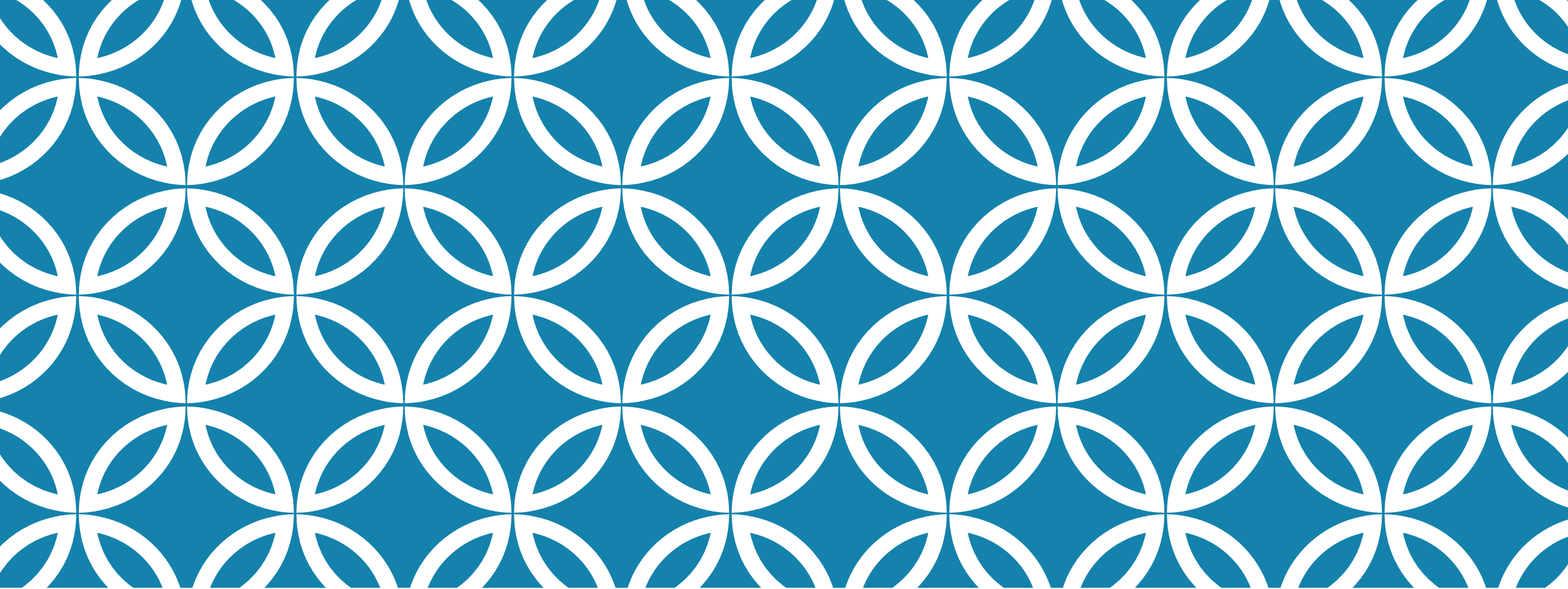




BASIC CONCEPTS IN ULTRASONOGRAPHY

Done by : Yara Khlaifat

Corrected by : Raghad Abu-Sarhan

بِسْمِ اللَّهِ



BASIC ULTRASOUND PHYSICS

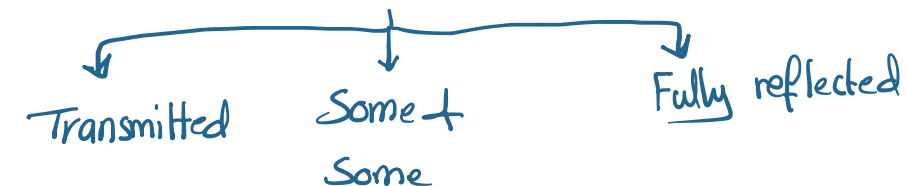
- The source of the ultrasound wave is the piezoelectric crystal, which is placed in the transducer.
→ transforms energy from one form to another.
↳ present in the probe.
- This crystal has the ability to transform an electrical current into mechanical pressure waves (ultrasound waves) and vice versa.
* من كهرباء الى موجات
- Once the ultrasound wave is generated and travels through the medium, the crystal switches from 'sending' into 'listening' mode and awaits returning ultrasound echoes.



- Actually over 99% of the time is spent “listening”.
- This cycle is repeated several million times per second. This principle is called “pulsed-echo” principle.
- Returning sound waves are converted into images on the ultrasound monitor.
- Diagnostic ultrasound used for common medical imaging uses frequencies between 2 and 20 million Hertz (Megahertz, MHz).

* US measures the strength of returning echos (it doesn't depend on the density of the structure).

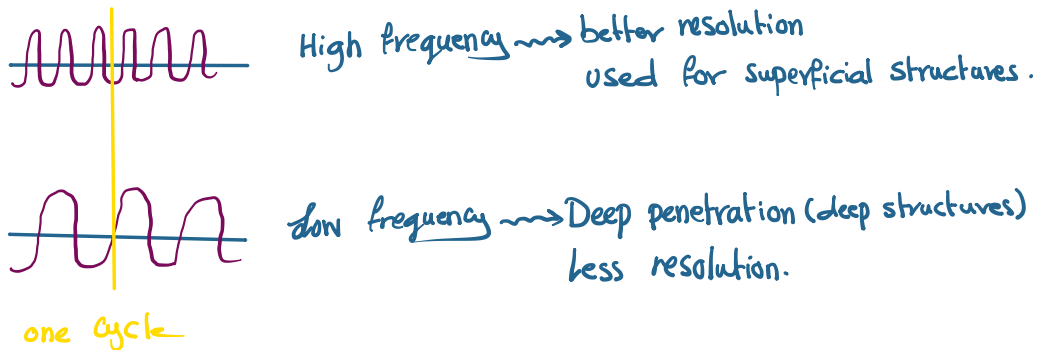
* Echos can be :



* US is not suitable for bone lesions.

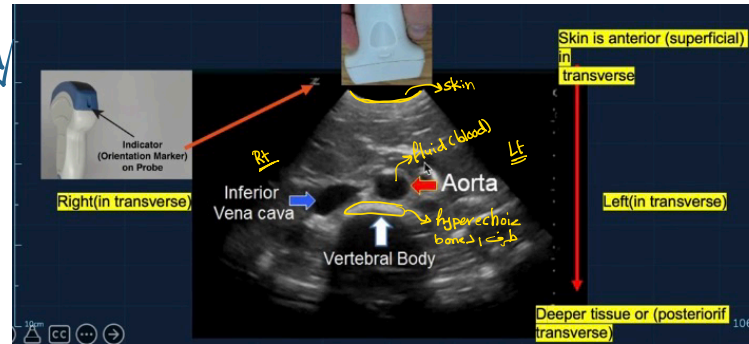
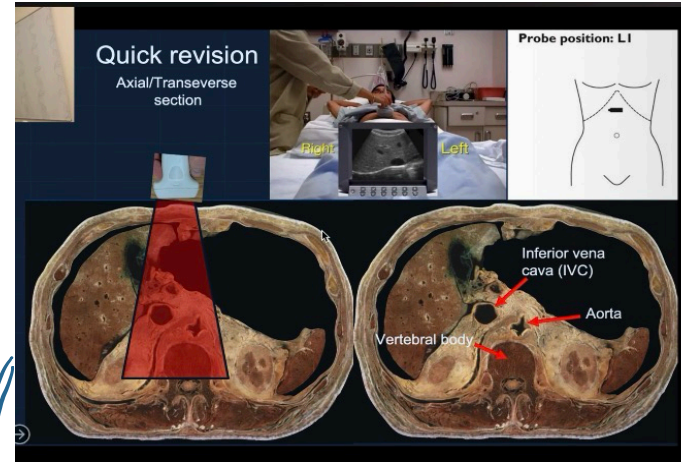
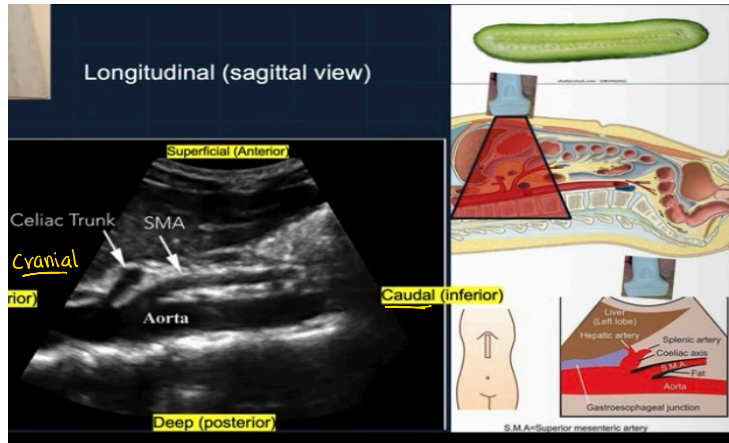
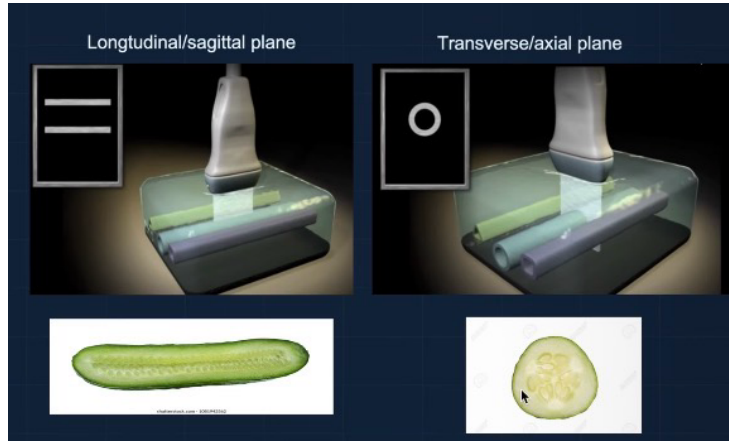
PROBES

- **Lower frequencies** are able to penetrate **deeper** into tissue but show **poorer resolution**.
- In contrary **higher frequency** ultrasound will display more detail with a **higher resolution** in exchange for **less depth** penetration.
- This is a very important principle when choosing your probes and frequencies.

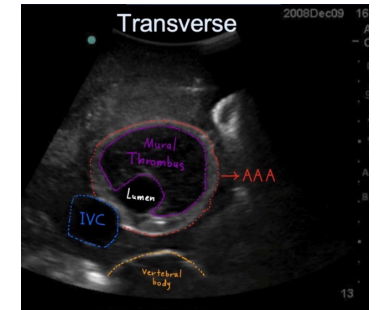


* Planes

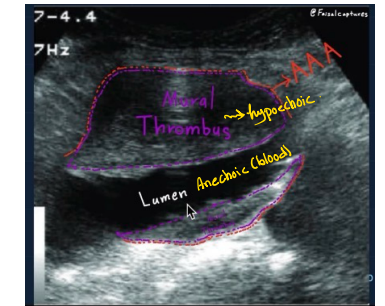
Extra



* Example: Abd. aortic aneurysm.



- Longitudinal view.

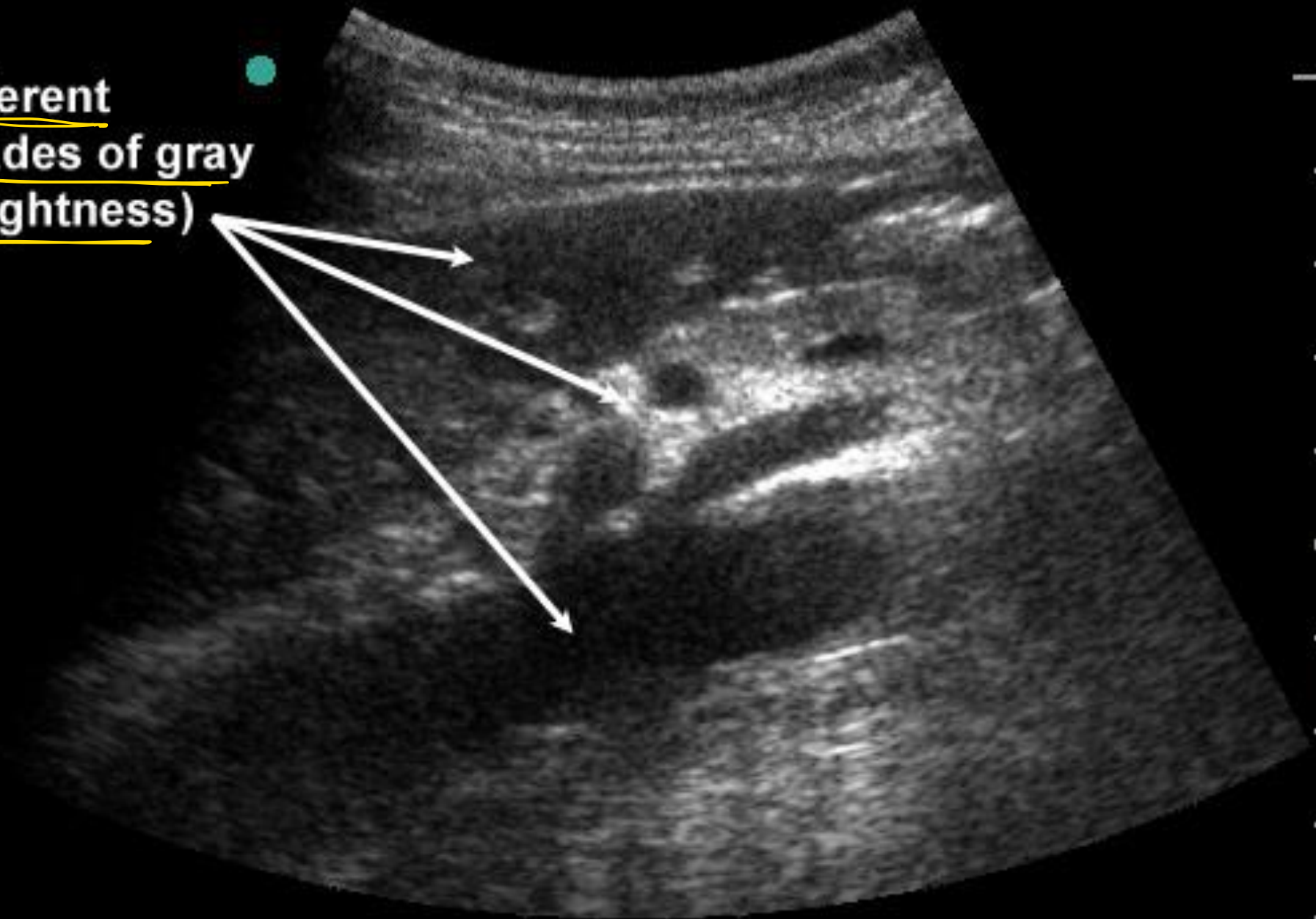


ULTRASOUND MODES

- **B-mode** stands for 'brightness mode' and provides structural information utilizing different shades of gray (or different 'brightness') in a two-dimensional image.



different
shades of gray
(brightness)

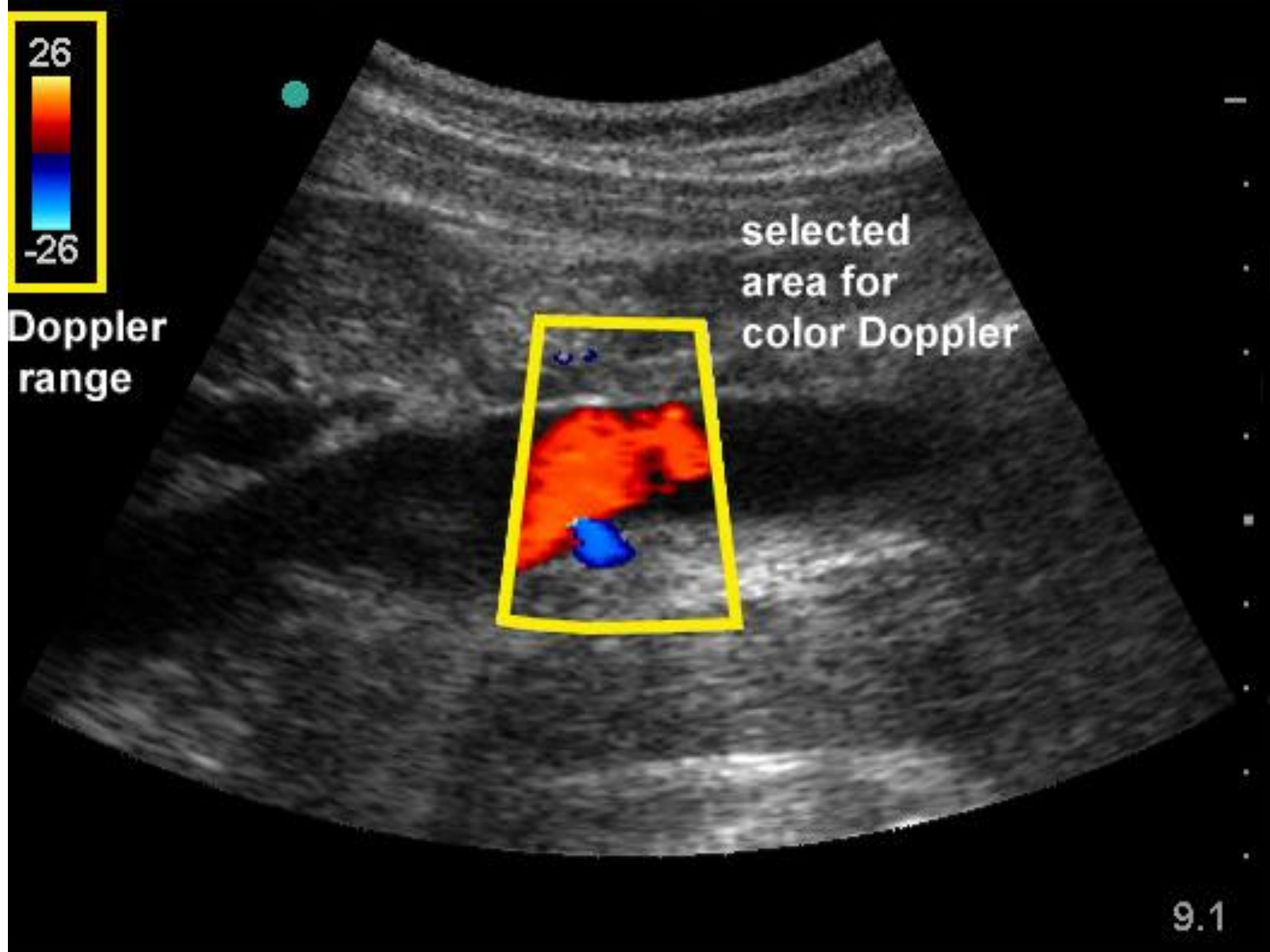


THE DOPPLER MODE

"Blood vessels"

- It utilizes a phenomenon called 'Doppler shift', which is a change in frequency from the sent to the returning sound wave.
- **Color Doppler** ultrasound is also called color-flow ultrasound. It is able to show blood flow or tissue motion in a selected two-dimensional area. **Direction and velocity** of tissue motion and blood flow are color coded and superimposed on the corresponding B-mode image.





26
-26

Doppler
range

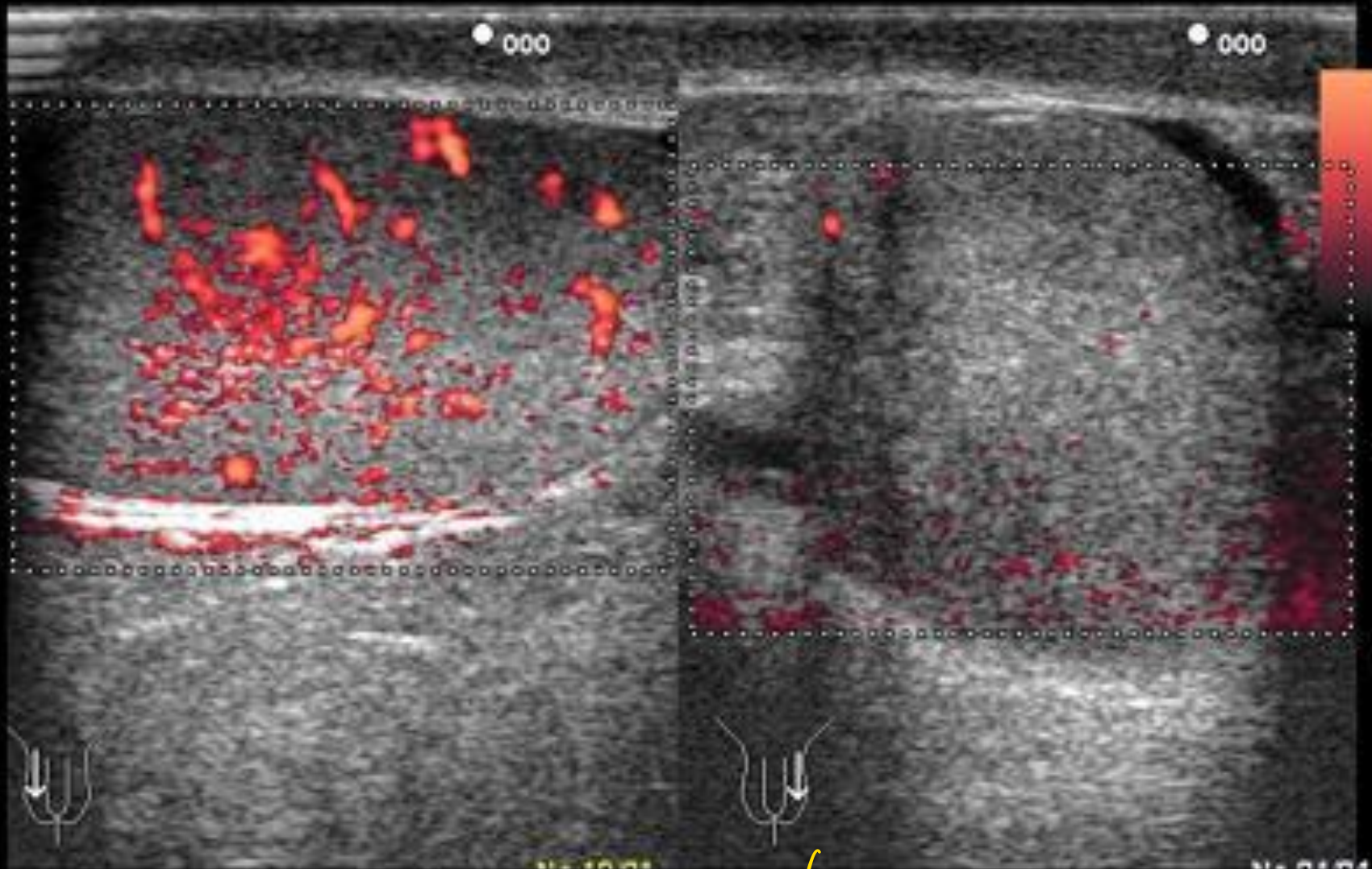
selected
area for
color Doppler

*Towards the probe
→
Red
*Away → blue.

POWER DOPPLER

- Unlike color Doppler, common power Doppler does not examine flow velocity or the direction of flow.
- It looks at the amplitudes of the returning frequency shifts and is able to detect even states of very low flow.
- **This is of use when examining vascular emergencies such as testicular or ovarian torsion.**





* Is there a flow or not ?

* You have to compare both sides .

↳ The flow is absent.



SPECTRAL DOPPLER (PULSED-WAVE FORM)

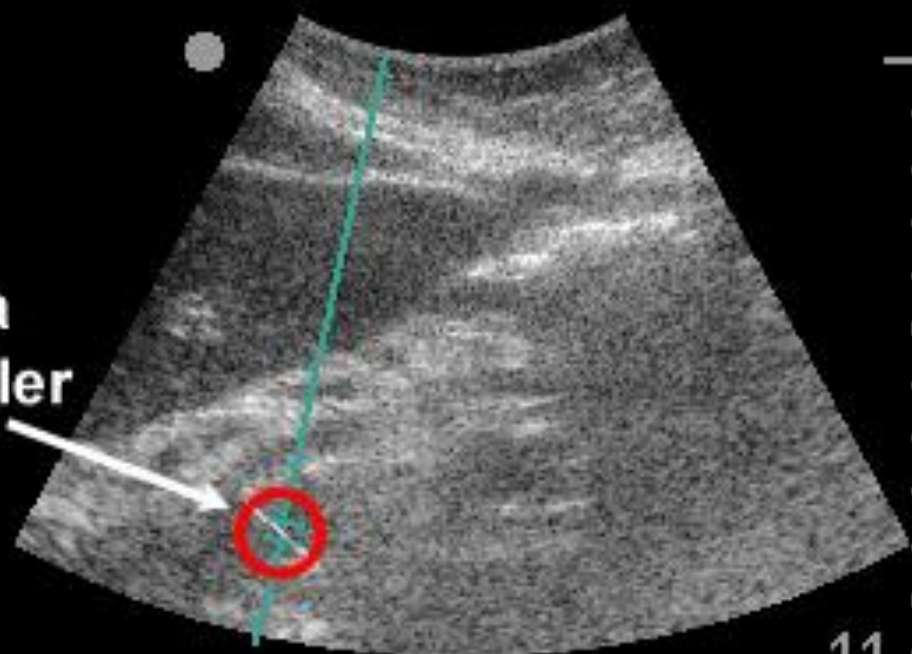
- Pulsed-wave spectral Doppler shows the “spectrum” of the returned Doppler frequencies in a characteristic two-dimensional display.
- Venous flow demonstrates a more continuous, band like shape. *monophasic*
- Arterial flow shows a more triangular shape



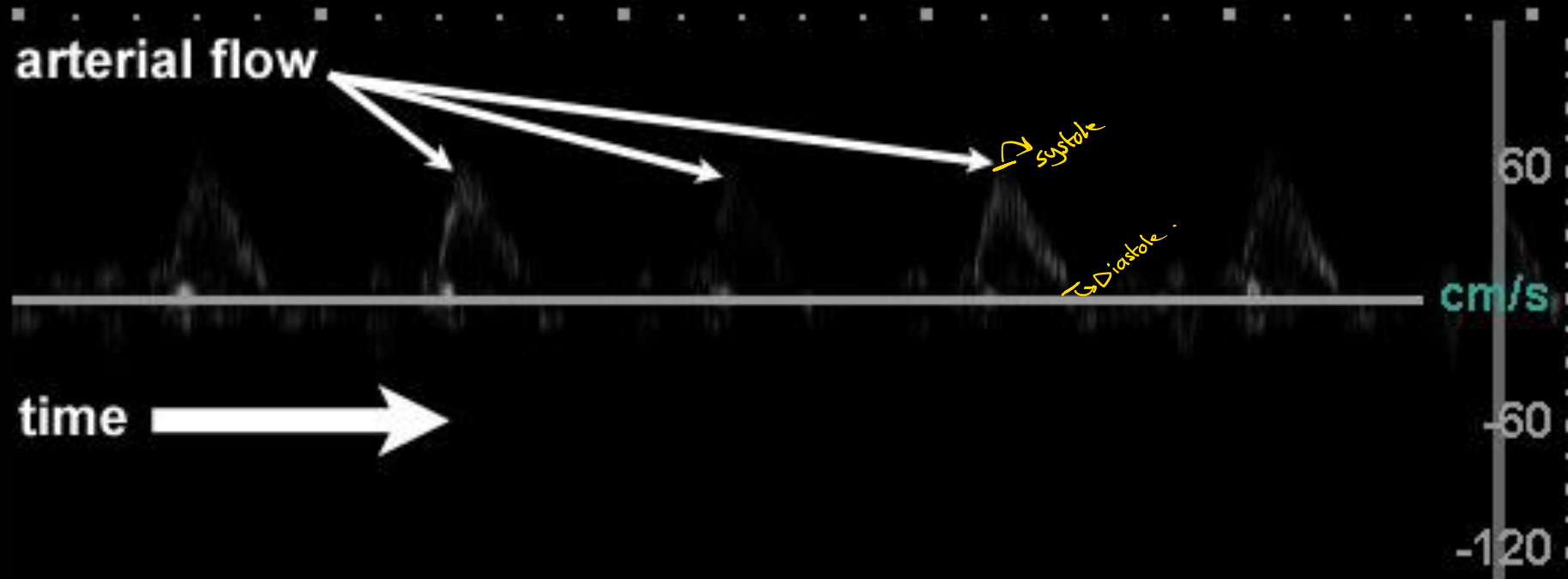
selected area
for PW Doppler

arterial flow

time



11



PROBES

The most common transducers utilized in the emergency department are:

- **Large Convex Probe:**

- ❖ Main ED utilization is **transabdominal** sonography. Produces a sector shaped image with a large curved top. The active element is arranged in a large curved line, also called large curved probe or transducer.

- **Linear Probe:**

- ❖ Main utilization is **vascular** sonography or evaluation of **superficial** soft tissue structures. The active element is arranged in a straight line.

Extra :

Probe	Frequency	Best for	Image shape
Linear	High (7–18 MHz)	Superficial structures, vessels, <u>thyroid</u>	Rectangular
Curvilinear (convex)	Low–medium (2–6 MHz)	Abdomen, obstetrics	Curved sector
Sector (phased array)	Low (2–5 MHz)	Heart, chest, FAST	Fan-shaped sector

**intracavity probe
(microconvex)**

↳ Trans-rectal
Trans-vaginal

sector probe

↳ special cath probe
used in cath lab.

low frequency, high penetration, low
resolution compared to linear probe, used
in deep structures examination as the abd.
organs.

large convex probe

High frequency, high resolution, low
penetration, good for superficial
examination (thyroid, breast,
scrotum, deep veins w/out
DVT)

linear probe



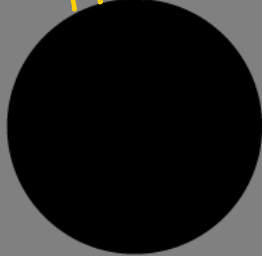
COMMON TERMINOLOGY

Image Interpretation:

- ❖ **Anechoic / Echolucent** - Complete **absence** of returning sound waves, area is black.
- ❖ **Hypoechoic** - Structure has (very few echoes) and appears **darker** than surrounding tissue.
- ❖ **Hyperechoic / Echogenic** - Opposite of hypoechoic, structure appears **brighter** than surrounding tissue.

