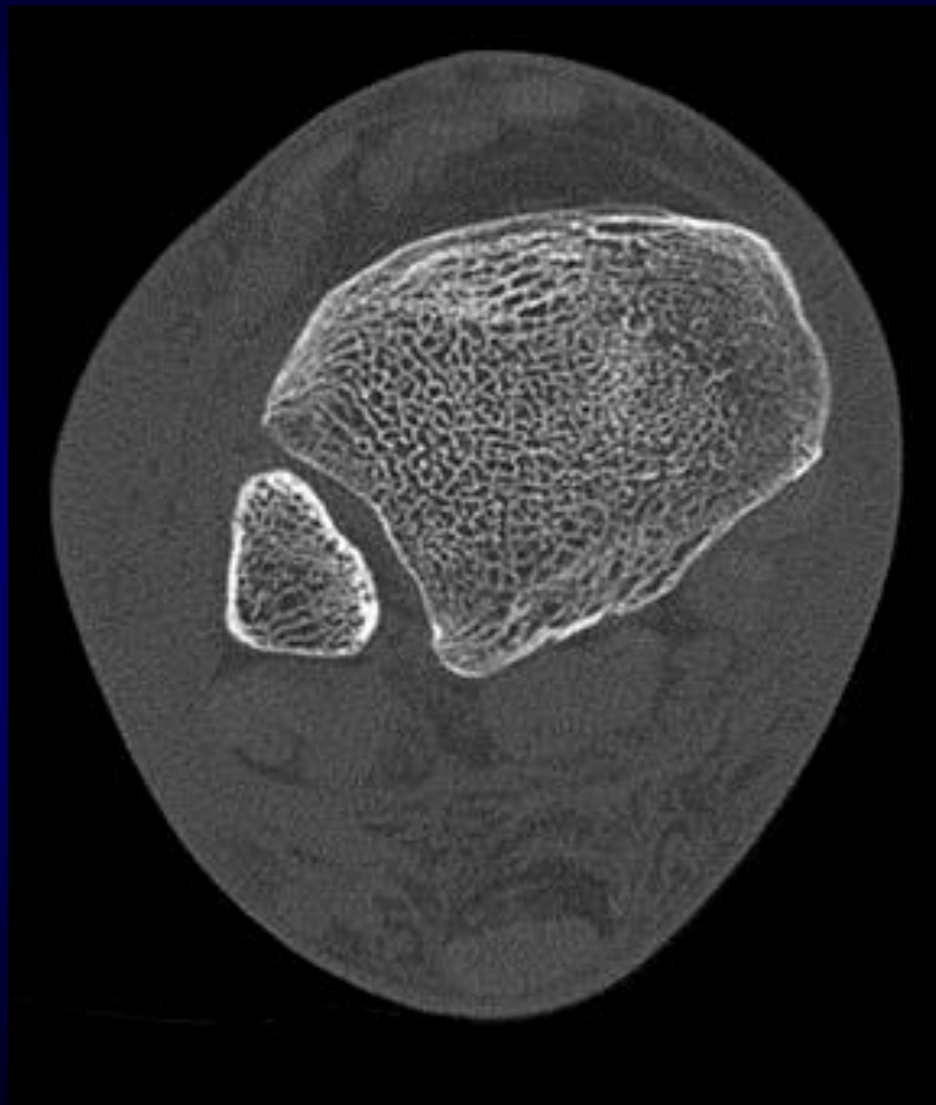


MRI T2 fat sat

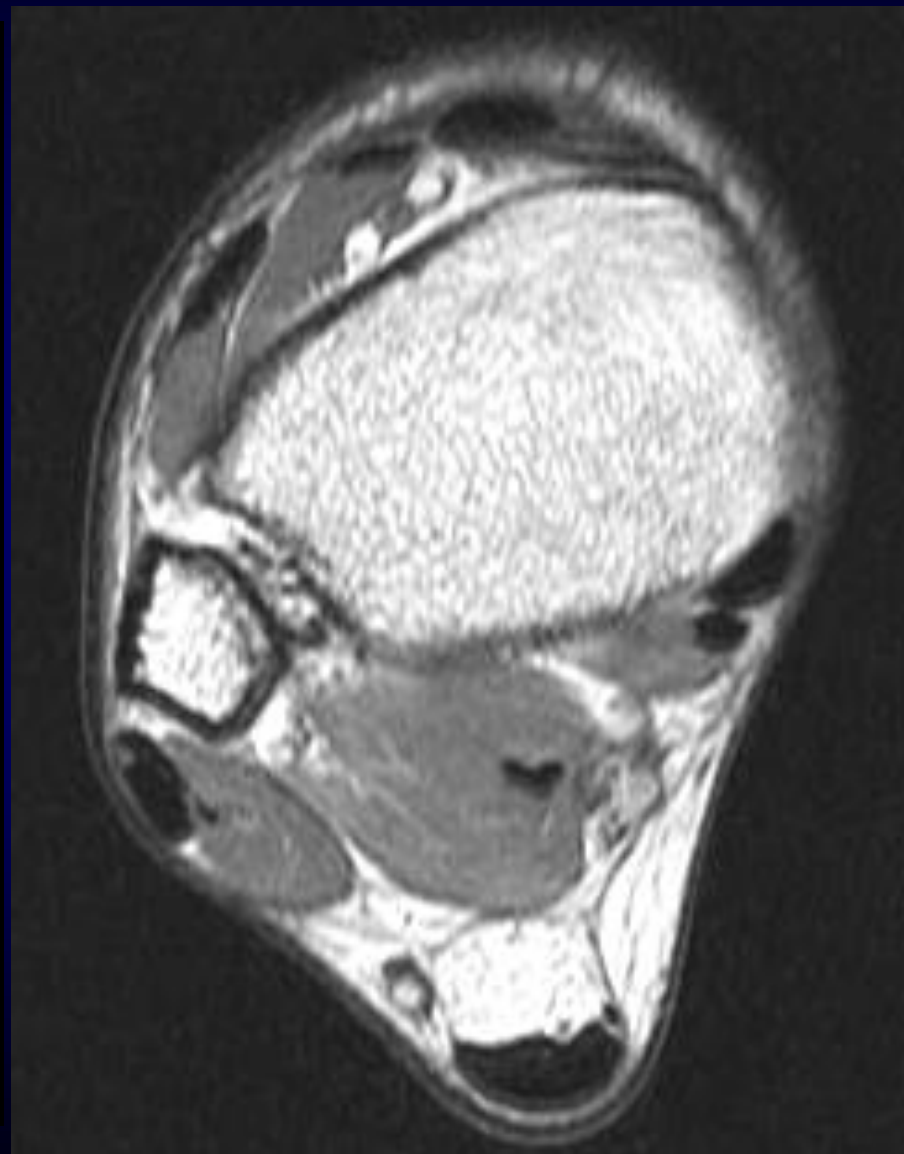


Soft tissue contrast

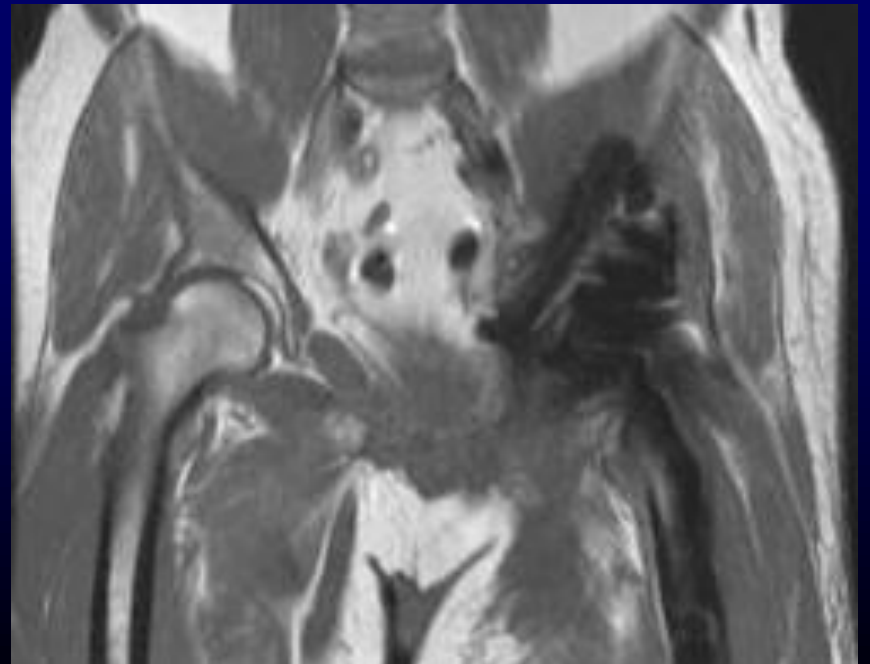
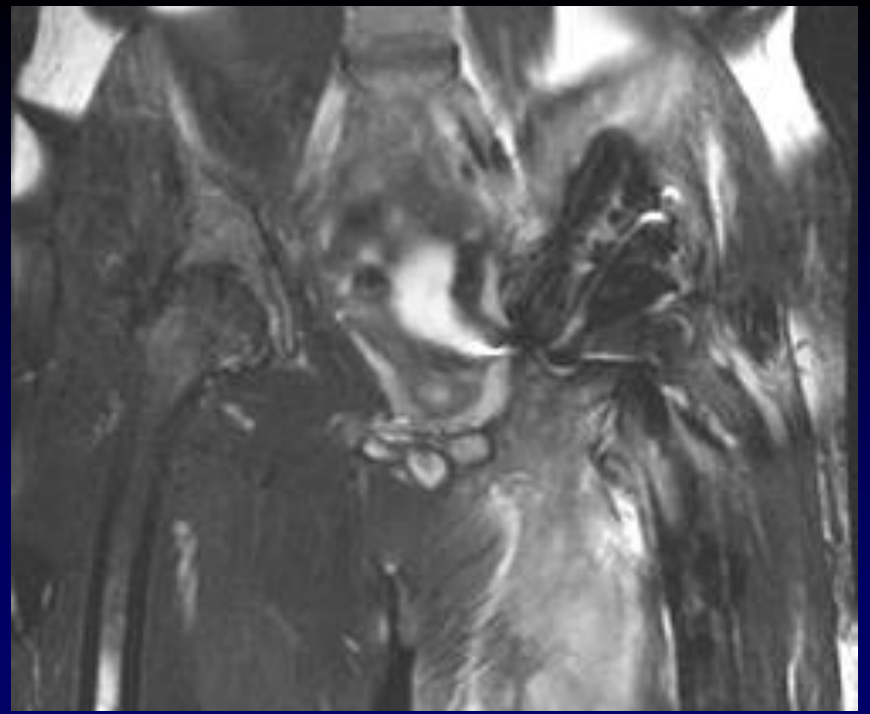
**CT**



