An Introduction to Bedside Ultrasound (in office)

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Acknowledgements

- Point of Care Ultrasound for Emergency Physicians by Steve Socransky and Ray Wiss (Contributions through diagrams)

Objectives

- 1. Define terms used in ultrasound
- 2. Describe the reference point on the probe
- 3. Introduce the two common planes of view
- 4. Describe different forms of artifact
- 5. Types of probes
- 6. Describe movements of the probe using the three Ss, H & R
- 7. Describe how to perform the scan using the mneumonic "DOGG"
- 8. Perform an abdominal aortic scan, check for free fluid in the abdomen, transabdominal obstetric scan, gallbladder scan

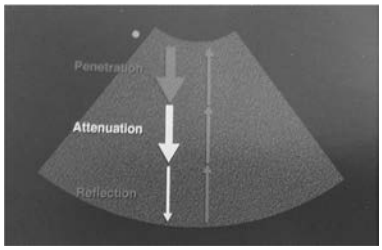
What is Ultrasound?

- Sound waves with higher frequencies that are not detectable by humans but can penetrate tissue.
- These sound waves echo off the tissue to the probe with varying reflection and this is how images can be detected on a screen.

What is Ultrasound?

- Ultrasound waves pass through a medium (PENETRATION)
- As it moves deeper into the medium the energy dissipates in the the process of ATTENUATION
- Some of the energy bounces back to the source known as REFLECTION

Penetration, Attenuation and Reflection



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Glossary of Terms

- Echogenic: much of the sound waves bounces off (reflected) an object back to the probe (appears white on the screen)
- Echolucent: very little sound wave is reflected back from the object to the probe (appears dark on the screen)

Glossary of terms cont'd

- Hyperechoic: objects appear whiter than surrounding tissue (typical of solids) e.g bone is 100% hyperechoic
- Hypoechoic: objects appear darker than surrounding tissue (typical of liquids)e.g urine in the bladder is hypoechoic

Glossary of terms cont'd

- Isoechoic: objects appear similar in color to the surrounding tissue
- Anechoic: absolutely no sound waves are reflected back to the probe (appears black) : in the deep areas of the scan

The reference point/Indicator/ mark

- The point of reference to orient the probe.
- It is always placed to patient's right side (transverse view) and toward the head (longitudinal view)

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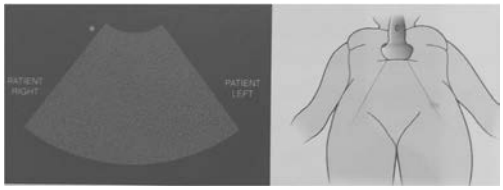
Two Planes of View

- 1. Transverse Plane (Right to Left)



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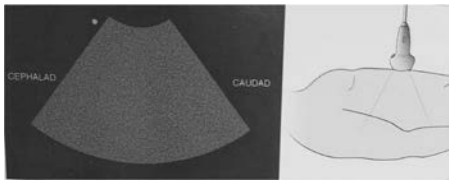
Two Planes of View

- 2. Longitudinal View: Head (cranial) to toe (caudal)



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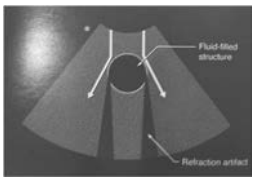
Artifacts

1. Edge Artifact
2. Enhancement
3. Acoustic shadow
4. Scatter
5. Dead zone

Edge Artifact

- Ultrasound waves hit a smooth, curved, fluid filled structure (e.g gallbladder, aorta) and is deflected (refracted). This causes a shadow on the edges



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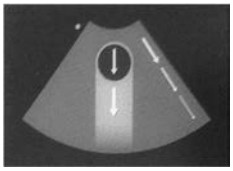
Edge Artifact

Enhancement

- When ultrasound waves pass thorough a liquid medium (e.g. bladder) and hit a more solid/denser structure behind it (e.g. uterus), it makes the structure light up more.