* ↑ Echo ~~~> ↑↑ brightness.

Anechoic
↳ Transmitted
Fluid.



No signal

Hypoechoic



Isoechoic



Hyperechoic



Reflective

↳ it doesn't pass (bone, air, gallstones)



Shadow

Soft tissue, muscles,
fat, ligaments, fibrous tissues.

↳ if there's a
difference in
density between
2 media.

ECHOGENICITY

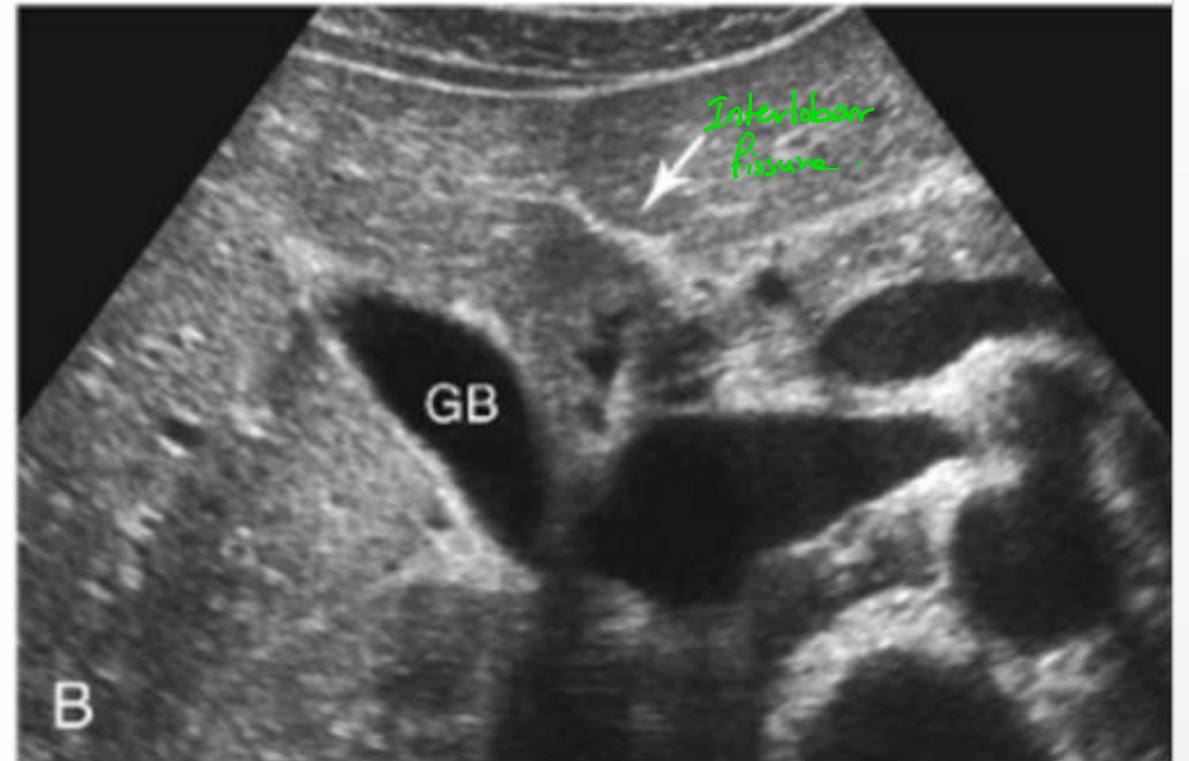
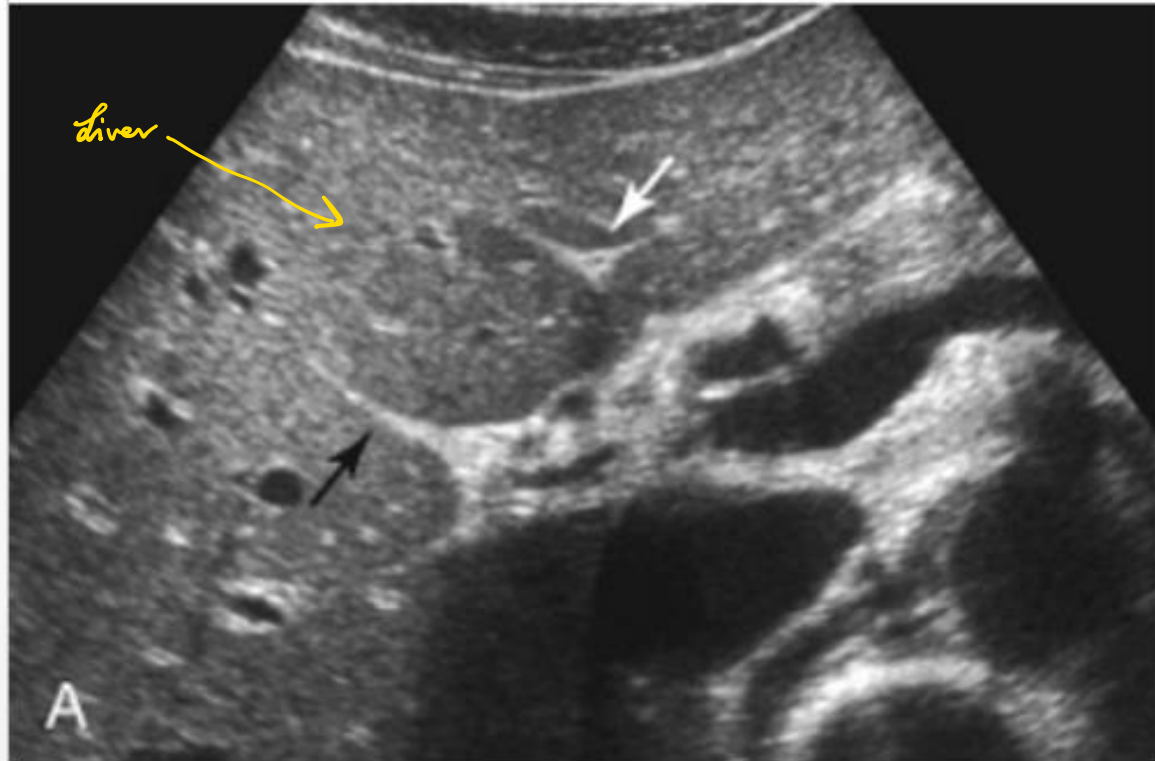


THE GALLBLADDER

Characteristic	Appearance
Location	Inferior to interlobar fissure Between left and right hemiliver
Size	<4 cm transverse عرض more relevant <10 cm longitudinal طول
Wall thickness	<3 mm
Lumen	Anechoic Fluid.



* Done with the curvilinear probe.



TECHNIQUE

- Ideally, patients should **fast 8 hours** after midnight before they undergo a gallbladder sonogram to ensure adequate gallbladder distention^① and to reduce upper abdominal bowel gas.^②
↓
↑↑ bile.
- Most gallbladder examinations start with the patient in the supine^① position using a 3- to 5-MHz sector transducer. *Then the lt lateral decubitus*^②

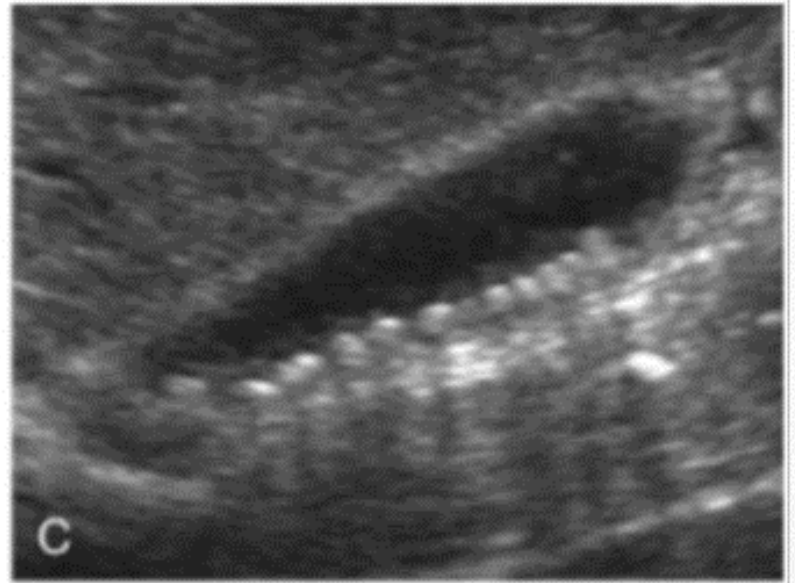
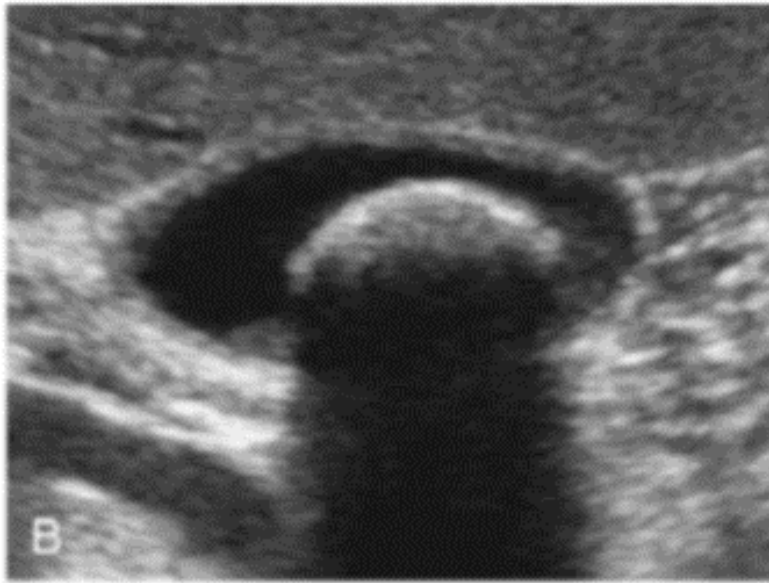
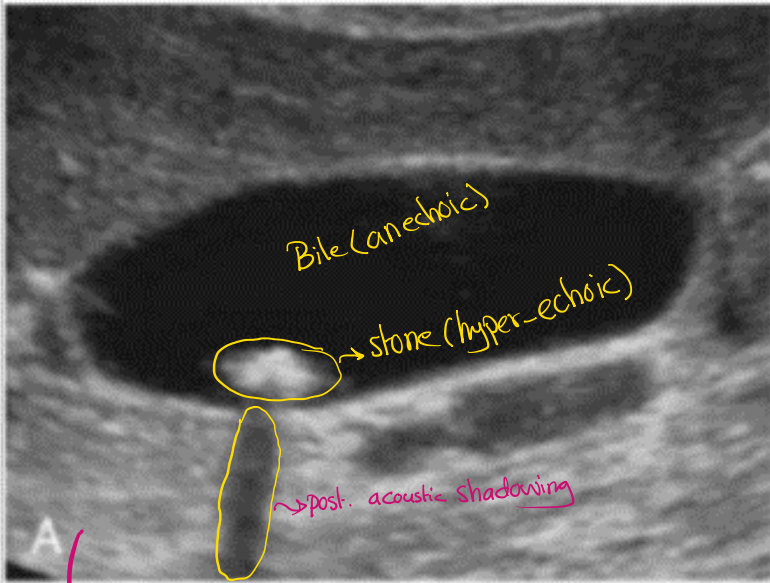
GALLSTONES

- Gallstones are present in up to 10% of the population.
- The majority (60% to 80%) of gallstones are asymptomatic (silent).
- Approximately 30% of patients with gallstones will have only a (single episode of pain.)
- The most common symptom of gallstones is biliary colic, which manifests as acute right upper quadrant (RUQ) or epigastric pain lasting for up to 6 hours and ending when the stone disimpacts from the gallbladder neck or passes completely through the cystic duct.

* Polyps appear hyper-echoic, but they don't show acoustic shadowing.

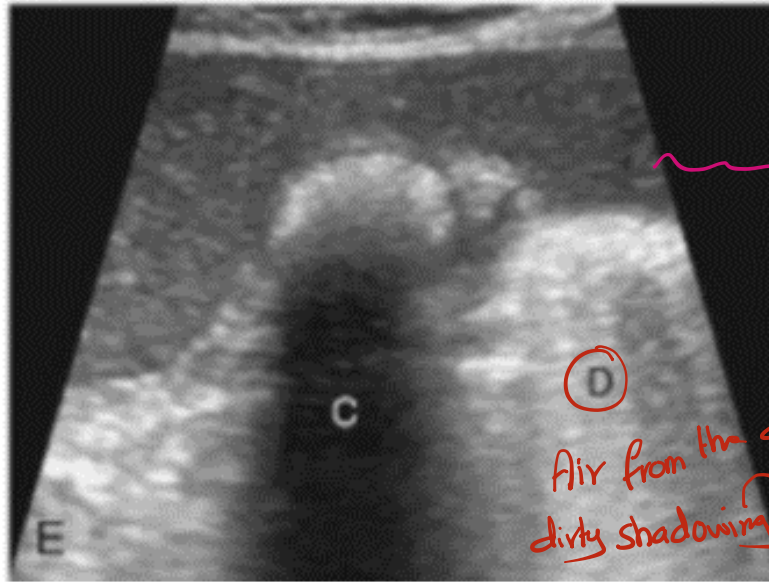
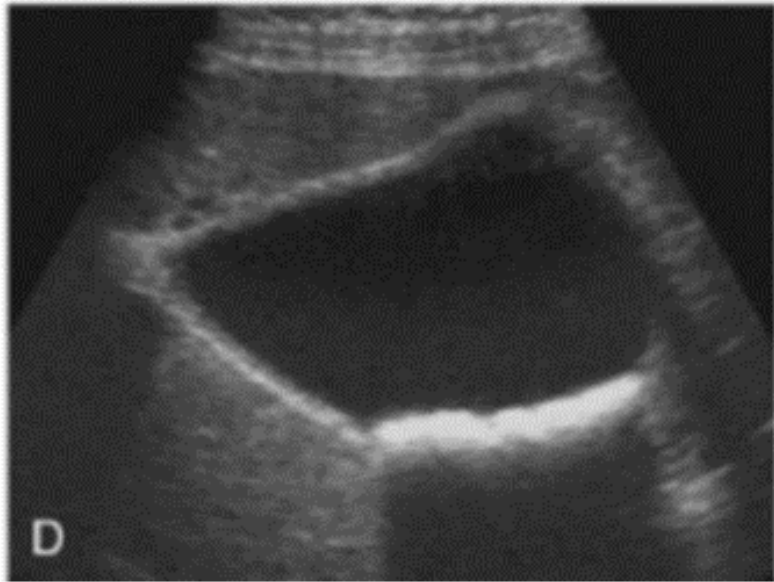
- Gallstones appear as mobile, ^①echogenic, ^②intraluminal structures that cast acoustic shadows. ^③*→ Only if it's large enough.*
- Shadowing occurs because of (sound beam absorption by the stone.)
- Demonstration of shadowing is important in distinguishing stones from other intraluminal abnormalities.
- Shadowing primarily depends on the size of the stone.
- Stones smaller than ^{< 3 mm.} 3 mm may not cast a detectable shadow.





Longitudinal view.

* Any stone / bone shows acoustic shadowing.

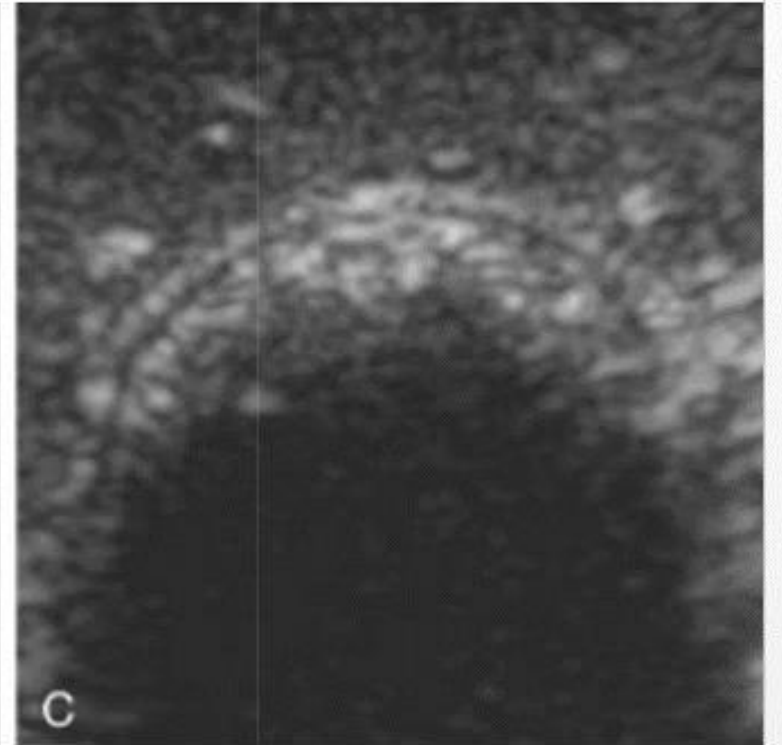
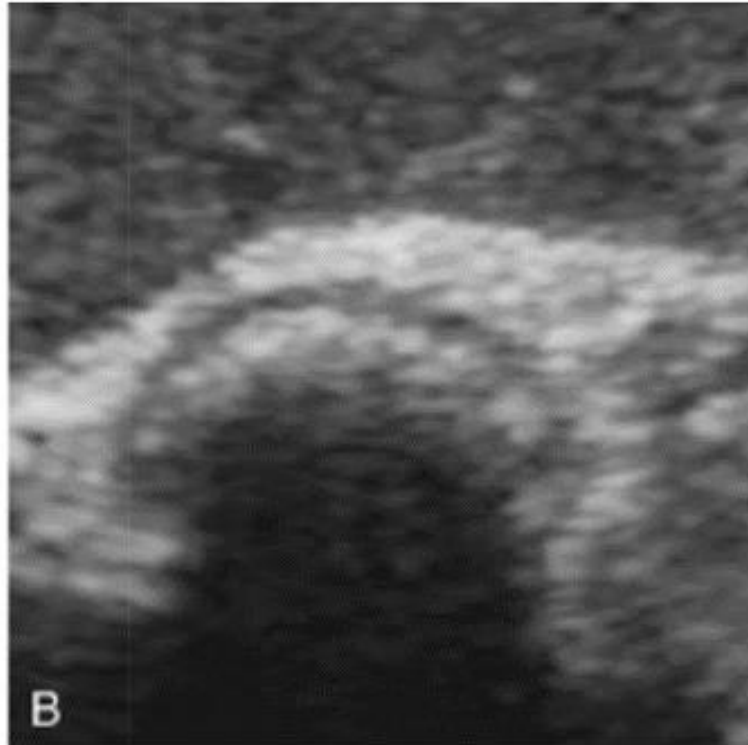


Contracted gallbladder.

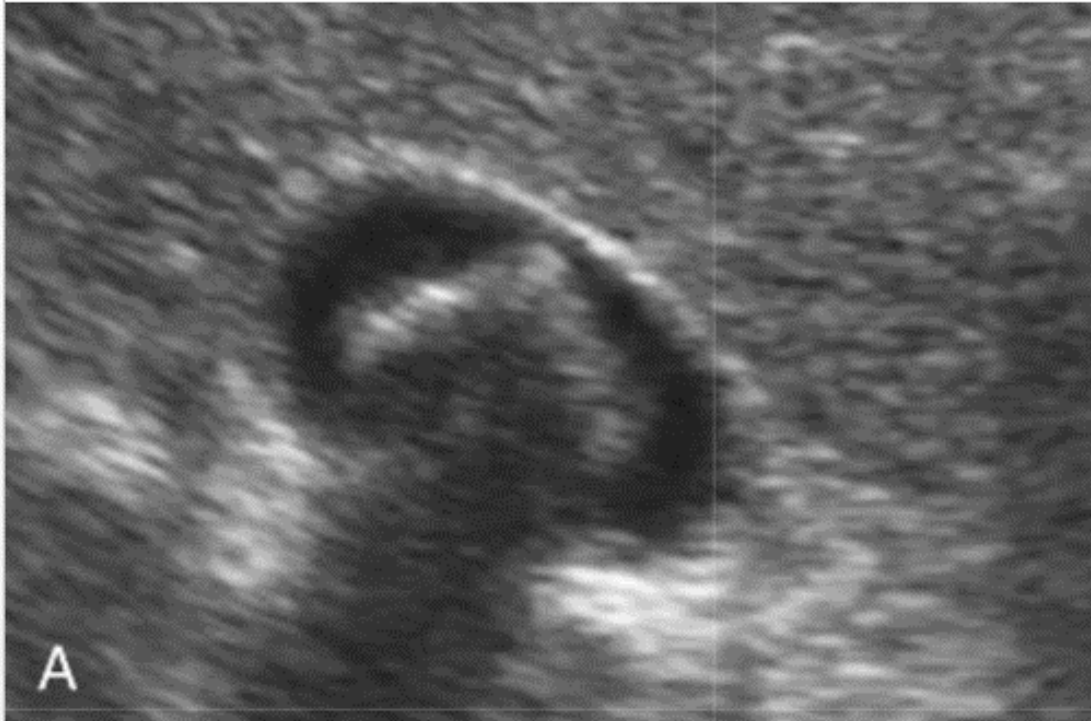
Air from the duodenum
dirty shadowing → That's why we use US gel to eliminate the air between the ultrasound transducer (probe) and the skin.



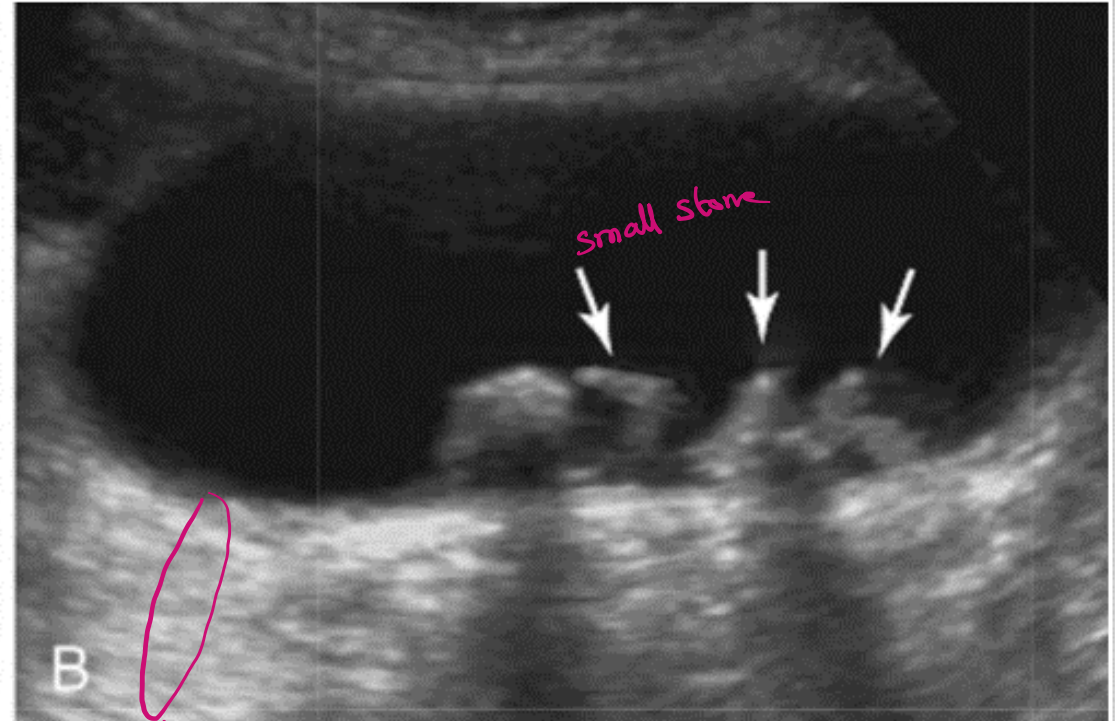
* Contracted gallbladder



Transverse view



Axial view



* Small gallstones might be confused with polyps (as they don't show acoustic shadowing... So how to differentiate between them?

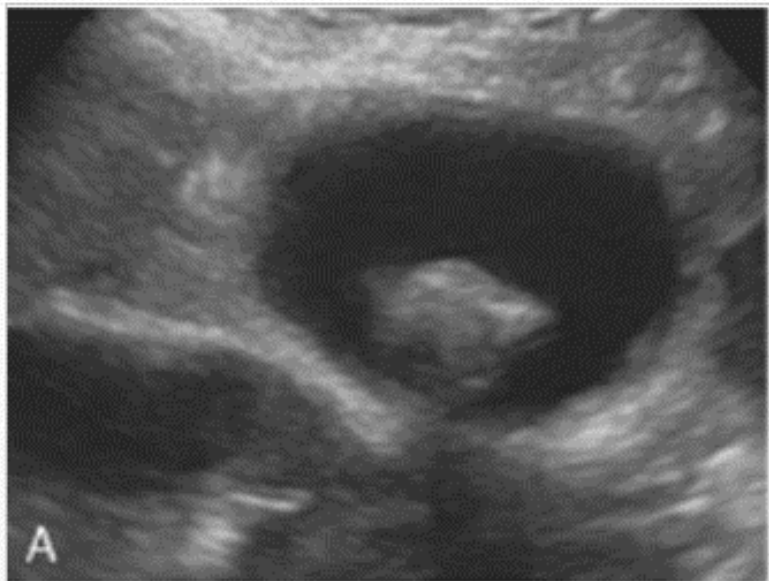
- Ask the pt to turn around 360 degrees, if it moves then it's a stone rather than a polyp.

Acoustic enhancement
it appears around any cystic structure. (e.g. urinary bladder).

- Multiple studies have documented sensitivities of greater than 95% and positive and negative predictive values that are close to 100%.
- Approximately 15% of gallstones are visible on abdominal radiographs.
- CT is significantly better in detecting gallstones than radiography, but is significantly less sensitive than sonography.
- This is because noncalcified cholesterol stones may have the same attenuation value as bile and be occult on CT.
- At best, CT has sensitivity of approximately 80%.

CT → Calcified gallstones only.
↓
The best for renal stones.





Transverse view.



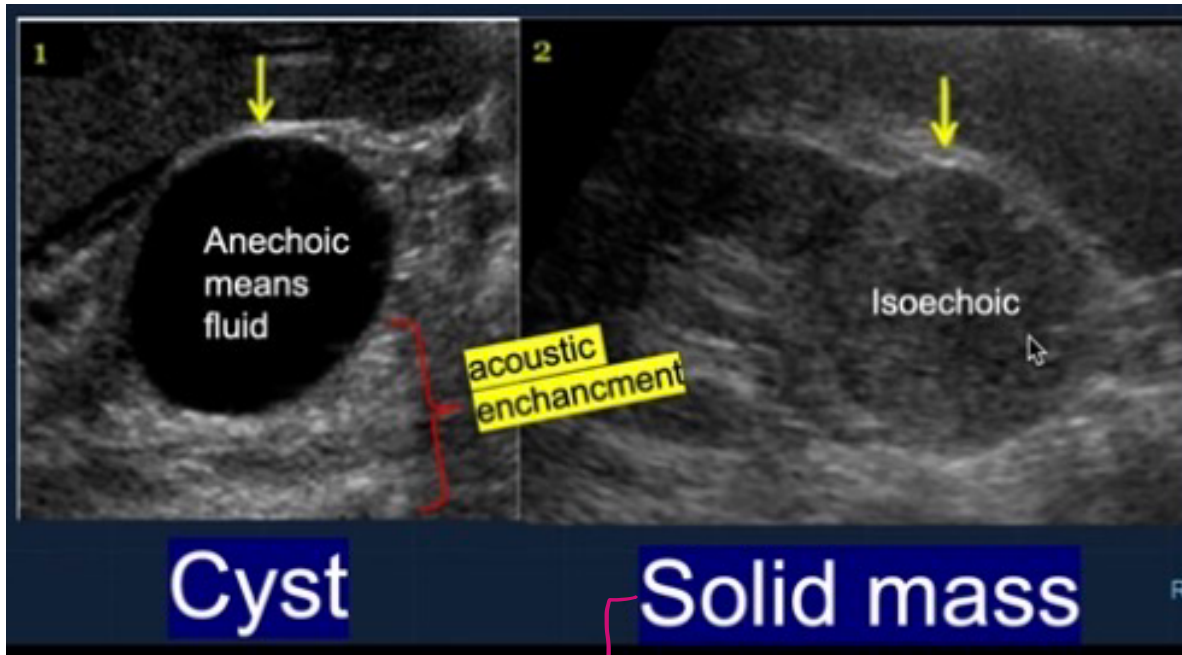
Large gallstones

Longitudinal view



Here it doesn't
appear on CT.

* Extras



→ Isoechoic means soft tissue
There's no acoustic enhancement, nor shadowing.