**MRI**

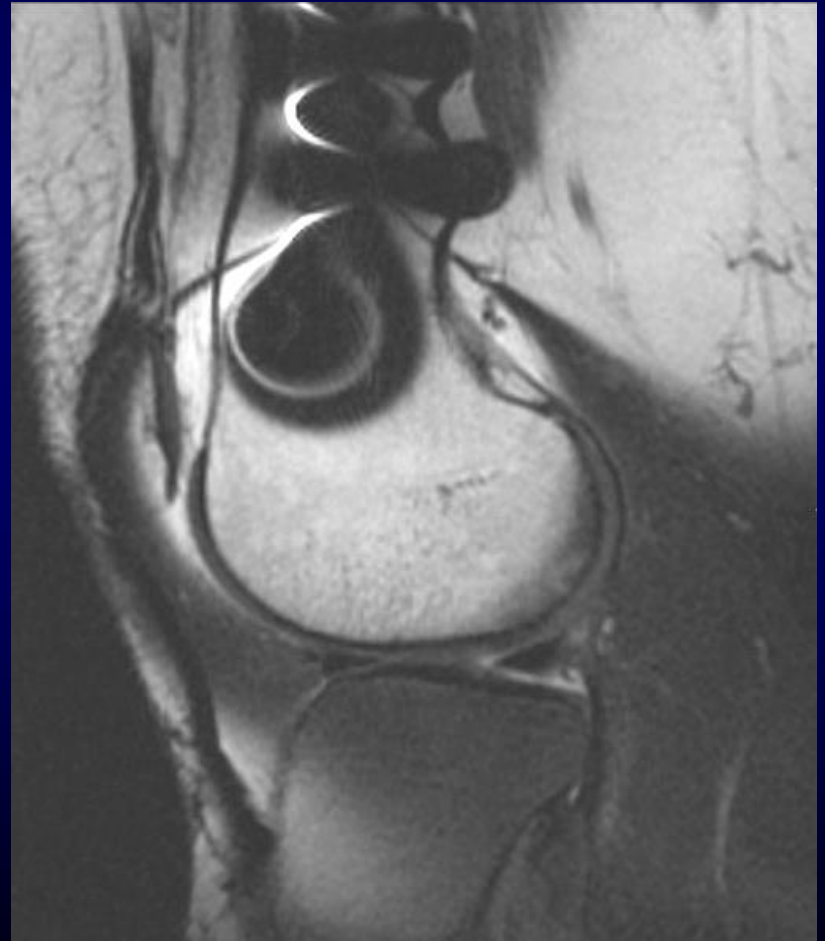


# MRI



# MRI

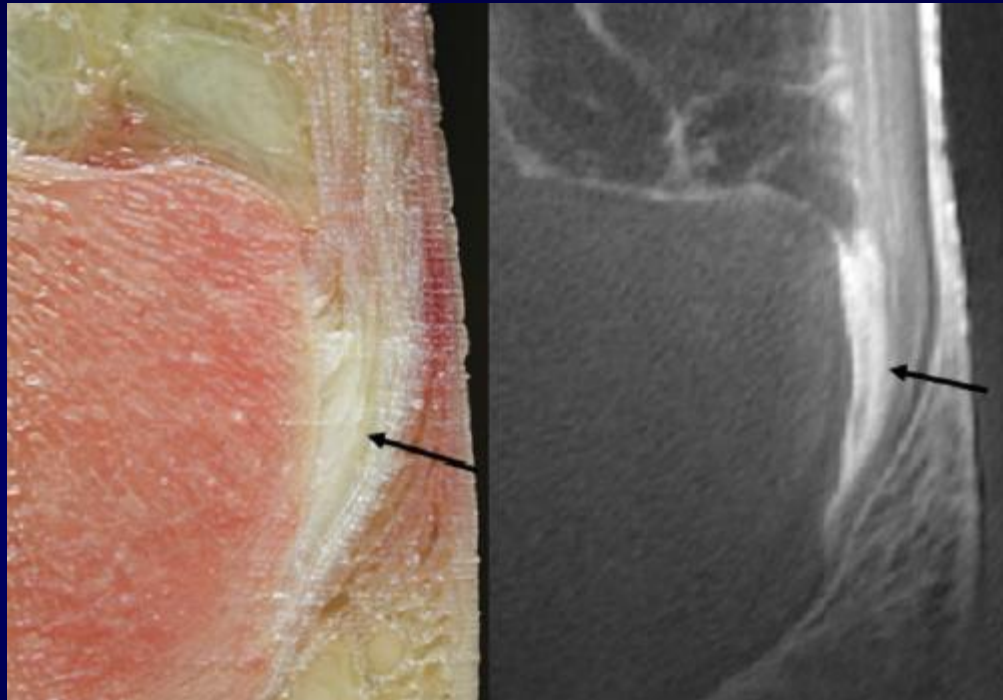
## Metallic Artifact



# MRI

## Ultrashort TE Pulse Sequences:

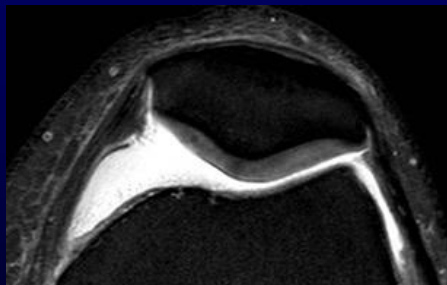
- Imaging of fibrocartilage at enthesis



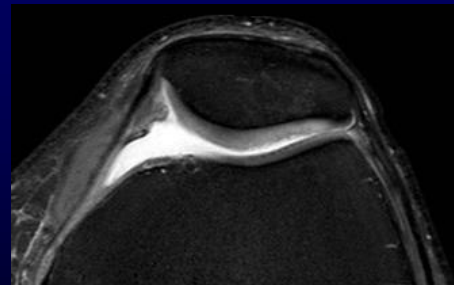
Benjamin M, Bydder G. Magnetic Resonance Imaging of Entheses Using Ultrashort TE (UTE) Pulse Sequences. JMRI 2007;25:381-389

# MRI

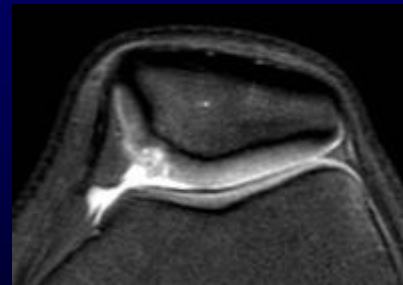