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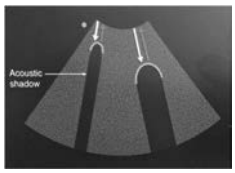
Enhancement

Acoustic shadow (window)

- Ultrasound waves hit a solid structure (e.g. bone) and the waves are reflected back to the probe. Because no waves get through, it casts a shadow behind the structure: appears black



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Acoustic shadow(window)

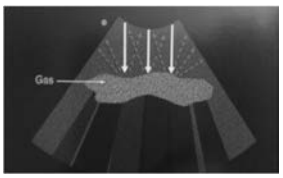
- Lines cut right across tissue planes and is straight (rib shadow)

Lung Sliding and rib shadows

What's a good use for the acoustic shadow?

Scatter

- When gas is present, the US waves gets deflected forming a gray snow pattern called scatter



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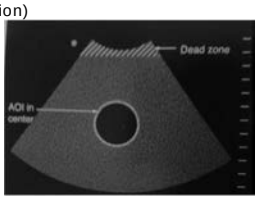
Scatter

Dead Zone

- Represents the area that is a few centimetres below the top of the screen. Seen with the low frequency probe: gives no useful information)



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Dead Zone

Types of probes

- 1. Curved array probe
- 2. Phased array probe
- 3. Microconvex probe
- 4. Linear array probe
- 5. Endocavitary probe

Curved Array Probe

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Curved Array Probe

- Low frequency : 2-5 MHz (usually 3.5MHz)
- Good penetration (down to 25-30 cm)
- Gives a pie shaped half circle
- Used for abdominal ultrasound
- Disadvantages: poorer contact with skin; cannot get between ribs.

Phased Array Probe

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Phased Array Probe

- Low frequency probe (usually 2.5MHz)
- Penetrates deep
- Smaller footprint and flat surface.
- Gets between intercostal spaces and better contact with skin
- Gives triangular image
- Disadvantages: Near field is small and the far field has poor resolution

Microconvex probe

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Microconvex probe

- Cross between the curved and phased array probe
- Low frequency probe (3.5MHz)
- Penetrates deep down
- Fits better into tight spaces (between the ribs)
- The image is a cross between the curved and phased array probes

Linear Array Probe

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Linear Array Probe

- High frequency probe (5-18MHz)
- Head is flat
- Gives a rectangular field of view
- Not great for penetration to deeper structures but higher resolution
- Negligible dead zone
- Ideal for small superficial structures like blood vessels and nerves

Endocavitary Probe

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Endocavitary Probe

- Mid frequency probe with a long handle (6.5MHz)
- Greater amount of curvature of the probe.
- Field spans out more than the curved array probe
- Used predominantly for transvaginal exams, but can be used for identifying structures around a peritonsillar abscess

Movements of the probe

- Find the start **SITE**
- **SLIDE** the probe
- **SWEEP** the probe
- **HEEL** the probe (not always used)
- **ROTATE** the probe

Sliding the probe (anterior/posterior)

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Sliding the probe (cranial/caudal)

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Sweeping the probe (side to side)

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Heeling the probe (tilting upward)

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Rotating the probe

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Performing the scan

- **D**: **DIVE** to the lowest depth (about 25-30cm with the low frequency probe and 10-15cm with the high frequency)
- **O**: **Orient** the probe (where is the reference point)
- **G**: **Goo/Gel**: Apply copious amounts to probe (only apply to patient when doing a cardiac scan)
- **G**: **Gain** (may be adjusted accordingly):

It modulates the strength of the signal returning to the probe. Increase the gain, increase the whiteness and decrease the gain, increase the darkness

Abdominal aortic scan (transverse plane only)

- 1. Patient supine
- 2. D (dive to lowest depth)
- 3. Orient probe in transverse plane (ref point to patient's right)
- 4. Apply gel
- 5. Place probe in transverse plane just below xiphoid process
- 6. Find aorta and center it (thick walls, not compressible completely, no respiratory variability, closest to the spine)
- Slide caudally to bifurcation (two lumens seen)
- Measure aorta at different points along its length

Abdominal aortic scan

Abdominal aortic scan

Abdominal aortic scan

Abdominal aortic scan

The Abdominal Scan for Free Fluid (RUQ,LUQ, pelvis)

Sliding anterior-posterior

Sliding cranial-caudad

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The Abdominal Scan for Free Fluid (RUQ,LUQ, pelvis)