ACUTE CHOLECYSTITIS

Box 2-1

Sonographic Signs of Acute Cholecystitis

Gallstones

Wall thickening (≥ 3 mm)

Gallbladder enlargement $> 4 \times 10$ cm

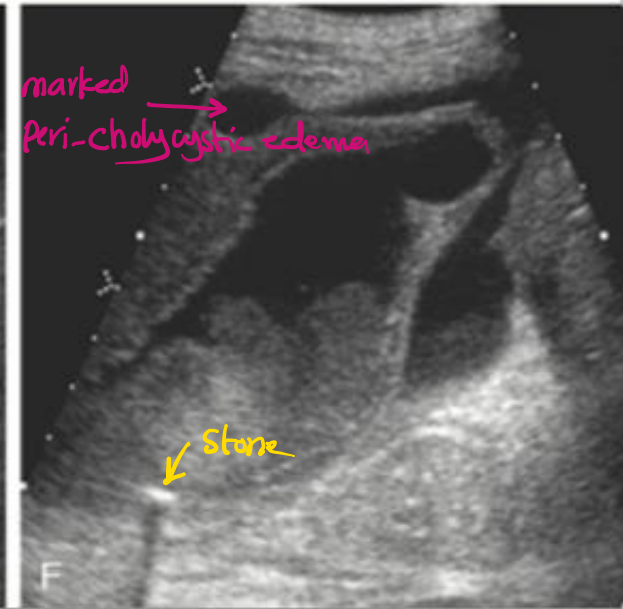
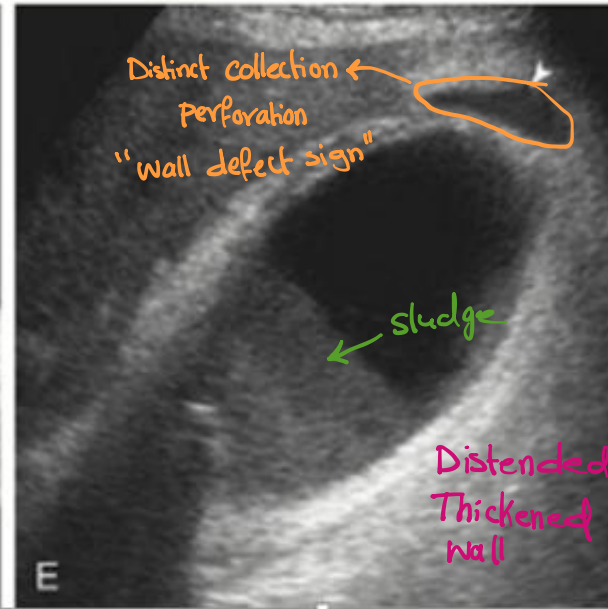
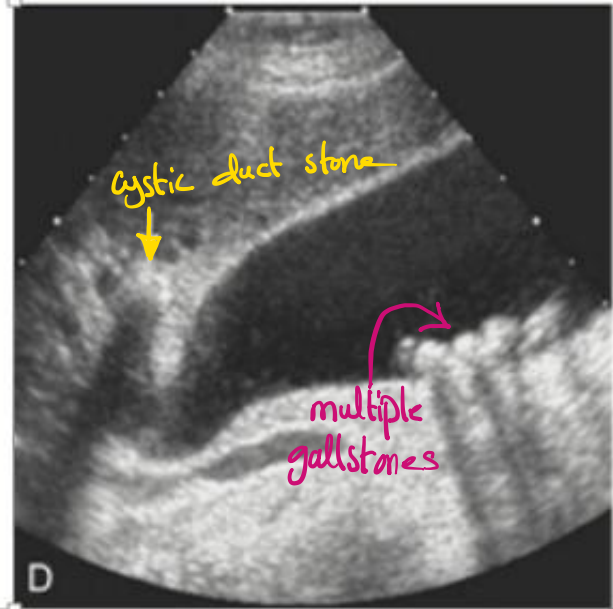
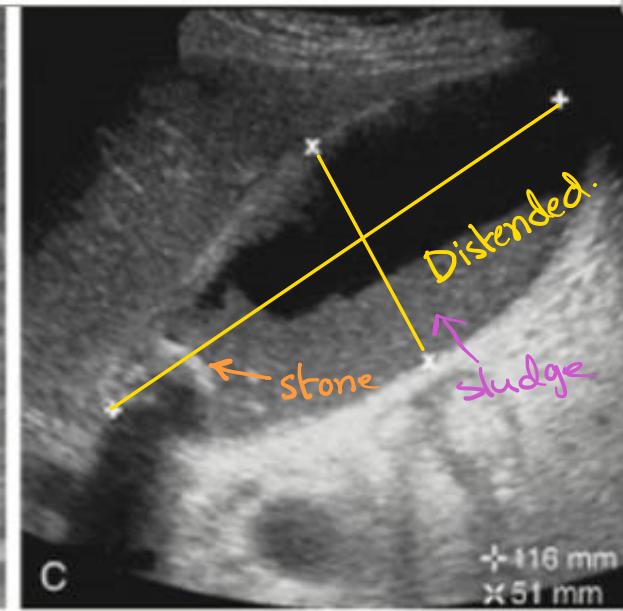
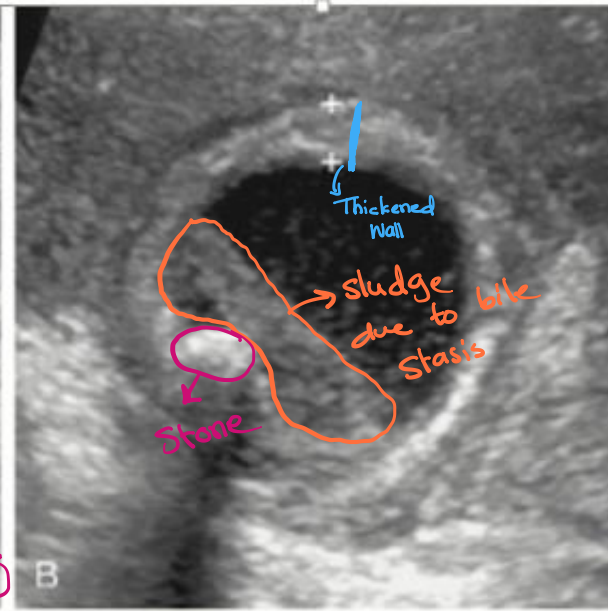
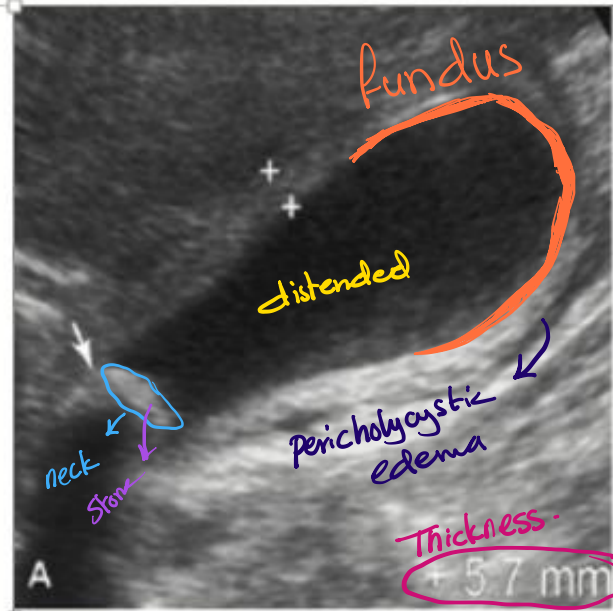
Pericholecystic fluid

Impacted stone

Sonographic Murphy's sign



Transverse view



LIVER

Characteristic	Appearance
Size	<15 cm
Echogenicity	≥Right kidney, ≤pancreas, <spleen (Fatty liver has less echogenicity).
Parenchyma	Homogeneous
Surface	Smooth

- Nodular in case of cirrhosis.

- Anatomy: Lt & Rt lobes of the liver are divided by cantlie's line (imaginary line) that runs from middle hepatic vein/IVC post. to gallbladder fossa ant.

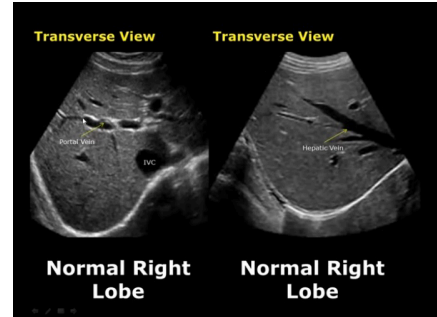
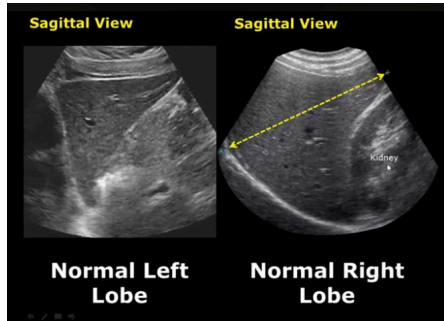
- Porta hepatis contains 3 structures:

- 1) Common bile duct.
- 2) Common hepatic artery.
- 3) Portal vein.

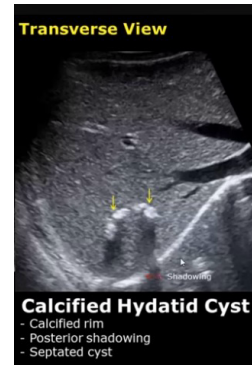
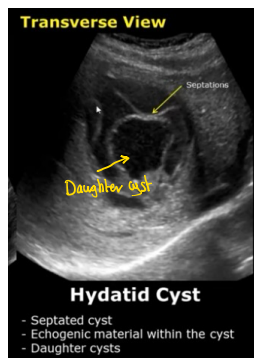
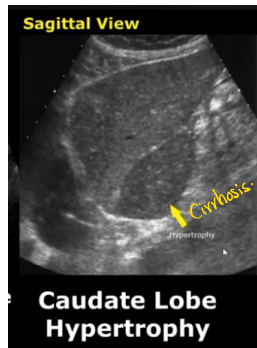
Ant.
↓
Post.

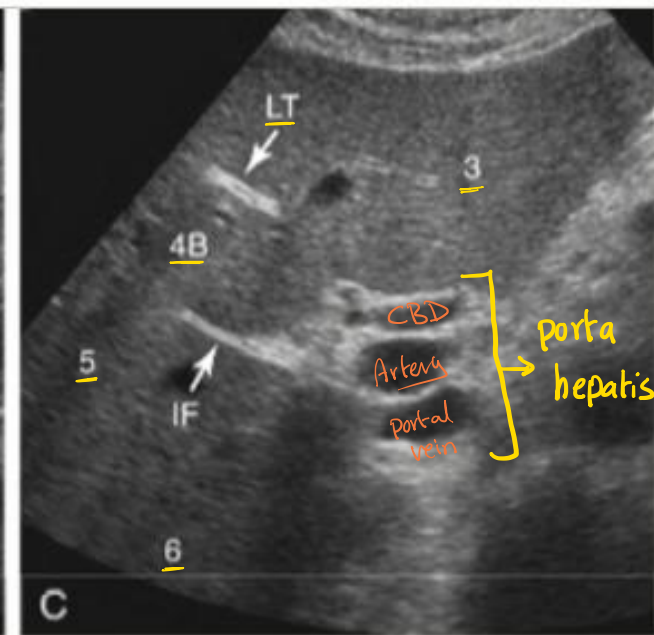
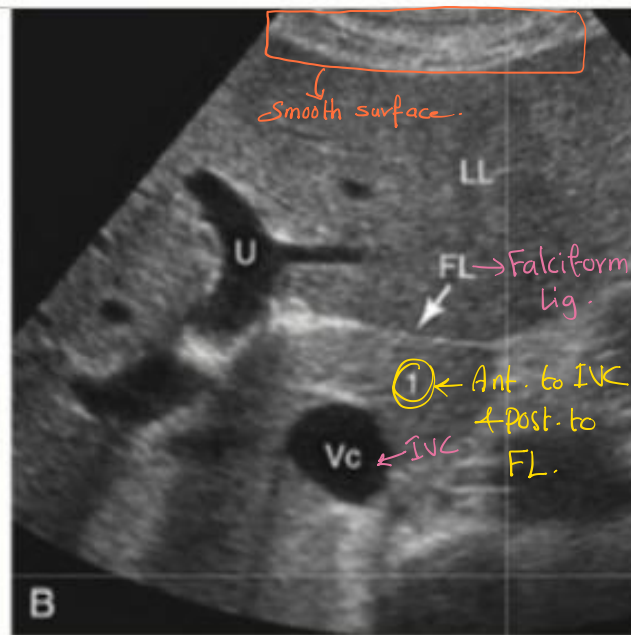
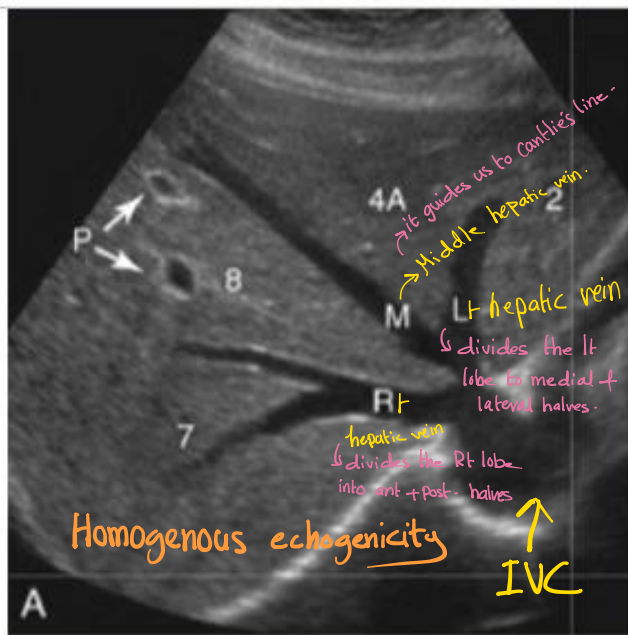


Extra :

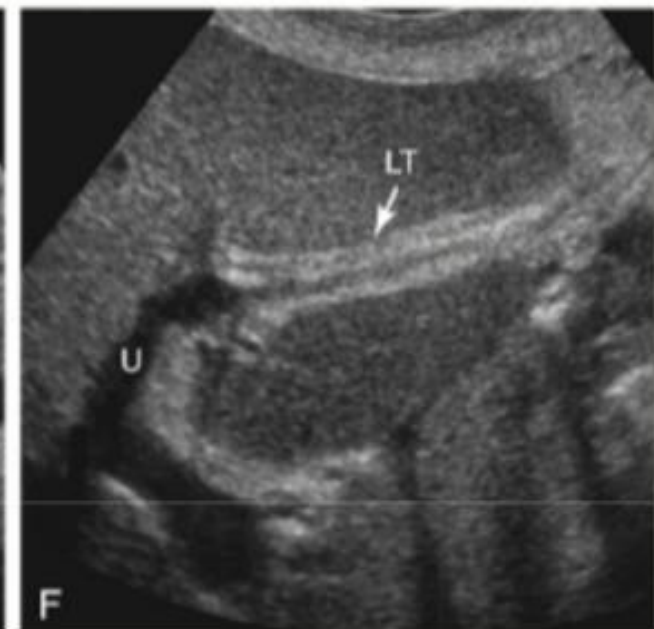
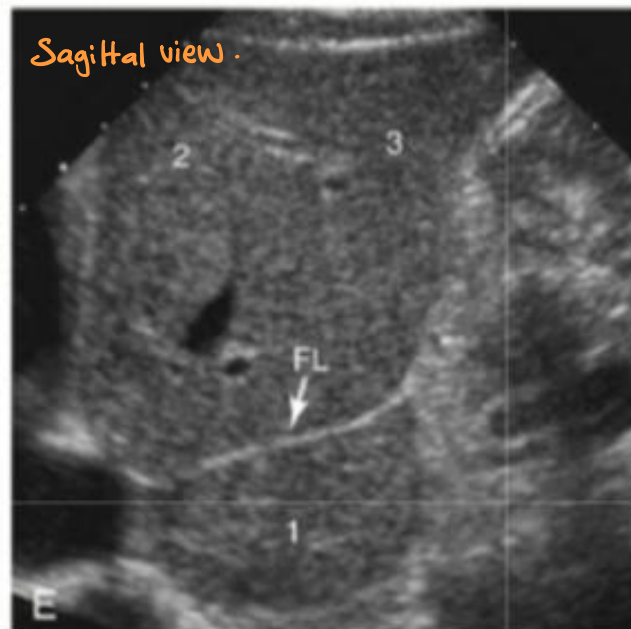
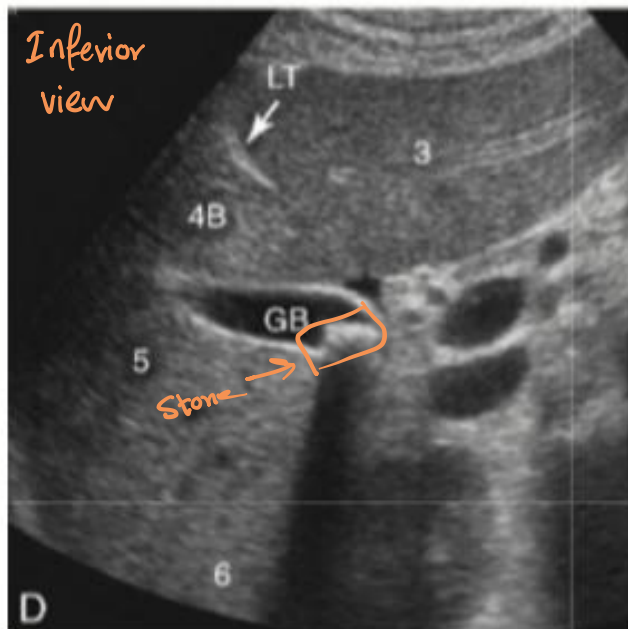


* Liver pathologies:





→ Inferior view



* Portal vein walls appear hyperechoic.

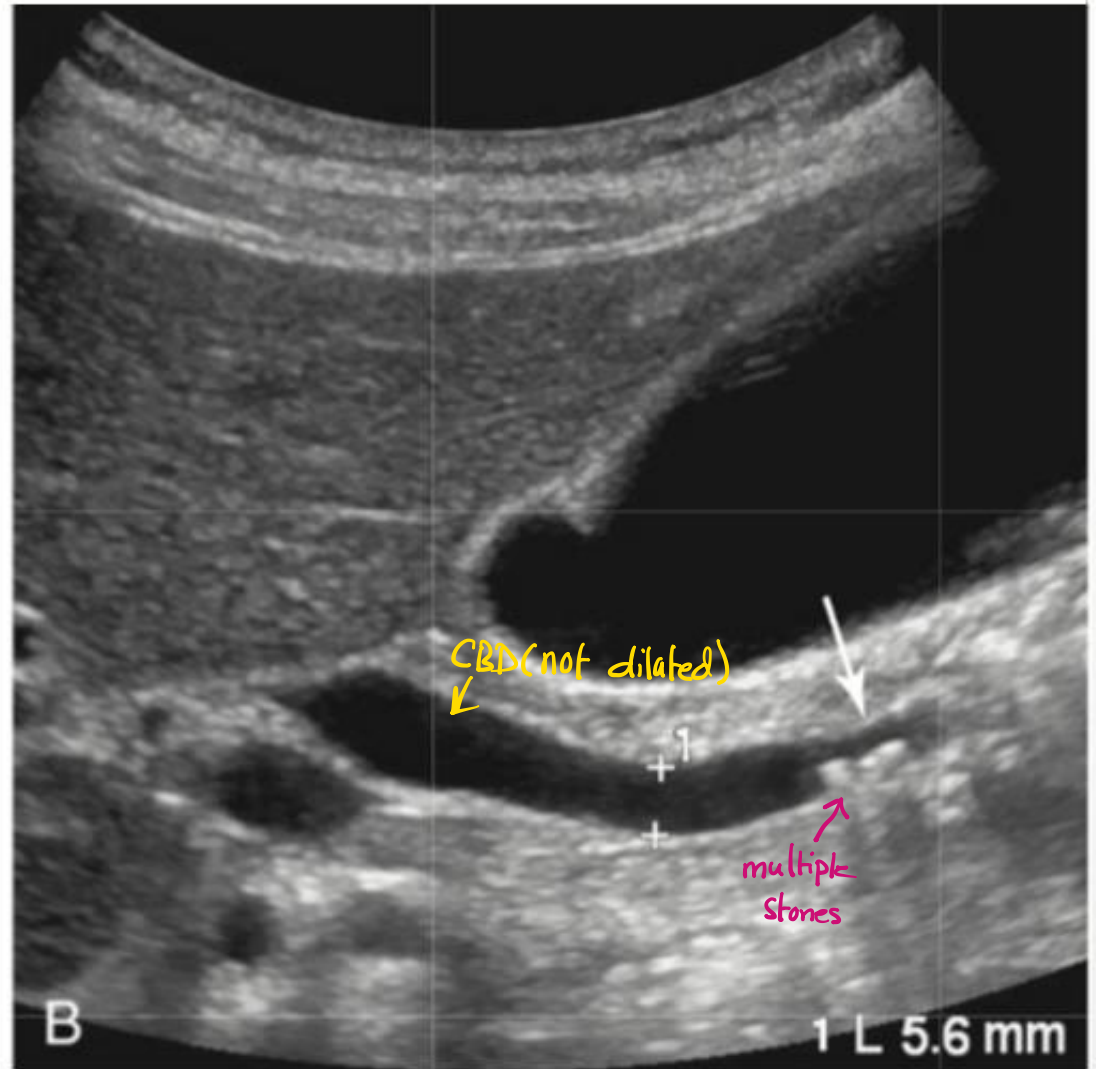
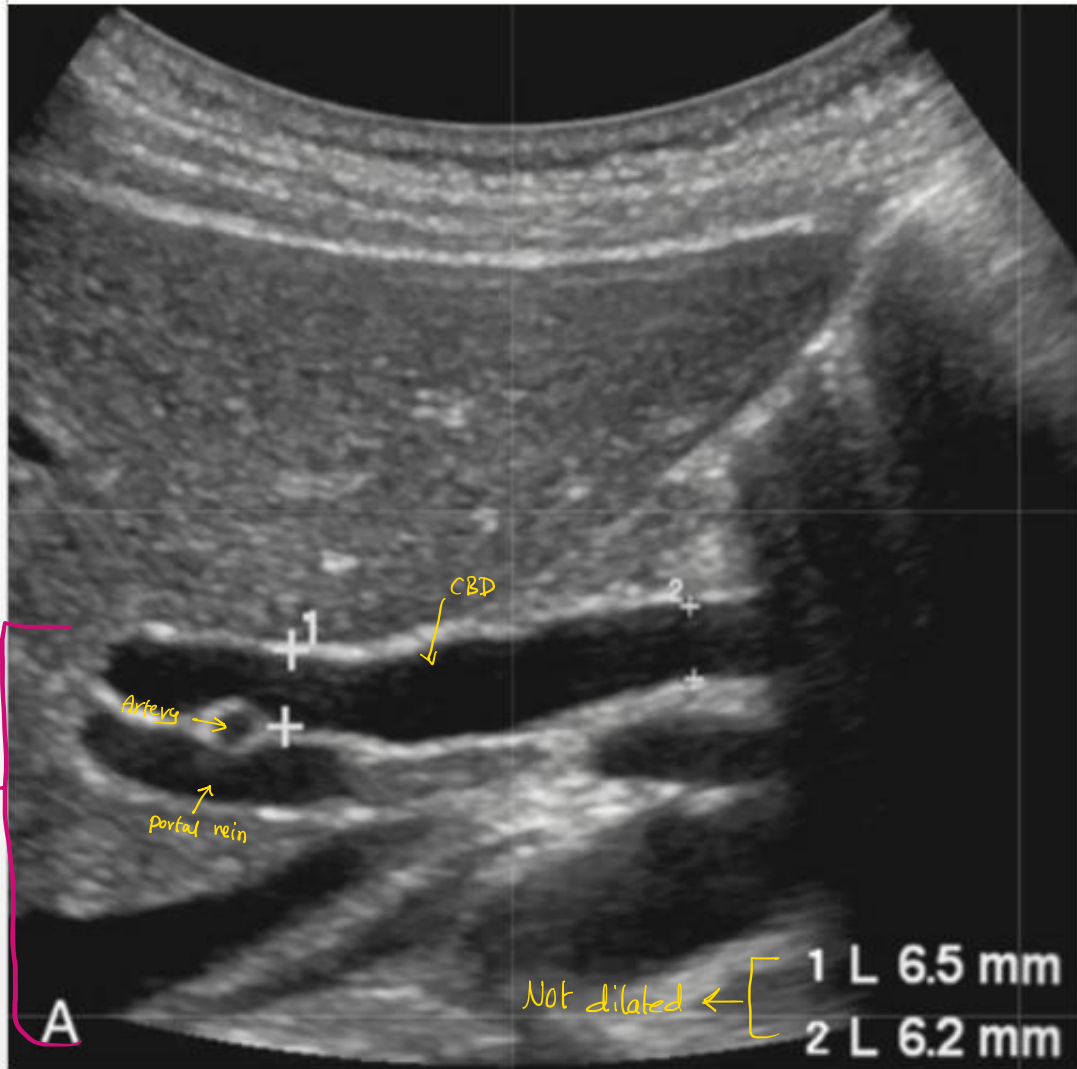
BILIARY OBSTRUCTION

→ Stones
→ Neoplasms.

- The least restricted segment of the bile duct is the mid segment (between the right hepatic artery and the pancreas), and therefore this segment dilates first in the setting of obstruction.
- This segment is generally considered dilated when it is 7 mm or greater in diameter, with the measurement taken from the inner to the inner wall.
- The common duct enlarges with age and most sonologists believe that the duct enlarges following a cholecystectomy.

↳ Acceptable up to 10 cm





THE KIDNEYS

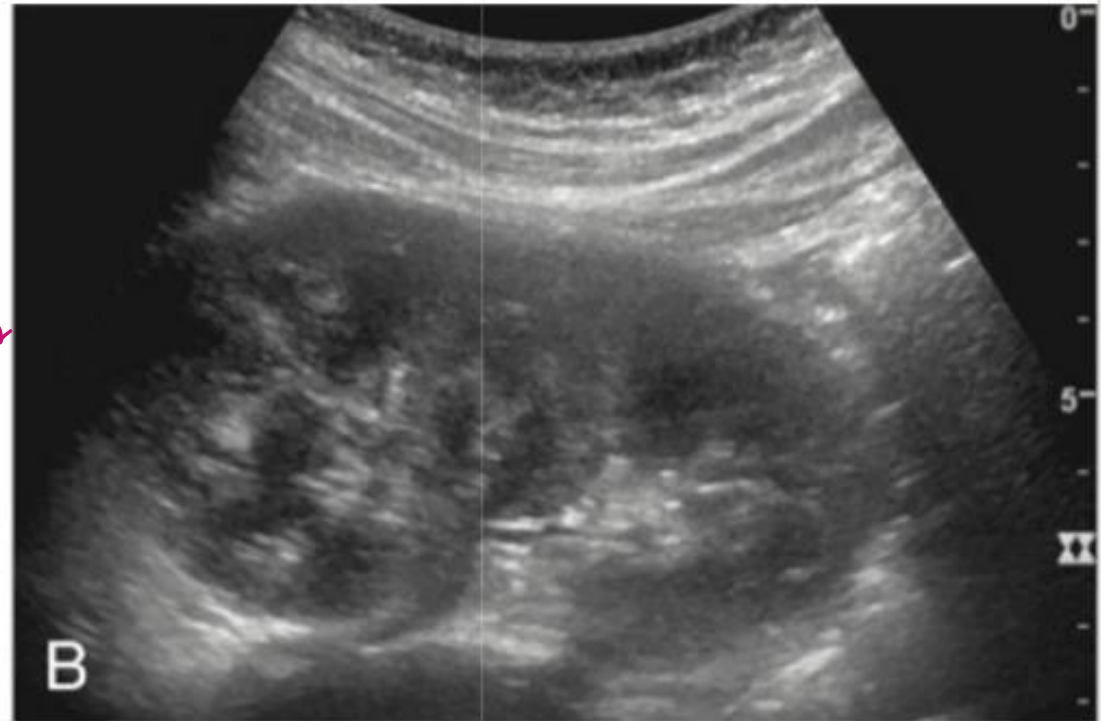
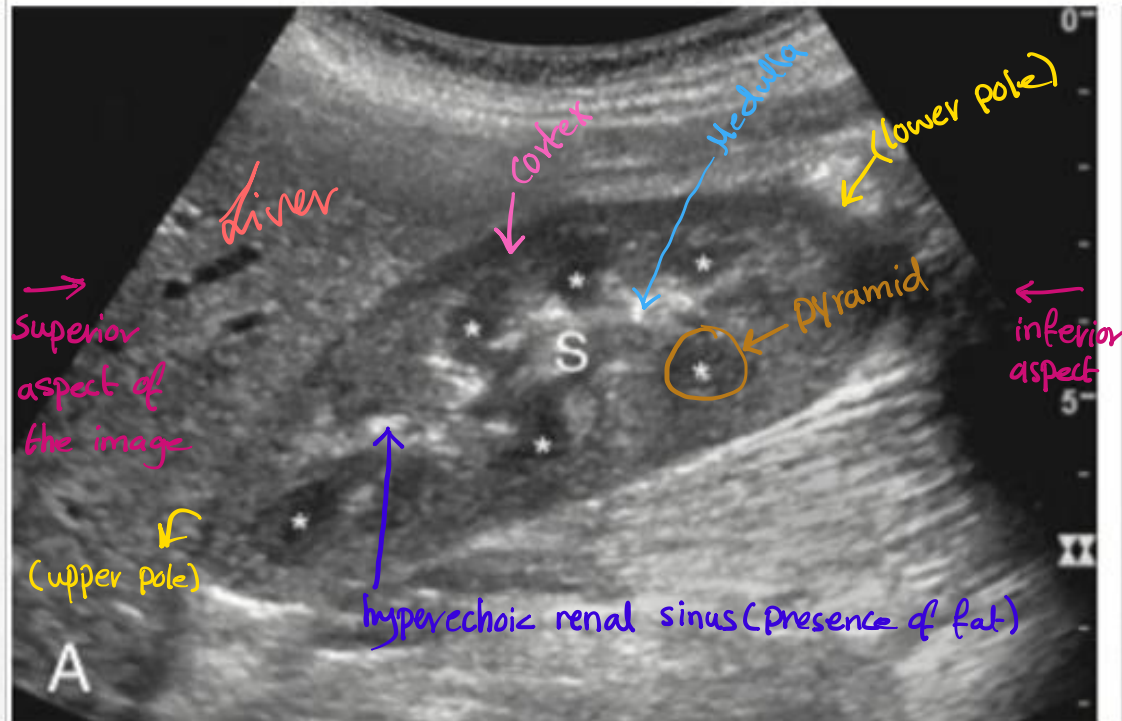
Retroperitoneal organs, located in each flank.

