Why

Ultrasound Guided

Regional Anaesthesia Nerve Blocks

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“In the country of the blind the one eyed man is King”

-Deciderius Erasmus (1466-1536)

Objectives

- Benefits of Regional Anesthesia
- Benefits of US guidance
- Role of ultrasound in regional anesthesia
- Ultrasound Nerve Appearance
- Nerve Block Procedures with US Guidance

Regional Nerve Blocks

Benefits

- Provide better post-op pain management
- Limit block to the body part undergoing surgery
- Reduced need for other analgesics (opioids)
- Decreased PONV
- Minimal side effects

Conventional Technique

- Define area to be blocked based on surface landmarks
- Insert stimulating catheter
- Confirm location with nerve stimulator watching for appropriate motor response
- Inject anesthetic

Conventional Nerve Block Procedures are performed without visual guidance

Role of Ultrasound Guidance

- See the target avoid the danger
  - Visualize nerve and surrounding vascular/pleural structures
- Provides real time guidance
- Improves accuracy
- Observe anesthetic spread
- US guidance “may” prevent intraneural injury and improve block safety and effectiveness

Why is US Physics Important?

Quality of the ultrasound image is dependant upon the operator.

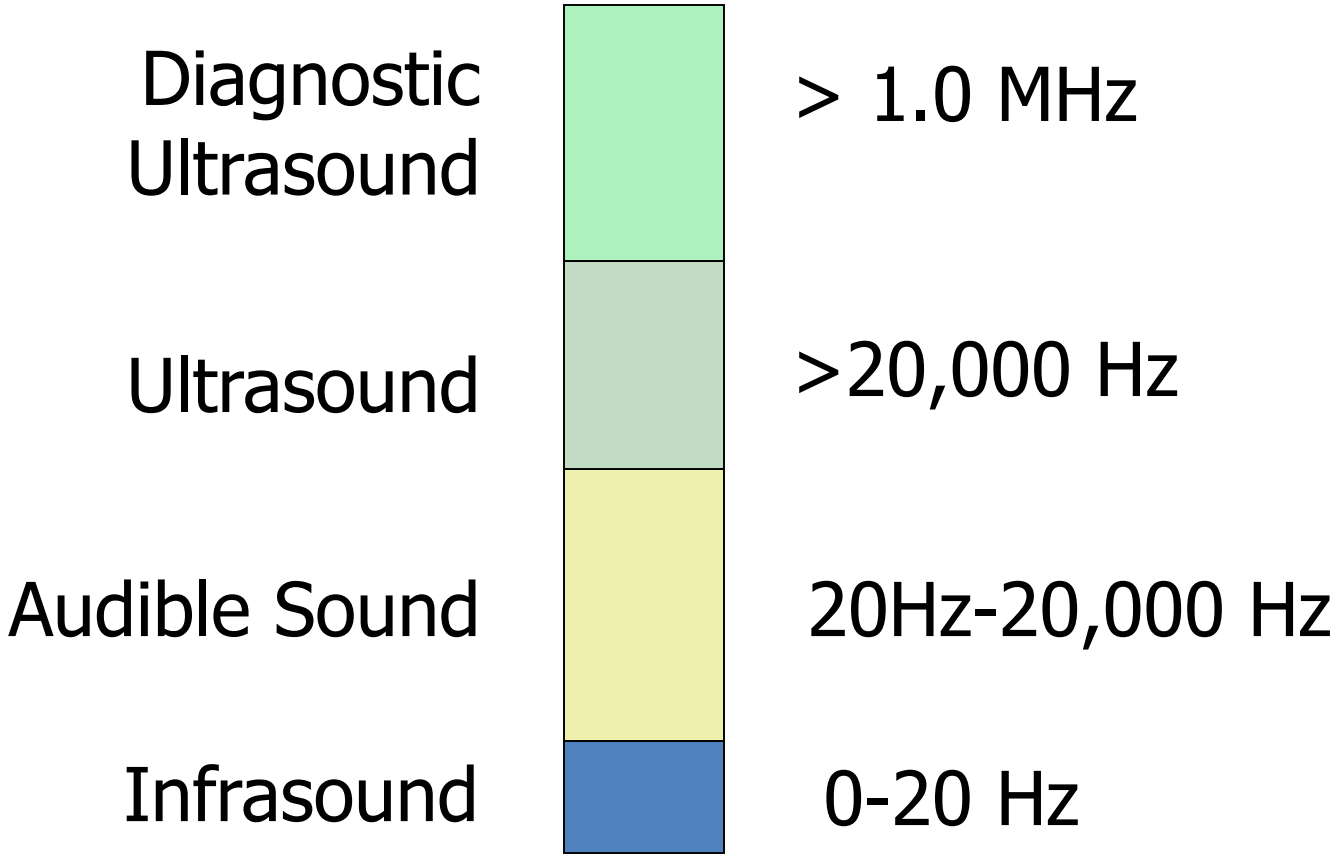
Why is US Physics Important?

- Knowledge of ultrasound physics needed for image optimization
  - Appropriate transducer selection
  - Gain Settings
  - Depth Settings
  - Tissue Echo Characteristics
  - Ultrasound Artifacts

Sound

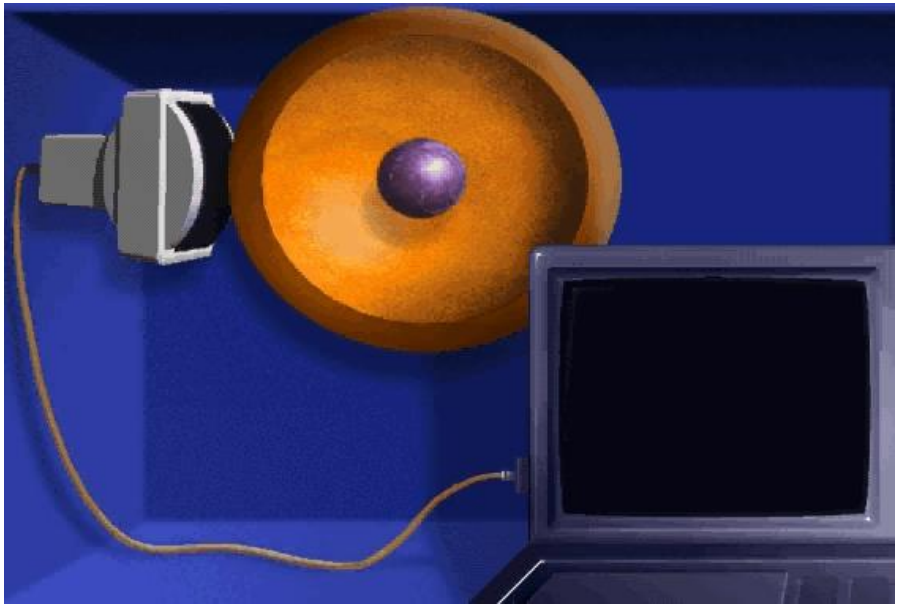
- Mechanical pressure wave
- A series of compressions and expansions through a medium
- Velocity: the speed of sound is 1540 m/s in human soft tissue