- Cartilage
- Laminar appearance
- Reflect variation in T2 values across the cartilage



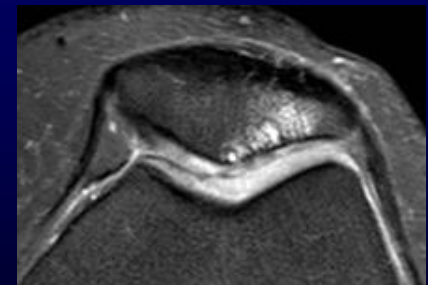
Grade 1



Grade 2



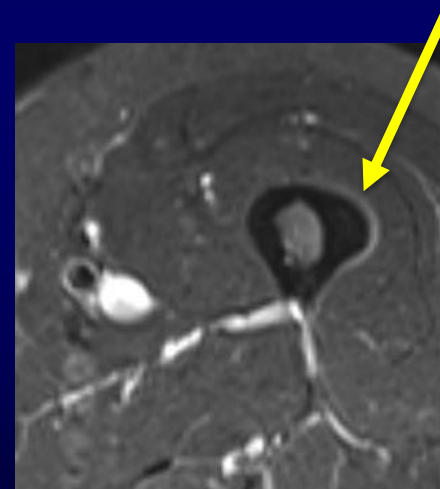
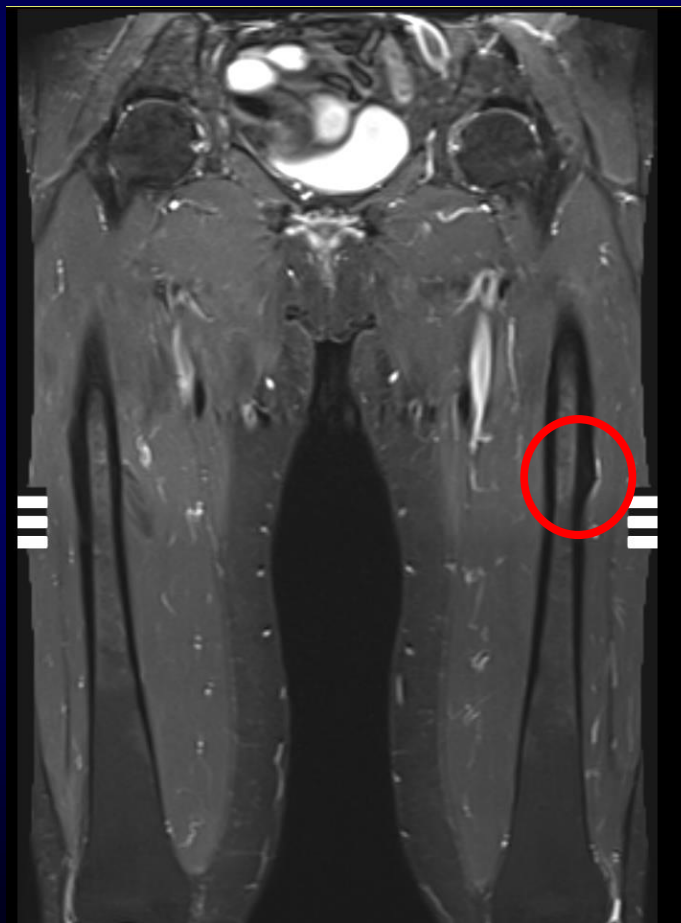
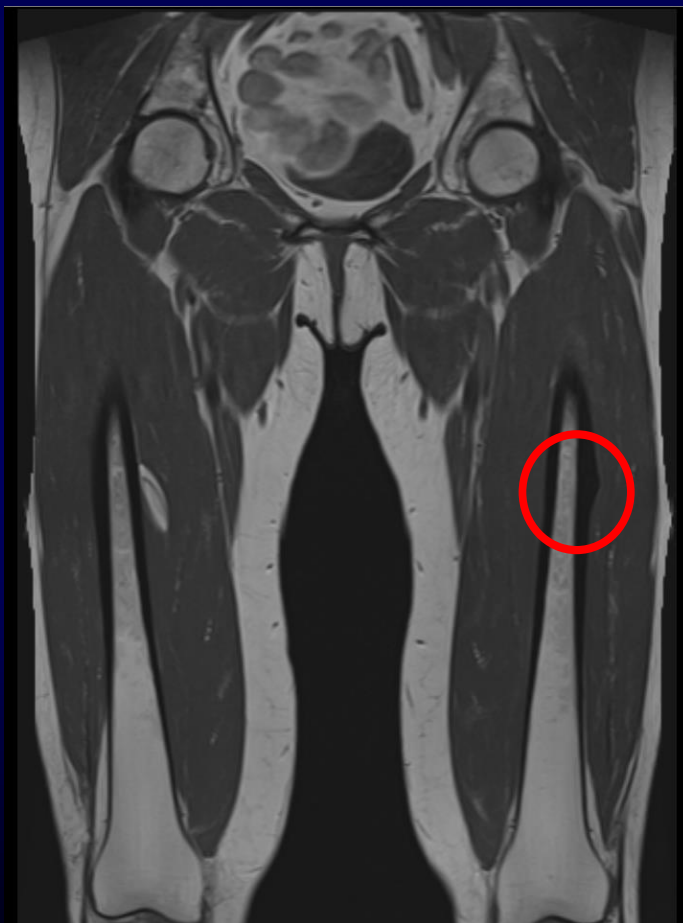
Grade 3



Grade 4

# MRI

- AFF











# Imaging of Early Inflammatory Arthritis

- Radiographs:
  - Gold standard
  - Cannot detect pre-erosive inflammatory change