Characteristic	Appearance
Size	Average <u>11 cm</u> (range, 9-13 cm)
Echogenicity	Right, less than or equal to that of the liver; left, less than that of the spleen
Parenchyma	Homogeneous (except for hypoechoic pyramids)
Renal sinus	Hyperechoic (bcz it contains fat).
Surface	Smooth

It appears lobular when there are multiple scars in the renal cortex. "on the calyx"
 ↳ when can it be normal? persistent fetal lobulation. "between the calyces"



longitudinal view



Comments - Kidney size

- Smooth outline
- Preserved cortico-medullary differentiation.

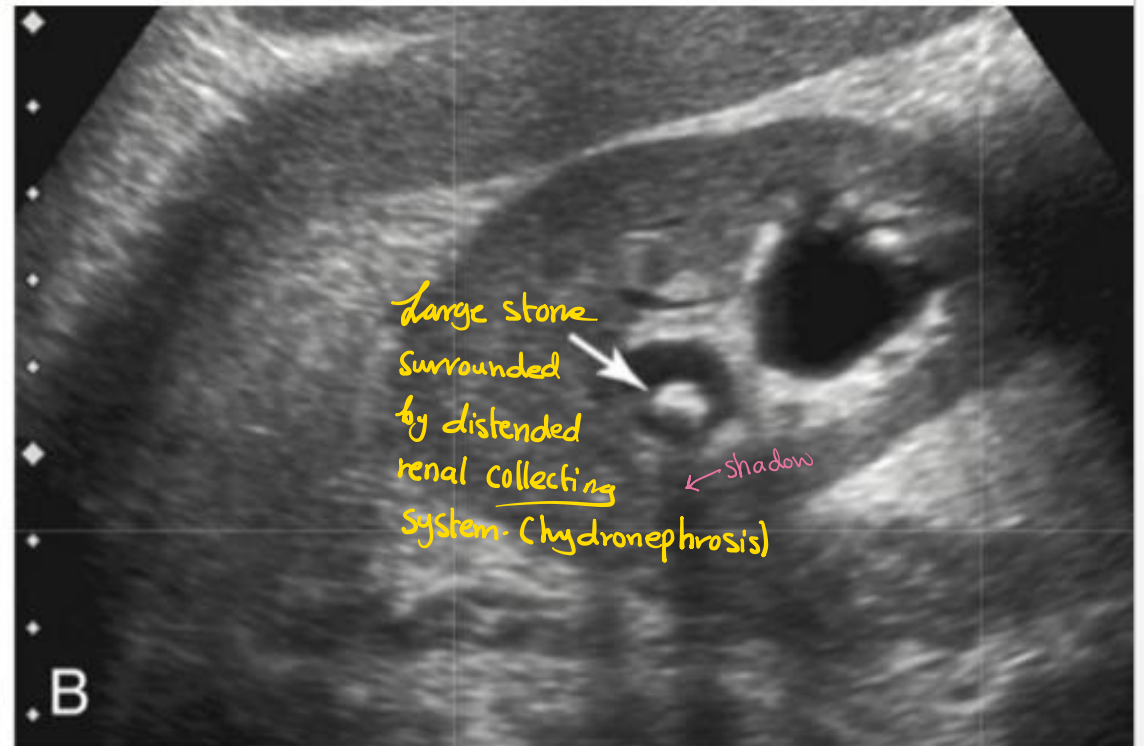
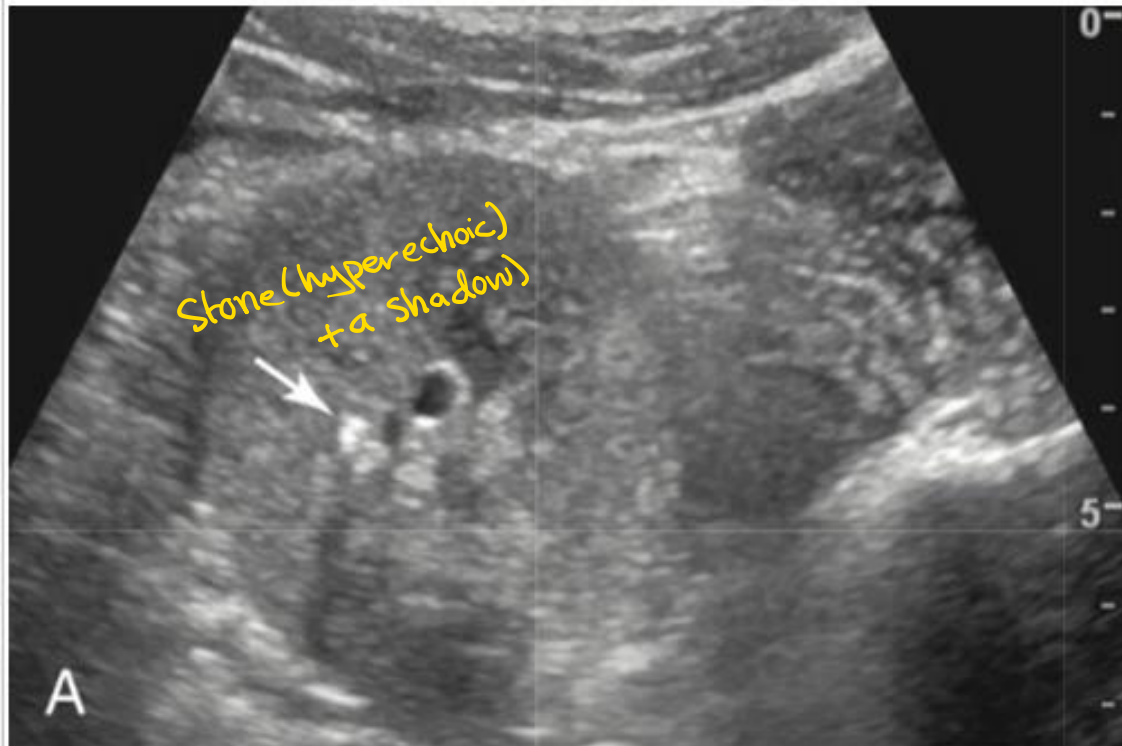
RENAL STONES

** Imaging modality of choice $\rightarrow$ CT without contrast.*

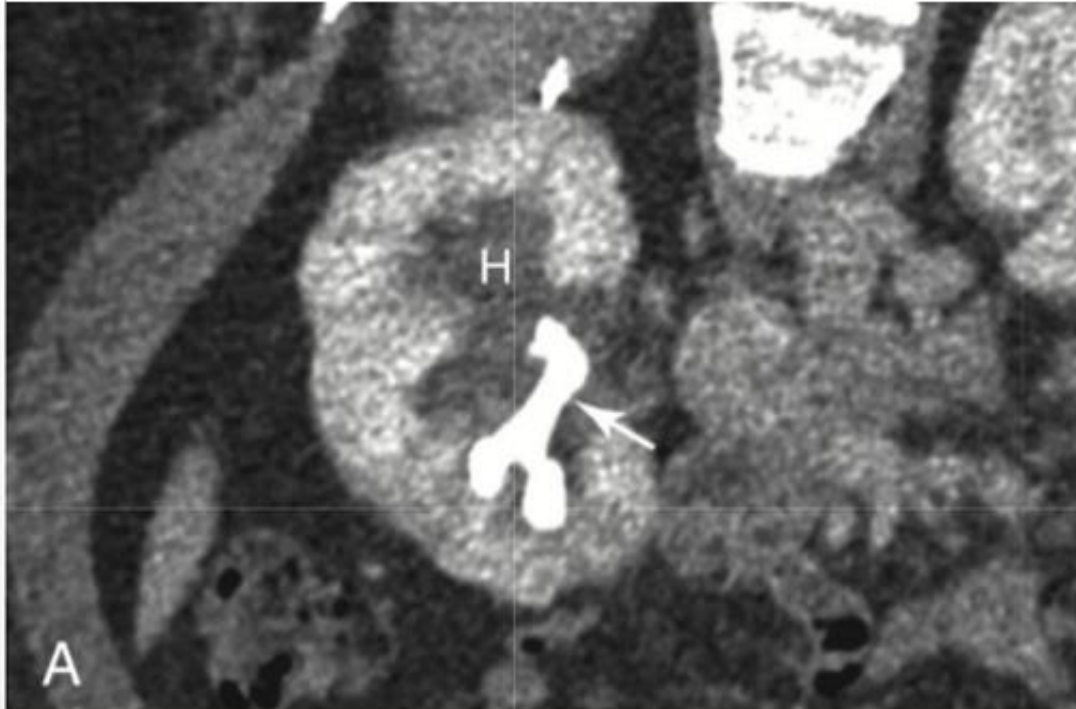
- Stones of sufficient size produce an echogenic focus in the renal sinus with an associated acoustic shadow.
- Stones that are ≤ 3 mm or smaller are a diagnostic problem because they are hard to separate from the echogenic renal sinus itself.
- Despite optimized technique small stones may not be seen with gray-scale sonography.
- A pitfall in the sonographic diagnosis of stones is refractive shadowing arising from the renal sinus.
- Sensitivity depends primarily on the size of the stones, with stones that are larger than 5 mm detected with a high sensitivity, whereas smaller stones are detected less reliably.



Transverse view.

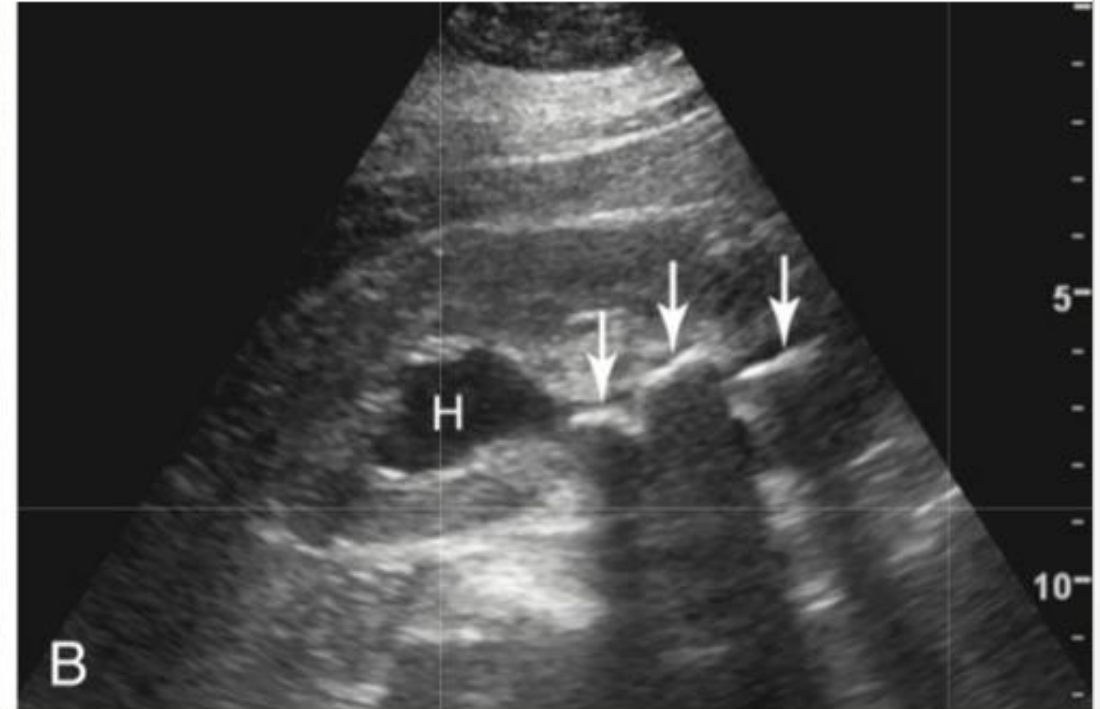


Coronal CT scan with contrast of the abdomen.
→ showing hyperdense renal cortex.



Staghorn stone at the lower calyceal group of the kidney.

US



Multiple stones with shadowing
Hydronephrosis (due to obstructive effect of the stone).

OBSTRUCTION

- Approximately 5% of patients with renal failure suffer from urinary obstruction.
- In most cases bilateral obstruction is required for renal insufficiency to develop.
- Early detection is important, as untreated obstruction can lead to irreversible renal damage.
- Patients with signs of infection who are suspected to have renal obstruction should be treated as emergencies, with immediate renal sonography and urgent drainage performed if hydronephrosis is detected.
- In general, uninfected patients with suspected renal obstruction are not considered emergencies and are scanned as soon as is reasonable.



→ Dilatation of the renal pelvis.

- The likelihood of sonographic detection of hydronephrosis in patients with renal failure depends on the patient's history.
- In many of these low-risk patients an ultrasound finding of hydronephrosis will ultimately prove to be incorrect, or the patient will receive no therapy despite the ultrasound results.
- approximately 30% of the patients with known risk factors such as a known pelvic tumor, a palpable abdominal or pelvic mass, a history of renal stone disease, renal colic, sepsis, recent surgery, or a history of bladder outlet obstruction will have hydronephrosis.

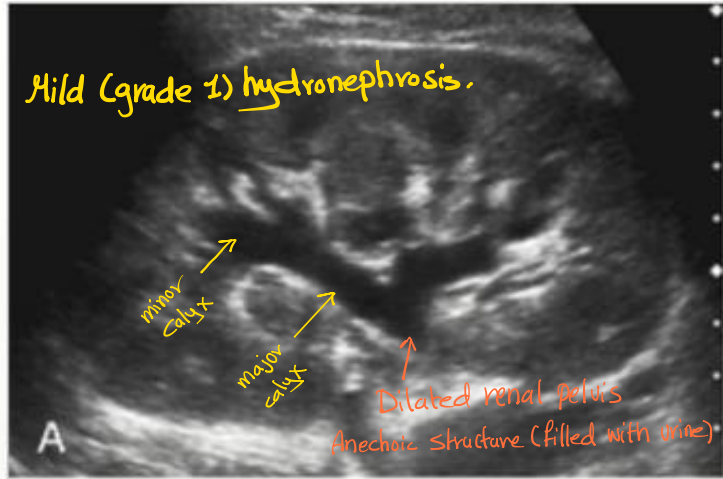
- The sonographic diagnosis of obstruction relies on the detection of a dilated collecting system.
- **Marked** hydronephrosis (sometimes called grade 3) refers to severe dilatation that is associated with cortical thinning.
- **Moderate** hydronephrosis (grade 2) refers to (dilatation of the collecting system) that is readily evident but is not associated with cortical thinning. ↳ with filling of the renal calyces.
- **Mild** hydronephrosis (grade 1) refers to minimal amounts of urine producing slight distention of the collecting system.



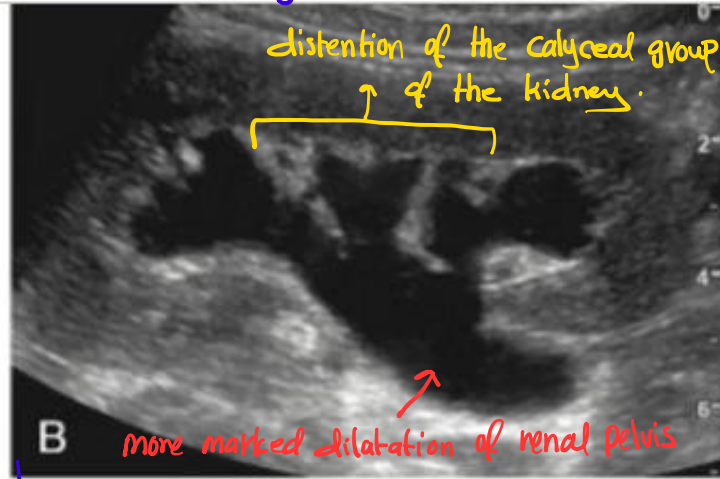
- Detecting the various grades of hydronephrosis is much less difficult than determining their significance.
- Repeated or long-standing obstruction may cause a dilated, ectatic collecting system that persists even when obstruction is relieved.
- Acute obstruction may produce minimal hydronephrosis or may be imaged before any hydronephrosis develops.
- For this reason, comparison with old studies is extremely valuable.

Longitudinal view.

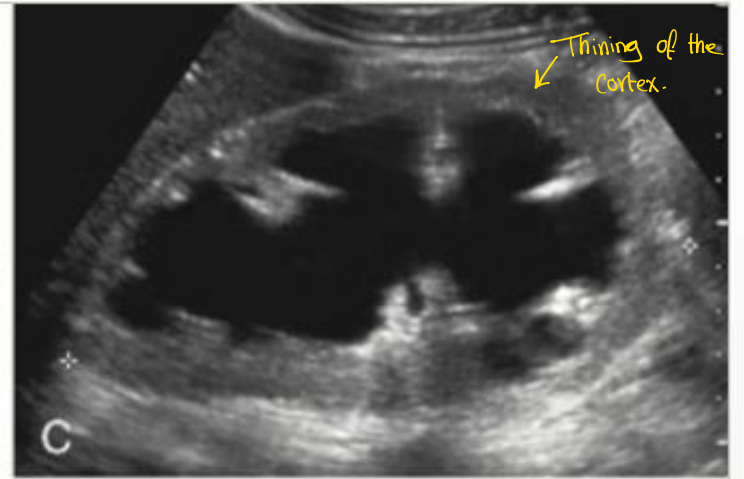
Mild (grade 1) hydronephrosis.



distention of the calyceal group
of the kidney.

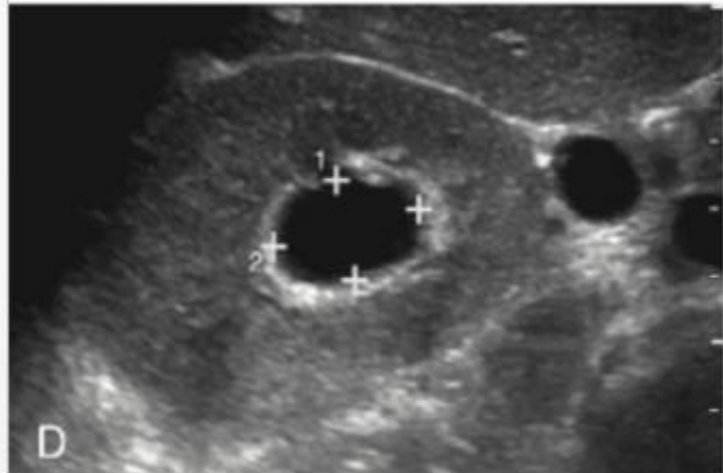


Thinning of the
cortex.



→ Moderate grade 2 (The cortex is
unremarkable, not thinned).

Severe hydronephrosis.



Axial image (short axis).

Box 5-1

Causes of Hydronephrosis

Common

Obstruction *(distal stone)*

Previous obstruction

Extrarenal pelvis *Anatomical variation (on CT, there's no stone & the calyceal system won't be dilated).*

Distended bladder *Fullness of the renal pelvis, however when the pt voids this will disappear.*

Pregnancy *The uterus is causing pressure effect on the ureter (more common on the Rt side).*

Uncommon

Active diuresis

Diabetes insipidus

Reflux nephropathy



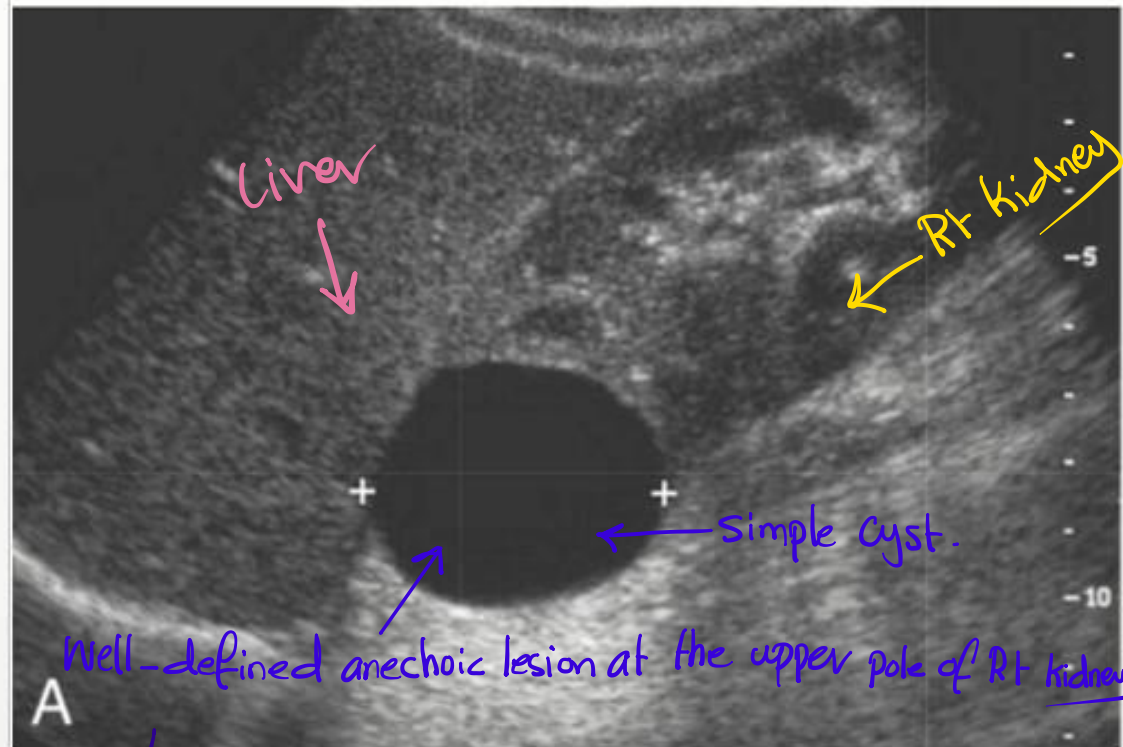
RENAL CYSTS

- Sonography is the most accurate way to evaluate cystic lesions in the kidney.
- To qualify as a simple cyst, the lesion should have the following characteristics:
 - ❖ Anechoic lumen ①
 - ❖ Well-defined back wall ②
 - ❖ Acoustic enhancement deep to the lesion ③
 - ❖ No measurable wall thickness ④

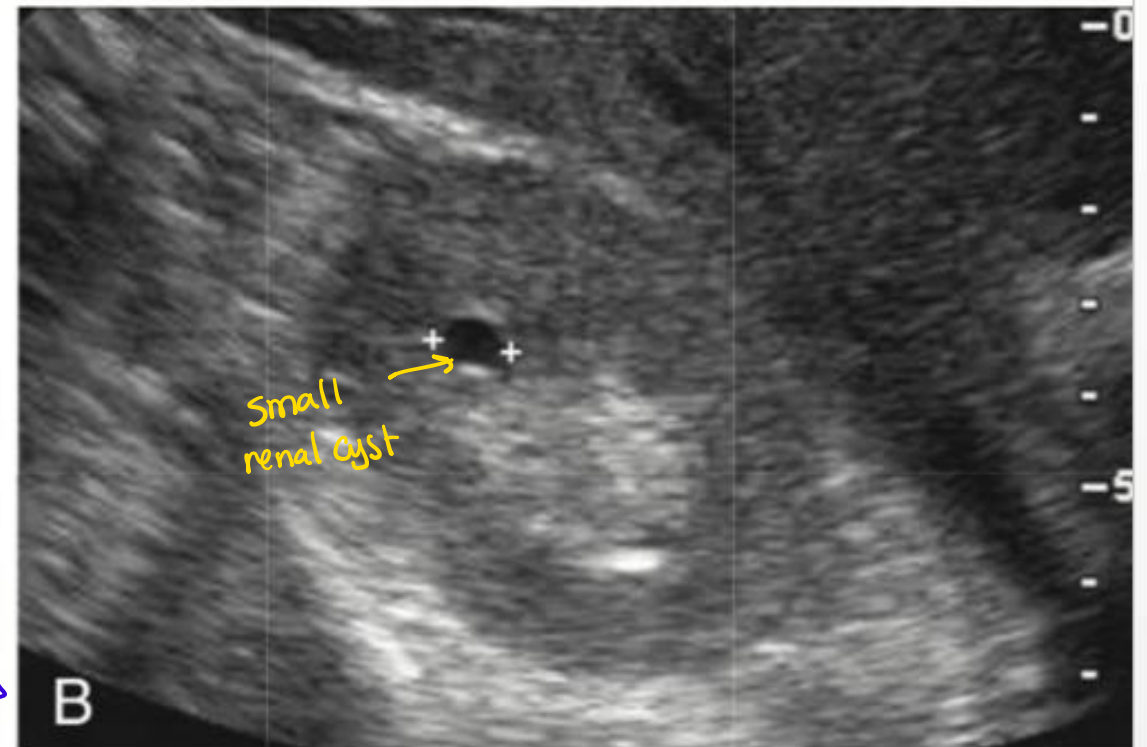
It doesn't need further evaluation.



Abd. US (longitudinal view) -



Axial view -



Well-defined anechoic lesion at the upper pole of Rt kidney

↳ Might be hereditary or post-infectious.

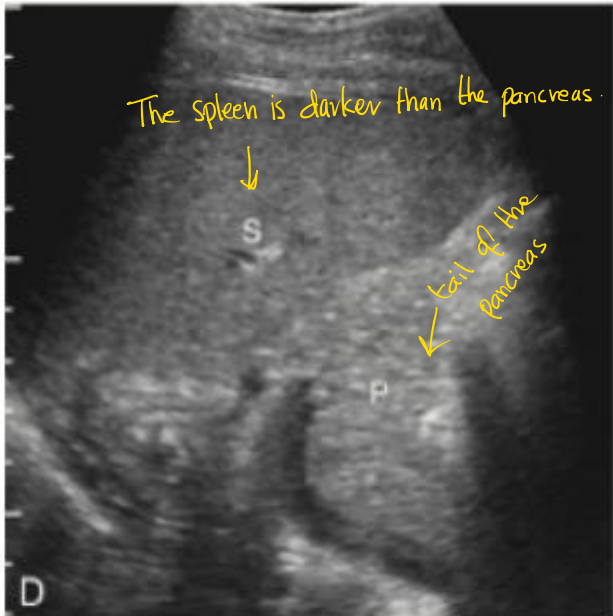
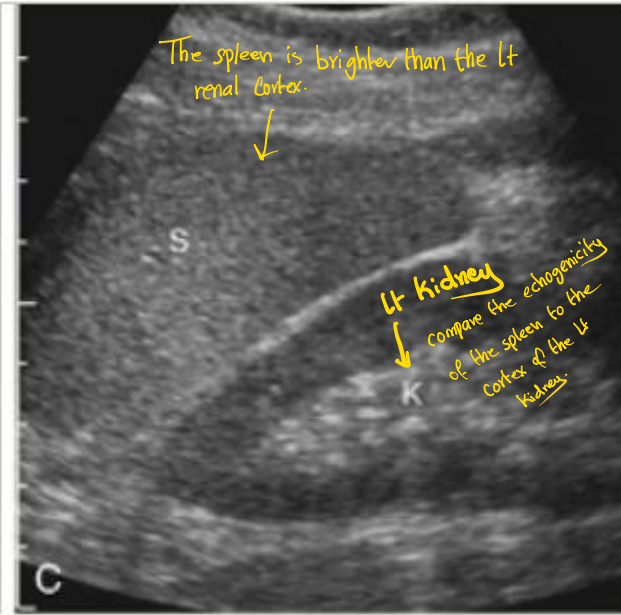
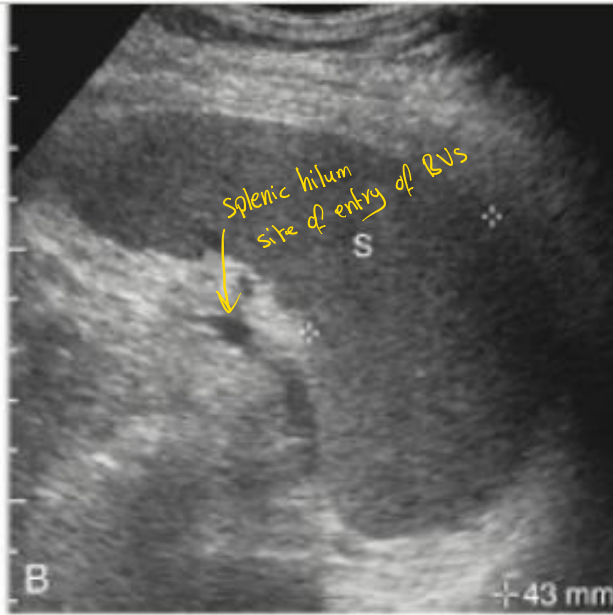
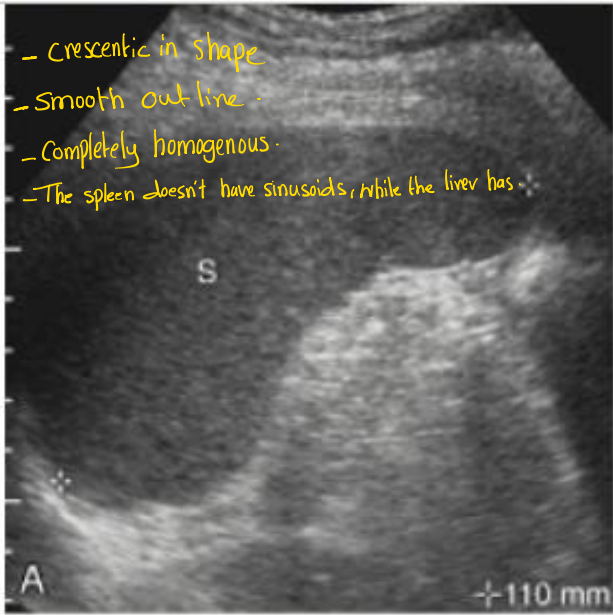
SPLEEN ^{LUQ}

→ important.

