Medical Ultrasound

October 2023

Center for Fast Ultrasound
Technical University of Denmark

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Agenda

- Medical specialties and ultrasound
- Scan planes
- What can we see?
- Artefacts in ultrasound
- Scanning organs
- Scanning vessels
- Procedures and conventions
- Scanning session

2

Medical Specialities and ultrasound

Which specialities use ultrasound?

Nearly all specialties

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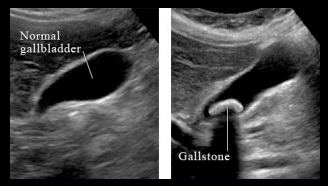

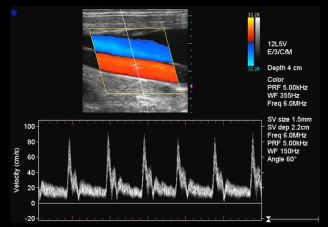

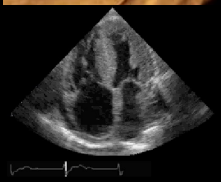

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Medical Specialities and ultrasound

Speciality	
Anesthesiology	Guide for local injections, catheters
Cardiology	Echocardiography
Emergency medicine	Point of care ultrasound / FAST
Gastroenterology / Gastro surgery	Abdominal organs Endoanal US Intraoperative US
Head and Neck Surgery	Thyroid, Parathyroid Lymph nodes
Cardiovascular surgery	Thrombosis/stenosis diagnostics
Neurology	Carotid arteries Transcranial US

Speciality	
Obstetrics/ Gynecology	Pregnancy Transvaginal US
Nephrology / Urology	Urogenital system
Rheumatology / Orthopedic surgery	Muscles, tendons Ligaments, joints Nerves
Pulmonology	EBUS
Radiology	Contrast-enhanced US (CEUS)
Radiology	Interventional US
Radiology	Image-fusion

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Ultrasound

- Convenient
- Rapid
- Real time
- Organ function independent
- No radiation
- Mobile equipment/portable
- Pt can stay in bed
- Inexpensive

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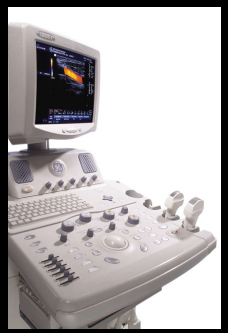
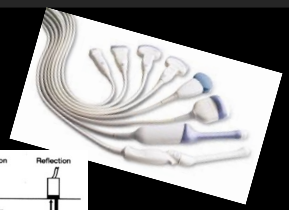
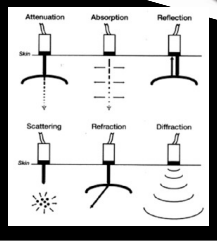
Ultrasound







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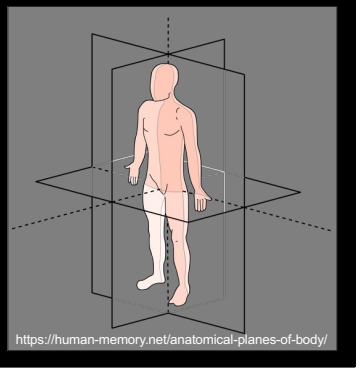
Scan planes

- Transverse/axial/horizontal plane
- Sagittal/vertical plane
- Frontal/coronal plane



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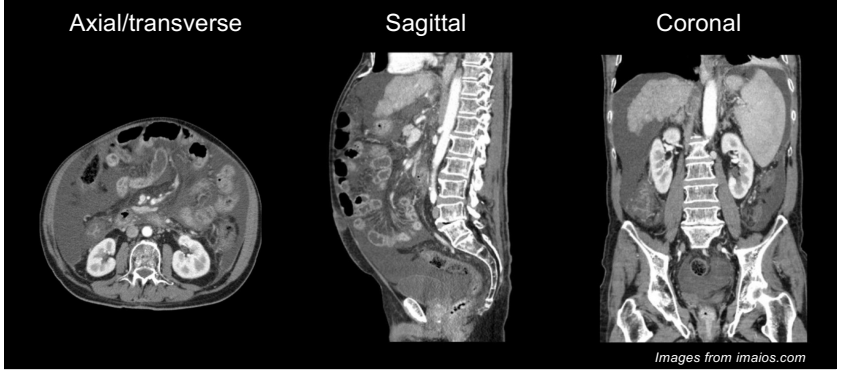
Scan planes



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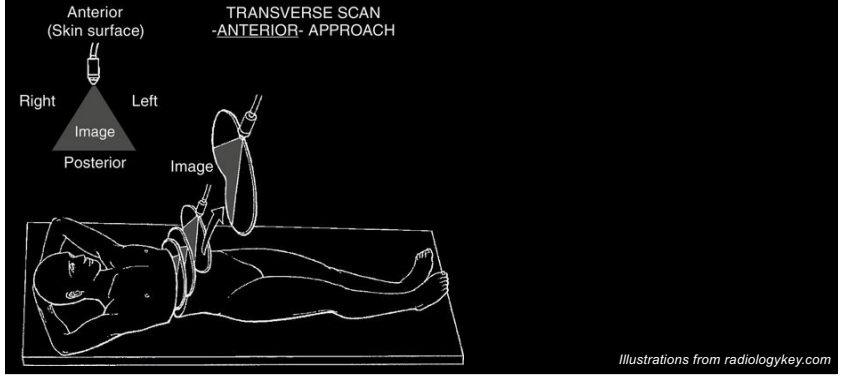
Transverse/axial plane