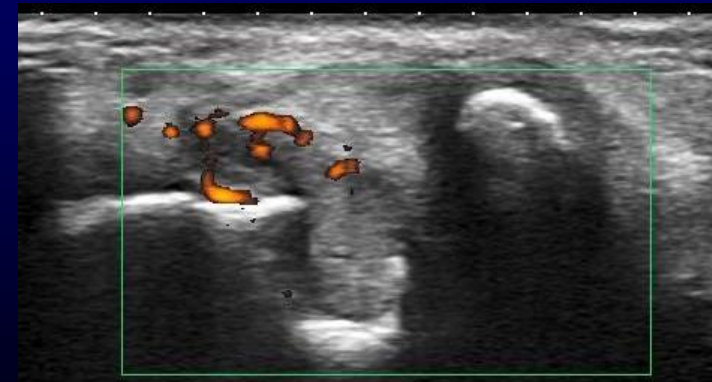


# Imaging of Early Inflammatory Arthritis



# Imaging of Early Inflammatory Arthritis

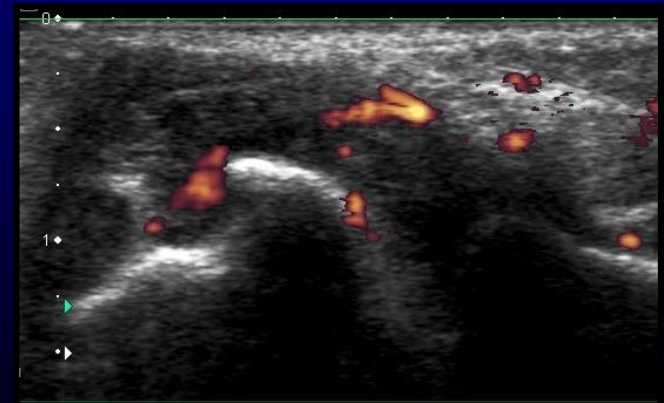
- MRI and US
  - Excellent soft tissue contrast
  - Direct visualization of synovitis and erosions



# Erosions/Synovitis

## Ultrasound

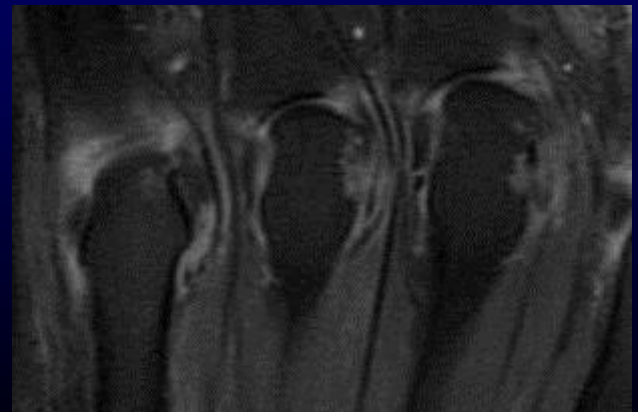
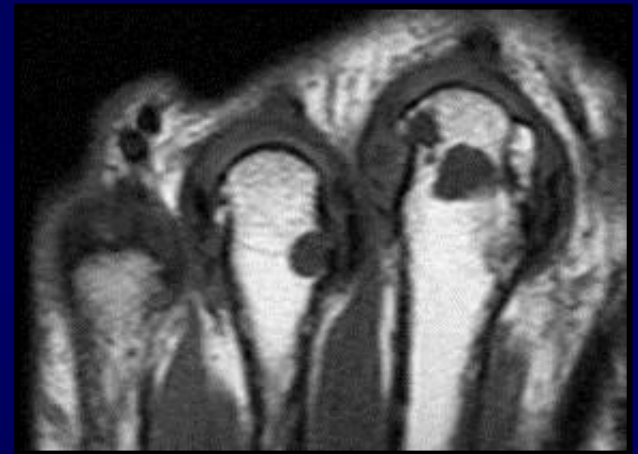
- Margins of joints
- Associated with synovitis
- New microvascular imaging



# Erosions/Synovitis

## MRI

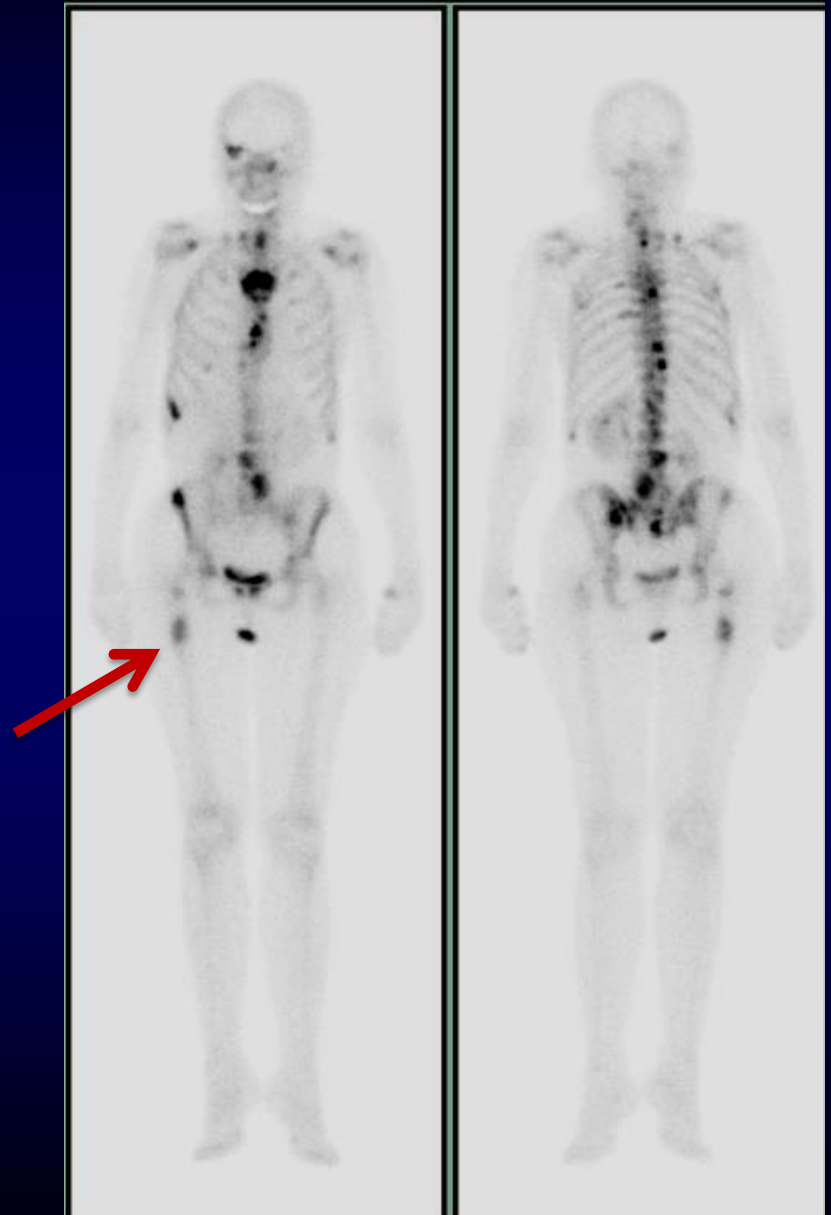
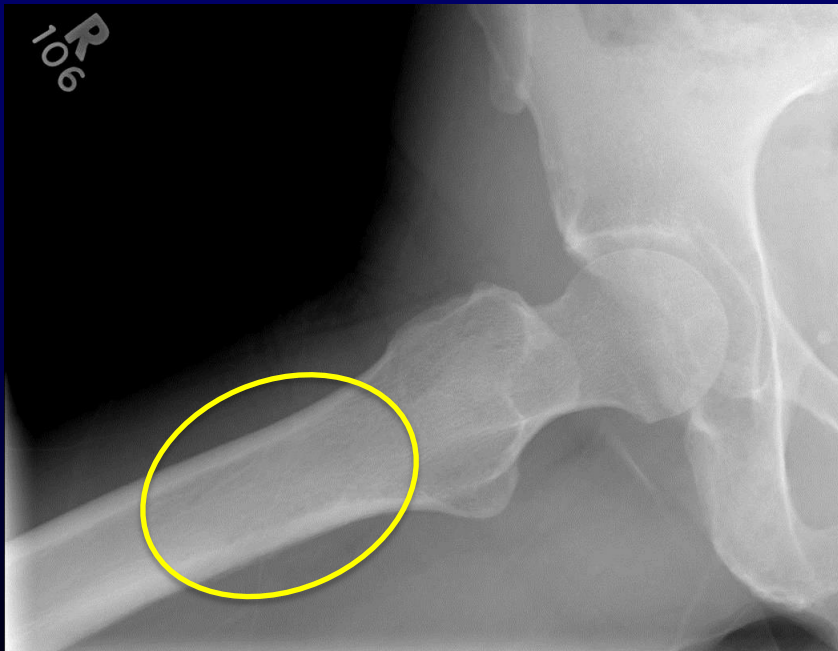
- Juxta-articular
- Synovitis, enhancement
- Gadolinium
  - ↑ sensitivity
  - Differentiate effusion vs. synovitis
  - ↑ cost