Characteristic	Normal finding
Size	<u>≤13 cm long</u> , <u>≤6 cm thick</u>
Echogenicity	> <u>Kidney</u> ; > <u>Liver</u> ; >, =, or < <u>Pancreas</u>
Echotexture	<u>Homogeneous</u>
Surface	<u>Smooth</u>
Shape	<u>Crescentic</u>



- crescentic in shape
- smooth out line
- completely homogenous
- The spleen doesn't have sinusoids, while the liver has



APPENDICITIS

RLQ, comes out of the cecum at McBurney's point.

- Appendicitis is a common cause of acute abdominal pain and is the most common condition requiring urgent abdominal surgery.
↳ with contrast.
- CT is the primary imaging modality used to image patients with suspected appendicitis, with sensitivity and specificity of approximately 90%.
- Sonography has sensitivity and specificity of approximately 80%.
- Sonography is used as the primary test in children and pregnant women to avoid radiation exposure, and in young women because of the frequency of gynecologic causes of pain.



- The appendix should be blind ending and noncompressible, and peristalsis should be absent or very minimal. *To differentiate it from the ileum (which has peristalsis).*
- It is important to realize that the normal appendix can be seen only by experienced sonographers, and usually only in thin patients.
- It is not necessary to see a normal appendix to exclude appendicitis.



Box 9-2

Sonographic Signs of Appendicitis

Diameter > 6 mm

Lack of compressibility

Inflamed, echogenic periappendiceal fat

Hyperemia *~> High blood flow.*

Appendicolith

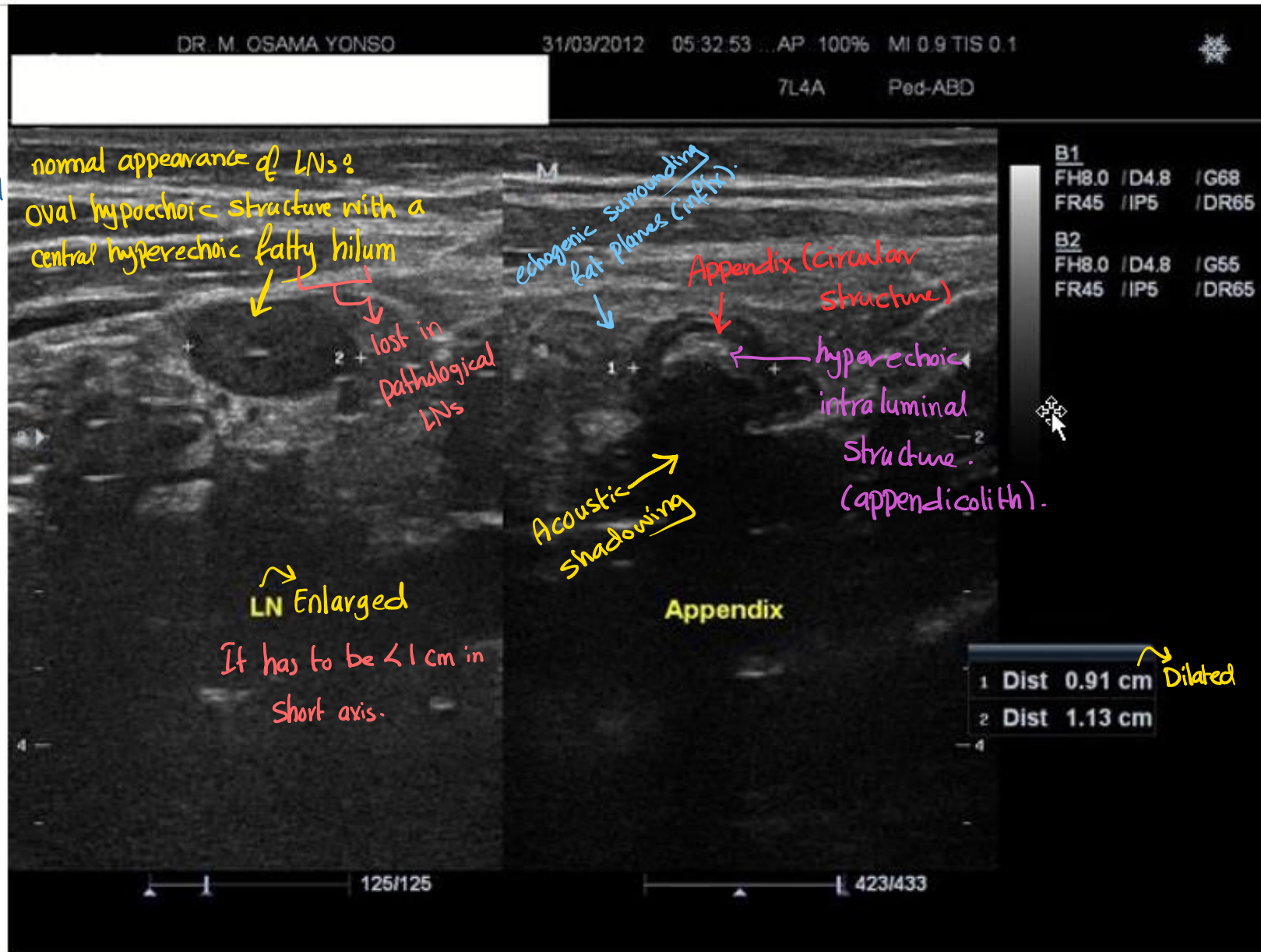
Adjacent fluid collections

wall thickening due to edema.

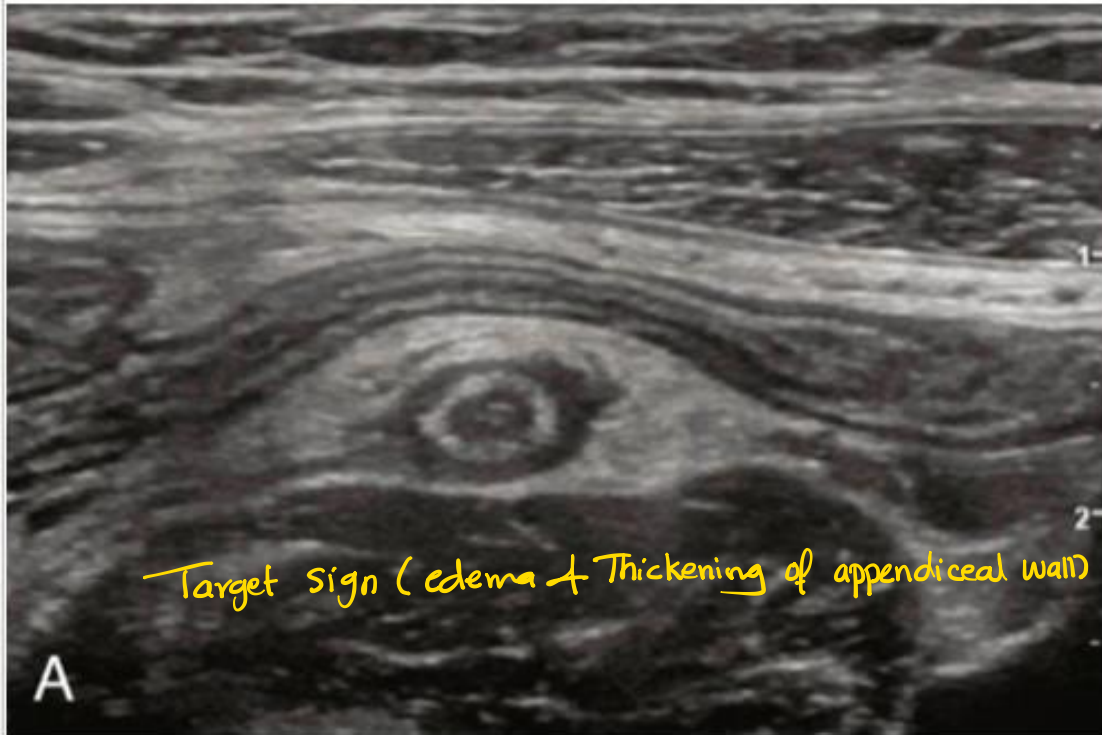


* Features of pathological LNs:

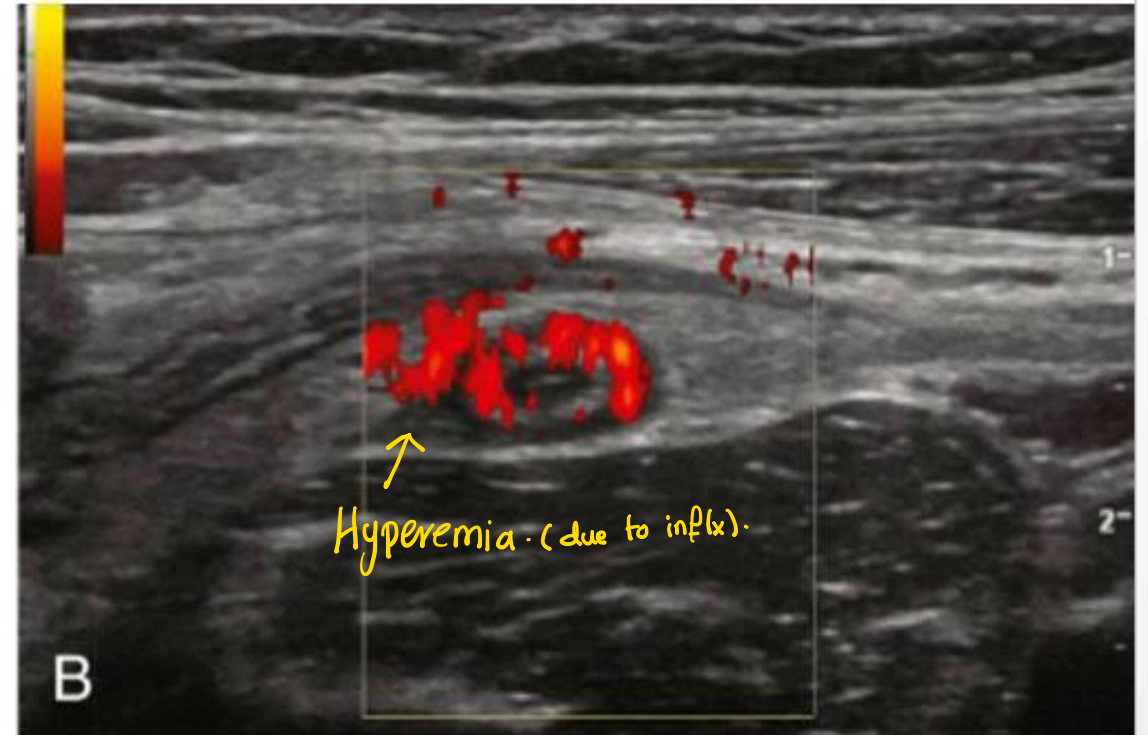
- 1) Rounded.
- 2) Thickened cortex.
- 3) loss of fatty hilum.
- 4) >1 cm in size.

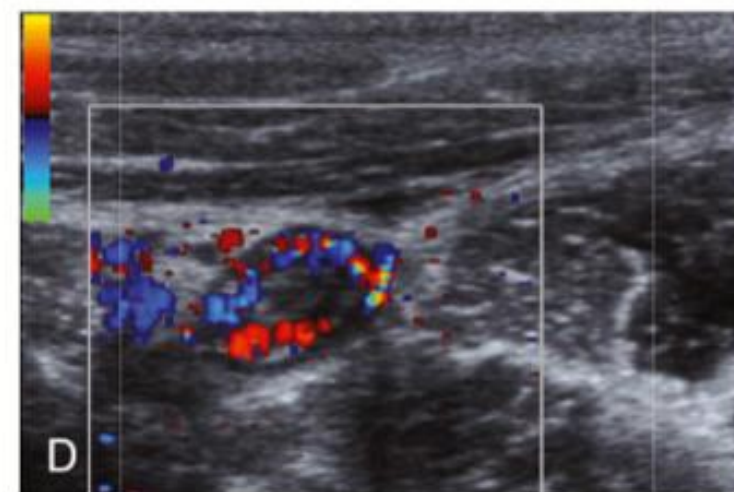
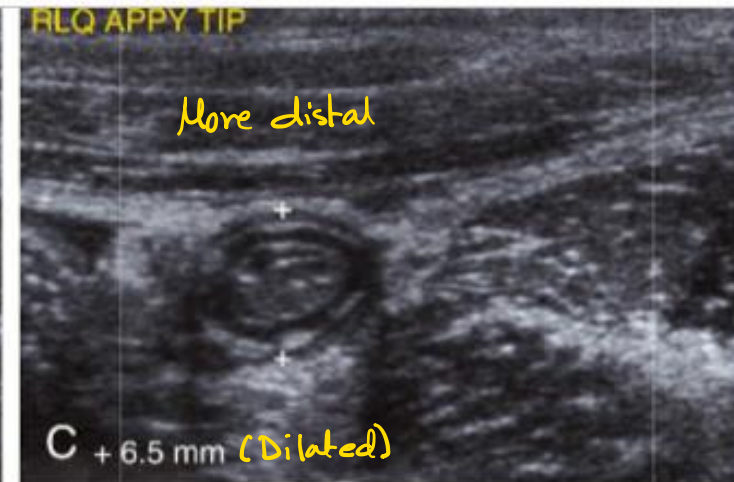
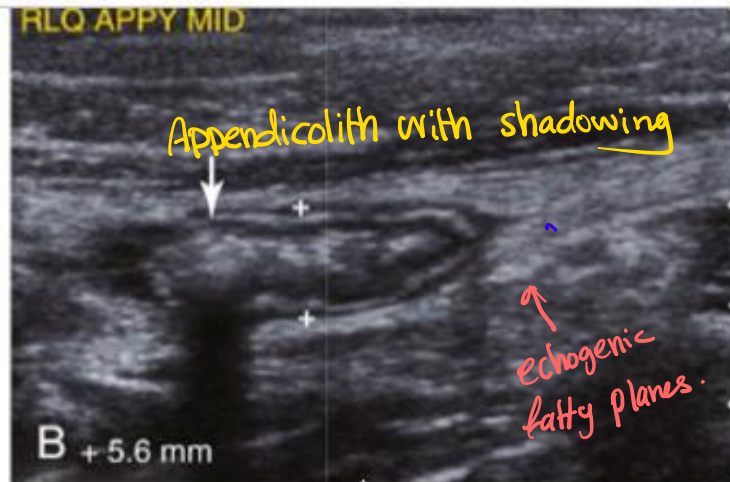
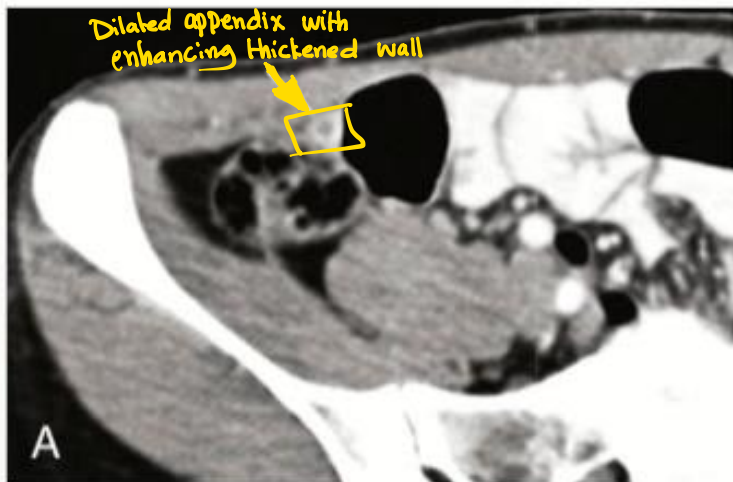


Transverse view



power doppler mode -





THYROID

Box 10-1

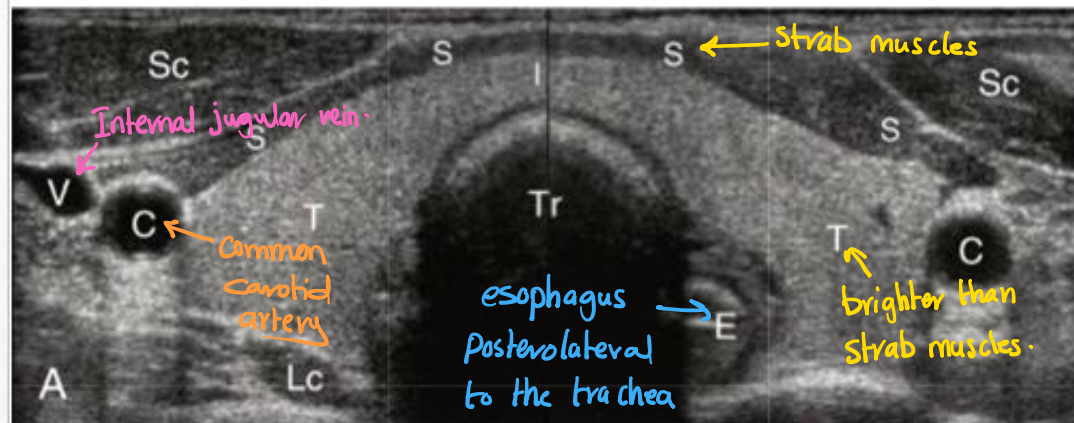
Characteristics of the Normal Thyroid

- Strab muscles located ant. to it.
- Hyperechoic to adjacent muscles
- Homogeneous
- Scattered readily detectable internal vessels *using the doppler mode.*
- Diameter of lobes less than 2 cm in AP and transverse views
- Isthmus less than 4 mm

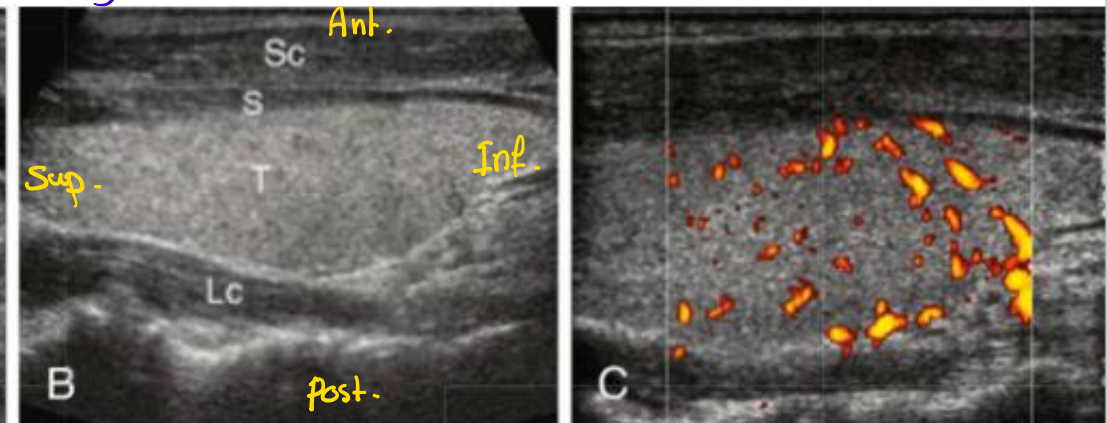
AP, Anteroposterior.



Transverse view



Longitudinal view of 1
thyroid lobe -



Power doppler Showing internal
blood flow.

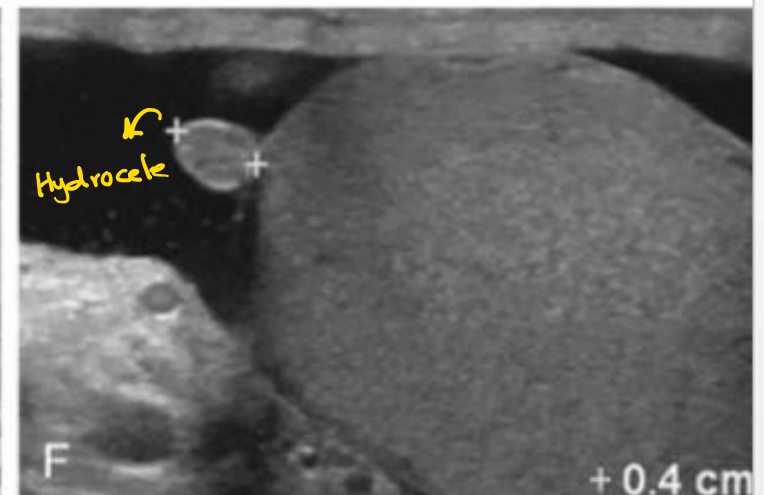
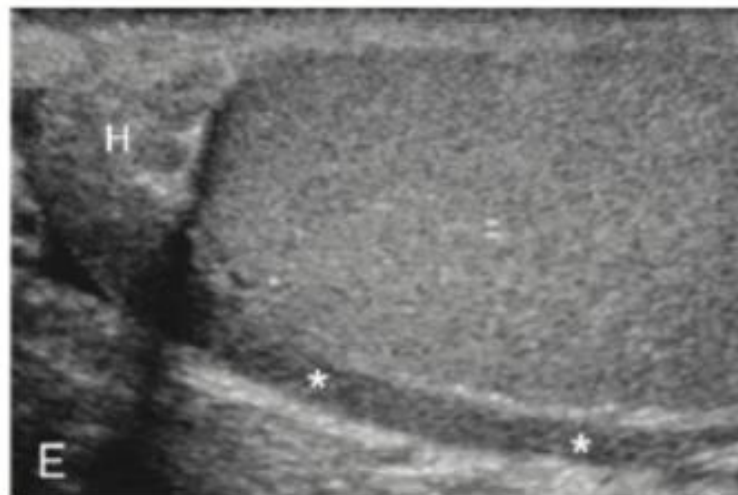
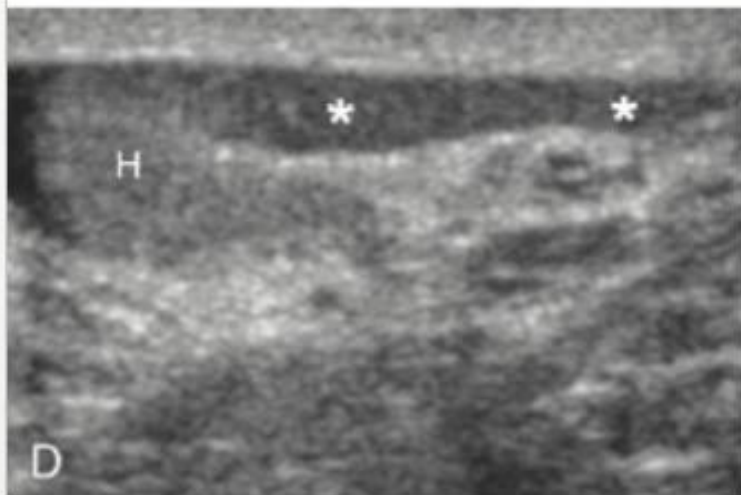
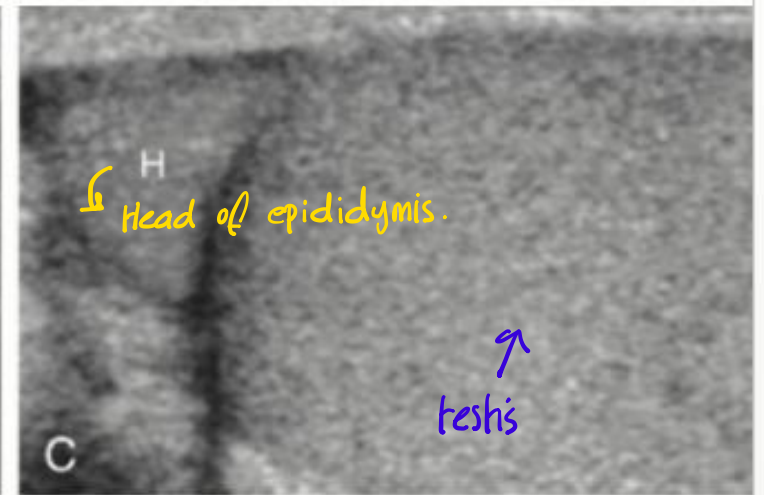
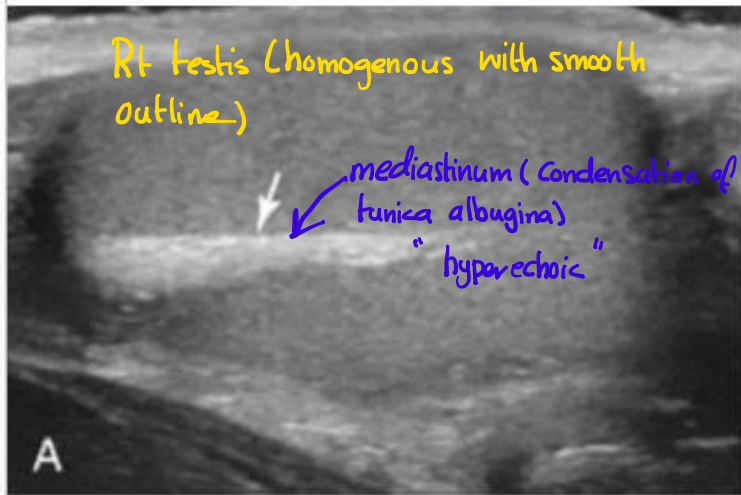
SCROTUM

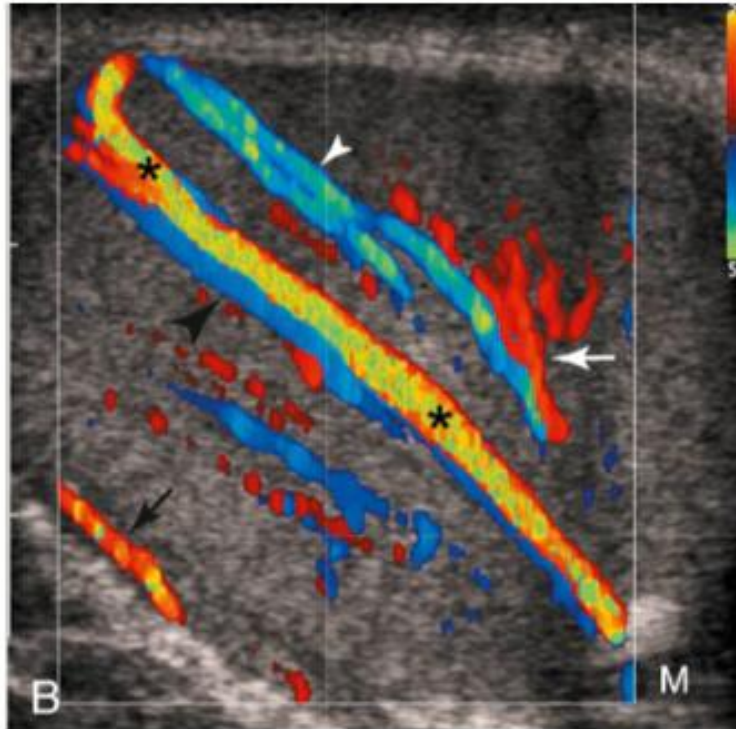
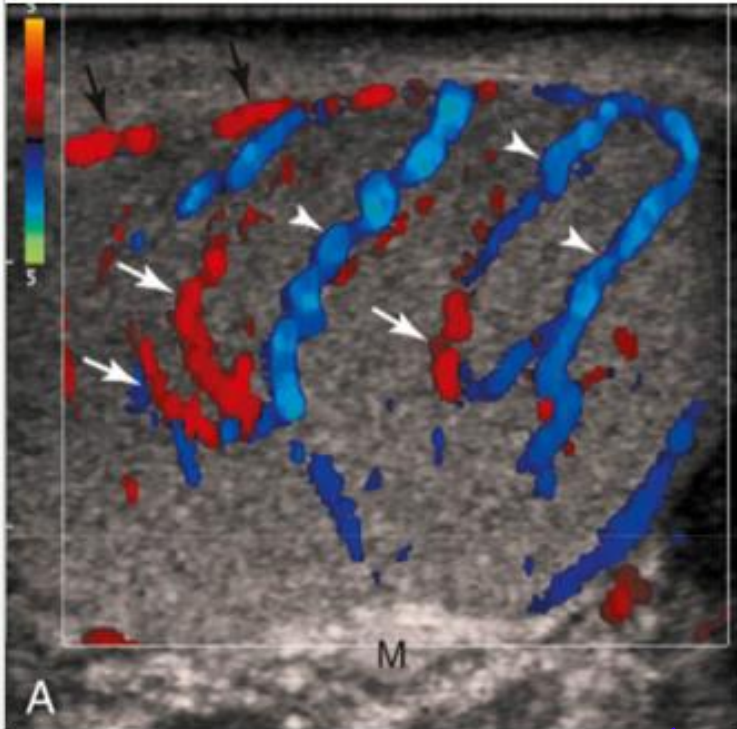
Done with the linear probe

Characteristic	Appearance
Echogenicity	Medium level (except <u>echogenic</u> mediastinum)
Texture	Homogeneous
Surface	Smooth
Vascularity	Largest vessels on surface
Size	15-20 cm ³ (average 4-5 × 2-3 × 2-2.5 cm)



Always compare both sides .