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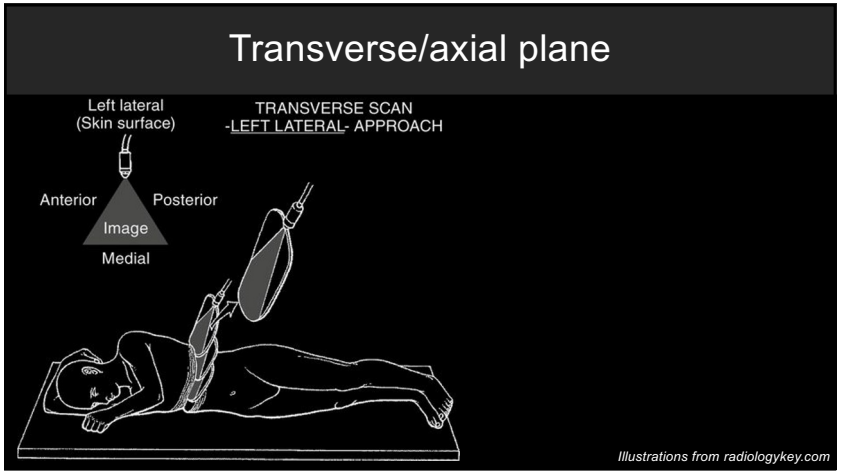
Transverse/axial plane



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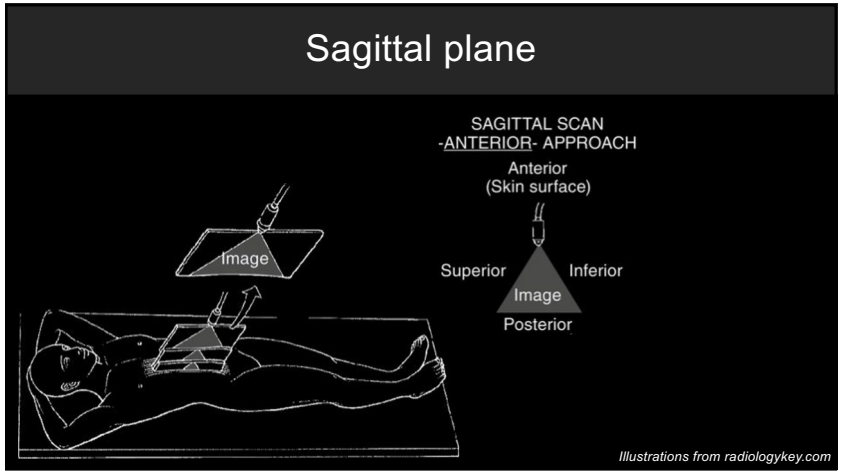
Sagittal plane



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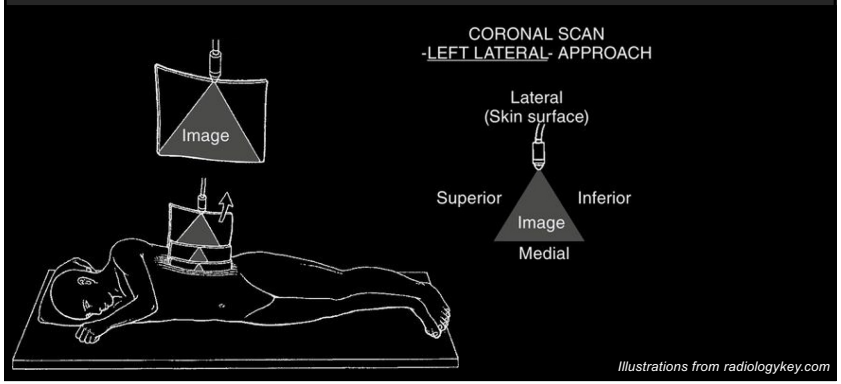
Coronal plane



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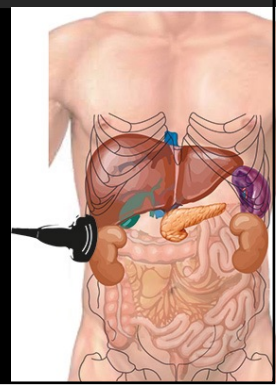
What can we see?

In medical ultrasound, it is possible to differentiate tissues/structures from each other due to differences in densities and in the speed of sound through tissues or structures.



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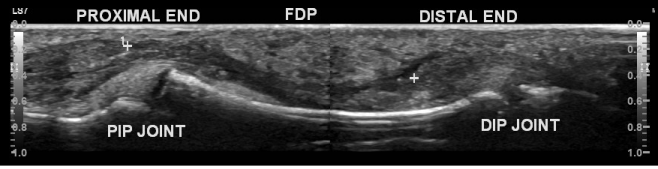
What can't we see?

Air and bony structures reflect and/or absorb the ultrasound waves completely with the closest edge appearing echo-rich (bright) and (almost) no image behind.



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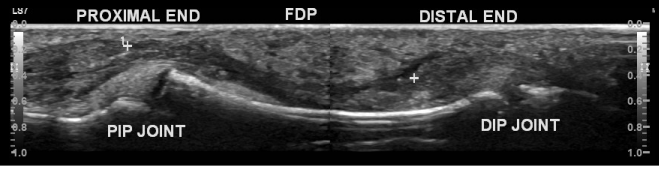
What can we see?

- Reflection occurs due to the differences in acoustic impedance (resistance) at the interface between tissues
- Total reflection between tissue and air/bone
- Absorption occurs when the tissue/medium reduces the intensity of an ultrasound wave as it passes through it



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What can we see?