Ultrasound

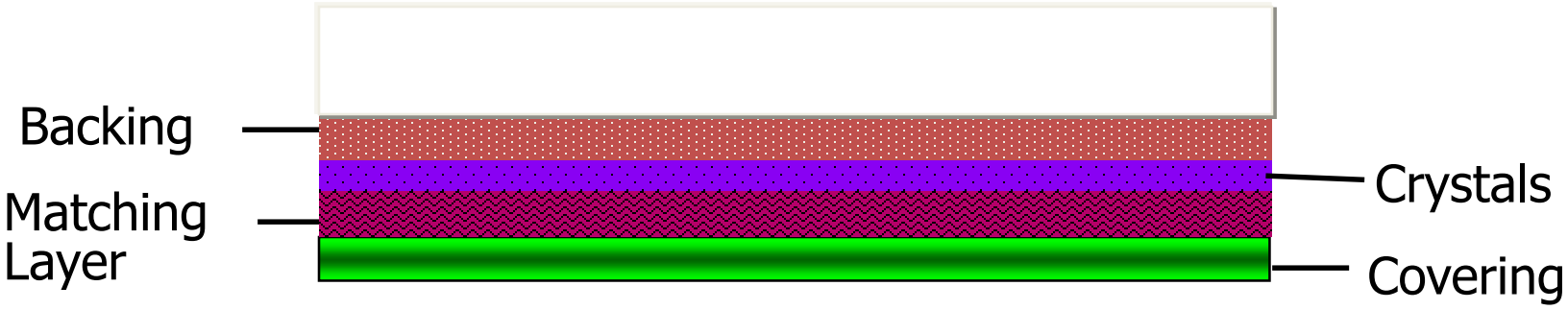

Diagnostic Ultrasound
> 1.0 MHz
Ultrasound
>20,000 Hz
Audible Sound
20Hz-20,000 Hz
Infrasound
0-20 Hz

Sound Wave Creation

- Electric charge causes crystals to vibrate
- Creates sound wave that travels through tissue
- Wave is reflected off of structures
- Echo returns to crystals
- Converted to electricity
- Signal processed
- Image displayed



Transducer Basics

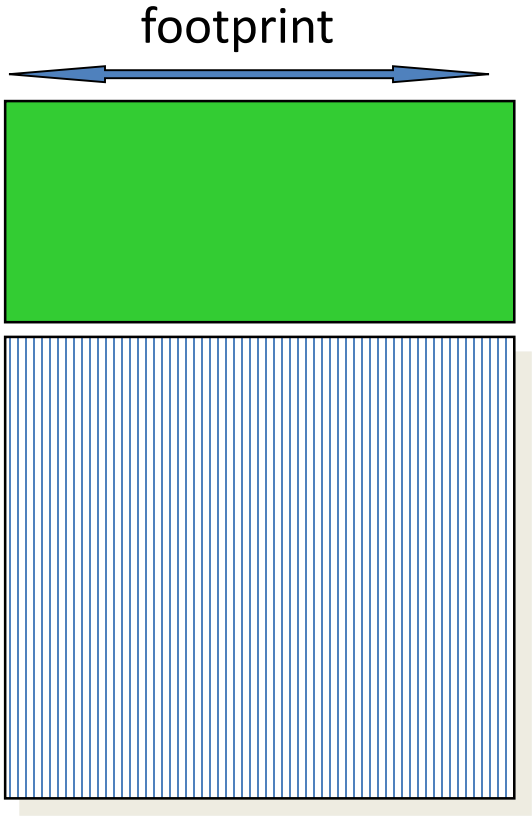


Backing - dampens sound after pulse is generated
Covering - protects transducer face
Crystals - transmit/receive sound
Matching Layer - assists in sound transmission

Transducer Basics

Linear Array

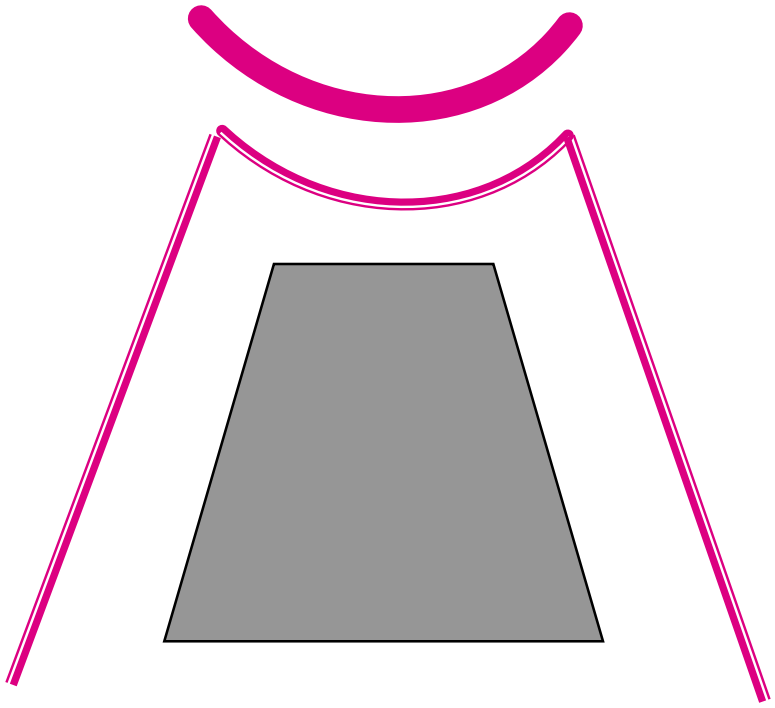
- Crystals are *lined up*
- Crystals are fired in order
- Linear probes are commonly used in vascular & superficial imaging



Transducer Basics

Curved Array

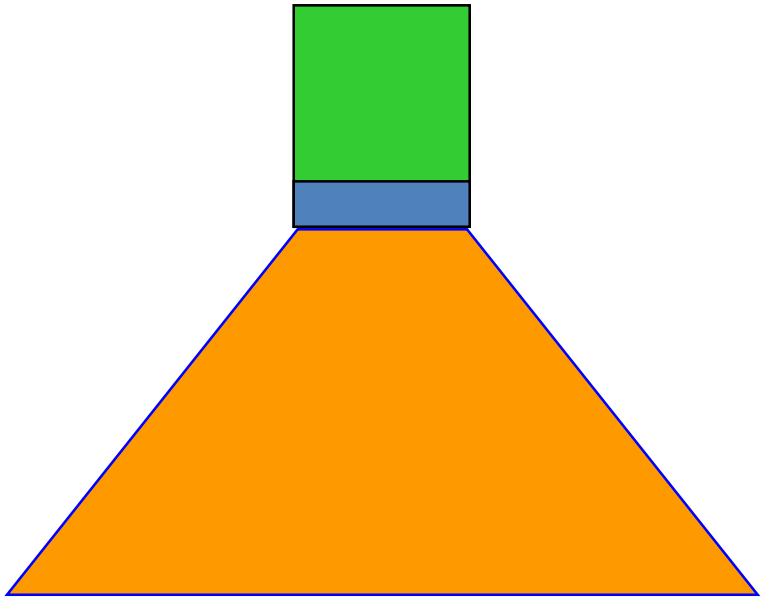
- The *curved* array is basically a *curved* linear array (curvilinear)
- Large field of view in both the near and the far fields
- Commonly used in abdominal and obstetrics applications



