Basic Principles, Echo Signature of Ultrasound Structures

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Disclosure

- Non-Declaration Statement: I have no relevant relationships with ineligible companies to disclose within the past 24 months.

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Acknowledgement

- Jacobson, Jon. Fundamentals of Musculoskeletal Ultrasound. 3rd Ed. 2018
- Shane Shapiro, MD
- Evan Peck, MD

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Objectives

- Review basic physics of US imaging
- Discuss Pros/cons of US transducers commonly used in MSKUS
- Identify common soft tissue structures with MSKUS

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Introduction

- Growing in popularity and acceptance
- # of exams growing be 10-20% annually
  - Working to be on sidelines of pro sports teams
  - New users: surgeons, rheumatologist, POCUS, sports medicine, radiologist (bone), chiropractors
- Economics
  - Costs of MRI an CT
  - U/S image quality is better on more affordable equipment
  - New users are looking ways to improve clinical practice

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Physics of US

- Sonography accomplished by pulse-echo technique
- US images are composed of many scan lines
- Pulse repetition frequency
  - Cycles/sec (Hz)
  - Beam enters and reflects

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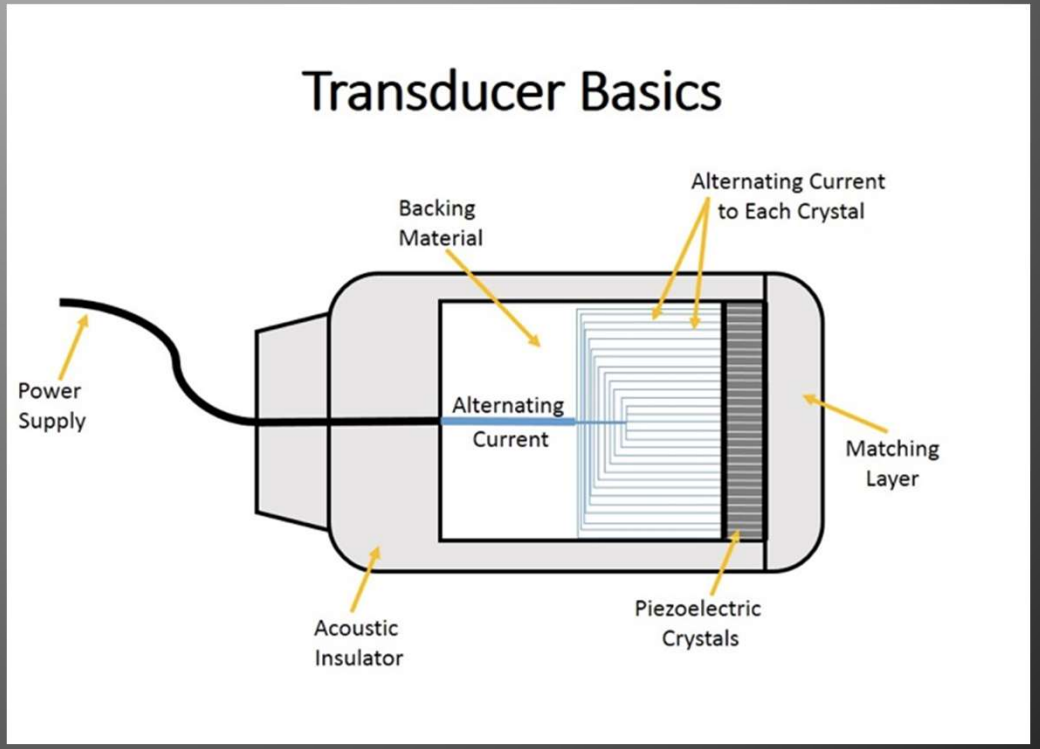
Physics of US

- Frequency of ultrasound waves
  - Pre-determined based on crystals in the transducer
  - Above that of human hearing