- Solid organs and other soft tissues appear in different shades of grey depending on their individual impedance mismatches
- Fluids (e.g. cysts, urine, blood, ascites, gall) are “echo empty” and appear black / dark grey = anechoic

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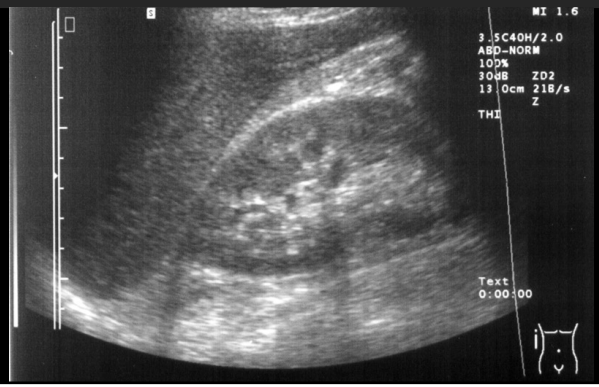
What can we see?



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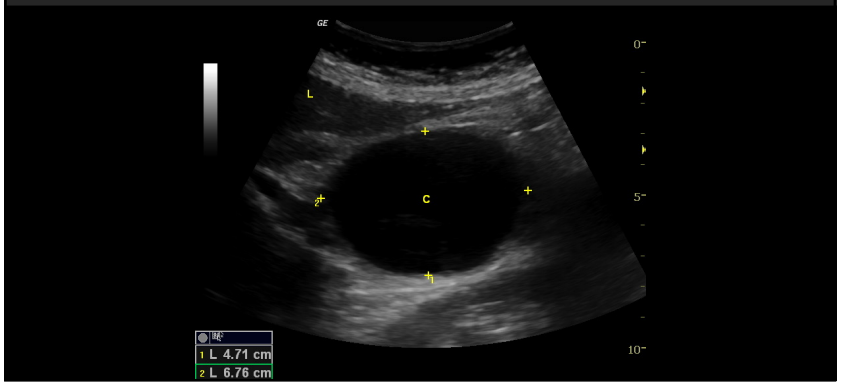
What can we see?



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What can we see?

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Artefacts in ultrasound

- Usually, artefacts are used as a systematic technological failure in the medical language and perceived negatively.

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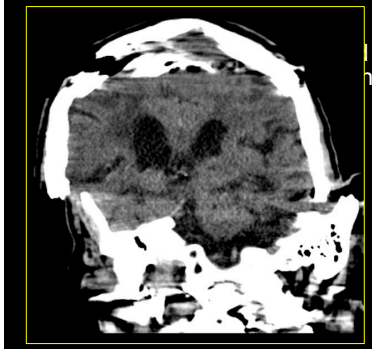
Artefacts in ultrasound



l as a systematic technological failure
nd perceived negatively.

Case courtesy of Dr David Cuete, Radiopaedia.org, rID: 25637

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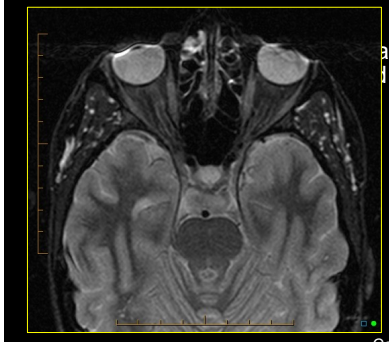
Artefacts in ultrasound



as a systematic technological failure
l perceived negatively.

Case courtesy of Dr Chris O'Donnell, Radiopaedia.org, rID: 51842

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Artefacts in ultrasound

- Usually, artefacts are used as a systematic technological failure in the medical language and perceived negatively.
- In ultrasound, diagnostic artefacts can be used constructively and they can draw our attention to pathology.

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Artefacts: Enhancement

- Homogenous watery fluids allow sound to pass through more easily due to low attenuation/no reflection.

  → only a minimal amount of sound is absorbed, and the region behind the fluid will receive more sound than the surrounding tissue. Therefore, the area will appear brighter.

  This effect is called acoustic **enhancement**.

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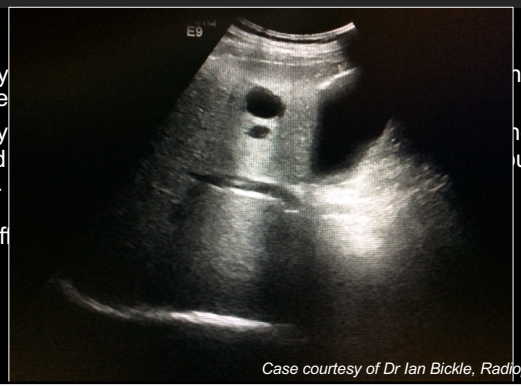
Artefacts: Enhancement

- Watery … more e … hrough
- → only … behind … tissue. … he region … unding

  This ef…



Case courtesy of Dr Ian Bickle, Radiopaedia.org, rID: 41375

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Artefacts: Shadowing

- Band of markedly reduced echogenicity behind strong reflectors (bone, air)

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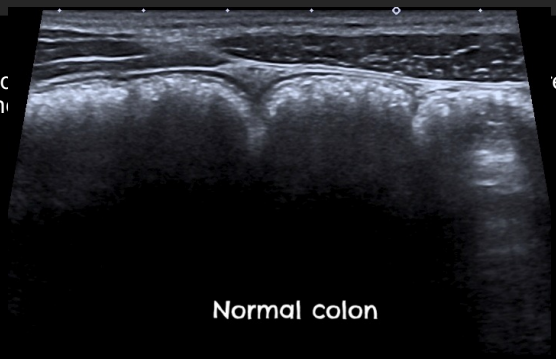
Artefacts: Shadowing

- Banc … (bon… …eflectors



Case courtesy of Brown Emergency Medicine

29

Artefacts: Shadowing

• Band of
(bone, a

reflectors

Case courtesy of Dr Ian Bickle, Radiopaedia.org, rID: 41375

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Artefacts: Edge shadowing

- Occur at the edges of round cavities whose walls lie tangentially to the sound beam.
- Result of the **refraction** of the ultrasound beam along the edge of the structure.
- This limits the penetration depth and will appear as **edge shadowing**.