Transducer Basics

Phased Array

- Crystals are fired in *phases* to create a sector image
- Small footprint
- Used for a small anatomical 'window' ie. between ribs
- Phased Arrays are common in cardiac, pediatric and abdominal applications

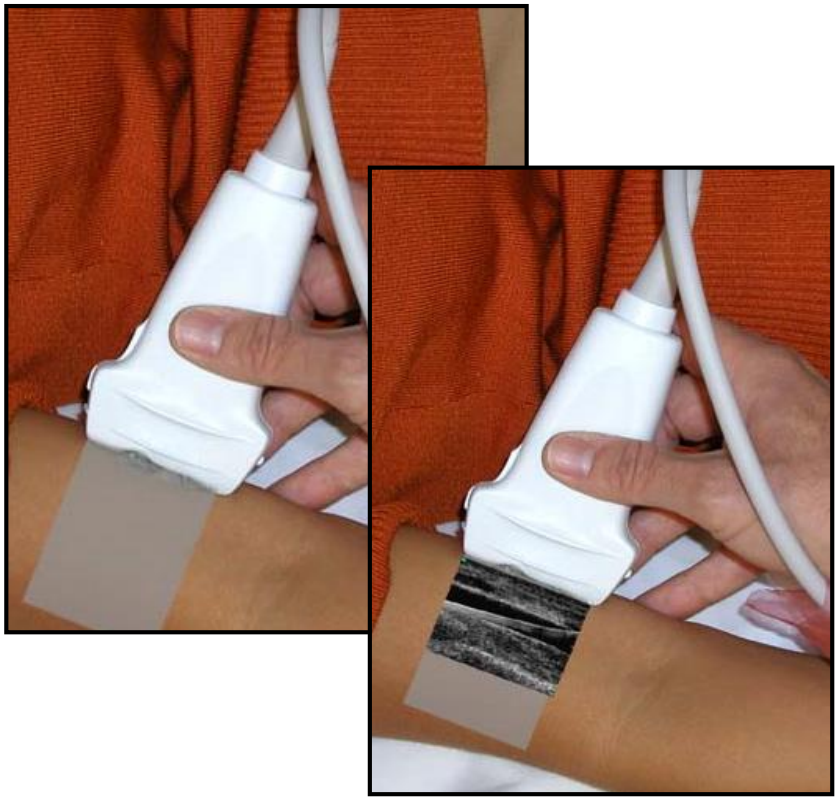


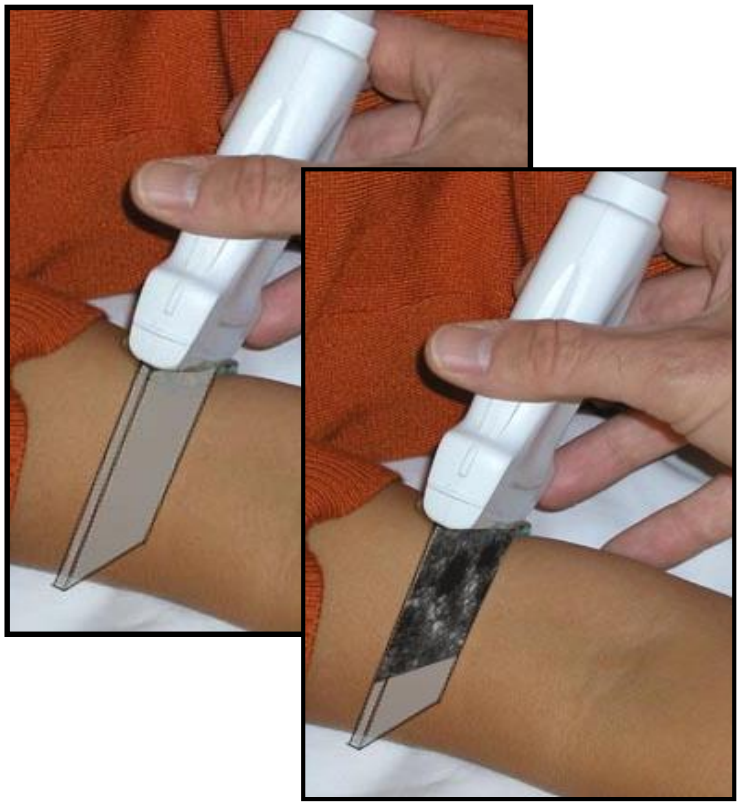
Ultrasound Beam

Beam slice – approx. 1 mm thick

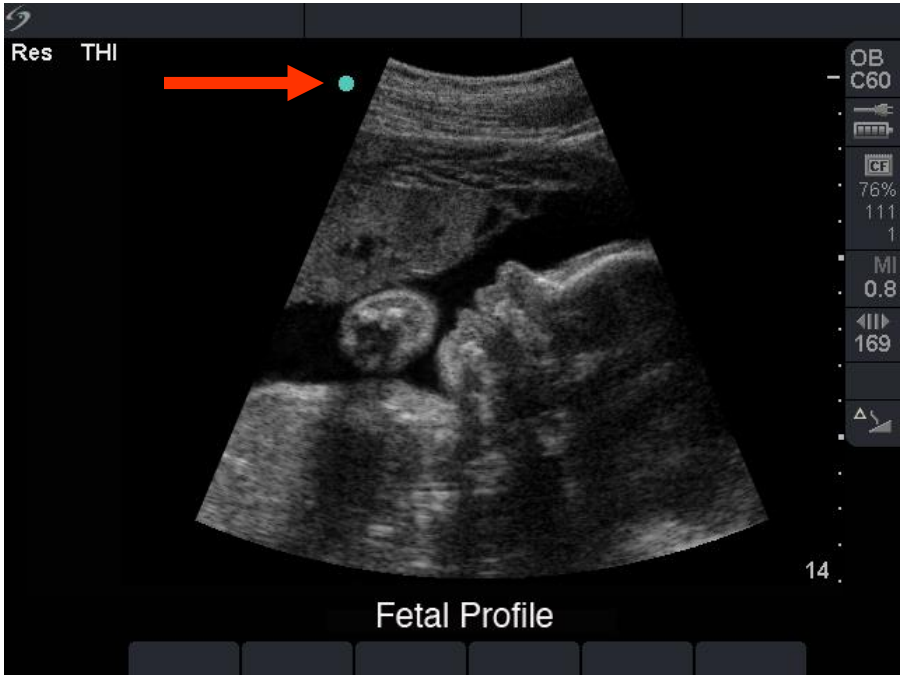
Image produced is “2D” tomographic slice