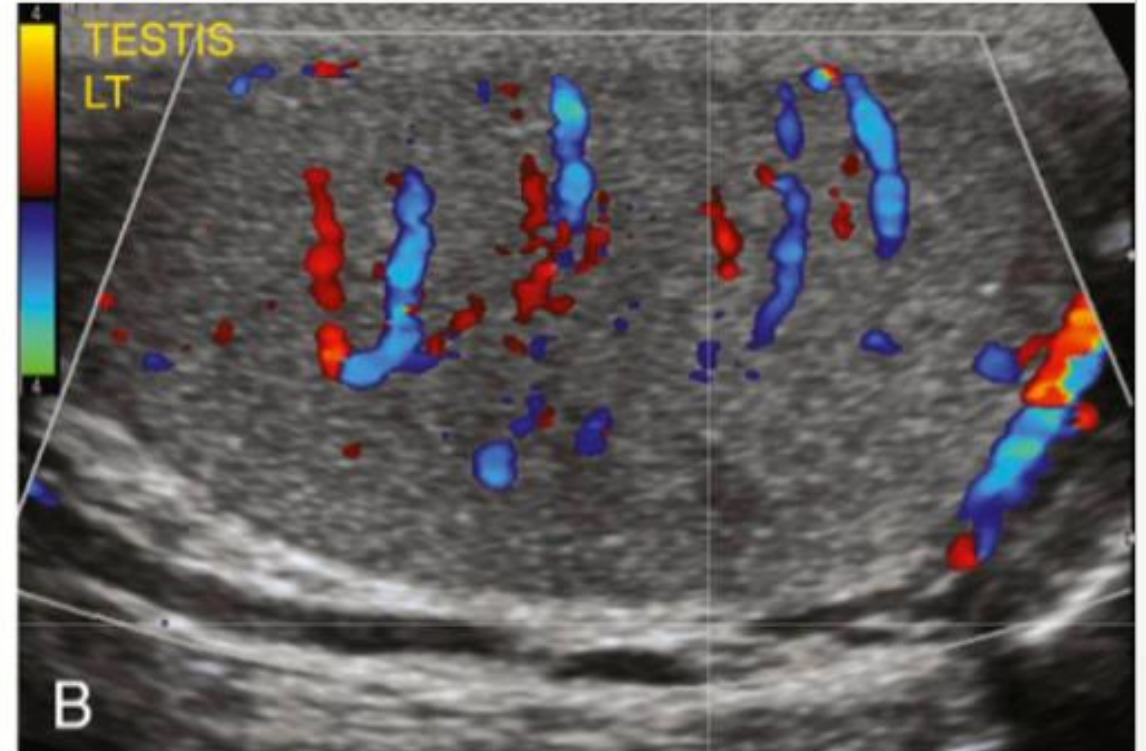
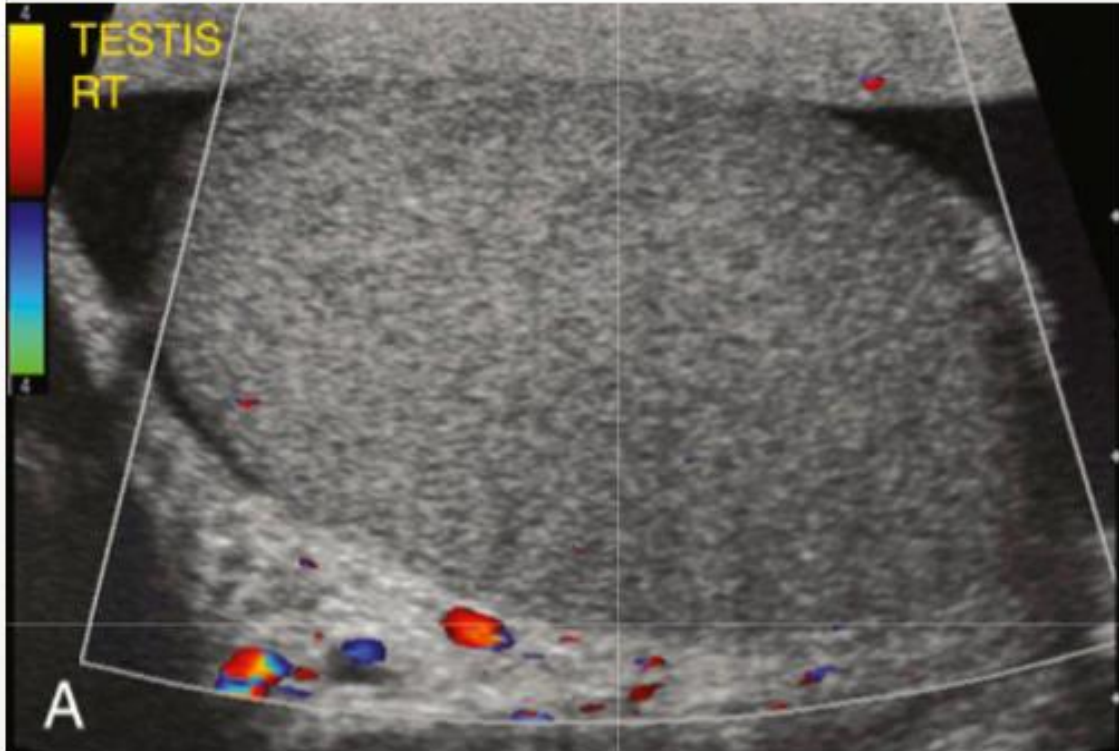
↓
preserved blood flow bilaterally.

★ = blood vessel that could be
seen on B-mode.

TESTICULAR TORSION *→ mainly clinical diagnosis.*

- **Color Doppler** is an effective way to detect testicular ischemia in the setting of torsion.
↳ bcz the testes have single blood supply which is the testicular artery.
- This is primarily done by **comparing the vascularity** of the normal and abnormal testes.
- In most cases a **torsed testis** will have no **detectable flow**.
- In a smaller percentage of cases there will be detectable flow that is clearly **asymmetrically decreased** compared with the other testis





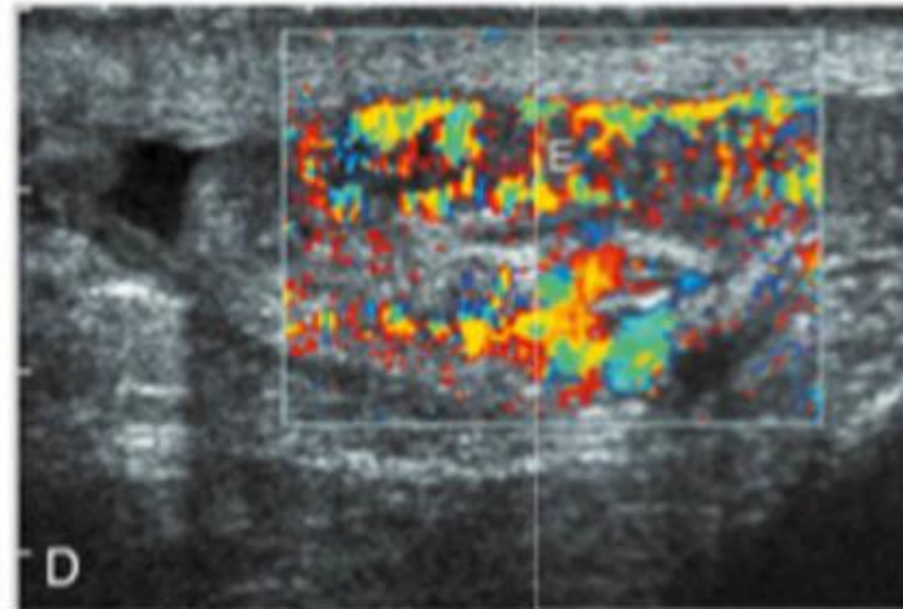
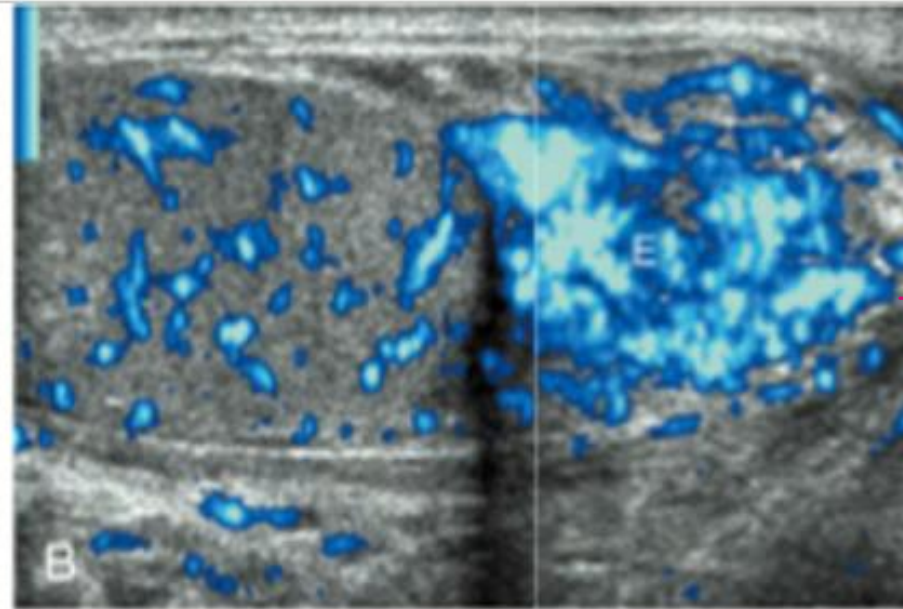
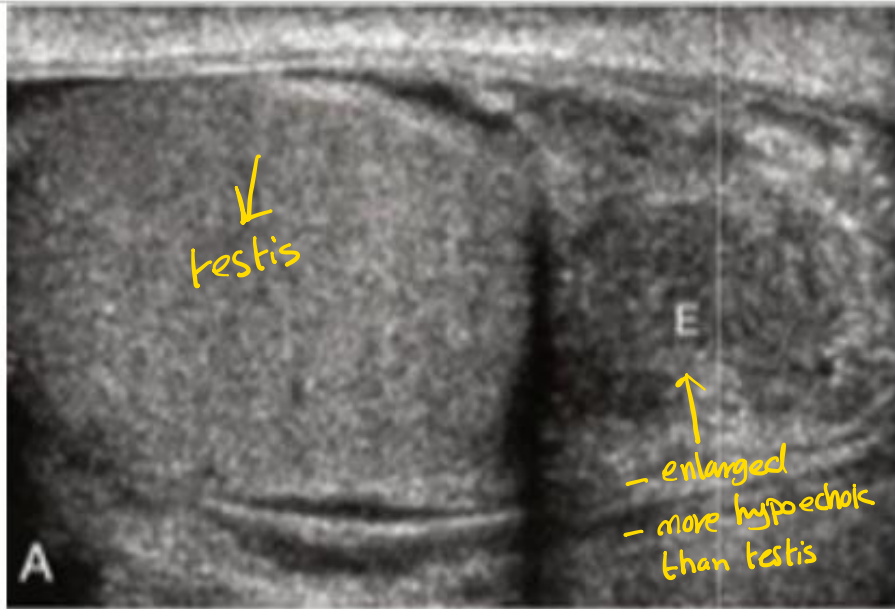
↳ No detectable blood flow
Rt testicular torsion -

EPIDIDYMO-ORCHITIS

- Scrotal inflammatory disease usually involves the epididymis initially and spreads from there to the testis, scrotal sac, or scrotal wall.
- The hallmark of epididymitis on gray-scale studies is ^①enlargement and, to a lesser degree, ^②decreased echogenicity of the epididymis.
- Color Doppler imaging is valuable when the gray-scale findings are equivocal or normal because it can detect ^③inflammatory hyperemia as increased epididymal vascularity.

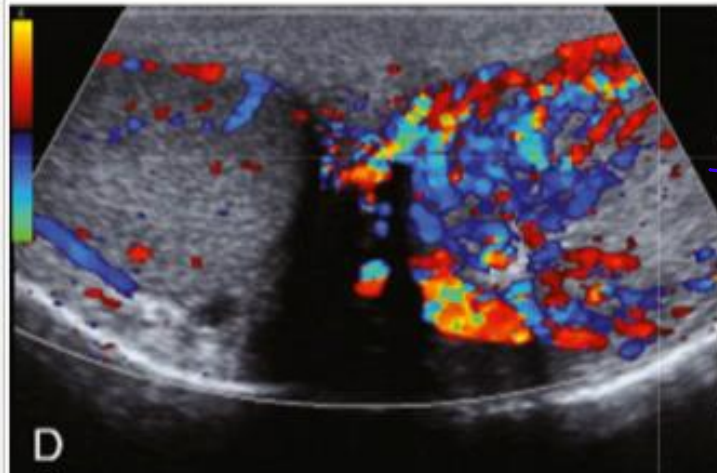
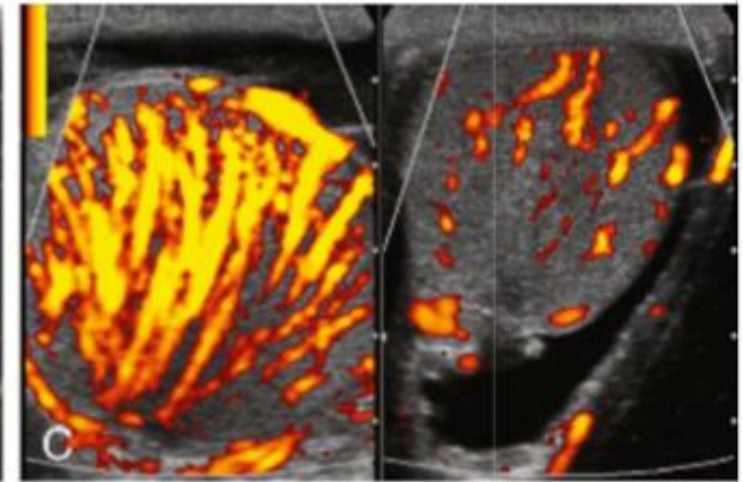
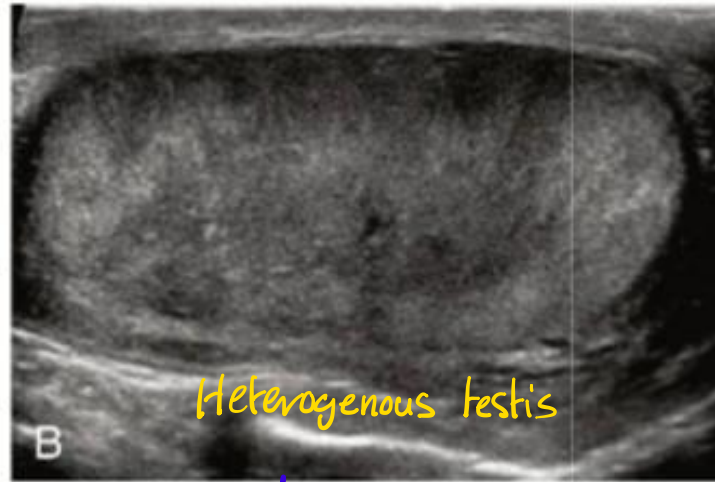
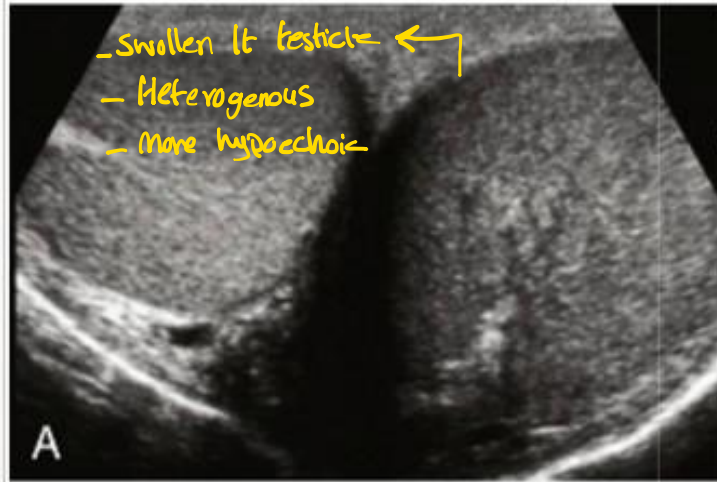
*Normally the epididymis has the same echogenicity as the testis.





- Orchitis usually occurs in conjunction with epididymitis.
- Isolated orchitis is less common and generally viral in nature (i.e., mumps).
- Testicular enlargement, decreased echogenicity, heterogeneity, and hypervascularity are all typical findings





↳ longitudinal view.

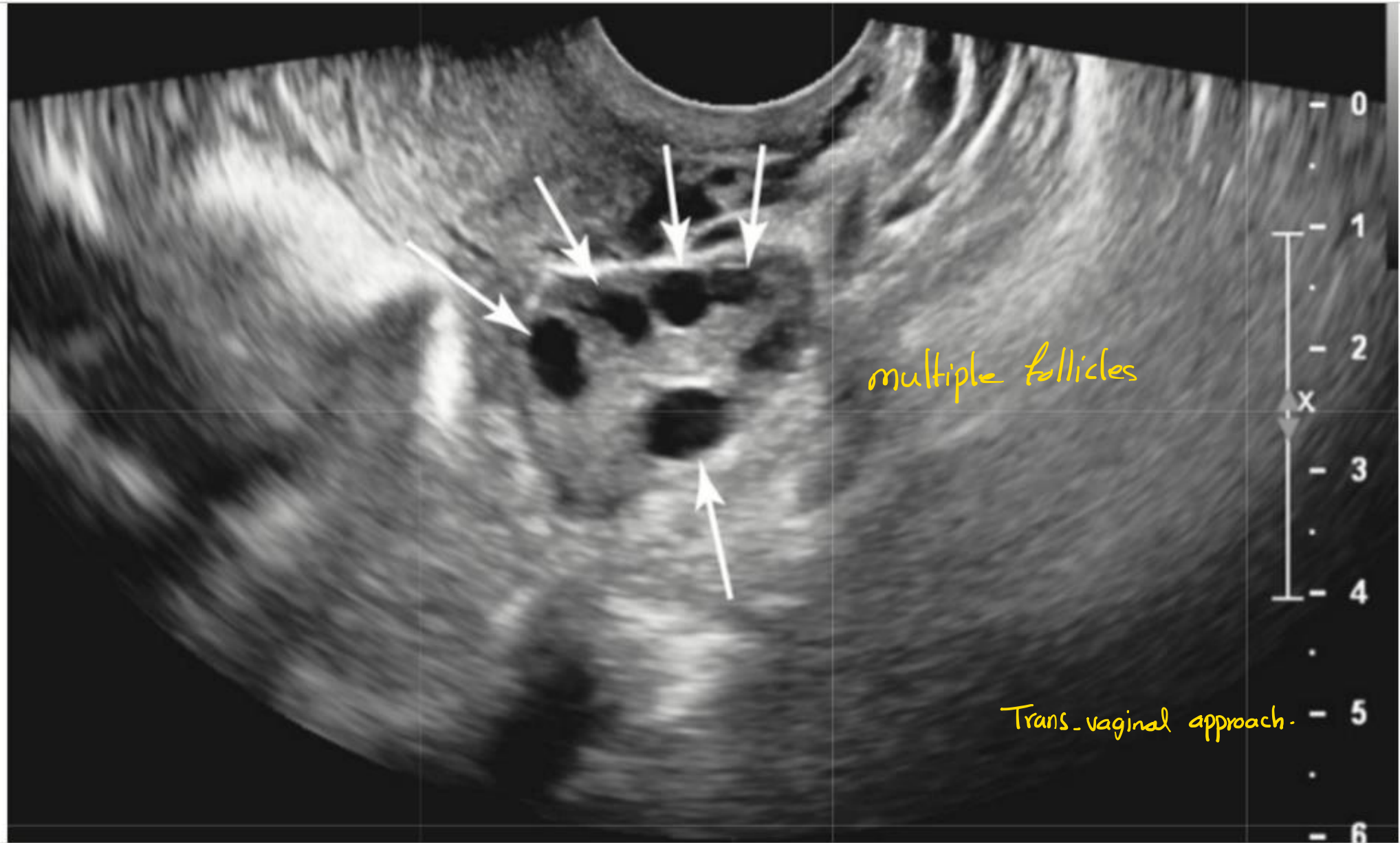
↙
↑↑ blood flow.

NORMAL OVARY

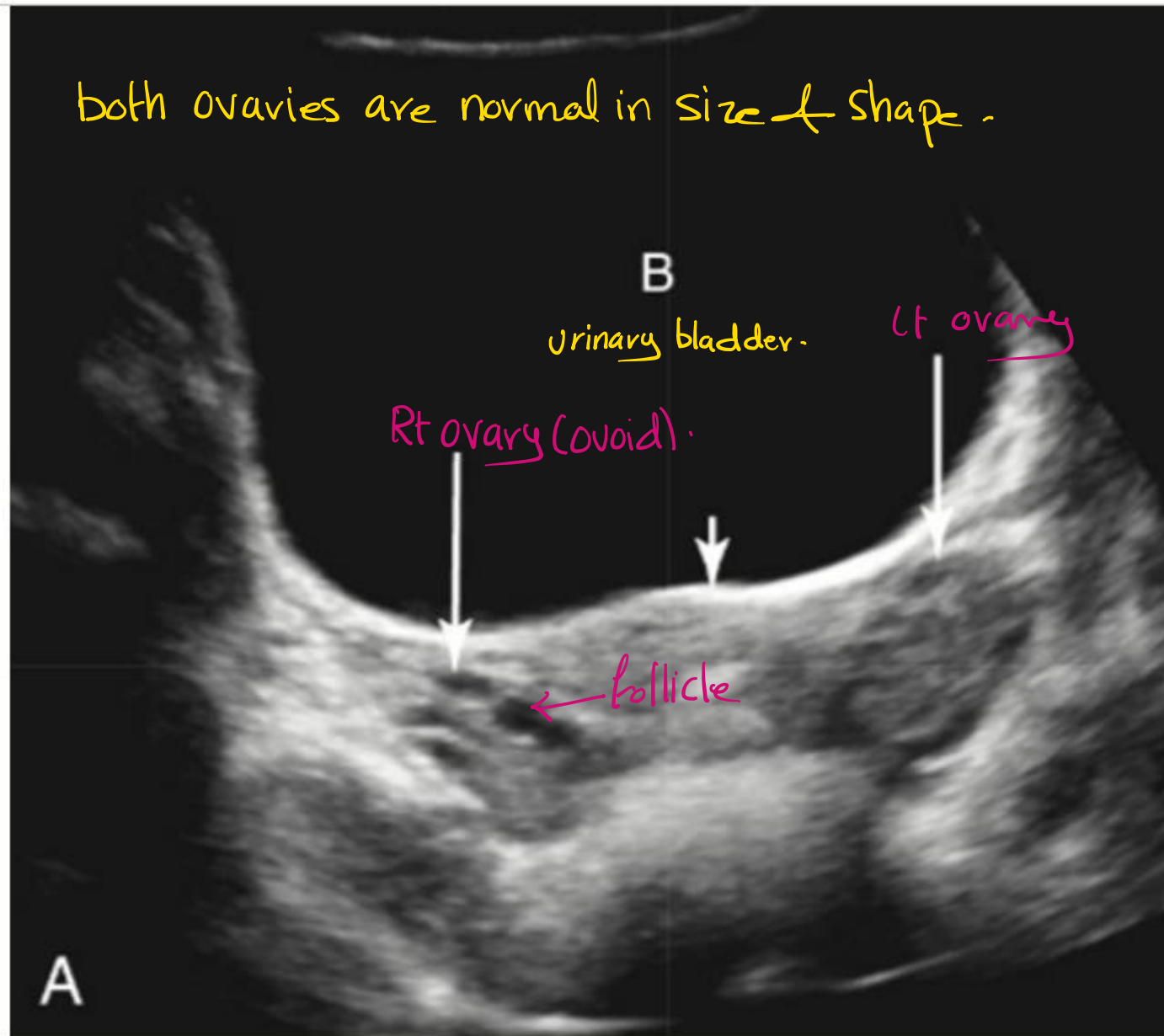
- The ovaries are ovoid or teardrop in configuration and elongated in contour.
- Follicles are depicted as rounded, thin-walled anechoic cystic structures in the ovary.
- Identification of follicles distinguishes the ovary from adjacent structures such as bowel loops and uterine masses.
- The ovaries are typically positioned lateral to the uterus and anteromedial to the internal iliac blood vessels.
- Ovarian volume can be estimated by multiplying length $\times$ width $\times$ depth and dividing by 2 (a simplified version of the formula for the volume of an ellipse).



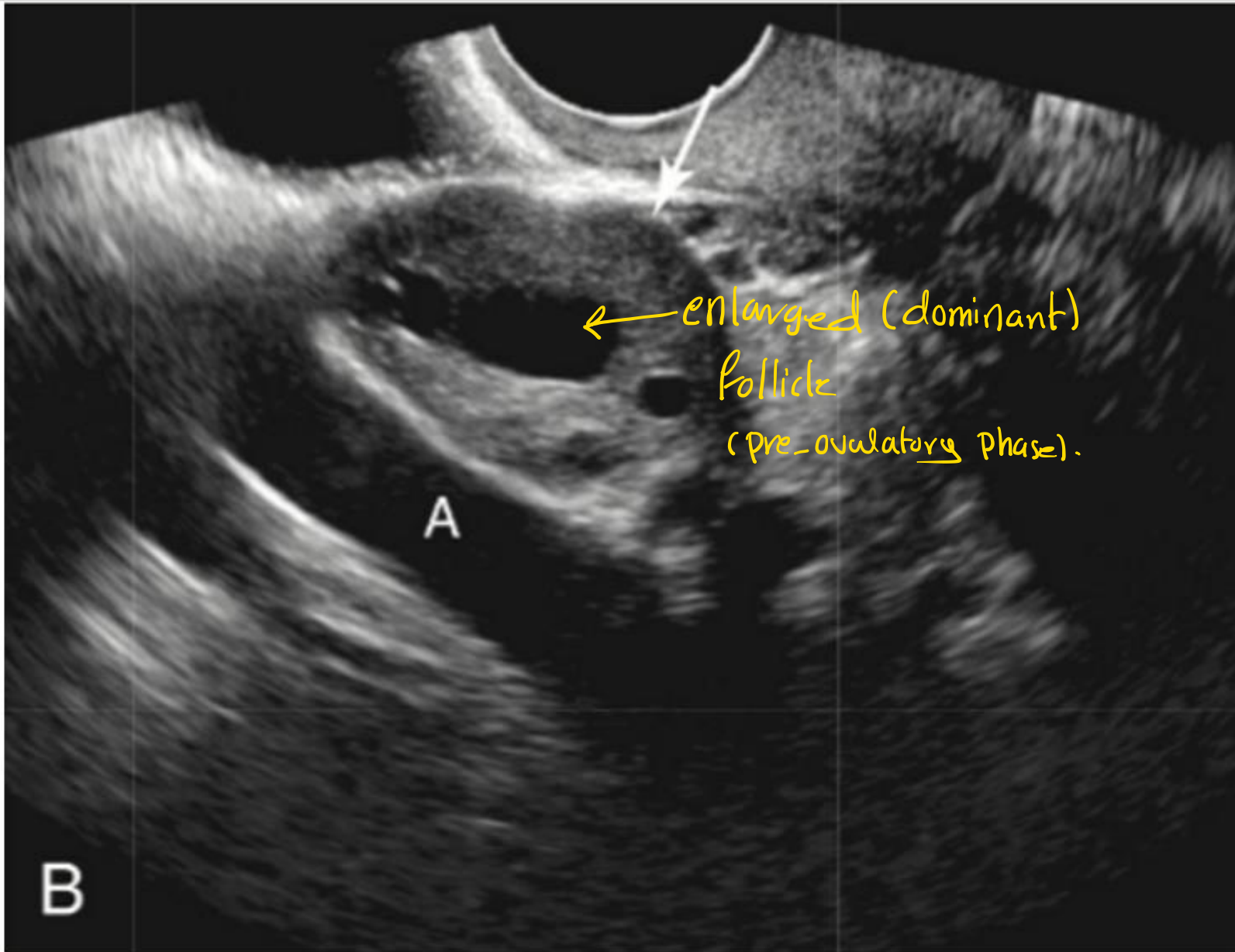
* Can be done by trans-abd. (curvilinear probe) or trans-vaginal approach.



both ovaries are normal in size & shape.



Trans - abdominal



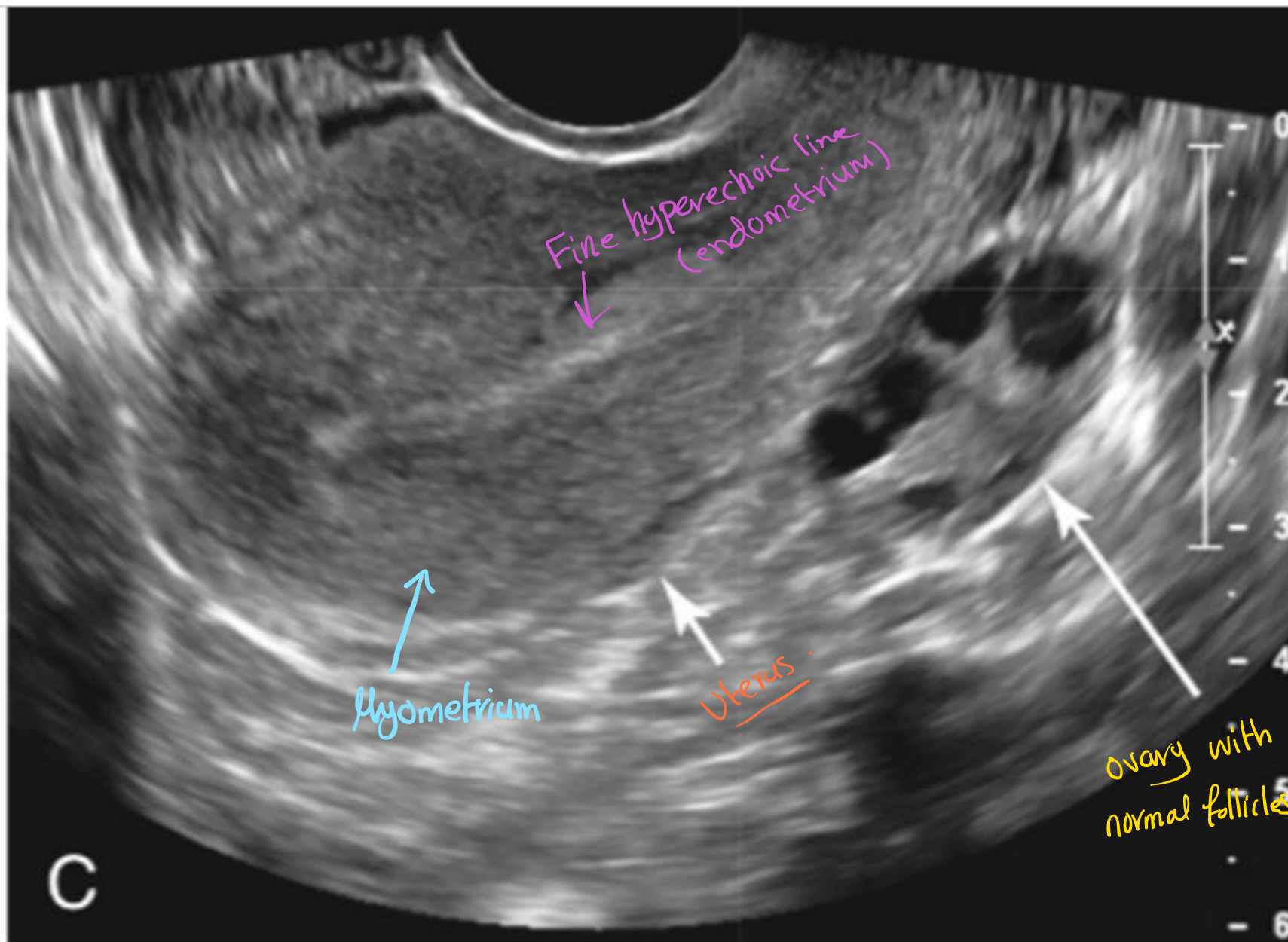
Trans-vaginal.