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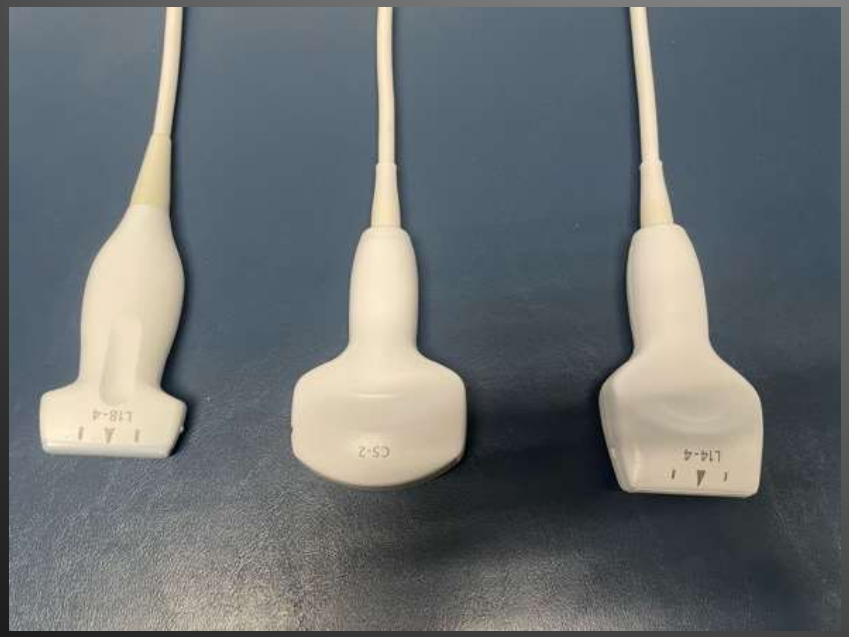
Physics of Ultrasound

- US transducers convert electric energy to US energy, and vice versa
- Avg propagation speed in soft tissue is 1.54 mm/µs
- Coupling gel facilitates US travel in/out of the body



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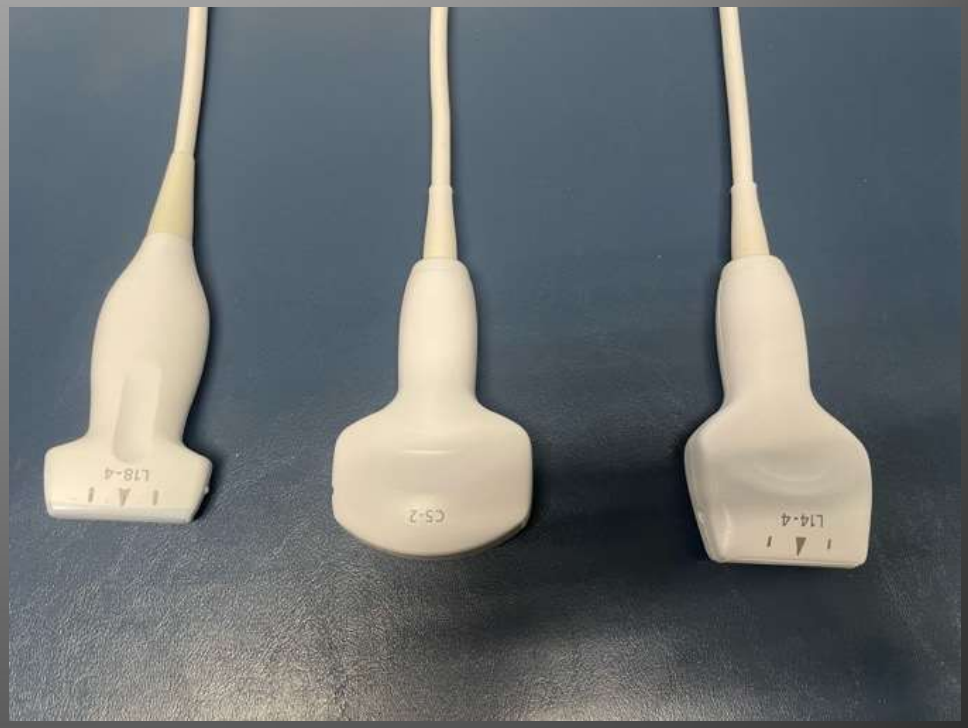
Broadband Transducers

- MSKUS
  - Linear
  - Curved Linear
  - Compact Linear
- Use a spectrum of frequency