Ultrasound Beam





Orientation Marker

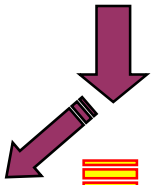


Attenuation

Progressive *Weakening* of the Sound Beam

Reflection – Back to the transducer

Scatter – Reflected in multiple directions

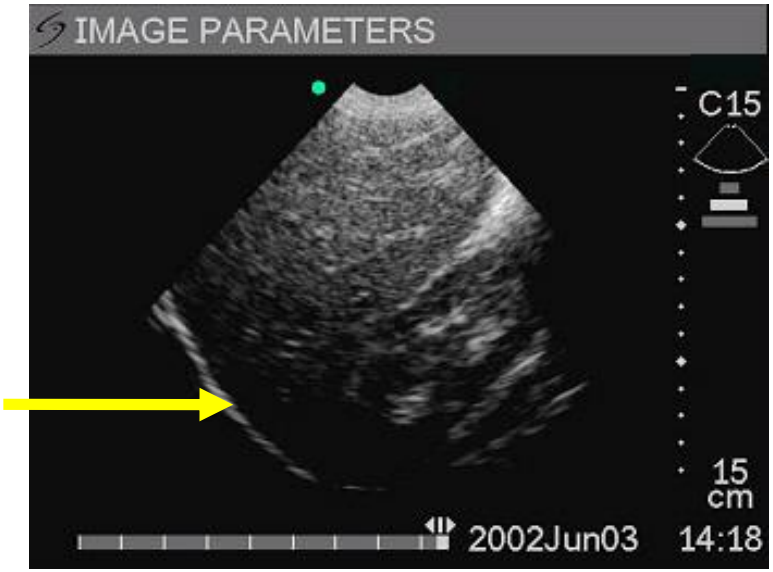


Refraction – Re-direction of part of the beam

Absorption – Converted to heat

Attenuation of Sound

- Sound attenuated by scatter, reflection and absorption
- Attenuation reduces strength of the signal
- Deeper signals are weaker



Attenuation & Gain

- Compensate by adjusting gain
- Time Gain Compensation adjusts returning echoes
- Based on depth
  - Near field / far field

Ultrasound Gain

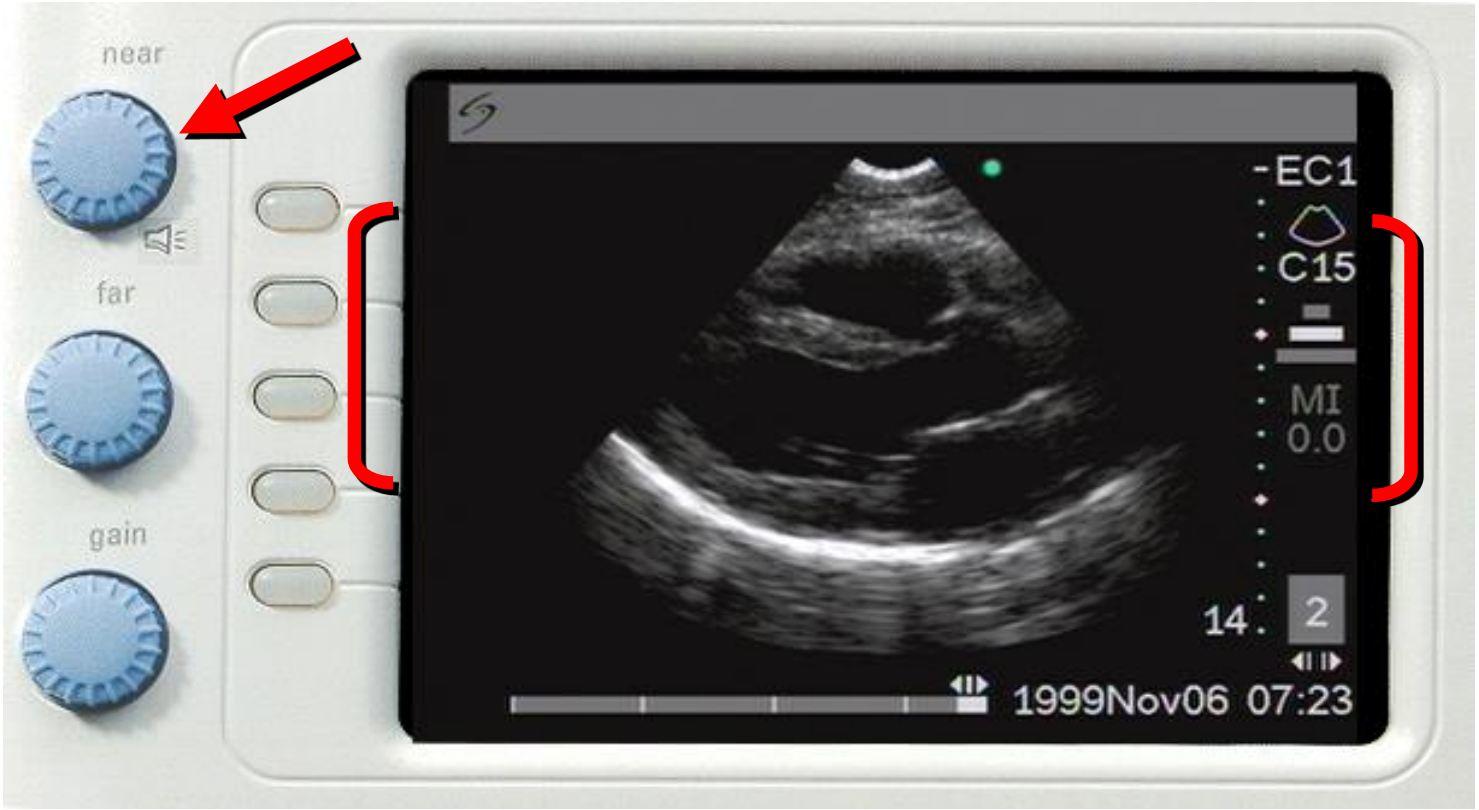
- Gain controls
  - Receiver gain only
  - Does NOT change output power
  - Think: stereo volume, not ↑ power to the stereo from the wall outlet

Ultrasound Gain

- Adjust image so same level of brightness displayed regardless of depth
- Increase gain = brighter image display
- Decrease gain = darker image display