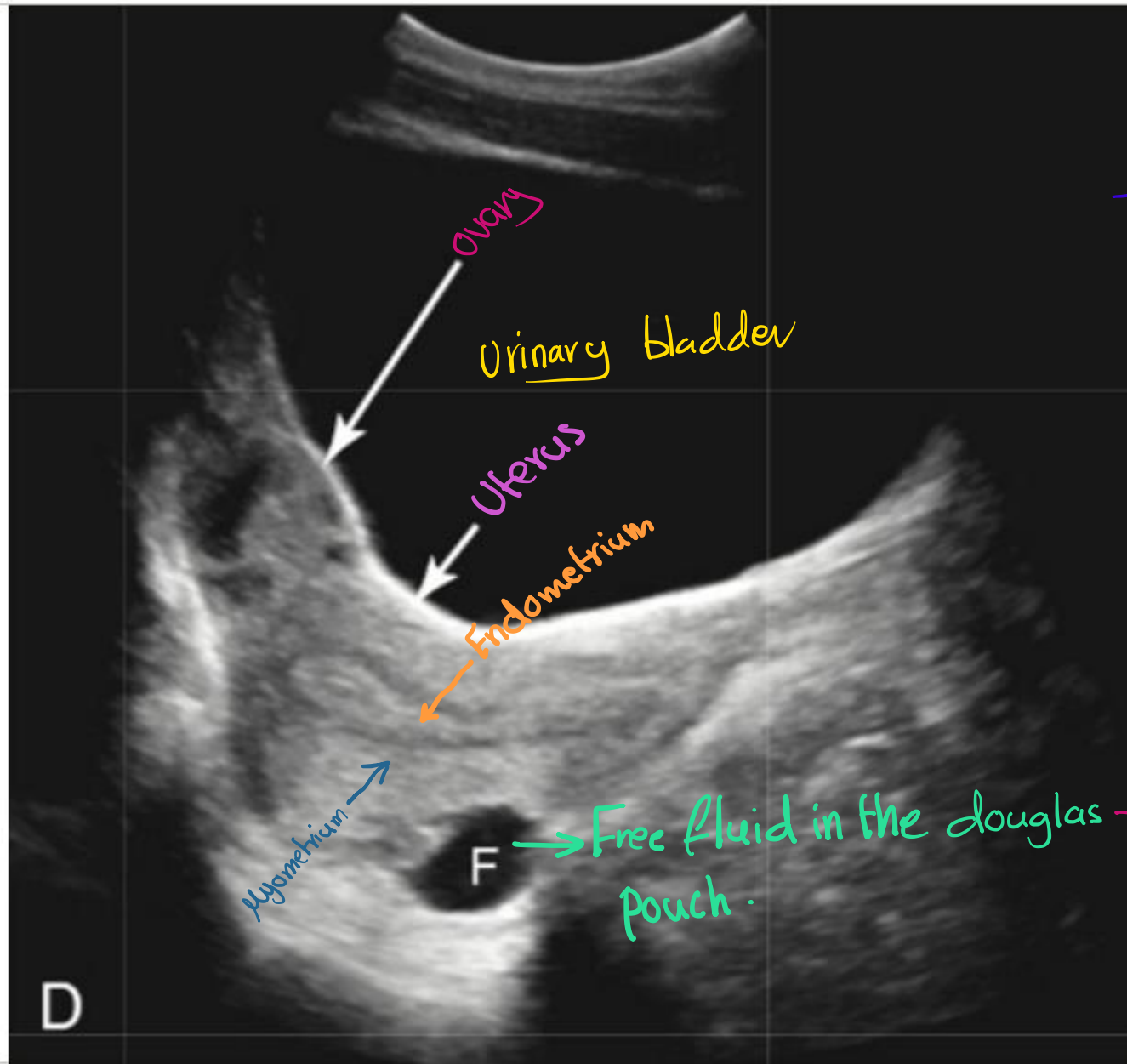
← enlarged (dominant)
follicle
(pre-ovulatory phase).

A

B

Trans-vaginal
US





ovary

Urinary bladder

Uterus

Endometrium

Myometrium

F

Free fluid in the Douglas pouch.

Trans-abdominal
The bladder is
Seen.

Normally present at the time
of ovulation or menstruation.

OVARIAN TORSION

- Patients with ovarian torsion typically present with acute onset of severe unilateral pain, often in conjunction with nausea and vomiting.
- Intermittent pain may precede the acute pain by weeks.
- Torsion may present at any time in life from the neonatal to the postmenopausal period, although it is (relatively uncommon following menopause.)
- There is an increased risk of ovarian torsion during pregnancy. ↑↑ risk
- When ovarian torsion is strongly suspected, rapid surgical intervention is important to improve the likelihood of a viable ovary following detorsion.



Box 24-4

Ovarian Torsion: Ultrasound Findings

The ovaries has dual blood supply. (gonadal & uterine arteries). / presence of blood supply doesn't rule out torsion.

Ovarian enlargement: especially asymmetric enlargement (on side of pain)
compared with contralateral ovary

Heterogeneous ovarian echotexture

Relative paucity of follicles very minimal follicles

Small follicles displaced peripherally

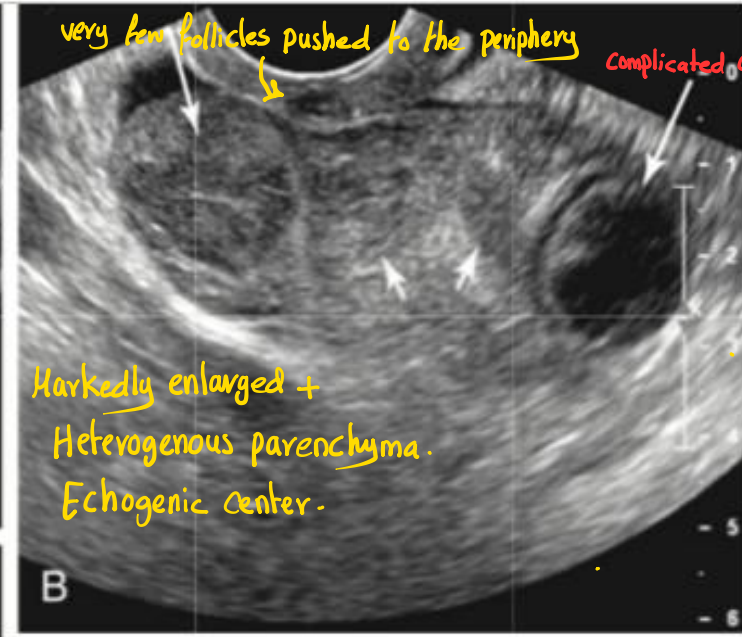
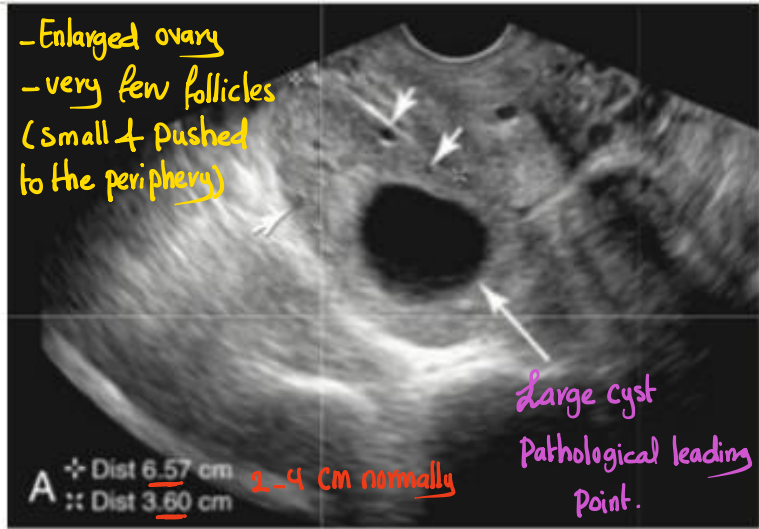
Peripheral echogenic ring around follicles (follicular ring sign)

Twisted pedicle with concentric circular bands

Whirlpool sign

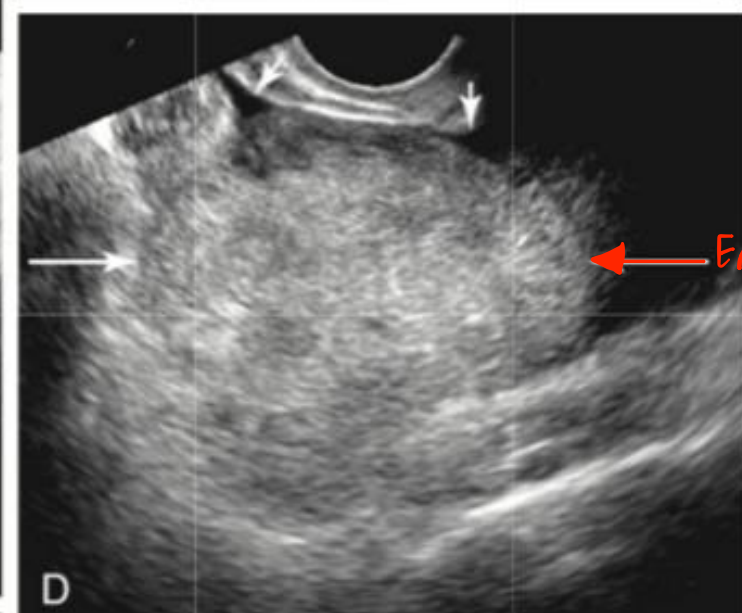
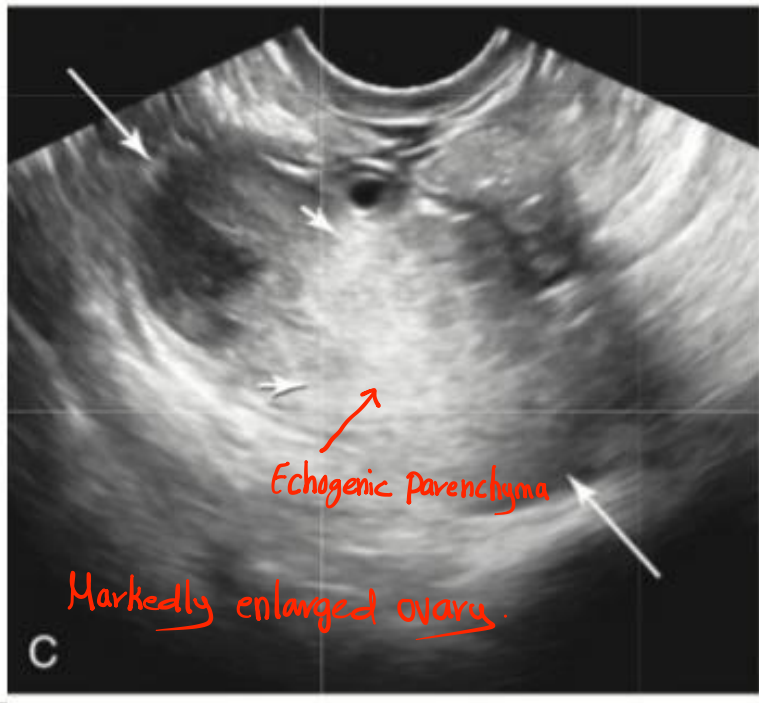
Ovarian cyst The leading cause of torsion.

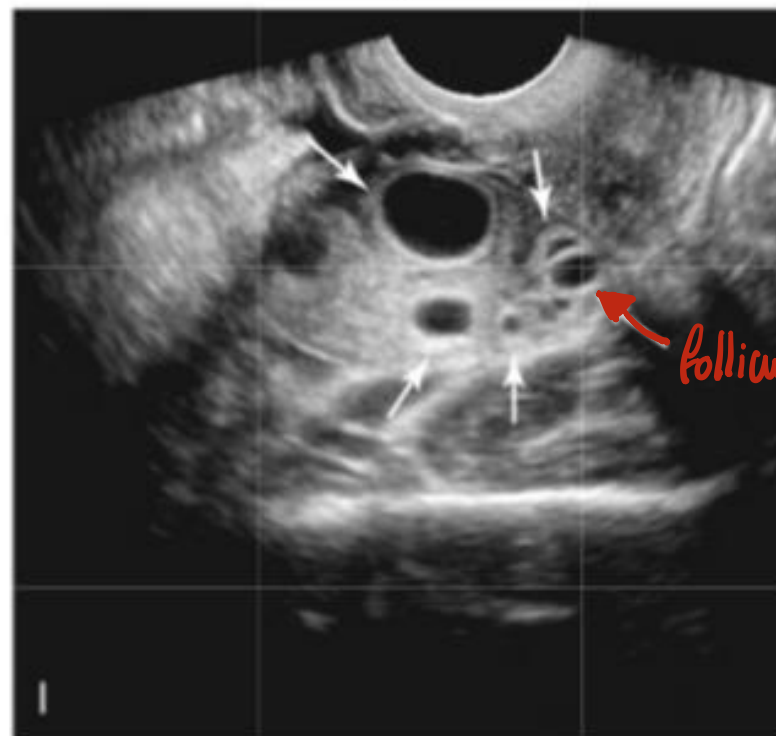
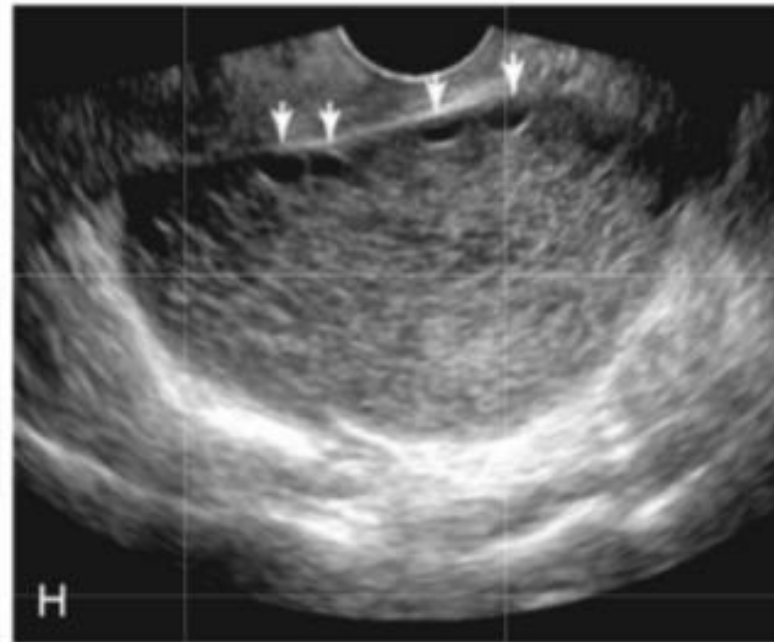
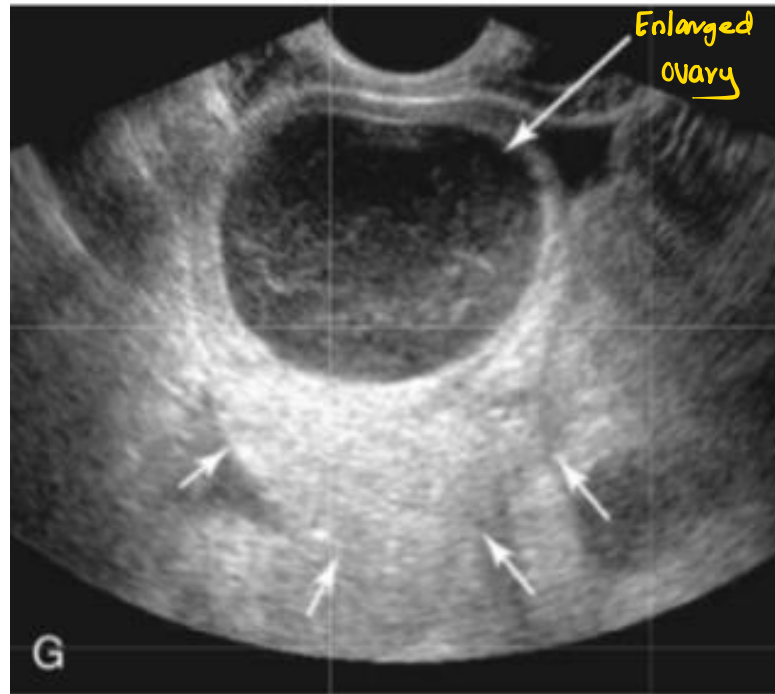




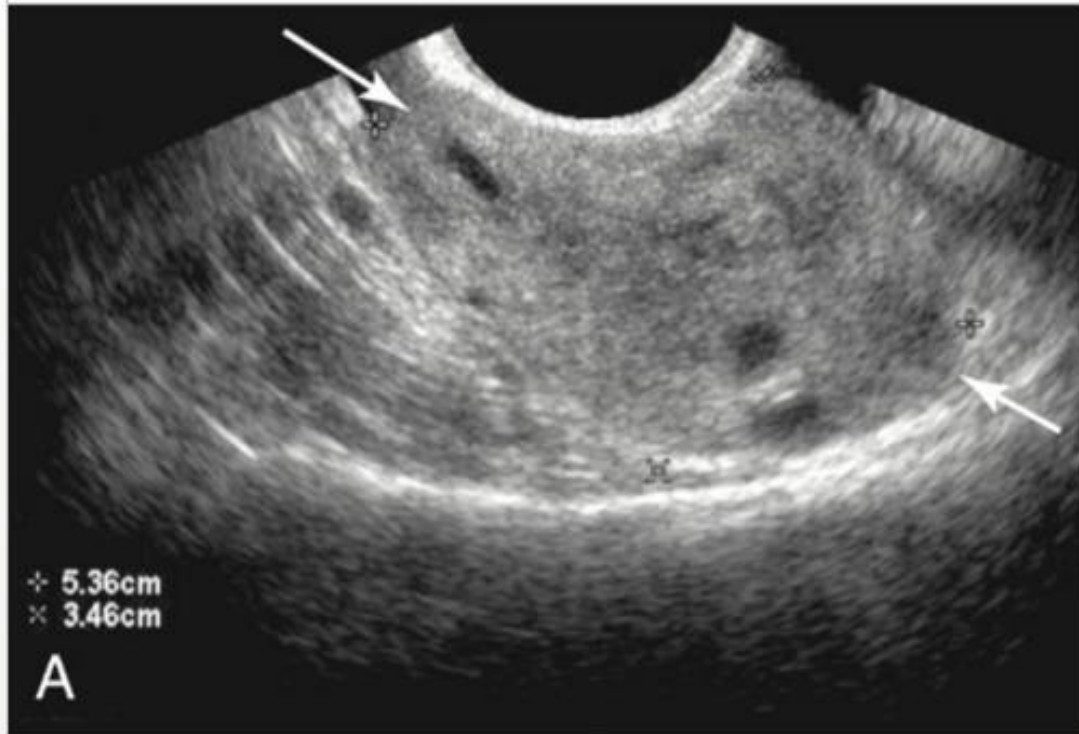
complicated cyst (mostly hemorrhagic cyst).

* Trans-vaginal

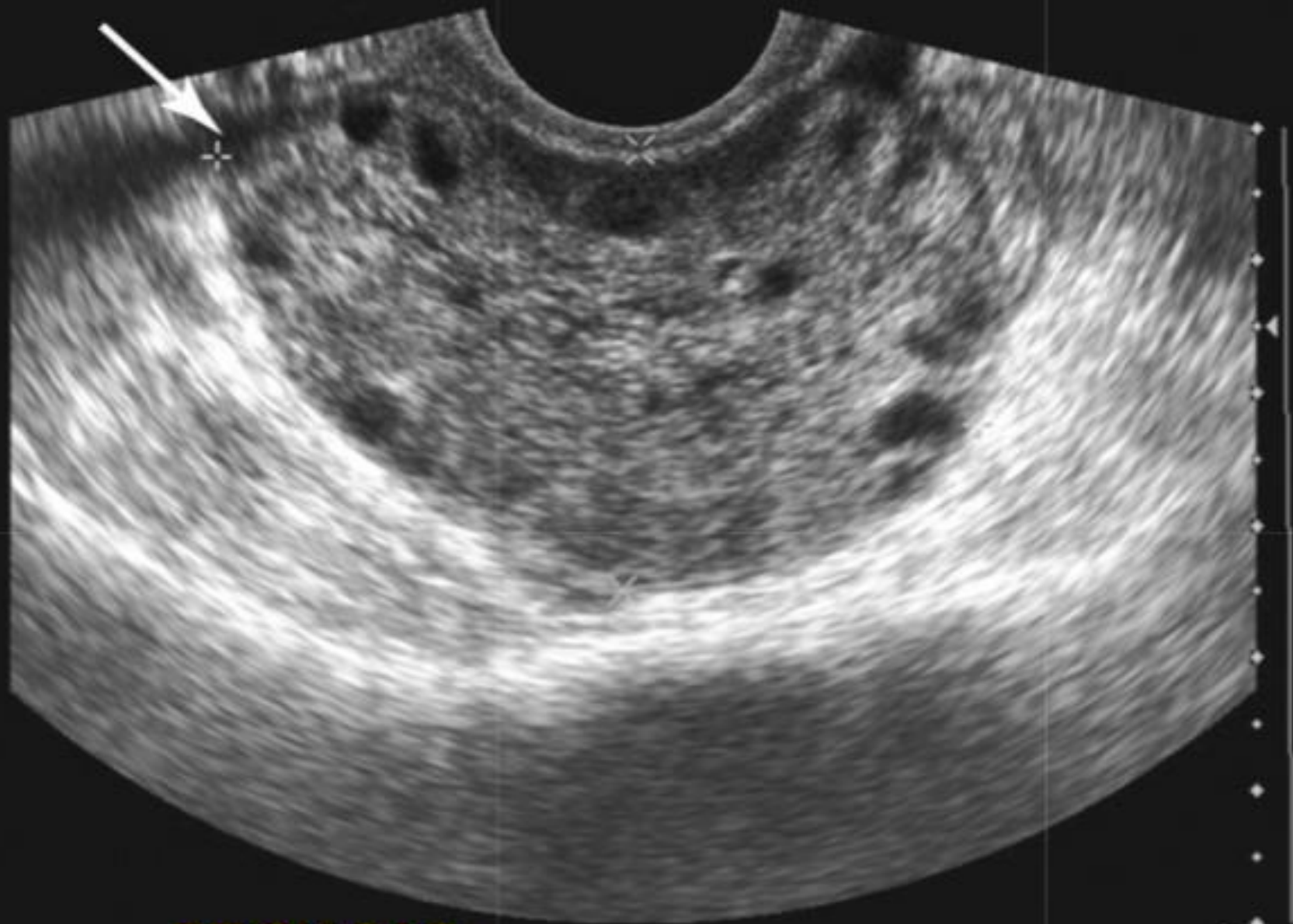




follicular ring sign.



Whirlpool sign (multiple layers) -



RT OV SAG

✦ D=61.1 mm

✕ D=33.3 mm

6cm
14fps

Fr56

- Doppler demonstration of blood flow in an ovary does not exclude torsion; torsed ovaries frequently exhibit blood flow at Doppler evaluation.
- Patterns of blood flow reported in surgically proven torsed ovaries include arterial and venous flow, arterial but no venous flow, venous but no arterial flow, and no flow.
- flow is frequently not identified in the normal nontorsed ovary when it is suboptimally visualized, as may occur due to deep location or a pelvic mass such as a fibroid positioned between the transducer and the ovary.
- Given these limitations, it is important to interpret the Doppler findings in cases of suspected ovarian torsion in conjunction with ovarian size, morphologic appearance, and clinical presentation.

DVT AND PE

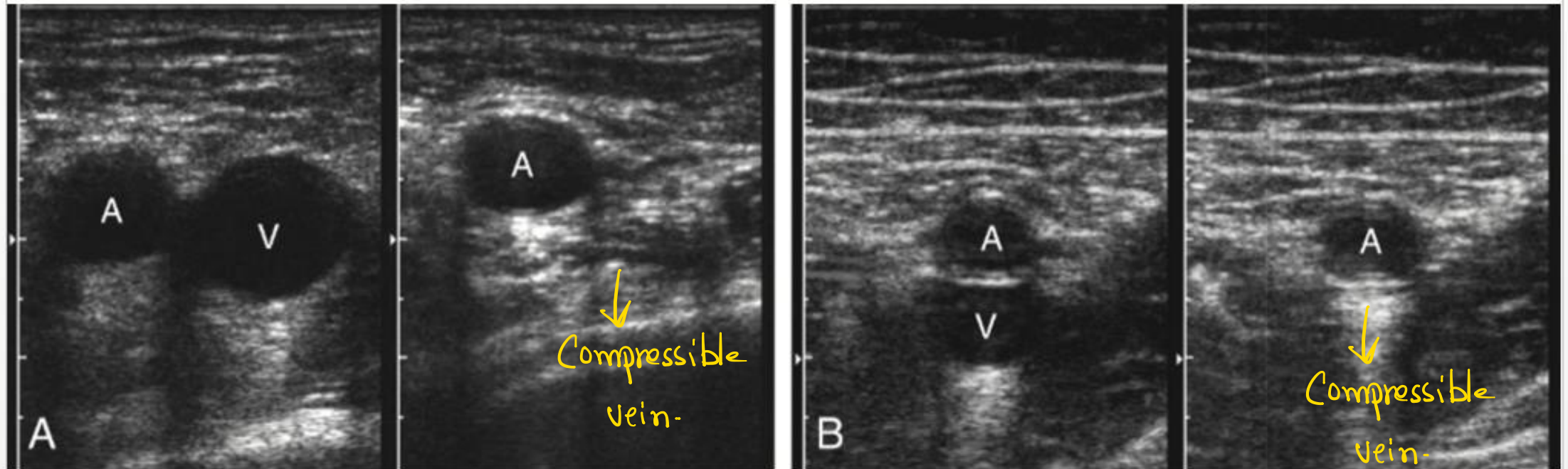
- Pulmonary embolism occurs in up to 50% of untreated cases and the mortality of pulmonary embolism is up to 25%.
- The clinical diagnosis of DVT is very difficult.
- Ultrasound is the procedure of choice in the evaluation of suspected lower extremity DVT.
- In the femoral-popliteal system of symptomatic patients, the sensitivity and specificity exceed 95% and 98%, respectively.