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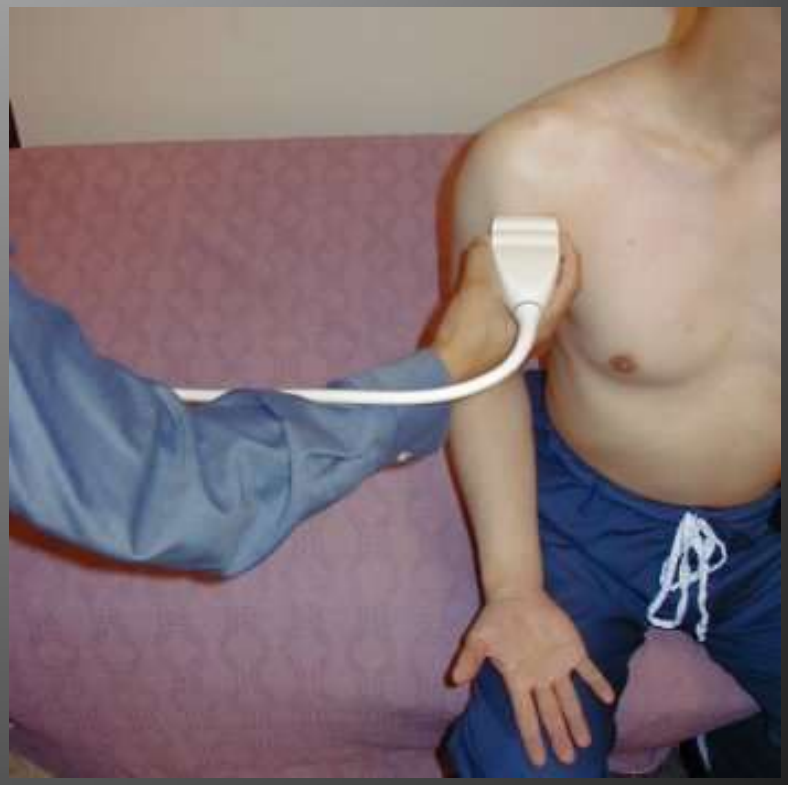
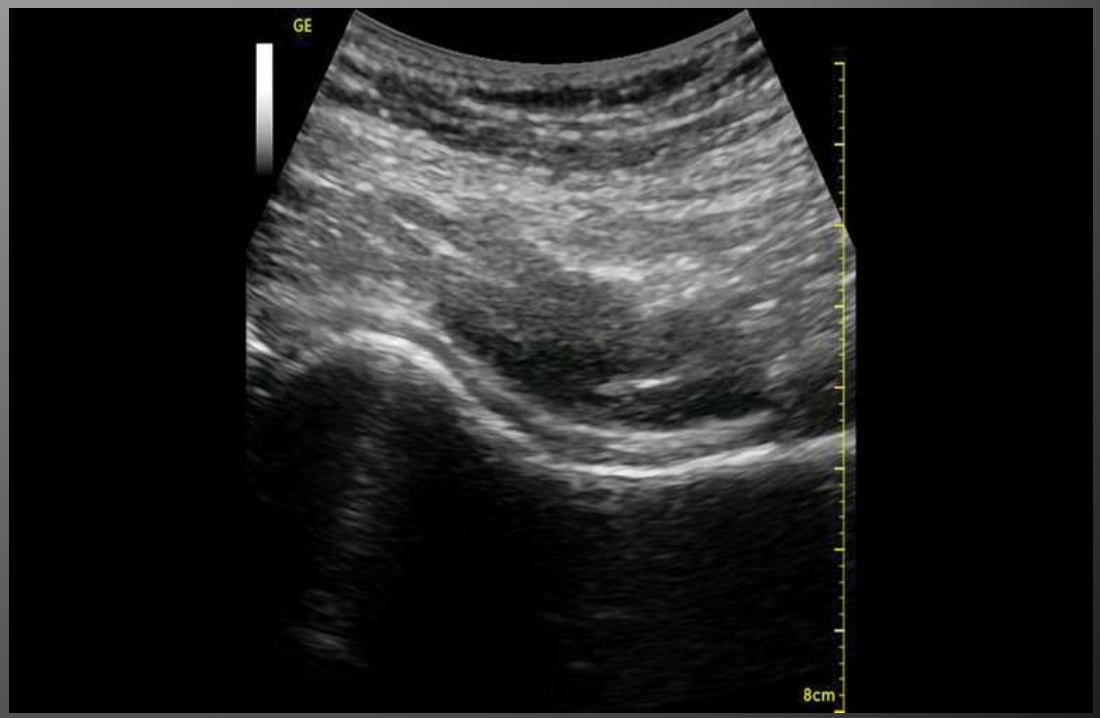
Linear Array

- High frequency
- High resolution
- Limited penetration
- Some with large FOV
- Better for dynamic imaging
- Workhorse probe



Curved Linear Array

- Lower frequency
- Lower resolution
- Better penetration
- Hips, shoulders



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Compact Linear (Hockey Stick)

- Very high frequency
- Very high resolution
- Superficial
- Limited field of view (FOV)
- Hand/wrist, foot/ankle

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Scanning Technique

- Hold with thumb and IF
- Stabilize with long, ring, small finger and palm
- Ergonomics
- Ambidextrous
- Small movements