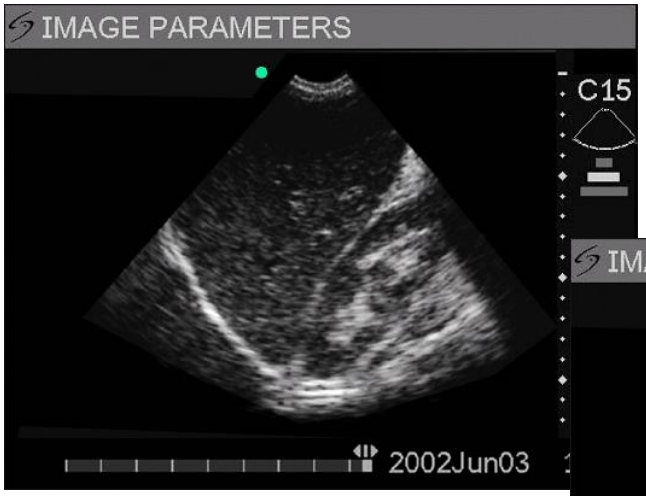
Ultrasound Gain

Use near or far field gains to balance the image

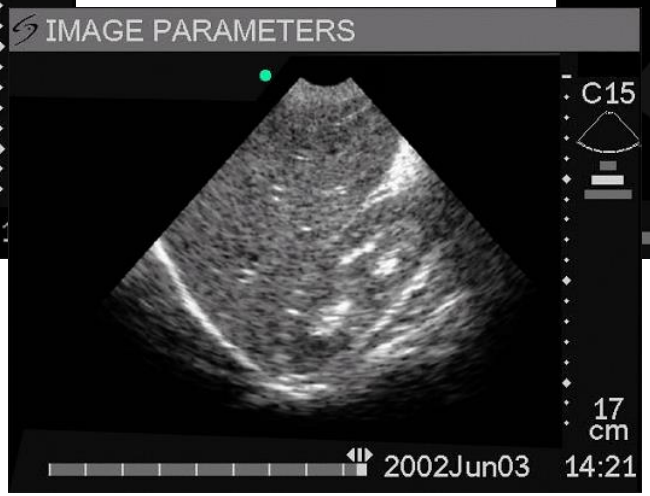


Gain Settings

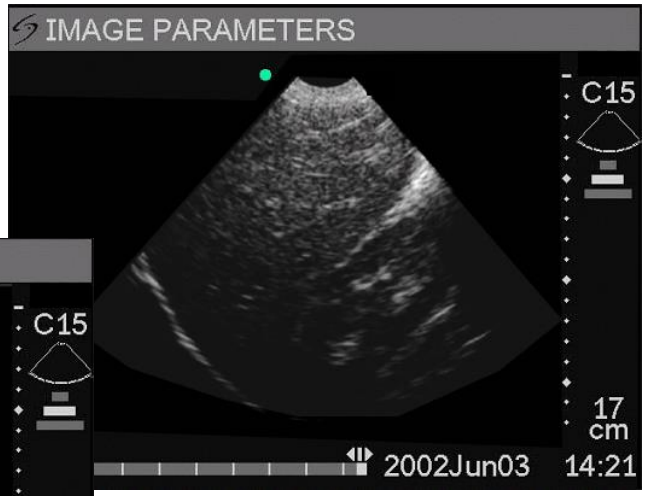
poor near field



balanced

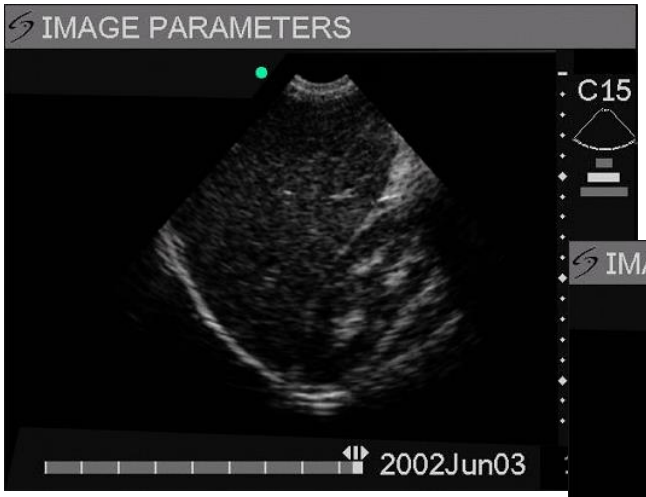


poor far field

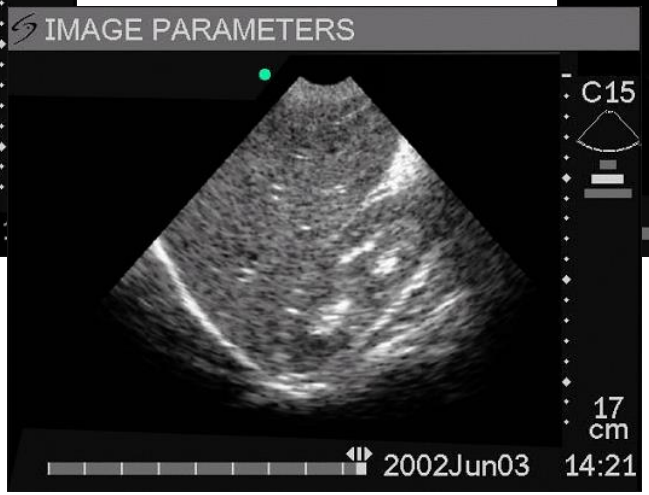


Gain Settings

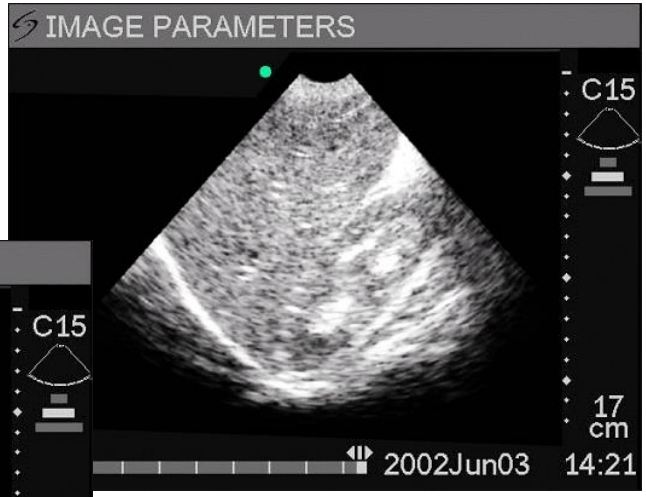
too dark



balanced



too bright



Transducer Selection

- Where is the area of interest?
  - Superficial or deep
- Size of scanning window?
- Patient size?

Transducer Selection

Frequency vs. Resolution

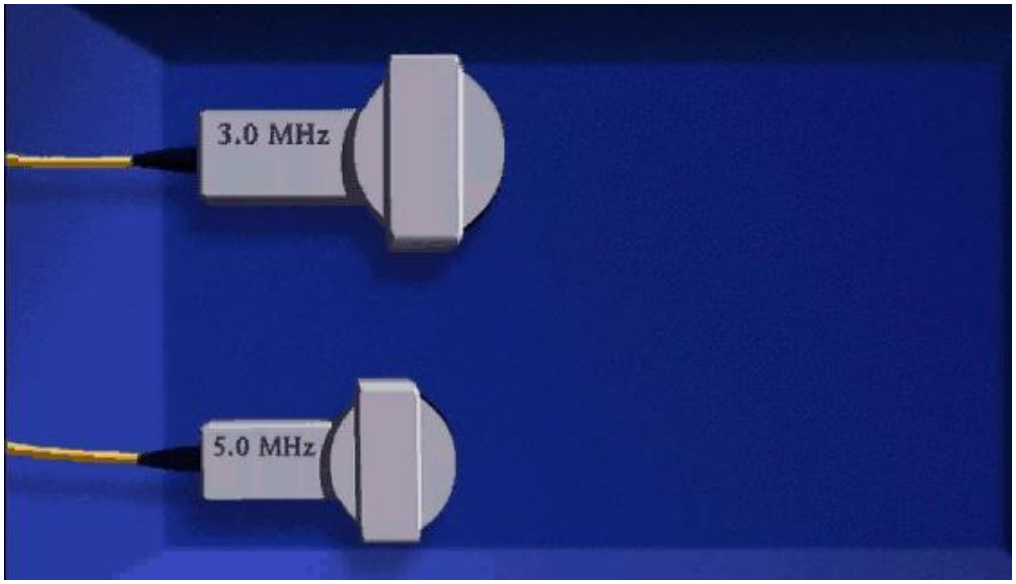
- Higher frequencies - shorter wavelength
  - better resolution/poor penetration