Sweeping the probe

Rotating the probe

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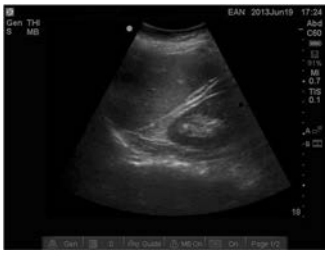
The Abdominal Scan for Free Fluid Liver and Kidney(RUQ)

- Site: posterior axillary line at xiphoid process in longitudinal plane
- Slide: Slide anterior to posterior to find the kidney and interface
- Slide: Slide cranially and caudally (longitudinally) to center the interface
- Decrease depth to magnify
- You may need to rotate for a better view(get ribs out of way)
- Sweep through the hepatorenal interface (Morrison's pouch) looking for free fluid. This is your Area of Interest!

Organs orientation in longitudinal plane (RUQ)



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Hepatorenal interface

The Spleen and kidney scan (LUQ)

- Leave the depth at the magnification previously set
- Site: posterior axillary line slightly ABOVE the xiphoid process in longitudinal plane. (kidney is more cranial on that side)
- Slide: Slide anterior to posterior to find the kidney and interface
- Slide: Slide cranially and caudally (longitudinally) to center the interface
- Should see diaphragm from 6 to 9 o 'clock
- Sweep through the splenorenal interface (look for free fluid). This is your Area of Interest!

Splenorenal Interface

Free fluid in Morrison's Pouch (hepatorenal interface)

More free fluid anterior to the liver (ascites)

Pelvic scan (transverse plane)

- Site: Immediately cephalad to the symphysis pubis in the transverse plane
- Slide: Slide probe laterally and medially to find the bladder (patient should have full bladder, if possible)
- Find the uterus (female) or prostate (male)
- Sweep cranially and caudally to look for free fluid
- Rotate probe in longitudinally to corroborate findings , if needed

Transabdominal pelvic scan (male and female)

- Male (Look for prostate)

- Female (Look for uterus)

Transabdominal obstetric scan

- Start in longitudinal position in midline just above pubis symphysis
- Slide: Slide probe laterally and medially to find the bladder (patient should have full bladder)
- Uterus is juxtaposed posterior to bladder
- Center uterus, adjust depth and heel probe cephalad or caudad
- Sweep through uterus and endometrial stripe
- Rotate probe in transverse plane and sweep again

Identifying an intrauterine pregnancy (IUP)

- The **top three** out of FOUR are imperative
  - 1. **The decidual reaction** (hyperechoic decidual lining of the uterus): present around 14 days
  - 2**. The gestational sac**: present around (anechoic region within the decidua)
  - 3**. The Yolk Sac:** The "Double Ring Sign" (seen 5 weeks transvaginal and 6-7 weeks transabdominal)
  - 4. **Fetal Pole and cardiac activity** (6 weeks for transvaginal and 7-8 weeks for transabdominal : this trumps the yolk sac

Normal transabdominal scan

Identifying an intrauterine pregnancy (IUP)

Identifying an intrauterine pregnancy (IUP)

Identifying an intrauterine pregnancy (IUP)

Gallbladder scan (left lateral decubitus)

- Roll patient to left side (brings gallbladder closer to probe)
- Place probe (in heel cranial position)in epigastrium and slide laterally along the costal margin to the right anterior axillary line
- If not effective, turn probe in slightly oblique position and slide along the costal margin, keeping the liver in view
- Keep eyes in the near field for first cystic structure
- Ask patient to take deep breath in and hold (pushes bladder down)
- Find the "Exclamation Point sign" with the gallbladder, main lobar fissure and portal vein
- Look for stones, sonographic Murphy's sign, wall thickening (N: ≤3mm), distension (N:5cm(W)x10cm(L)), pericholecystic fluid, biliary sludge

Gallbladder scan (left lateral decubitus)

What is wrong here?

To become proficient in ultrasound

- Be consistent with your approach to ultrasound
- Understand your probes and their uses
- Ultrasound as many appropriate patients as you can
- Practice getting the image…the diagnosis will come
- Do not look at your hands, look at the screen
- Do not hold the probe in a "death grip"…your hands will tire easily
- Most of all: Get additional training!

- NOW LET'S GET SCANNING!