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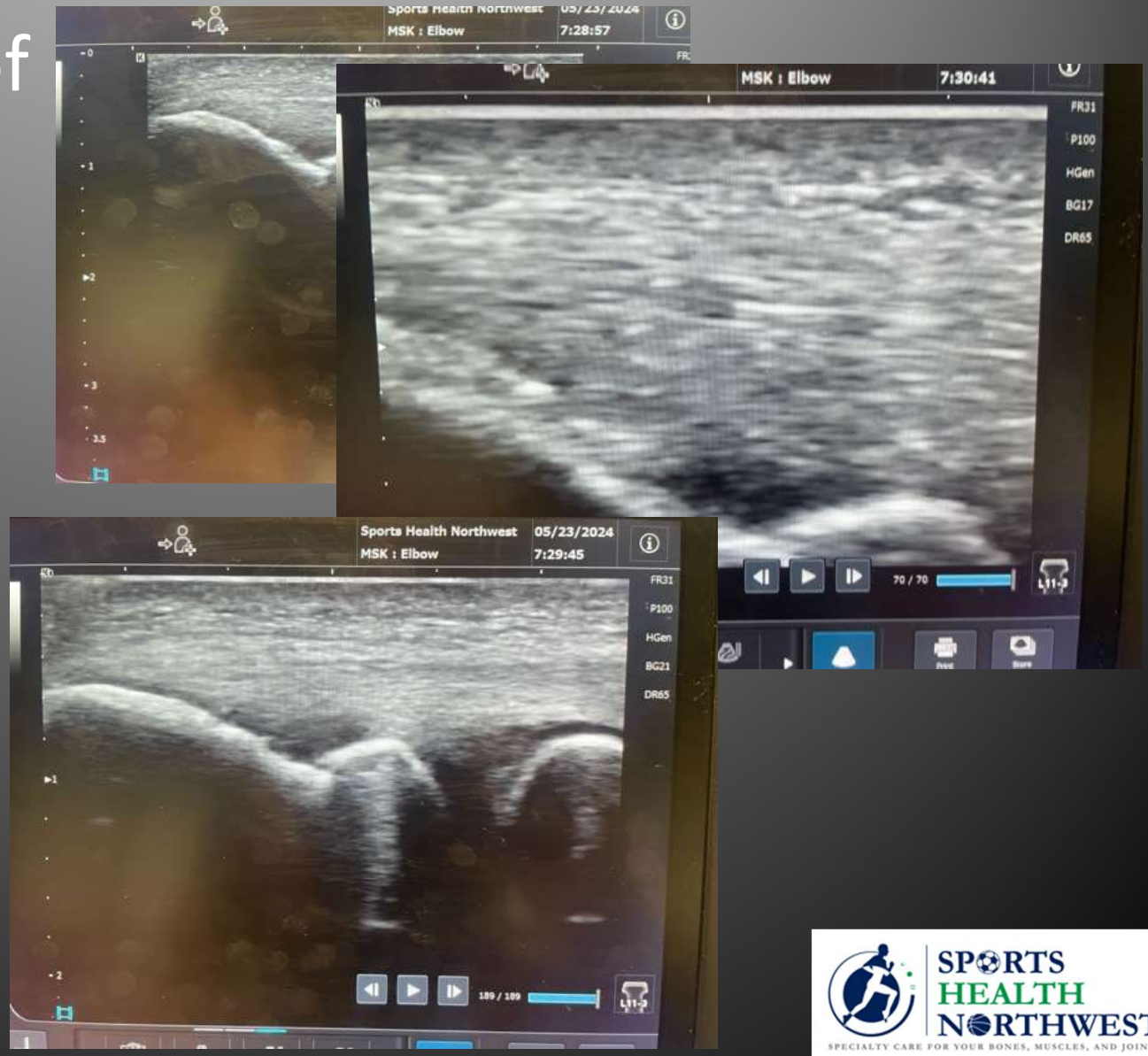
Variable Depth Imaging