- Lower frequencies - longer wavelength
  - poor resolution/better penetration

Transducer Selection

3.0 MHz

5.0 MHz



Ultrasound Beam Depth

- Determined by transducer frequency
- Adjusts displayed data
- Start deep to see all anatomy
- Adjust to fill display with area of interest

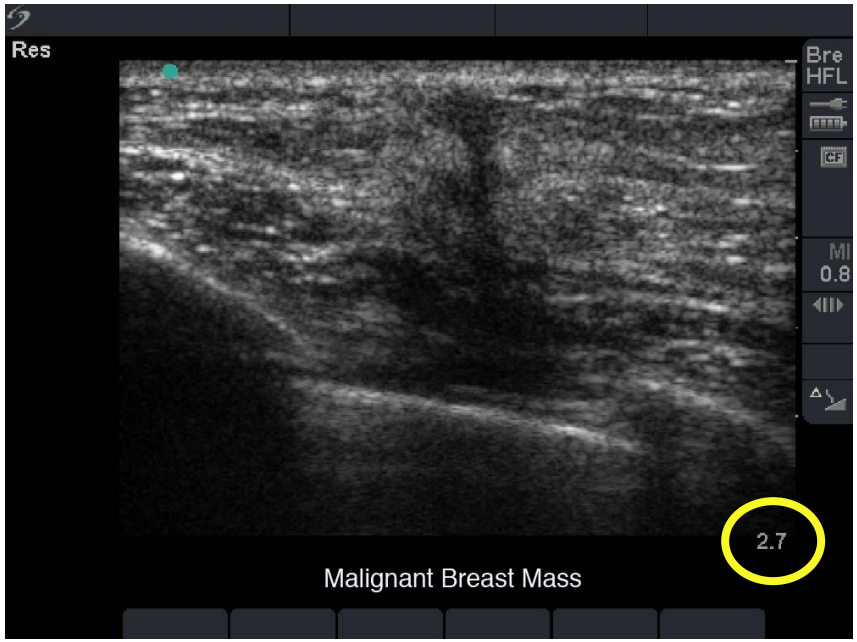
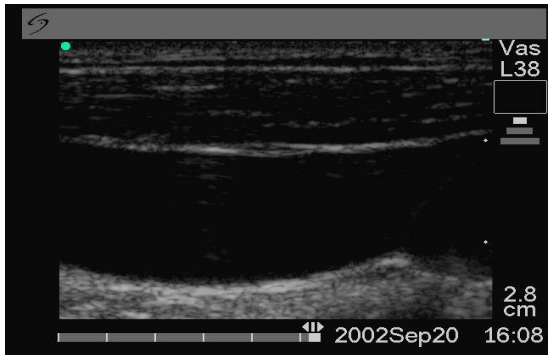


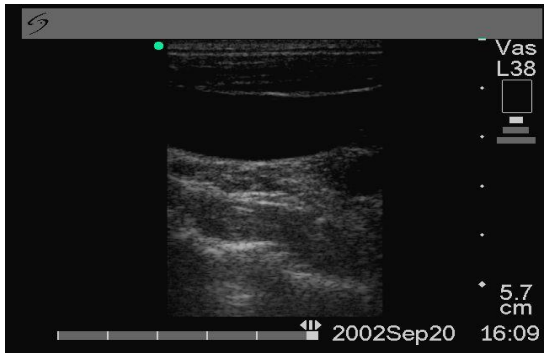
Image Optimization

Increasing the depth allows you to visualize deeper structures

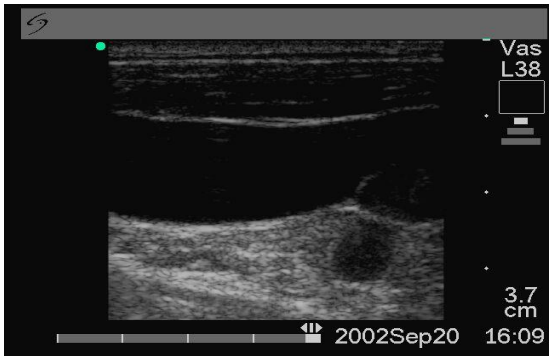
Adjust the depth so that the target vessel in centered in the image



Too close



Too far

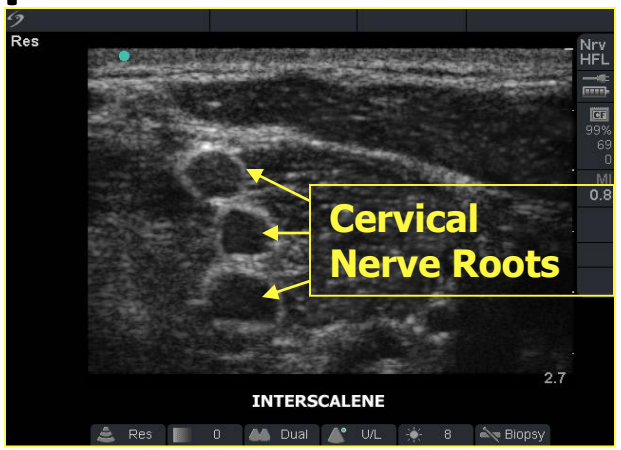


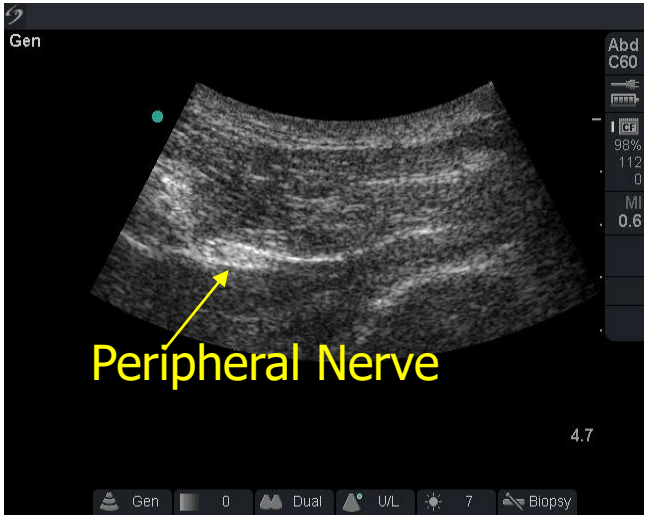
Just right

Ultrasound Appearance

Nerves can have 3 shapes:

- Round
- Oval
- Triangular





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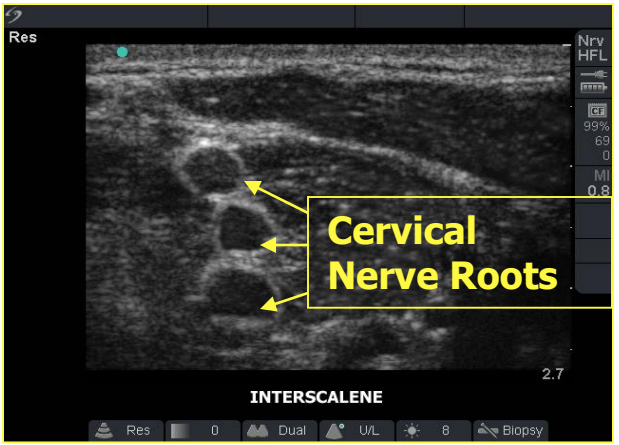
Ultrasound Appearance

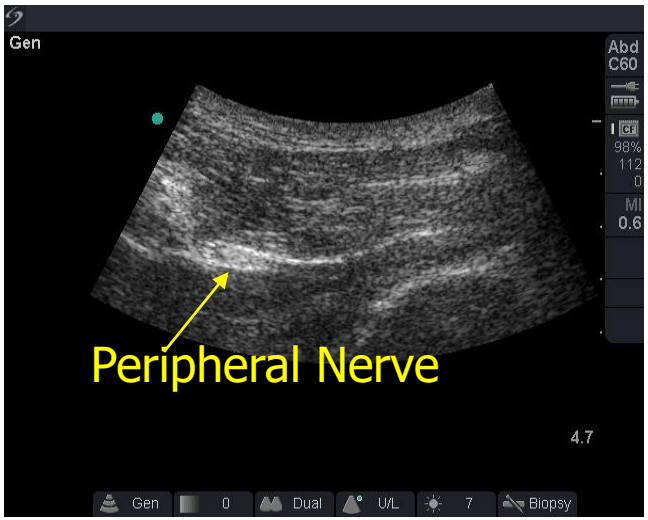
Cervical Roots

- Monofascicular appearance
- Dark Hypoechoic

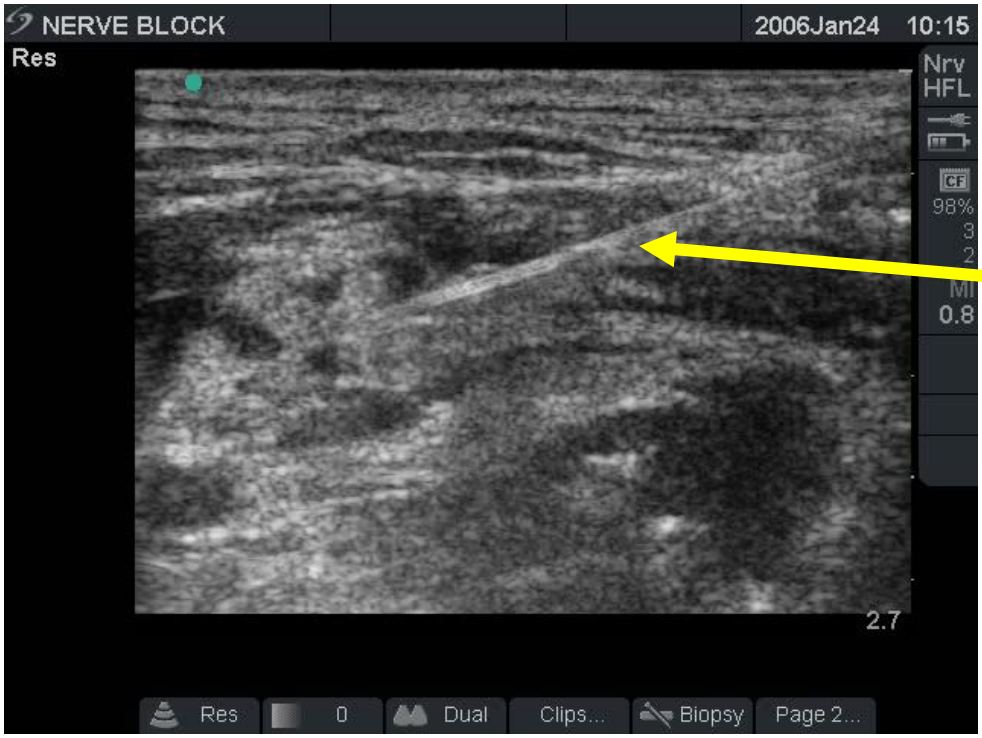
Peripheral Nerves

- Honeycomb appearance
- Hyperechoic



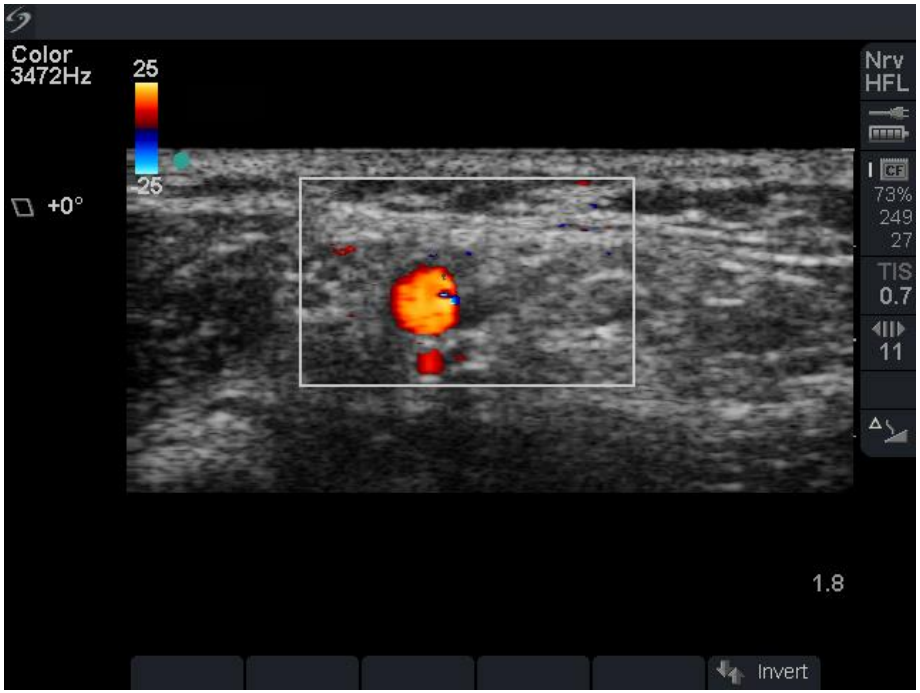