# Nuclear Medicine

- Bone scan
- Very sensitive, not specific



# Nuclear Medicine

- ‘Non-specific uptake xiphoid process region of the sternum. Correlation with clinical examination suggested.’
- ‘Unless there has been trauma to these sites I cannot exclude metastatic disease and further radiologic correlation is recommended.’
- ‘This likely represents a normal variant, however, correlation with x-ray is recommended to rule out loosening or other pathology.’
- ‘Clinical correlation and further investigation with a left shoulder radiograph is recommended.’
- ‘Suspected degenerative change midcervical spine, radiograph would be confirmatory.’
- ‘Possible traumatic injury to the sternoclavicular joints bilaterally. Radiographic correlation is recommended.’
- ‘Mild focal activity within the left acetabulum anteriorly which is non-specific and could be related to either degenerative changes or a metastatic deposit.’

# Nuclear Medicine

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- ‘Possible traumatic injury to the sternoclavicular joints bilaterally. **Radiographic correlation** is recommended.’
- ‘Mild focal activity within the left acetabulum anteriorly which is **non-specific** and could be related to **either degenerative changes or a metastatic deposit.**’

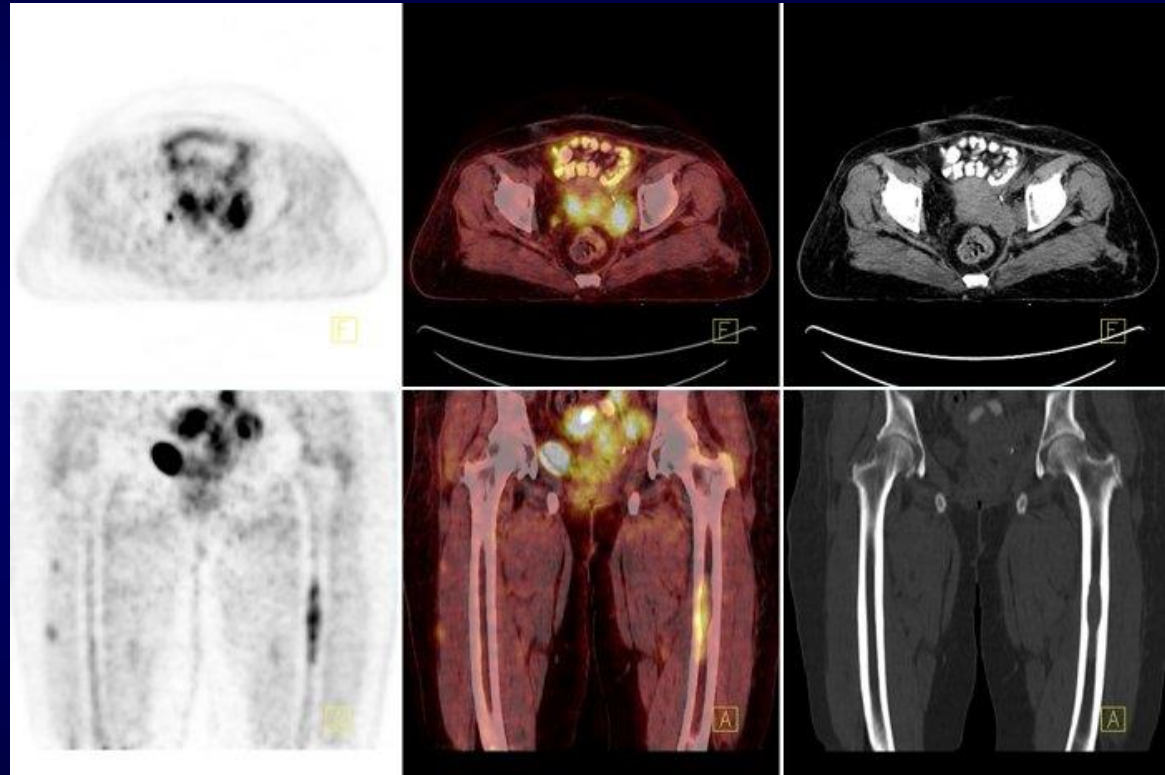
# PET

- Positron emission tomography
- Functional imaging for metabolic processes
- Demonstrates biologically active molecules



# PET CT

- Fusion of metabolic and anatomic information



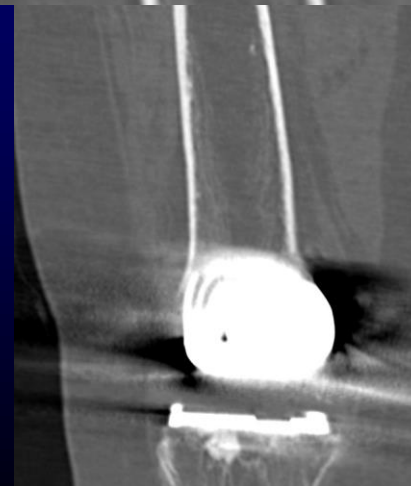
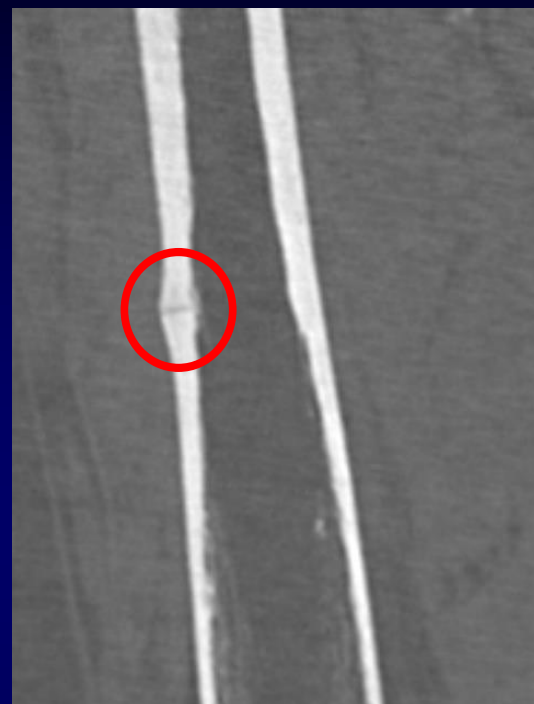
Ozdemir E, Poyraz NY, Uzun B, Turkolmez. Fluorodeoxyglucose positron emission tomography (FDG PET/T) for the detection of skeletal muscle and skin metastases in uterine leiomyosarcoma: A case report. *Rev Esp Med Nucl Imagen Mol* 2013;32(4):257-259.