- Center image of interest
- Adjust focal zones
- Adjust gain



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Anisotropy

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Anisotropy

Long head of Bicep Tendon in Short Axis

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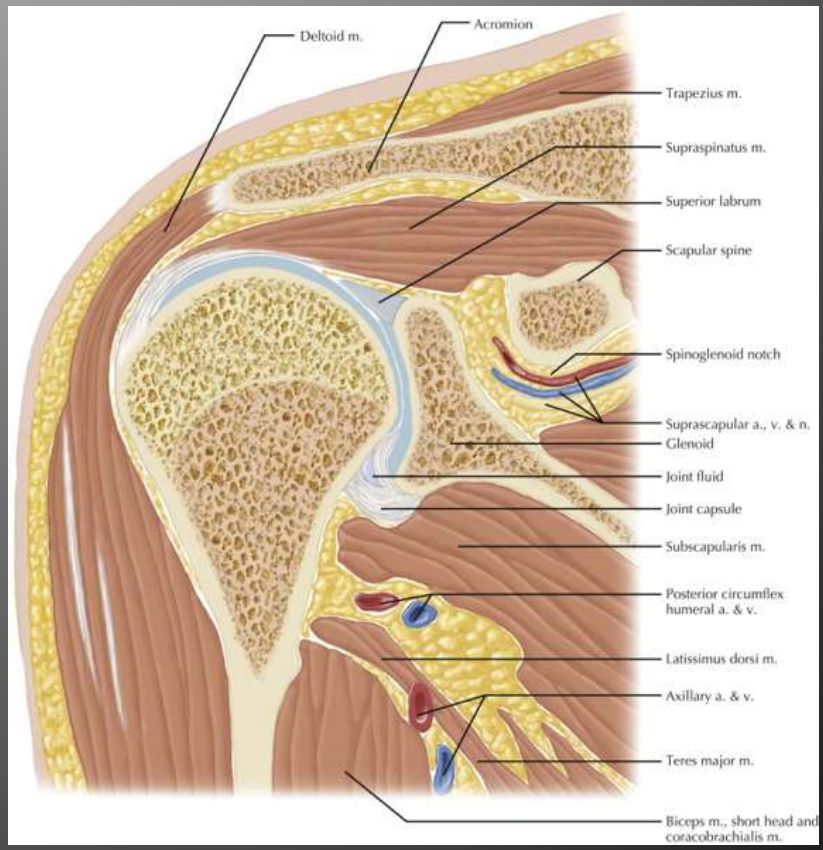
Standardize Vocabulary

- Anatomical Structures
  - Short Axis
  - Long Axis
- Imaging Planes
  - Transverse
  - Longitudinal

MSKUS

- Skin/subcutaneous tissue
- Tendons
- Ligaments
- Muscles
- Bursa
- Synovia
- Nerves
- Cartilage
- Bone cortex



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Tendons

- Connect muscle to bone
- Fibrillar pattern
- Bristle pattern
- Anisotropy
- Tendon sheath

Tendon

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Ligaments

- Bone to Bone
- Packed fibrillar pattern
- Capsule
- Effusion
- Cortical surface

MCL

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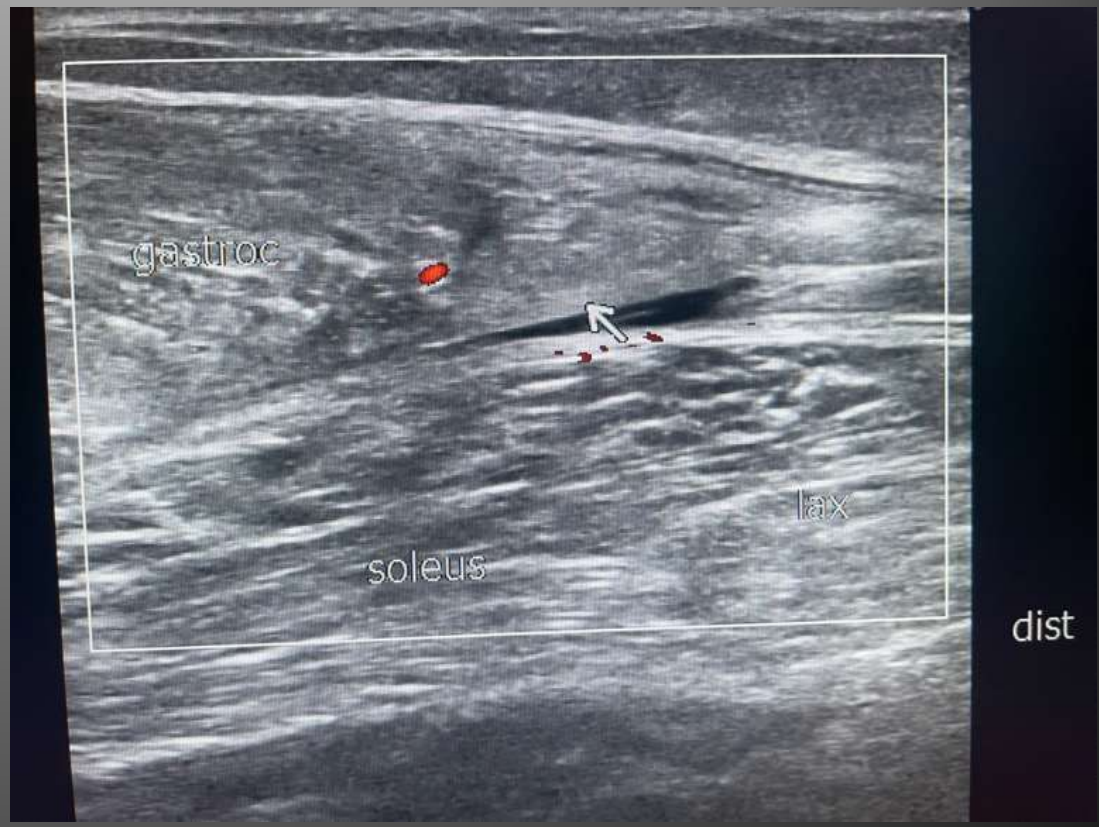
Muscles