Needle Appearance

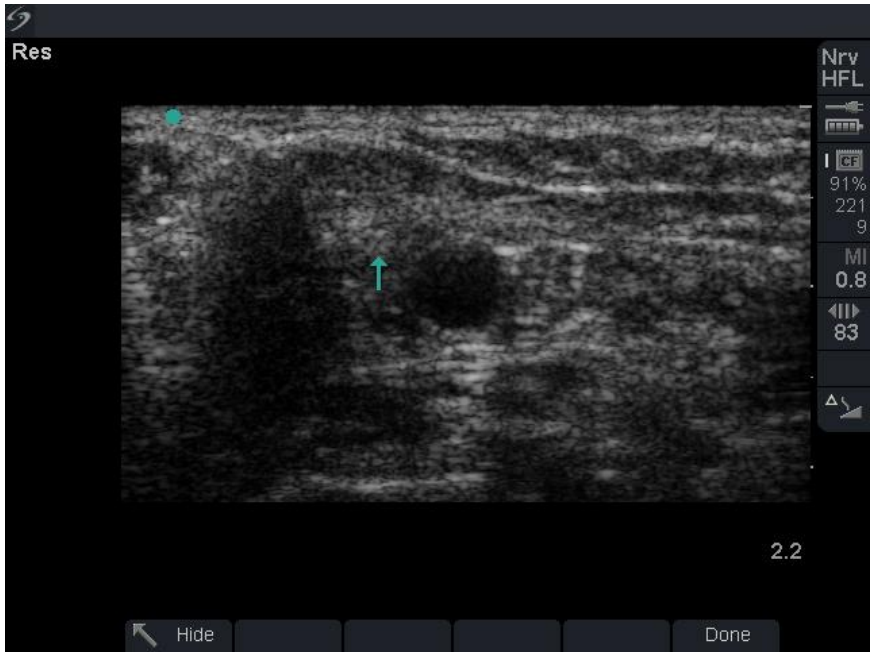


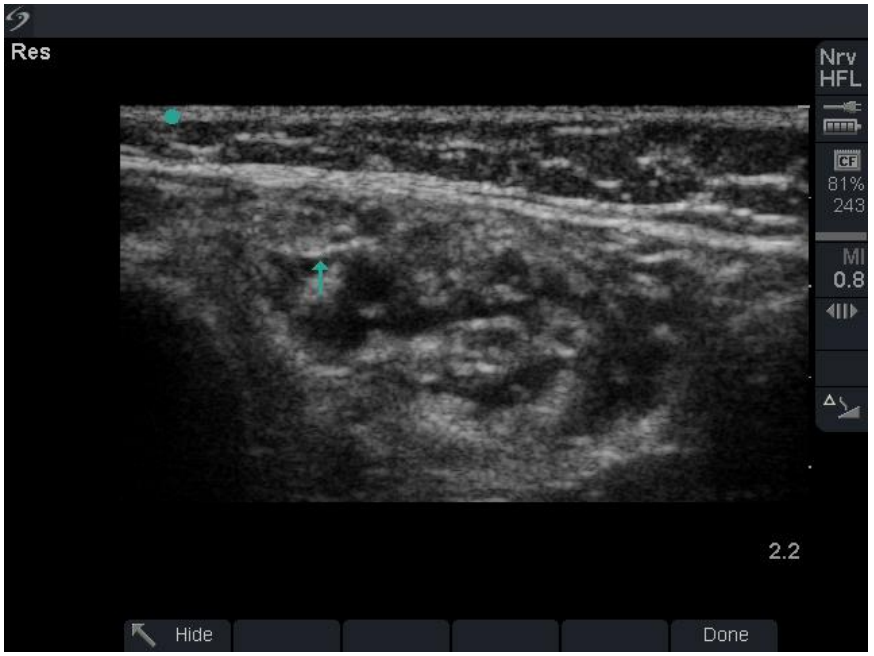
Ultrasound Appearance

- Identify adjacent vascular structures
- Easy to identify with Color Doppler



Nerve Pre/Post Injection





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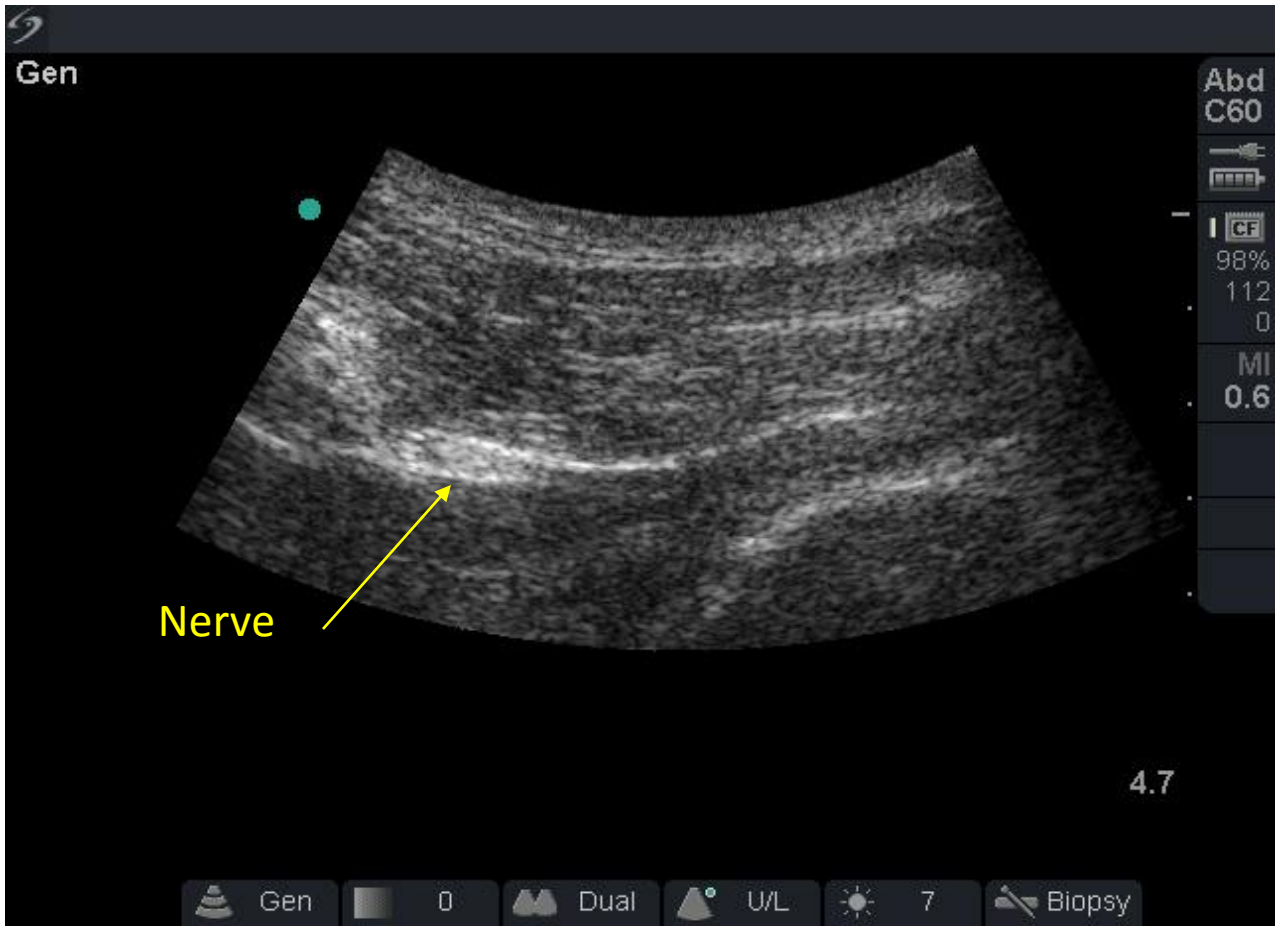

Nerve Pre/Post Injection