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Artefacts: Edge shadowing

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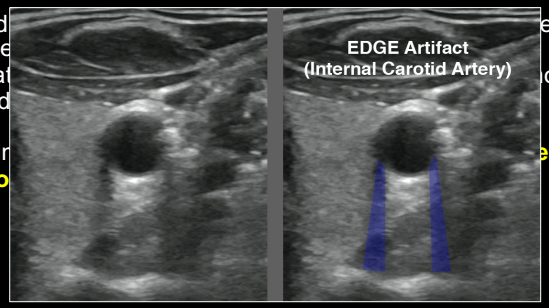

https://www.pocus101.com/basic-principles-of-ultrasound-physics-and-artifacts-made-easy/

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Artefacts: Reverberation

- **Reverberation** artefacts occur when ultrasound waves bounce between two reflective structures. The reflected sound waves will return with a delay.
- The delay is evaluated as increased penetration depth and the echoes are visualized as multiple copies of the structure too far down on the image

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Artefacts: Reverberation

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- The delay
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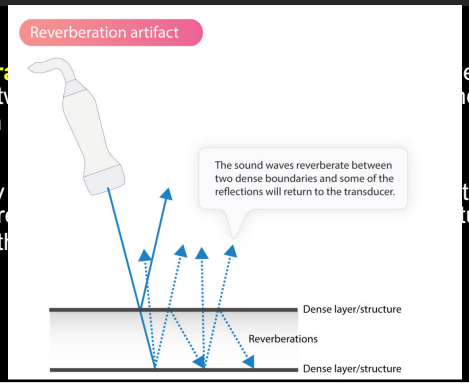

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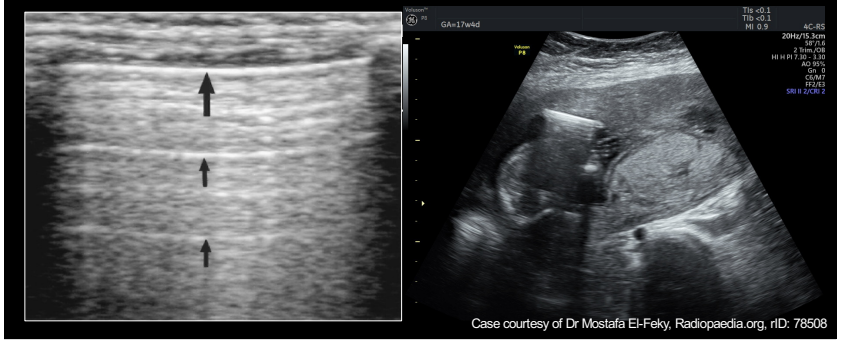
Artefacts: Reverberation



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Artefacts: Mirror image artefact

- This artefact occurs when there is a highly reflective surface (e.g. the diaphragm) in the path of the ultrasound beam.
- The sound waves are deflected laterally by the diaphragm, encounter a reflector, are reflected back to the diaphragm and returned to the probe.
- The **mirror image artefact** will mimic an object similar to the true object at the opposite side of the tissue.

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Artefacts: Mirror image artefact

- This artef
  (e.g. diap
- The **mirro**
  true objec

surface
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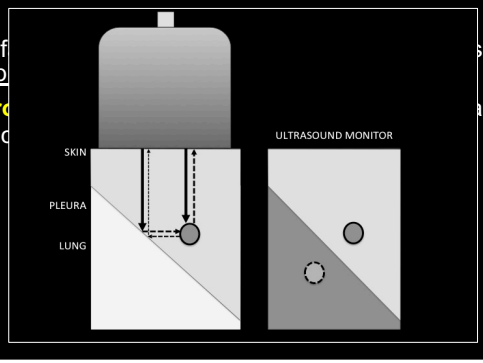

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Artefacts: Mirror image artefact

- This artefa surface (e.g. diaph
- The **mirro** ar to the true object

Case courtesy of Dr Ayush Goel, Radiopaedia.org, rID: 2656(

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Scanning solid organs: Liver

Upper middle abdominal: left liver lobe

Subcostal: right liver lobe, vena cava inferior, portal veins, gallbladder.

Intercostal position right flank: right liver lobe, portal veins, liver veins

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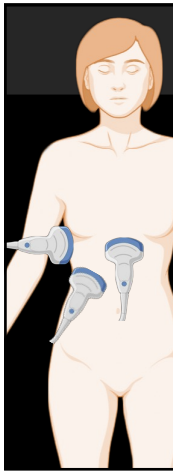
Scanning solid organs: Liver



Biorender.org

Case courtesy of Dr Henry Knipe, Radiopaedia.org, rID: 38664

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Scanning solid organs: Liver

Case courtesy of Dr Bruno Di Muzio, Radiopaedia.org, rID: 79127

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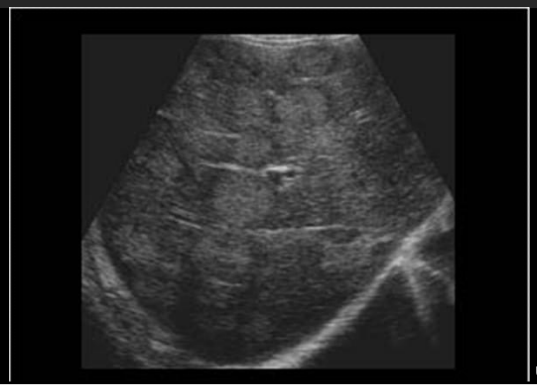
Scanning solid organs: Liver