# Nuclear Medicine

- Bone Density



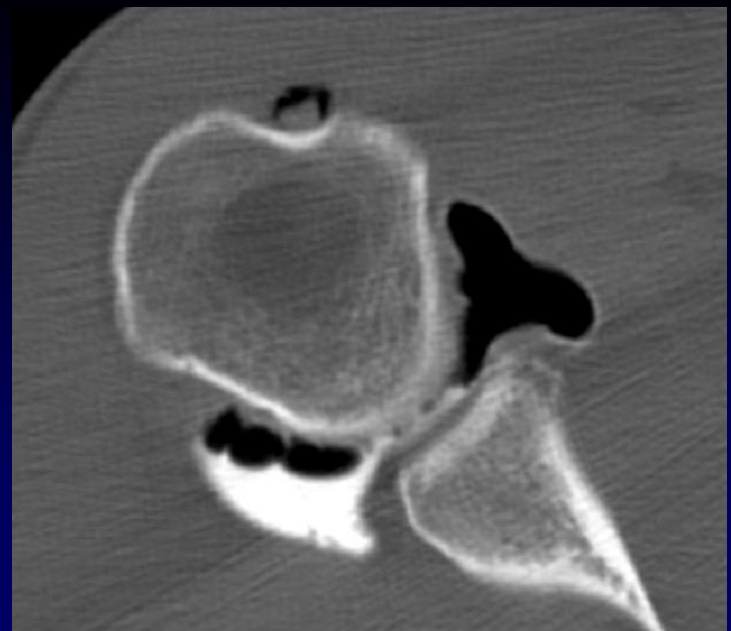
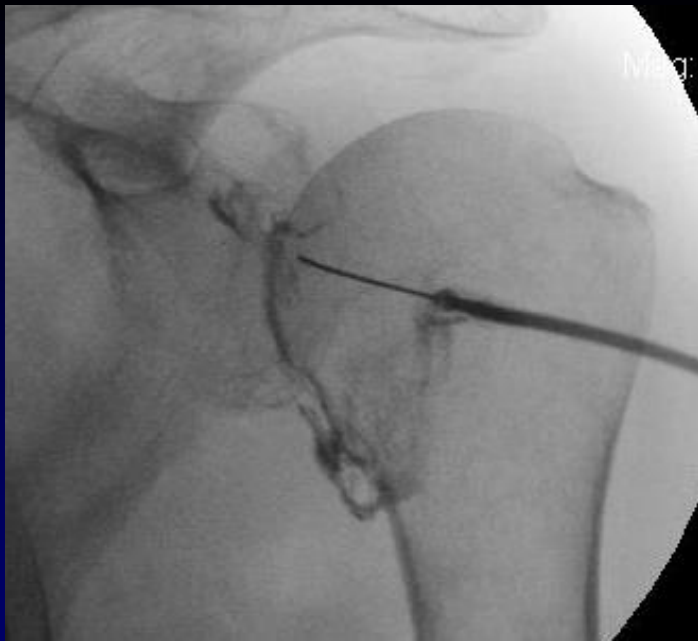
# Nuclear Medicine

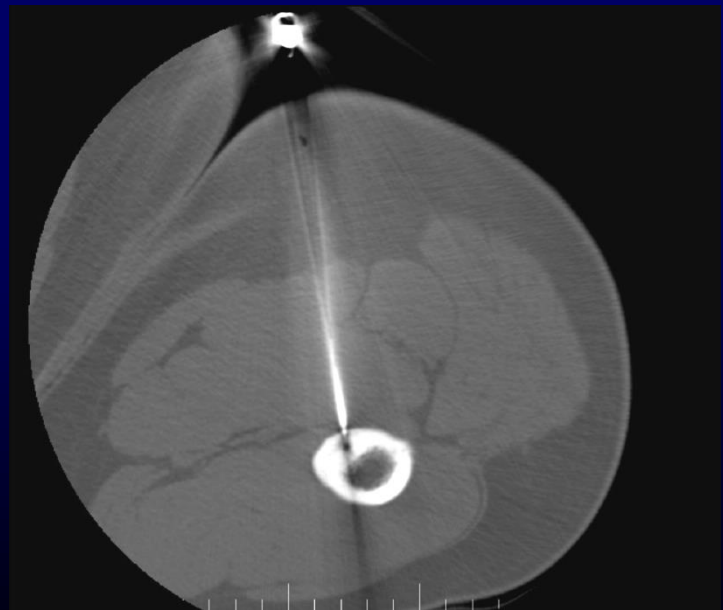
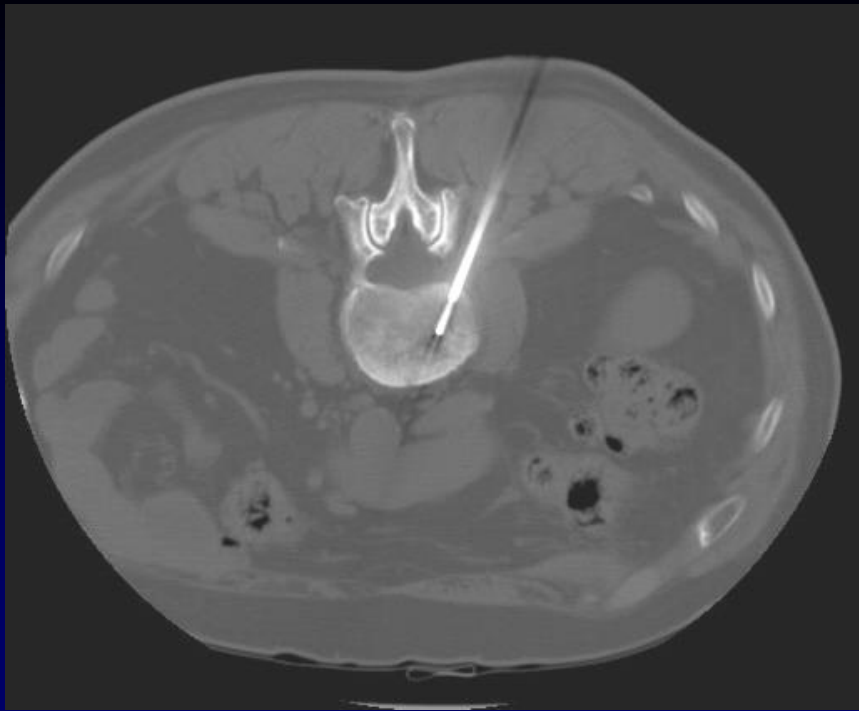


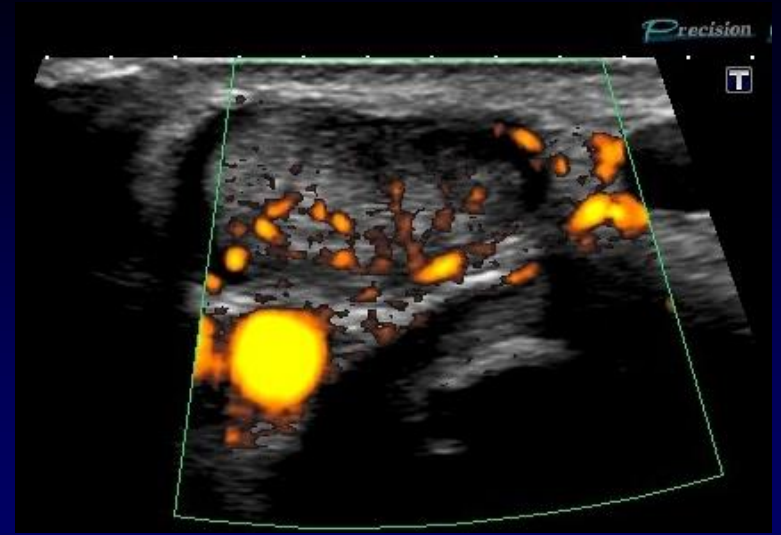
# Interventional

- Arthrography
- Joint injections and aspiration
- Biopsy
  - ultrasound guided
  - CT guided
- Spinal intervention
  - nerve root blocks
  - facet joint injections
  - discograms