- Septated
- Multipennate Pattern
- Starry Night Pattern
- Fascial Planes
- Complications



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Nerves

- Fascicular Pattern
- Follicular pattern
- Monotonous
- Hyper and hypoechoic
- Nerve sheath

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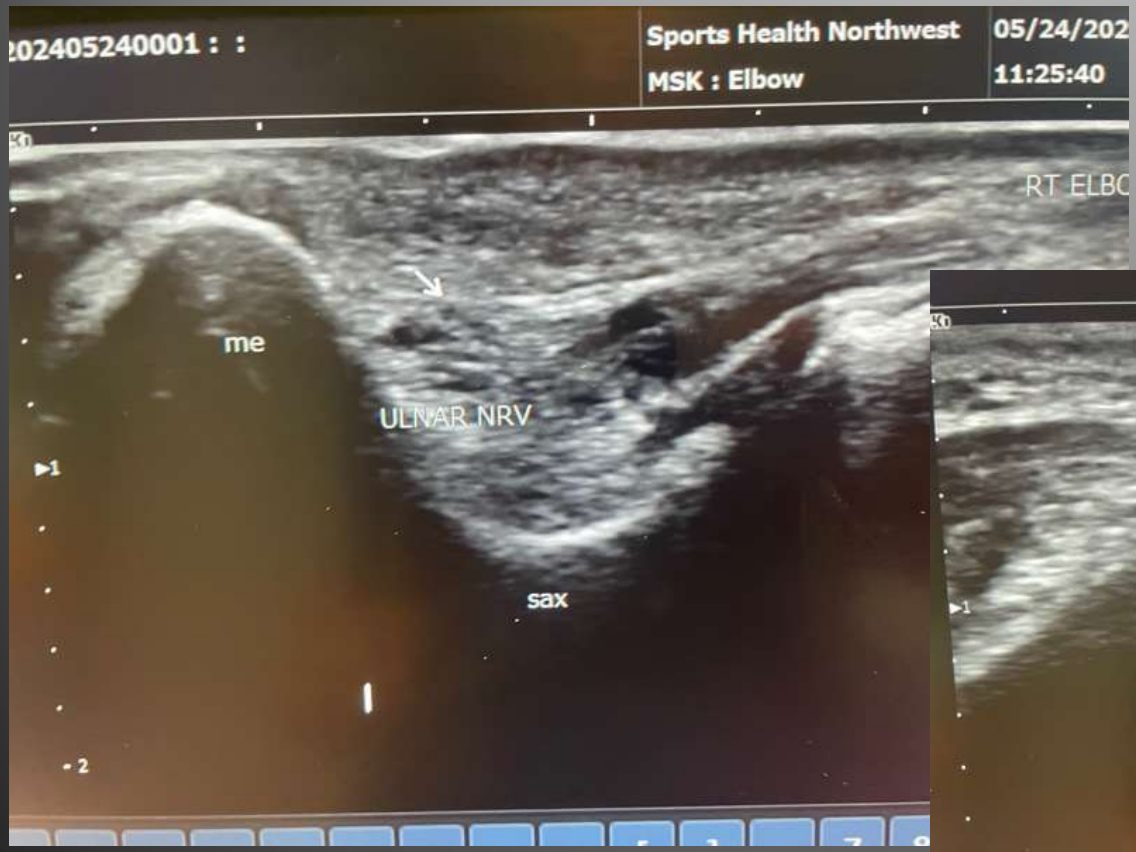
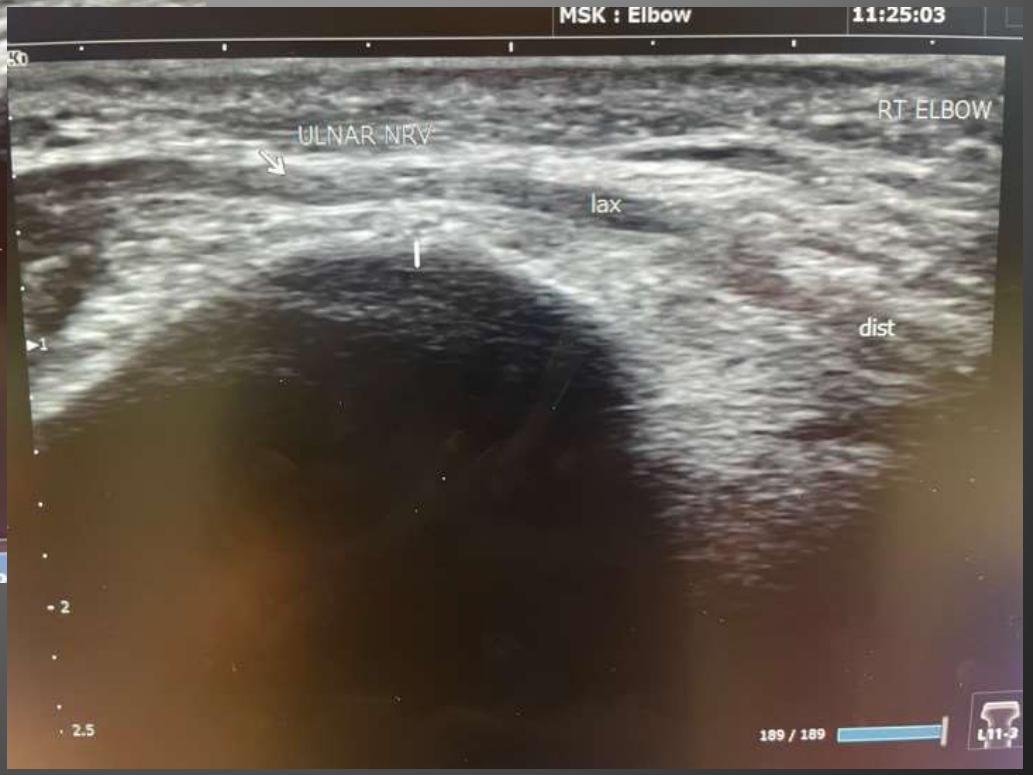
Ulnar Nerve