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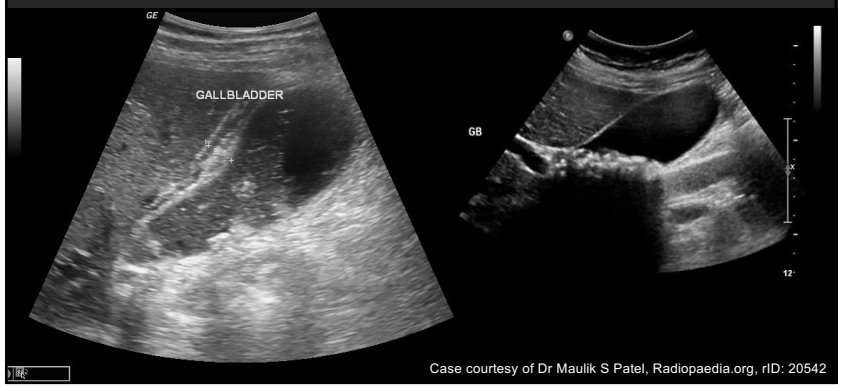
Scanning solid organs: Liver



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Scanning solid organs: Kidneys

Subcostal (“liver window”) or right flank scanning: right kidney

Left flank scanning: left kidney

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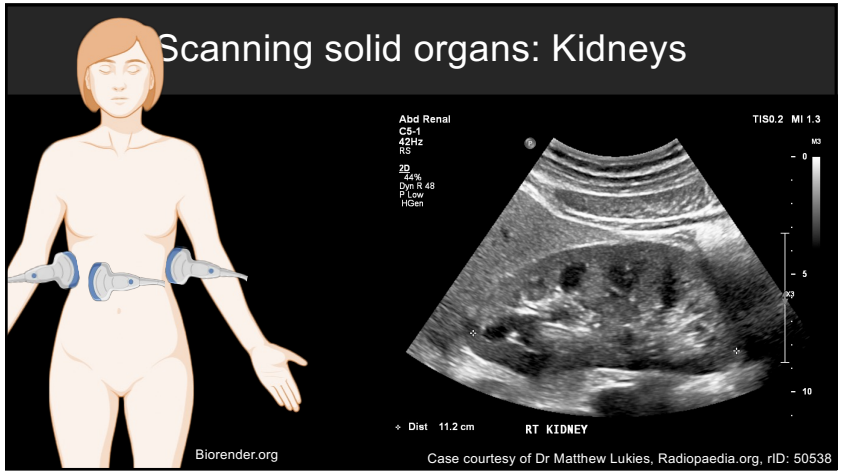
Scanning solid organs: Kidneys



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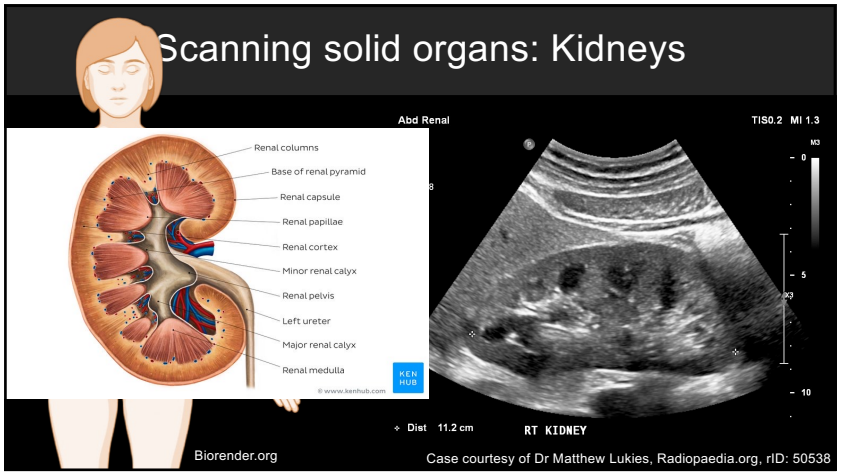
Scanning solid organs: Kidneys



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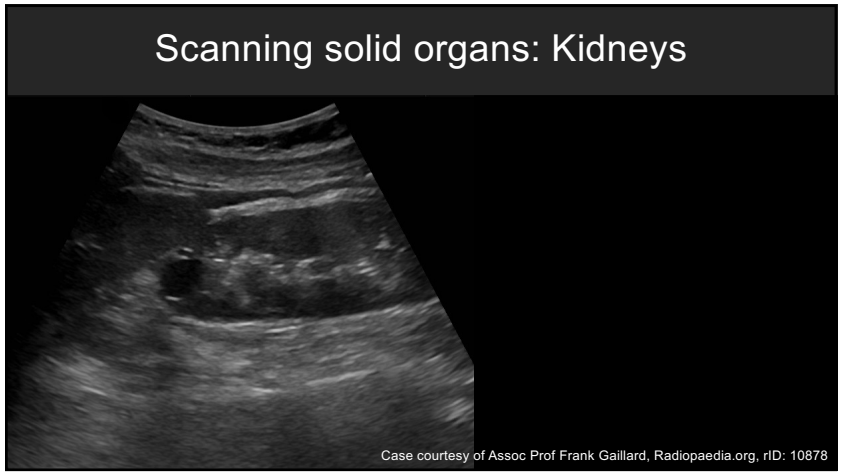
Scanning solid organs: Kidneys