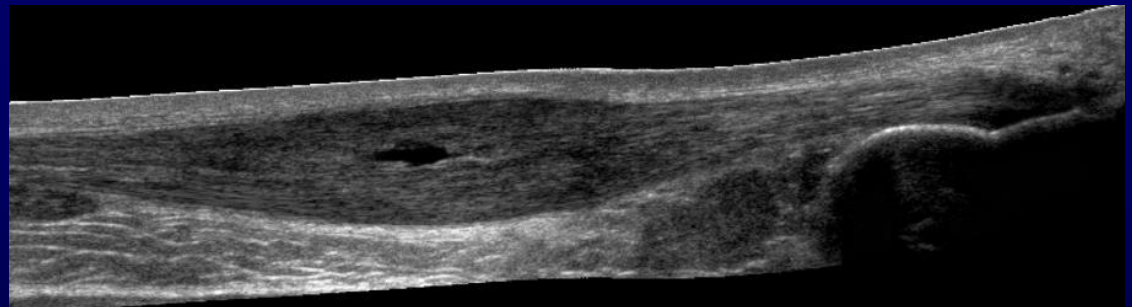


# Interventional

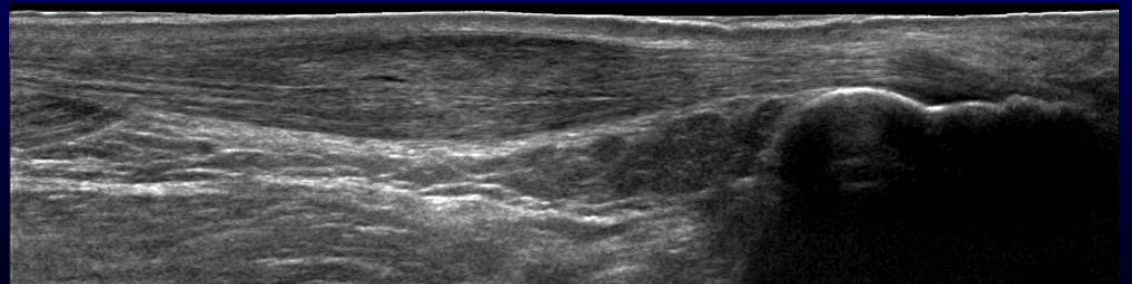
- Ultrasound
  - Dry needling
  - Steroid
  - PRP
  - Fibroblast



Pre

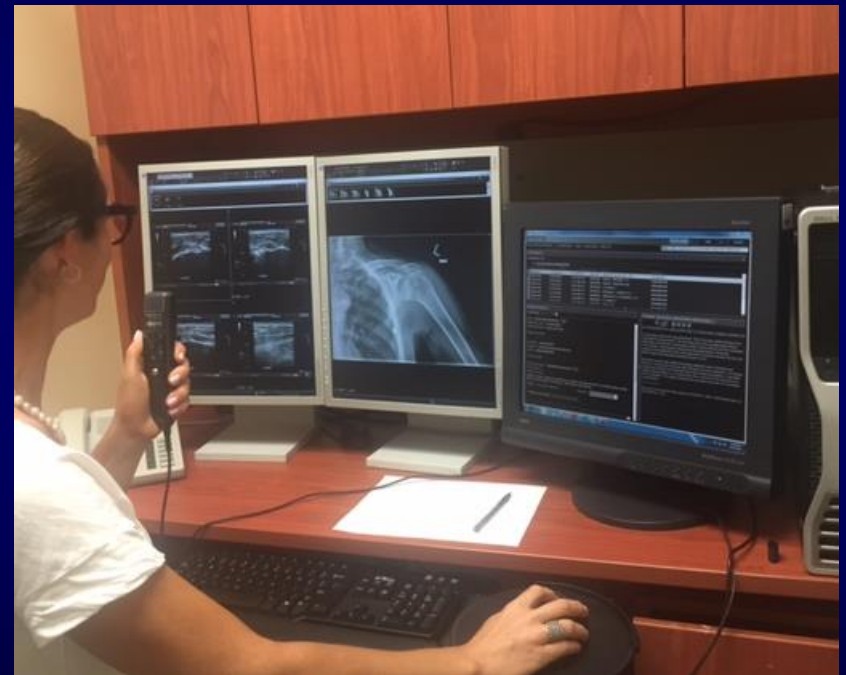


Post



# Quality

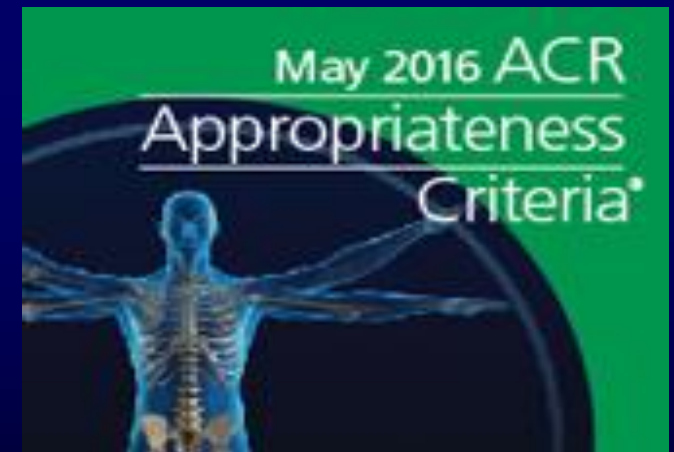
- Store images (PACS)
- Compare with previous & other imaging



# Quality

## Appropriateness criteria

- Evidence based guidelines
- Appropriate imaging and treatment decisions for specific clinical conditions



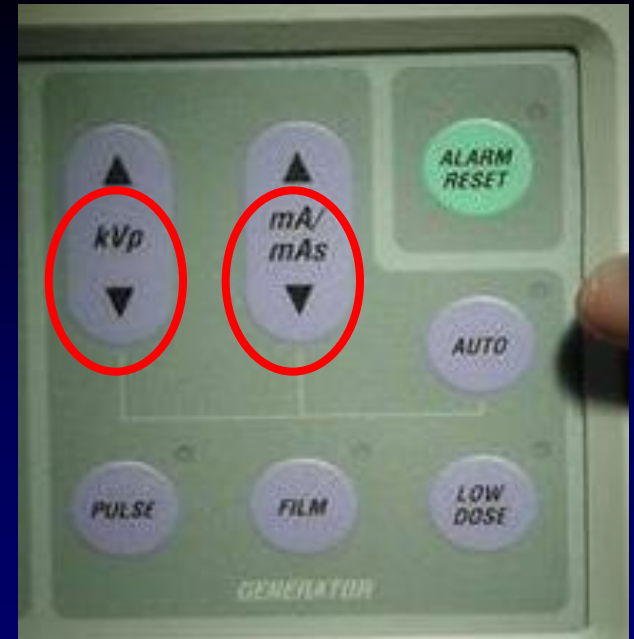
# Quality

- Aim to decrease radiation and eliminate unnecessary procedures

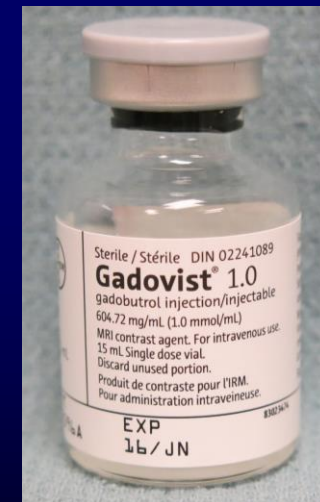
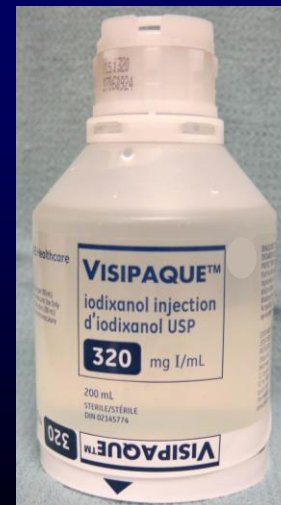