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Nerves

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Bursa/Cyst

- Virtual Spaces
- Effusion
- Anechoic or hypoechoic fluid
- Hyperechoic material in the bursa/cyst

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Cartilage

- Anechoic
- Not to confuse with fluid or tendon tear

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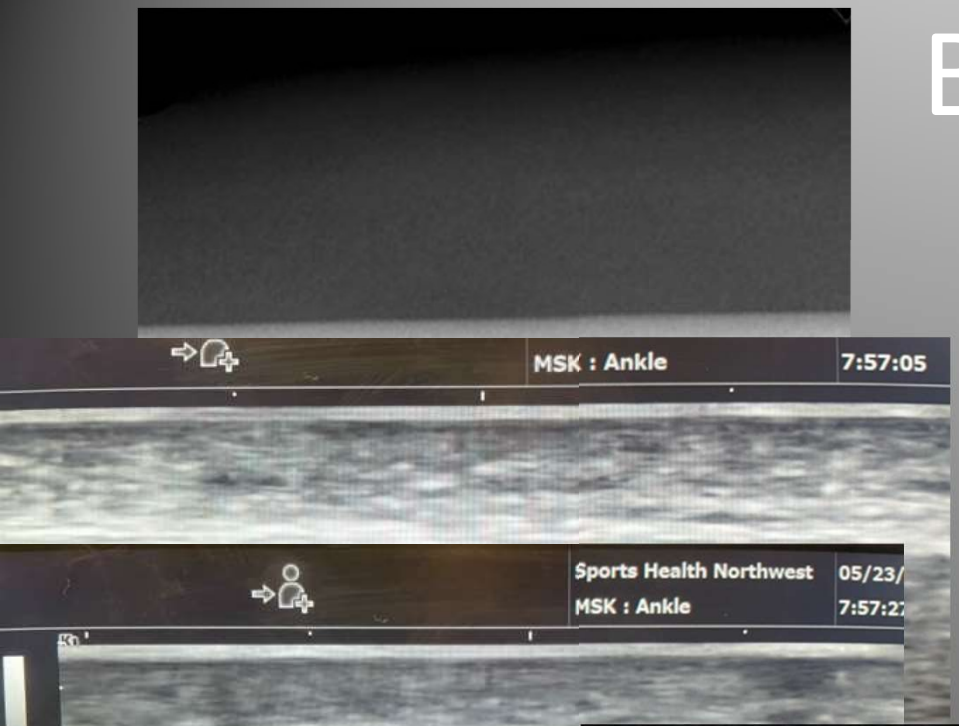
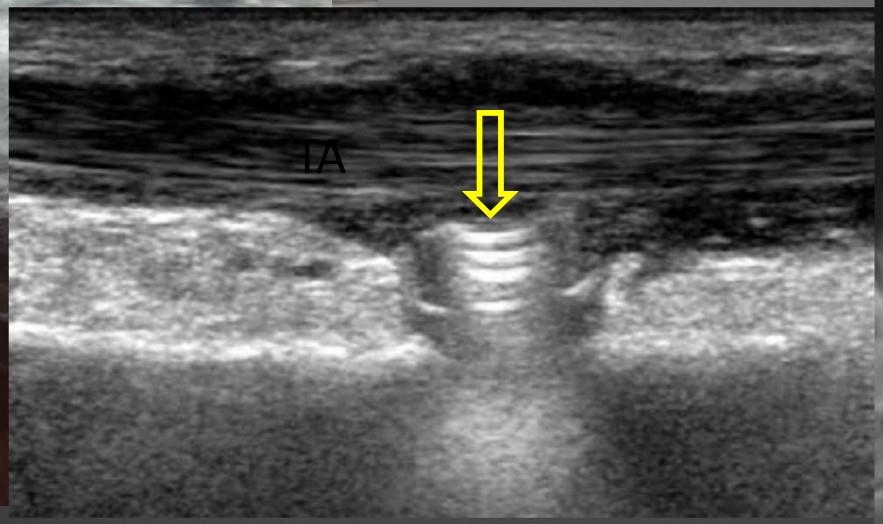
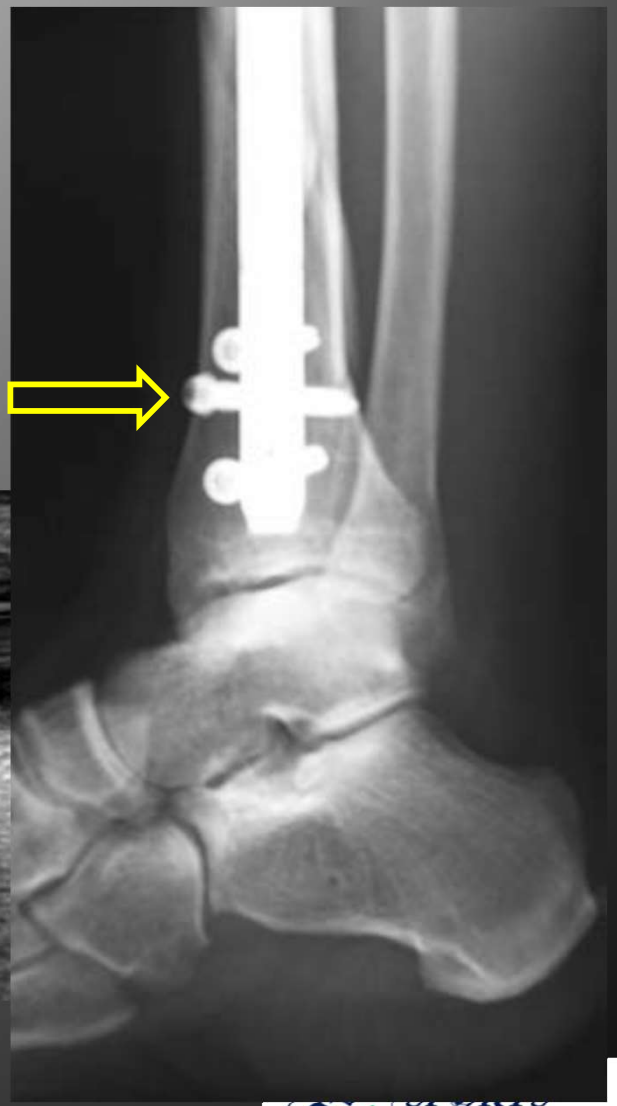
Bone







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Conclusion

- Transducers
- Anisotropy
- Echo-signature
- Normal vs abnormal

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