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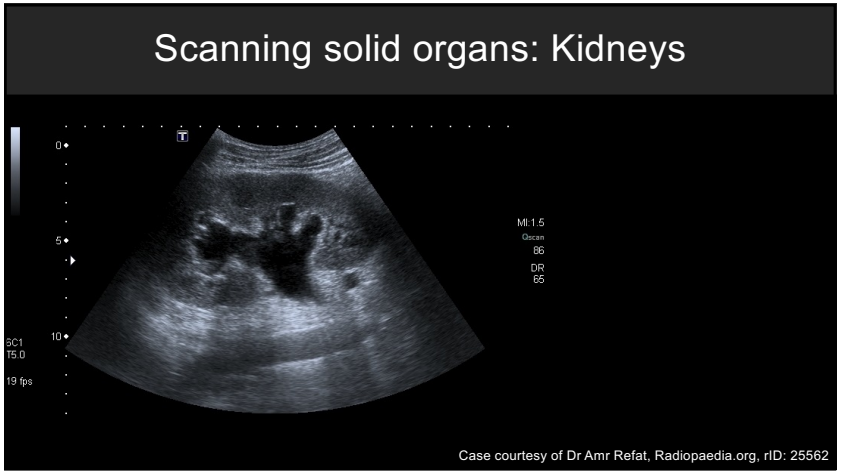
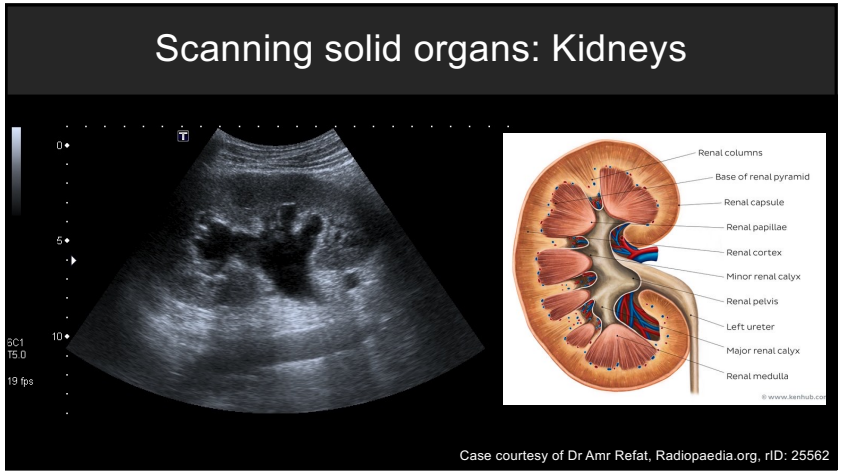
Scanning solid organs: Kidneys



48

Scanning solid organs: Kidneys



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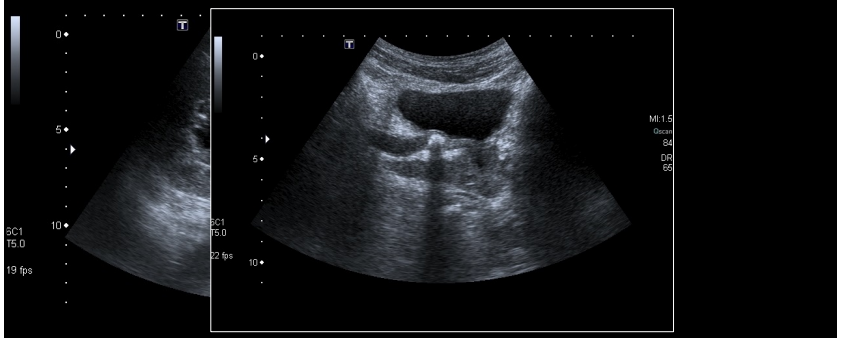
Scanning solid organs: Kidneys



Case courtesy of Dr Amr Refat, Radiopaedia.org, rID: 25562

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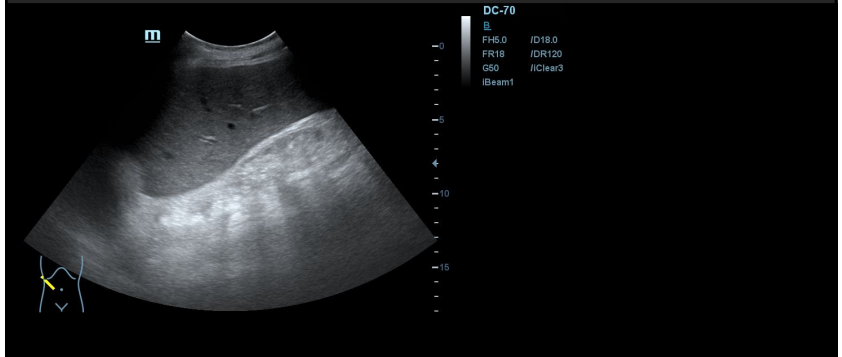
Scanning solid organs: Kidneys



Case courtesy of Dr Balint Botz, Radiopaedia.org, rID: 59788

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Scanning solid organs: Spleen

Intercostal scanning rear axillary line: spleen with the same structure as the liver

Subcostal scanning: thin people

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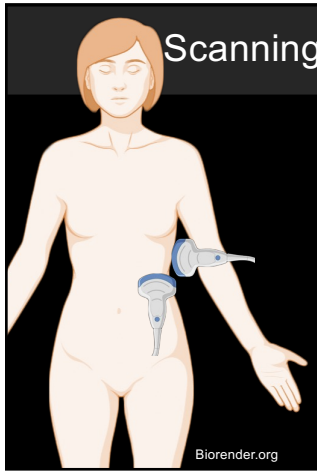
Scanning solid organs: Spleen



Biorender.org

https://radiologykey.com/ultrasound-of-the-spleen-and-lymphatic-system/

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Scanning solid organs: Spleen

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Scanning solid organs: Bladder

Transabdominal scanning: bladder (full)