# Quality

- Radiation
  - Dose reduction techniques
  - CT – reconstruct images



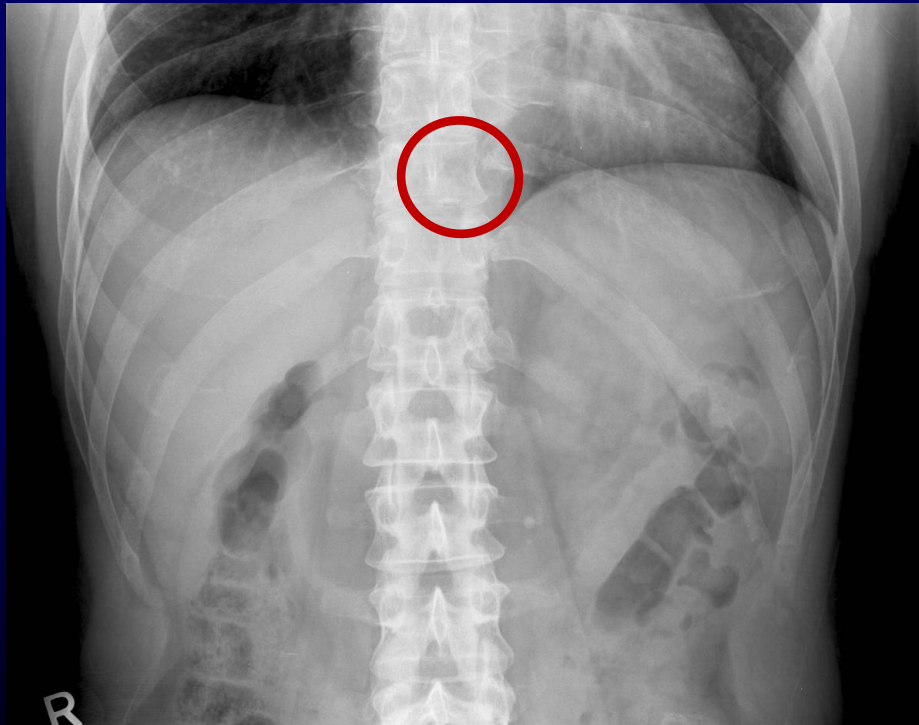
- Contrast Agents
  - CT & MRI
  - Much safer





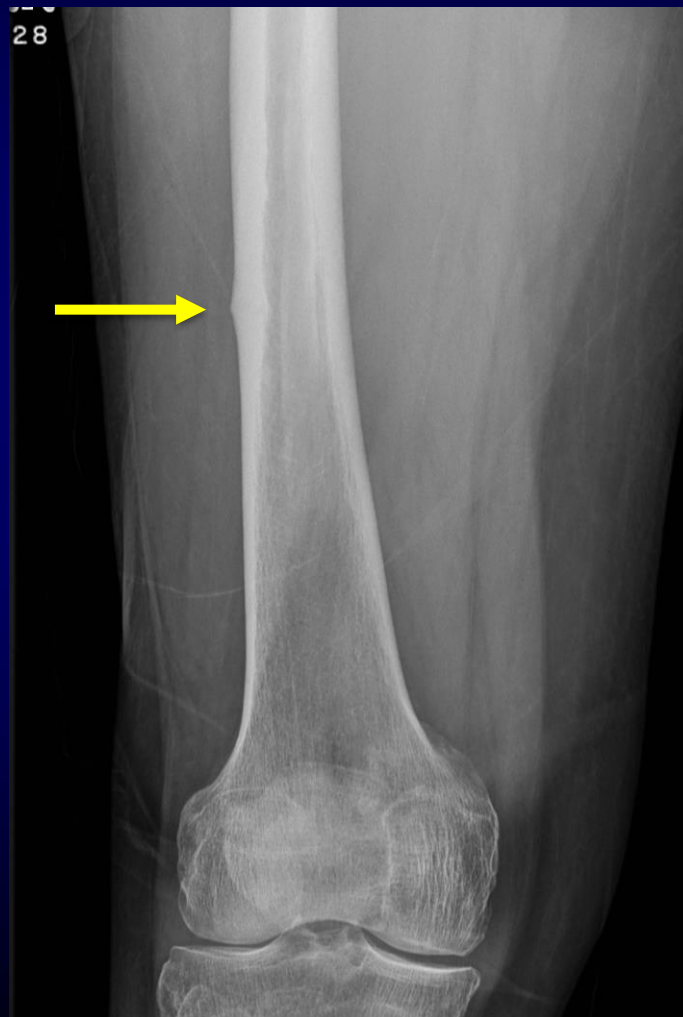
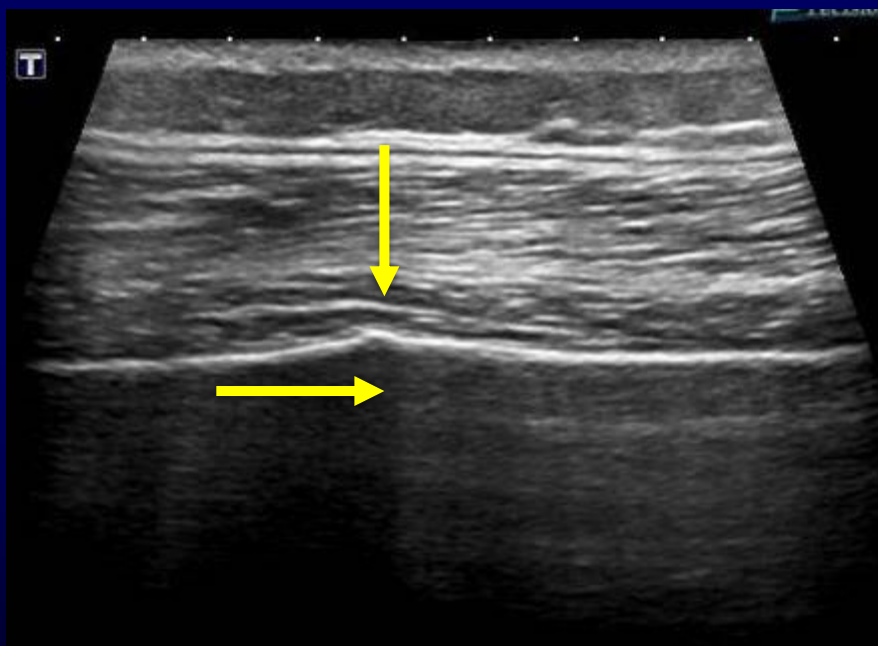
# Plain Films

- Basic concepts



# Unexpected Findings

- AFF on ultrasound





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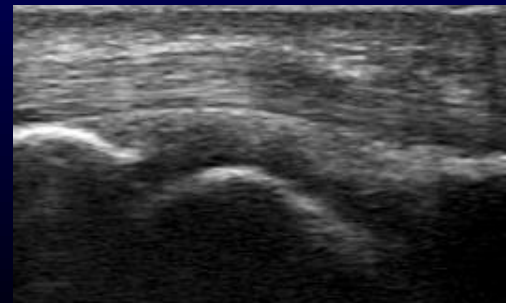




**“You see, Ms. Jenkins, by doubling up on patients in the MRI, we’re able to cut costs in half, thereby passing the savings on to you.”**

# Summary – Take Home Points

- Advancements in ALL imaging modalities
- Improved patient care & safety
- Need to maintain high quality
- Consideration for cost



The End

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