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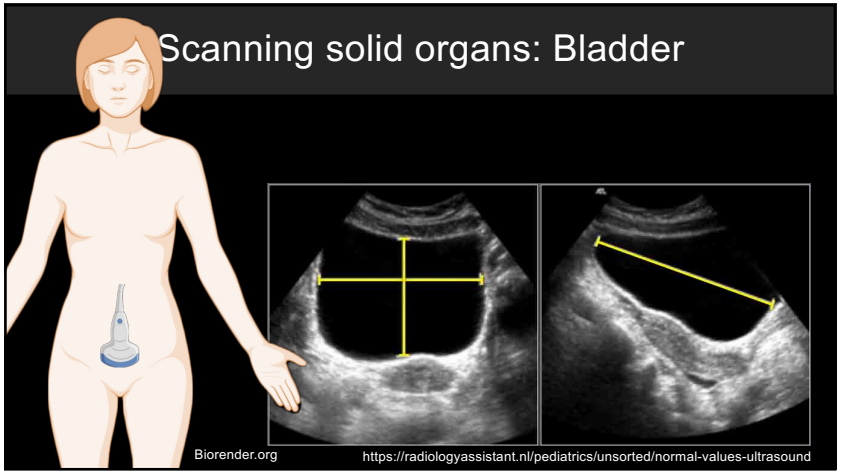
Scanning solid organs: Bladder



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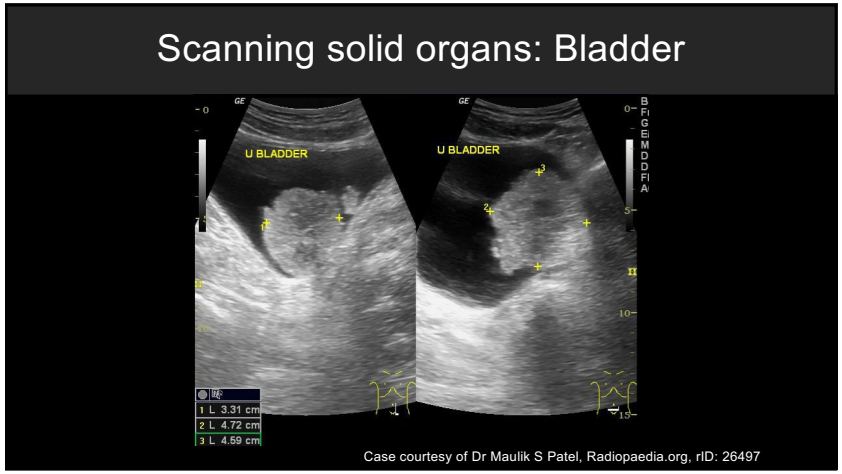
Scanning solid organs: Bladder



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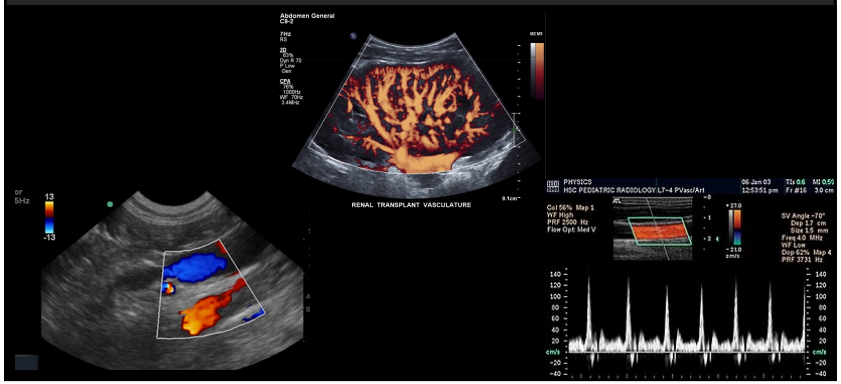
Scanning vessels: Doppler



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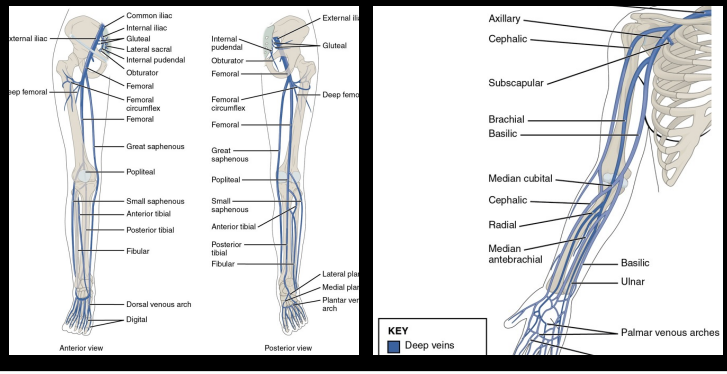
Scanning vessels: DVT



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Scanning vessels: DVT

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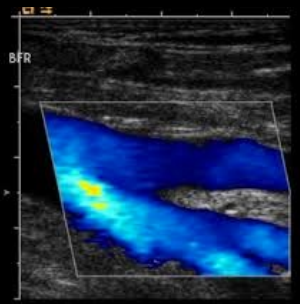
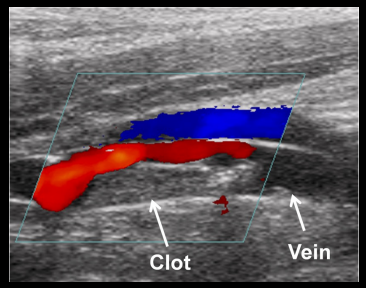
Scanning vessels: DVT





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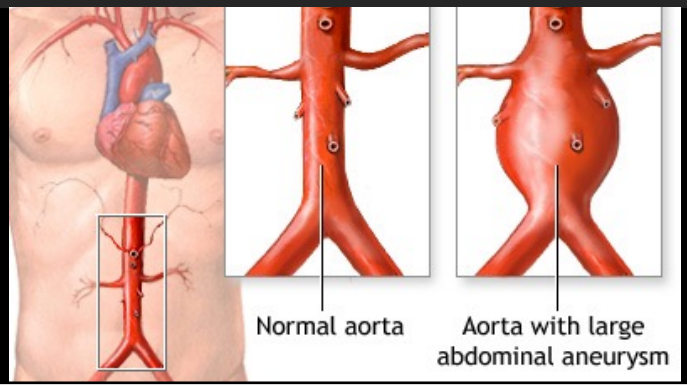
Scanning vessels: Aorta



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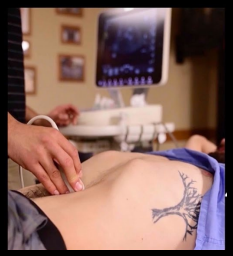
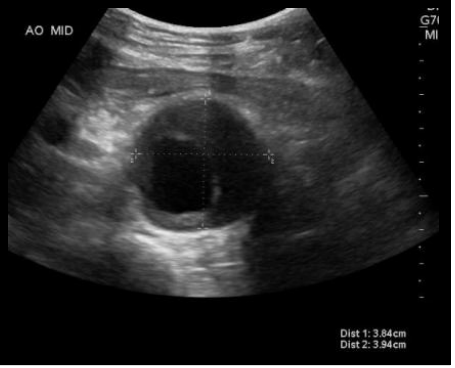
Scanning vessels: Aorta





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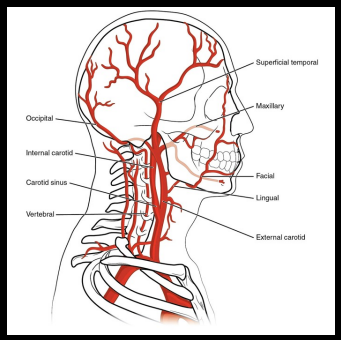
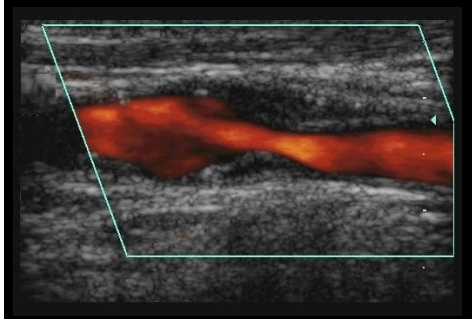
Scanning vessels: Carotid arteries





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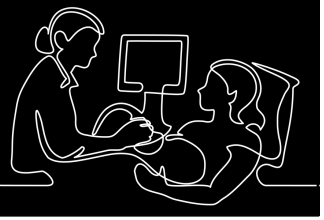
Procedures and conventions

- Dim light in the room
- The examiner on the right side of the patient
- Transducer in the right hand
- Grab as if you are holding tweezers or a pen
- Identify left / right or up / down on the transducer (NB! Indicator on transducer head)
- Use plenty amounts of gel
- Support the forearm and hand on the person you are scanning
- View the screen and not the person you are scanning
- Optimize image according to target



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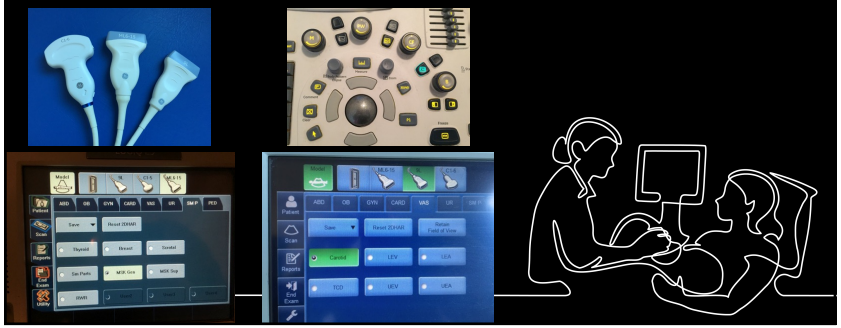
Procedures and conventions

- Optimize image according to target



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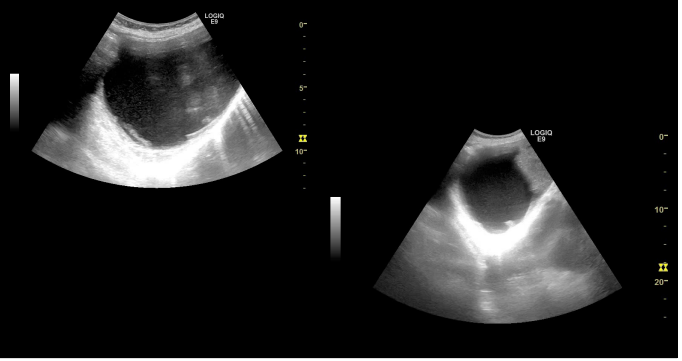
Procedures and conventions

- Gain
- Depth



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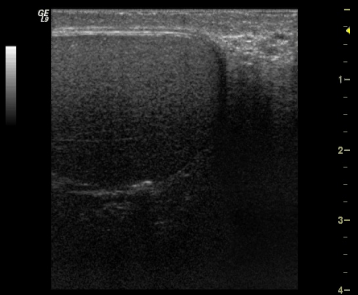
Procedures and conventions

- Focal zone



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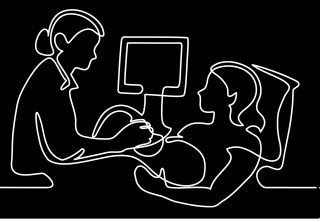
Procedures and conventions

Moving the transducer

- Parallel shift (or sliding)
- Rotation 90 degrees
- Rocking (from side to side)
- Tilting (back and forth)
- Compression



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Scanning solid organs

Let’s try

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