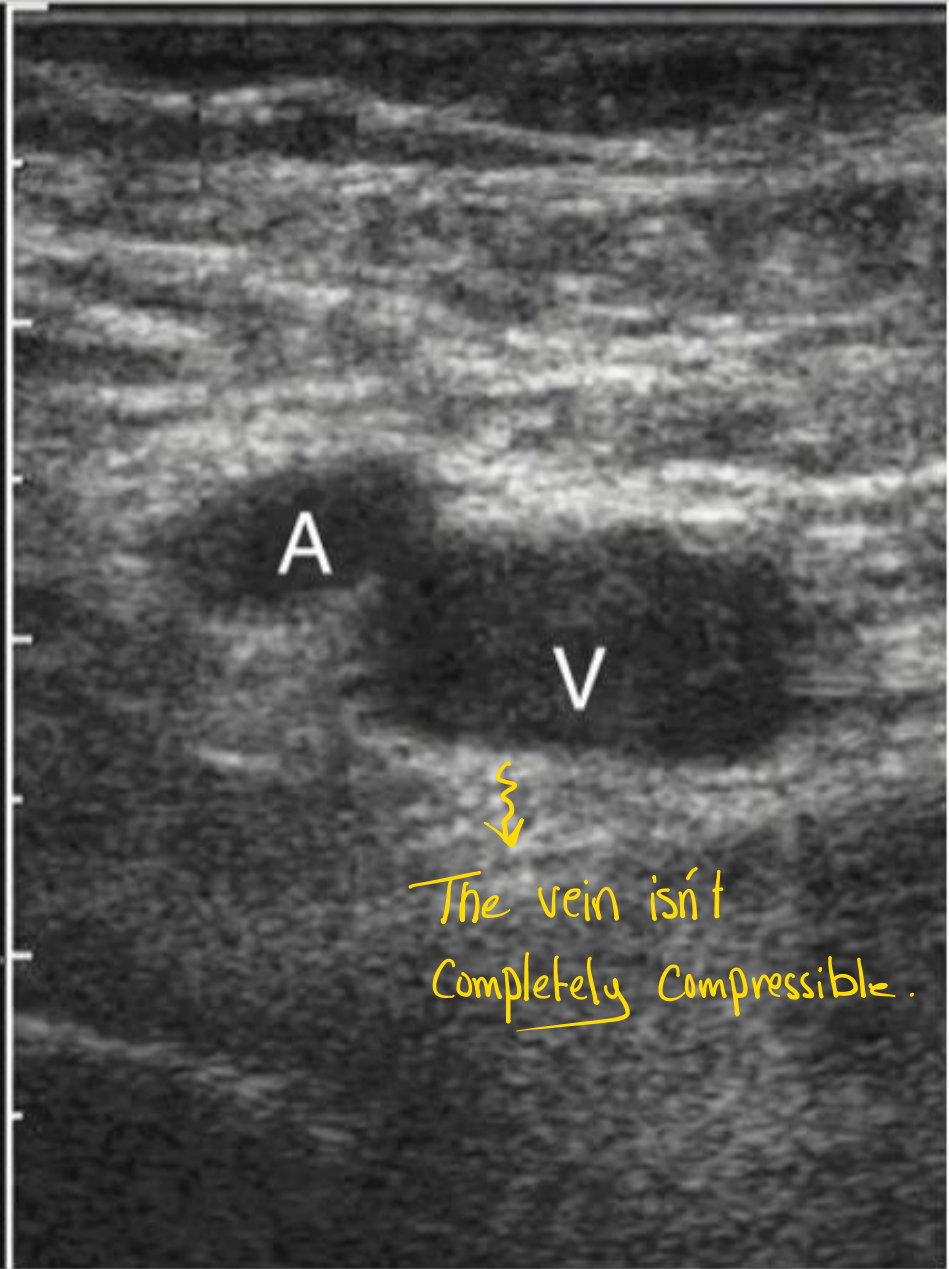
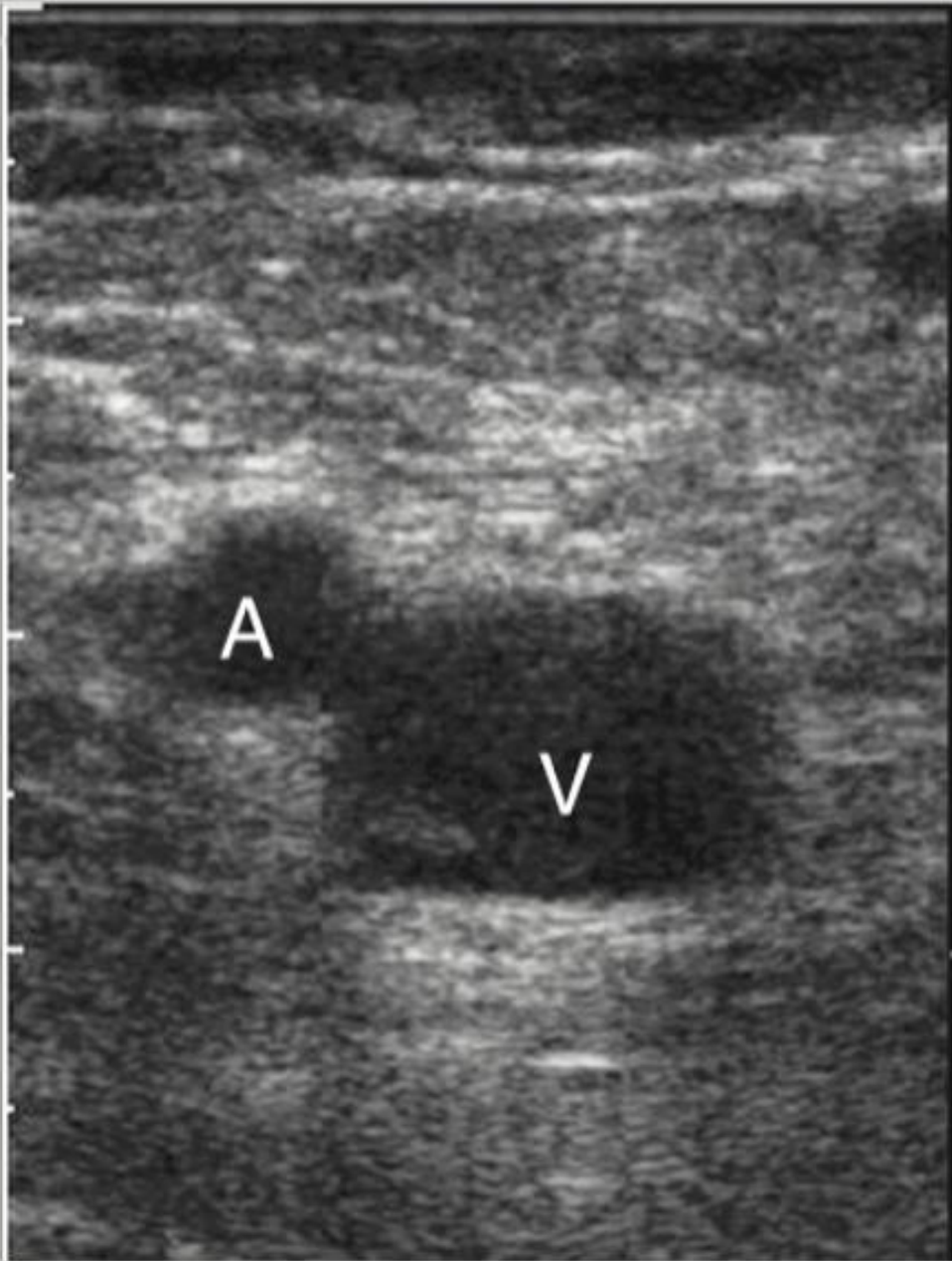
- Lower extremity venous examinations should include evaluation of the common femoral vein, femoral vein (previously referred to as the superficial femoral vein), origin of the profunda femoris vein, proximal greater saphenous vein, and popliteal vein.
- Normal deep veins are completely compressible.
- Lack of complete compressibility is the primary criterion for diagnosing DVT in the femoral-popliteal veins

- 1) Compressible
 - 2) Normal diameter
 - 3) Preserved blood flow
 - 4) No echogenic content (thrombus)
- 

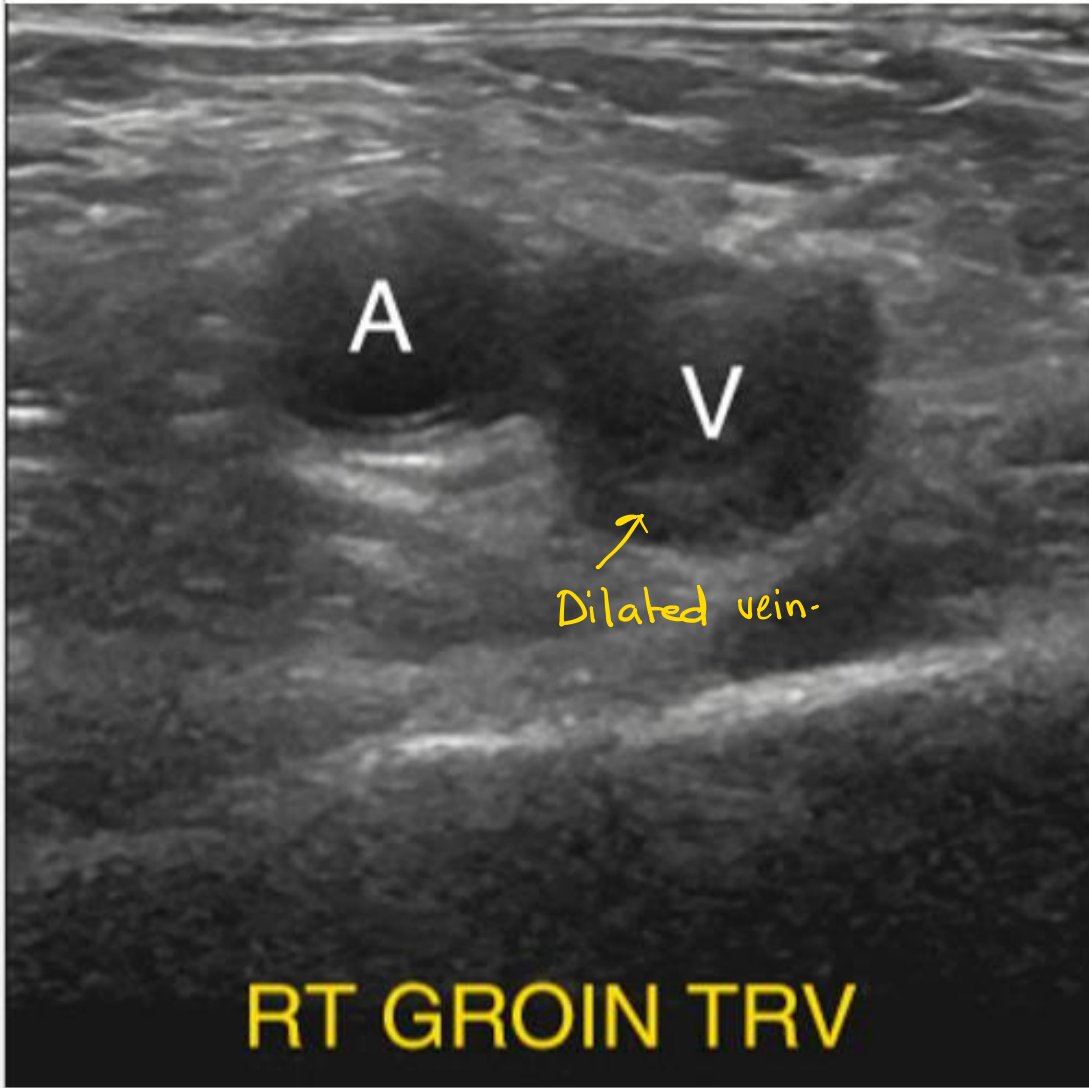
NO DVT



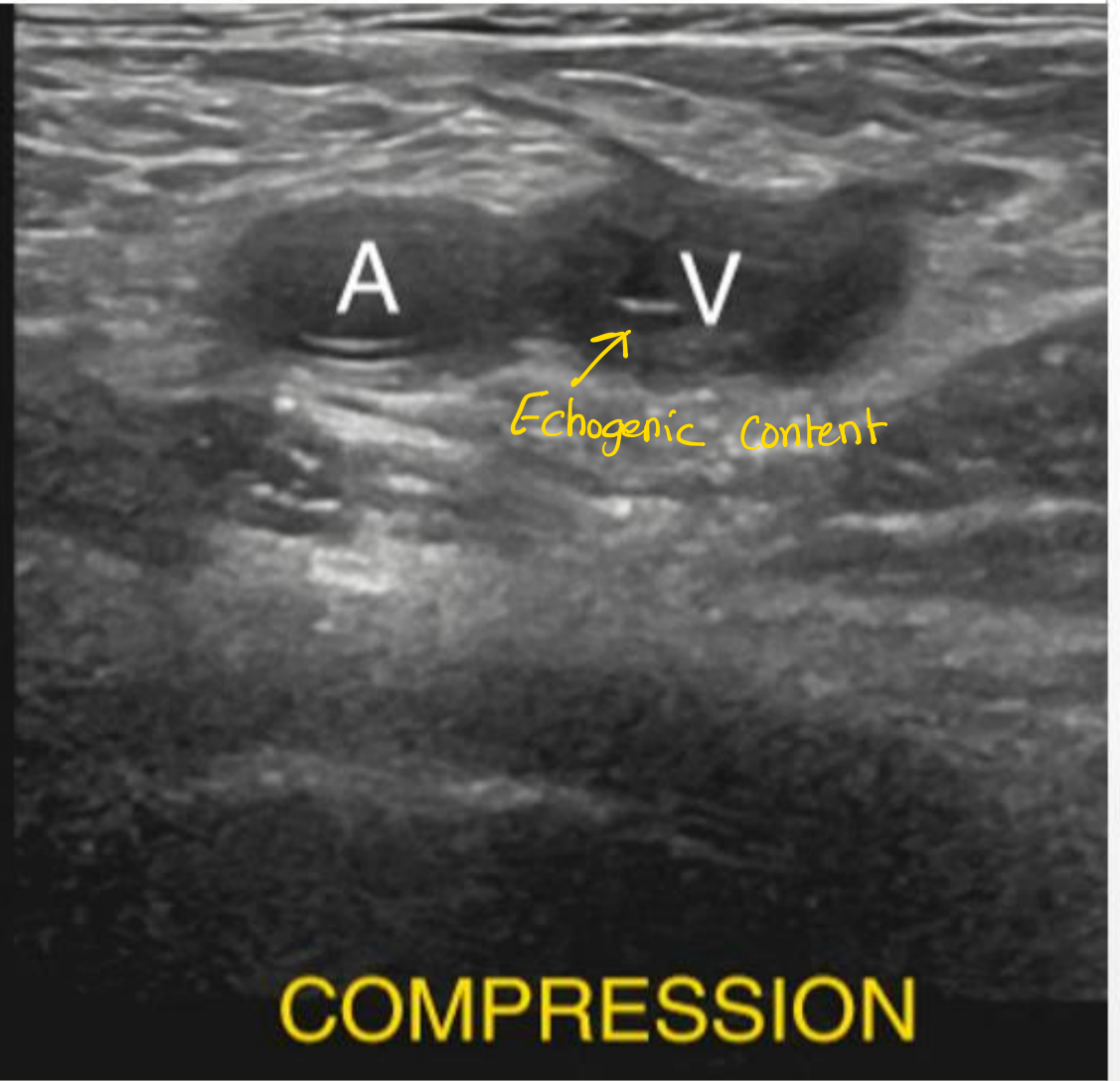
- *In the lower limb, the vein is always deep to the artery (common + superficial femoral veins)
- *The popliteal artery is deep to the vein.



The vein isn't
completely compressible.



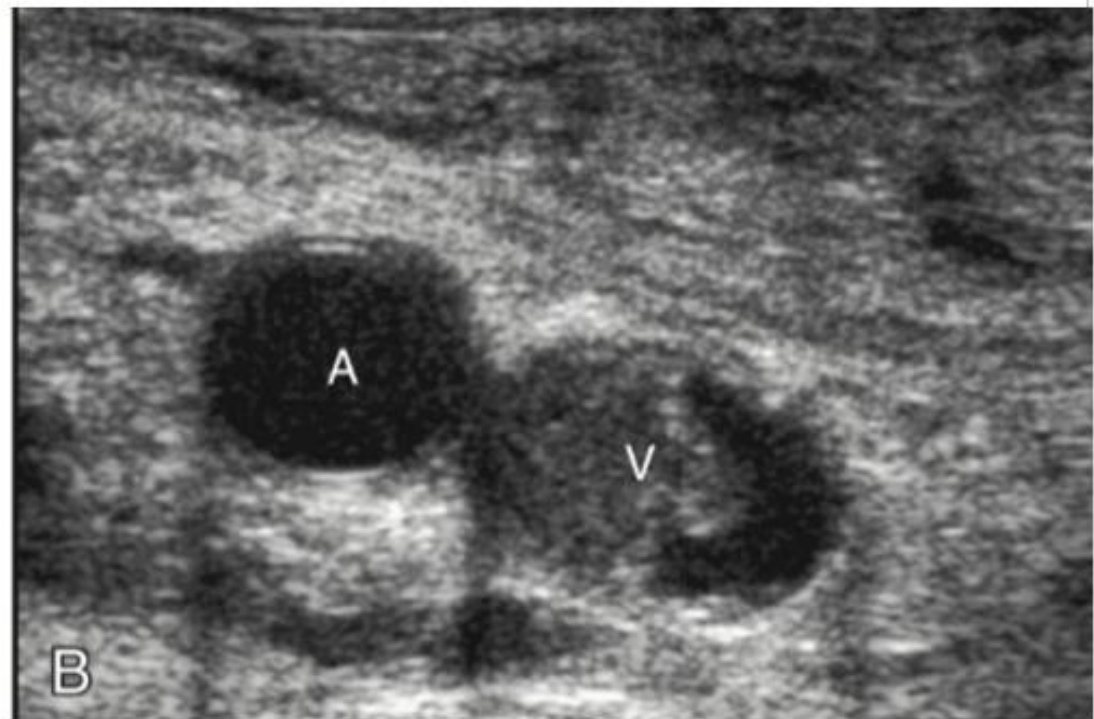
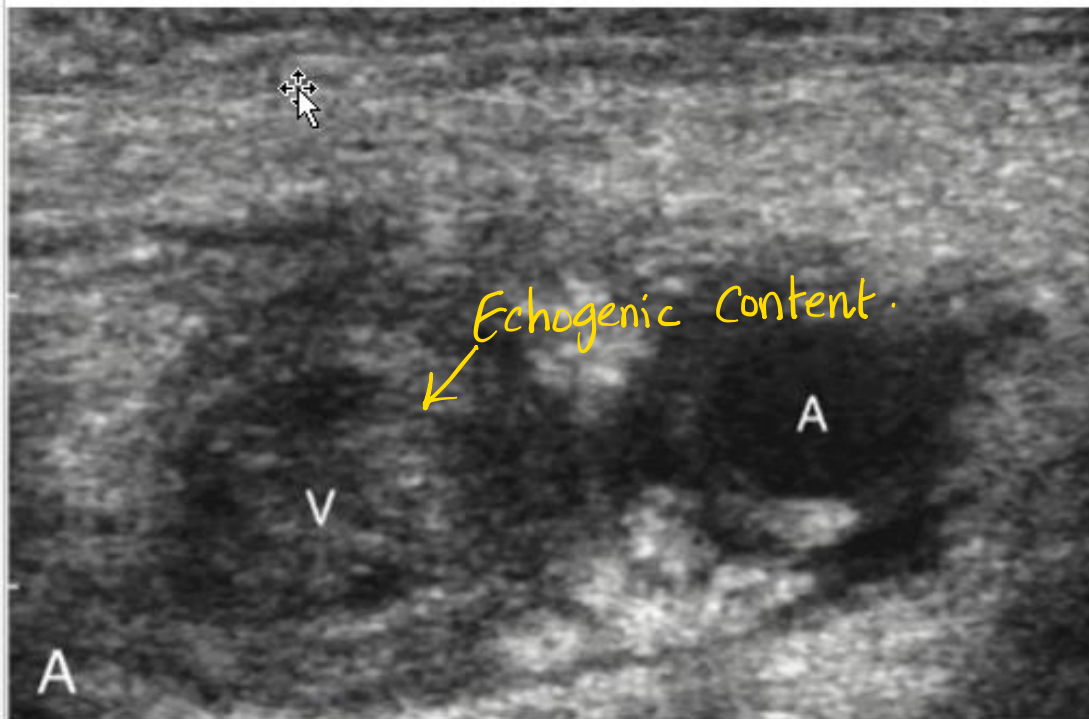
RT GROIN TRV



COMPRESSION

DVT

- In some cases thrombus can be seen on gray scale.
- However, the appearance of artifactual intraluminal echoes overlaps with the hypoechoic echoes from clot. Therefore analysis of echogenicity is not a primary focus of lower extremity venous examinations.



Don't compress more !!
This causes PE.

* Usually the assessment is done by the linear probe.

- In obese or very edematous patients, gray-scale identification of the femoral and popliteal veins may be very difficult.
- In these situations color Doppler may help to localize the vessels.
- Augmentation of proximal venous flow by compression of the calf or plantar flexion of the foot can accentuate the veins and further assist when color Doppler is required.





F.A.S.T

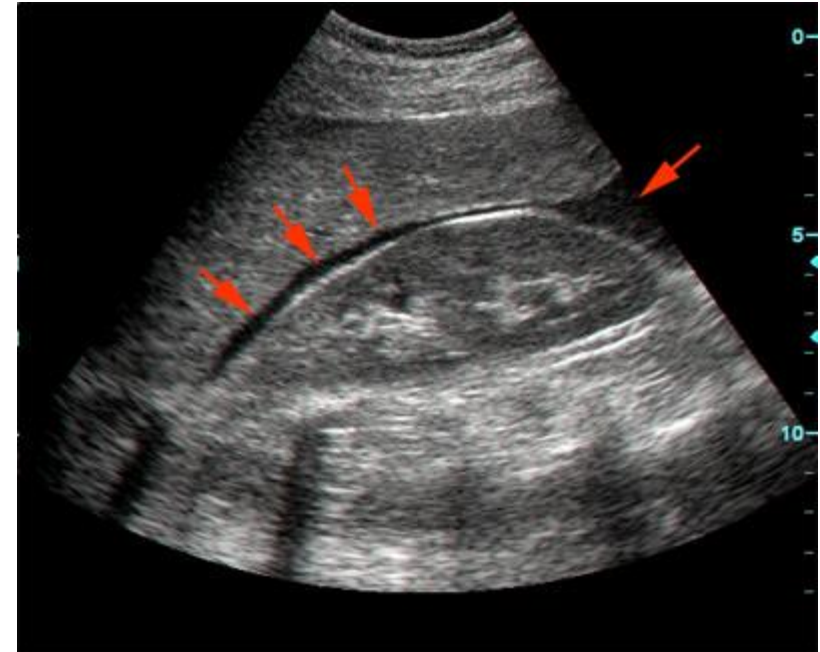
Focused Assessment with Sonography in Trauma

It's a bedside ultrasound exam done during trauma to evaluate for intra-abdominal injury.

SO WHAT IS A **POSITIVE** FAST?

The main principle of **FAST** is the presence of the **ANECHOIC Stripe**.

In any emergency case, it is the presence of **anechoic stripe** in one or more of the 4 known places.





WHAT'S ANECHOIC ON ULTRASOUND?

Fluid (not static)

Active Flow

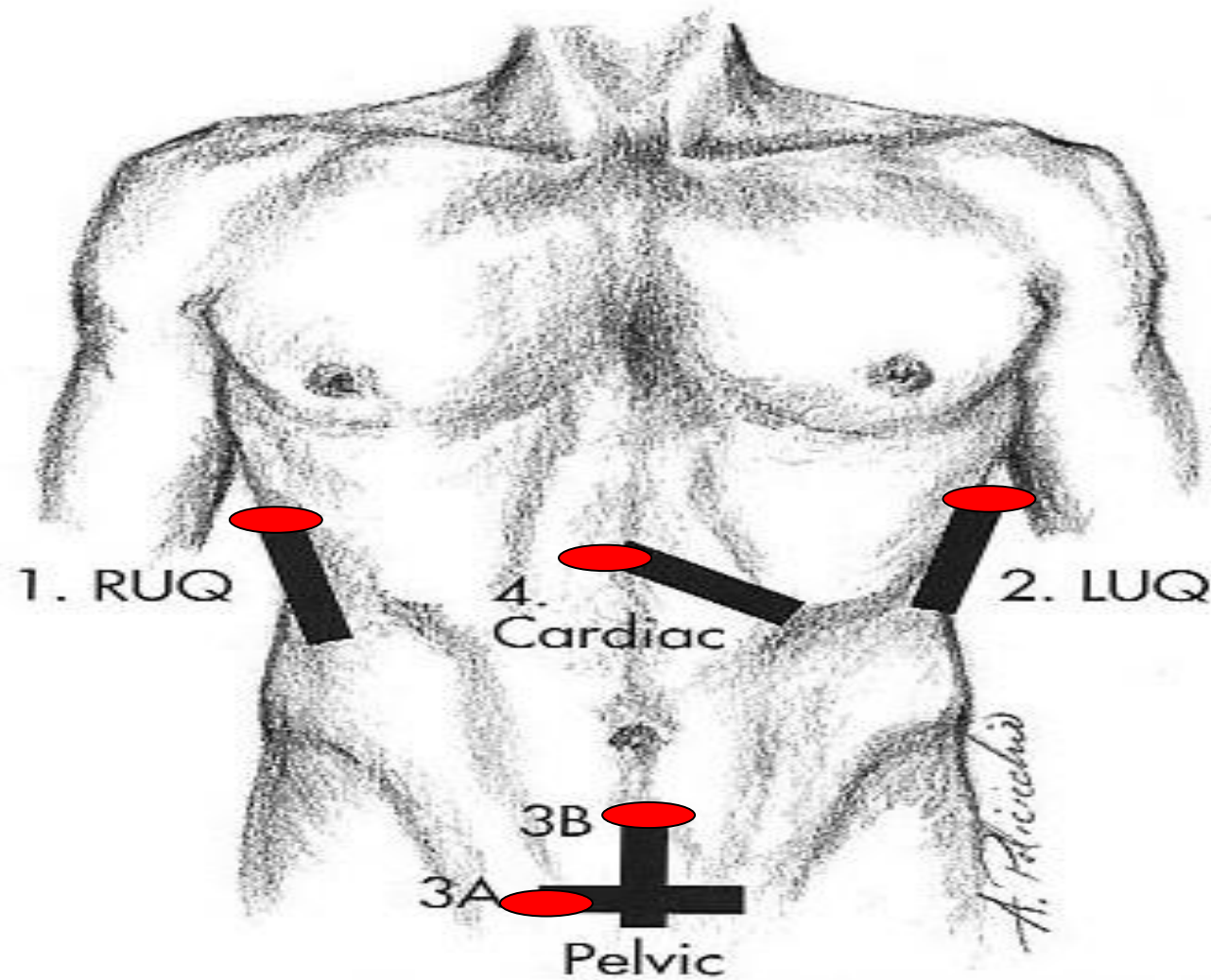
Old Blood

WHAT ARE THE KNOWN PLACES?

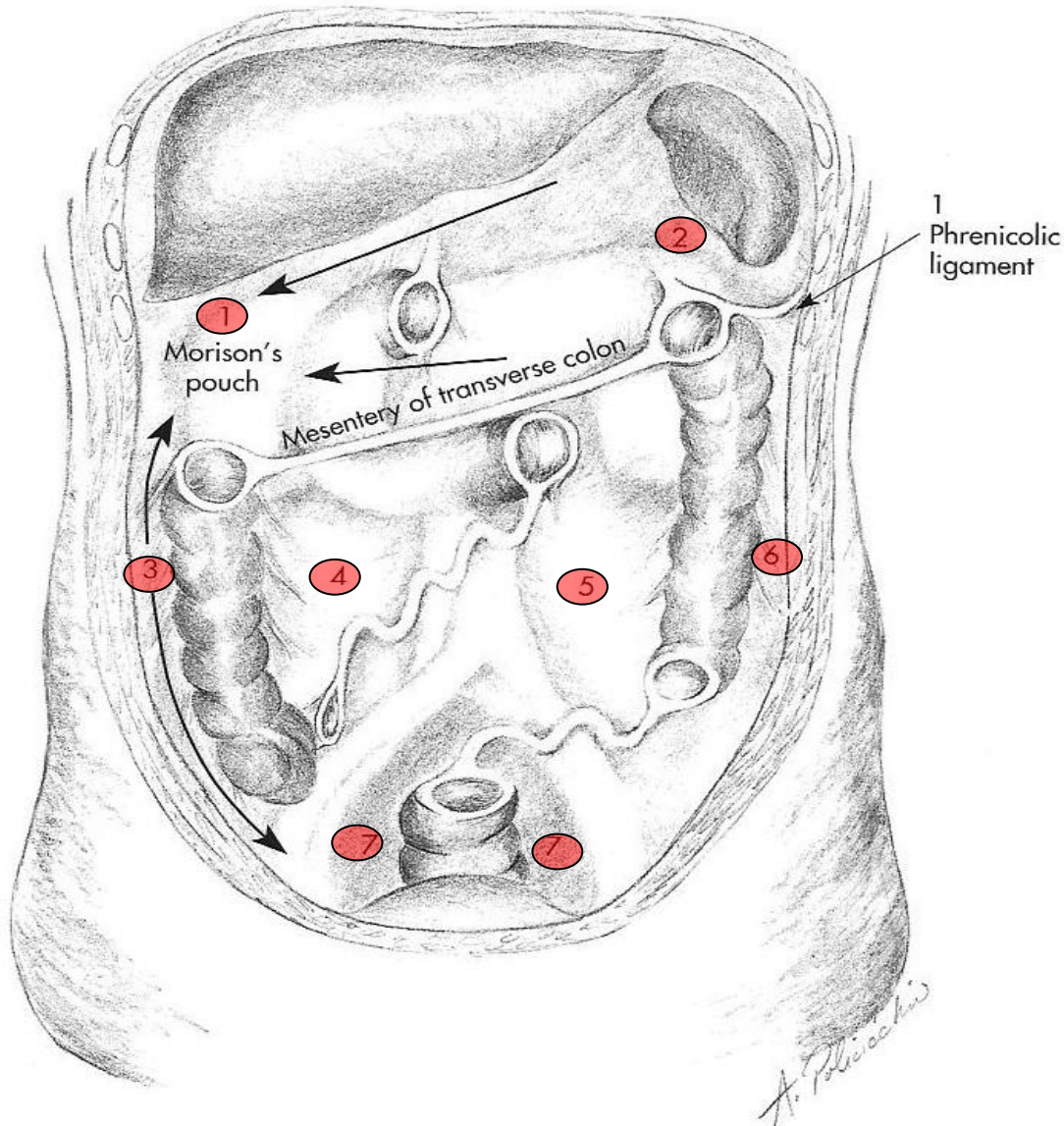
The **classical** four places to look for free fluid in FAST are:

- RUQ
- LUQ
- SubXiphoid
- Suprapubic

THE CLASSIC 4 PLACES



FAST: ANATOMY



7 dependent sites

1. Right Supramesocolic (Morison's pouch)
2. Left Supramesocolic (Splenorenal recess)
3. Right Pericolic gutter
4. Right Inframesocolic
5. Left Inframesocolic
6. Left Pericolic gutter
7. Pelvic cul-de-sac

FAST: RUQ EXAM



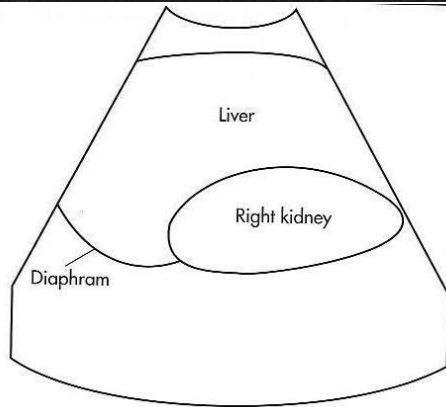
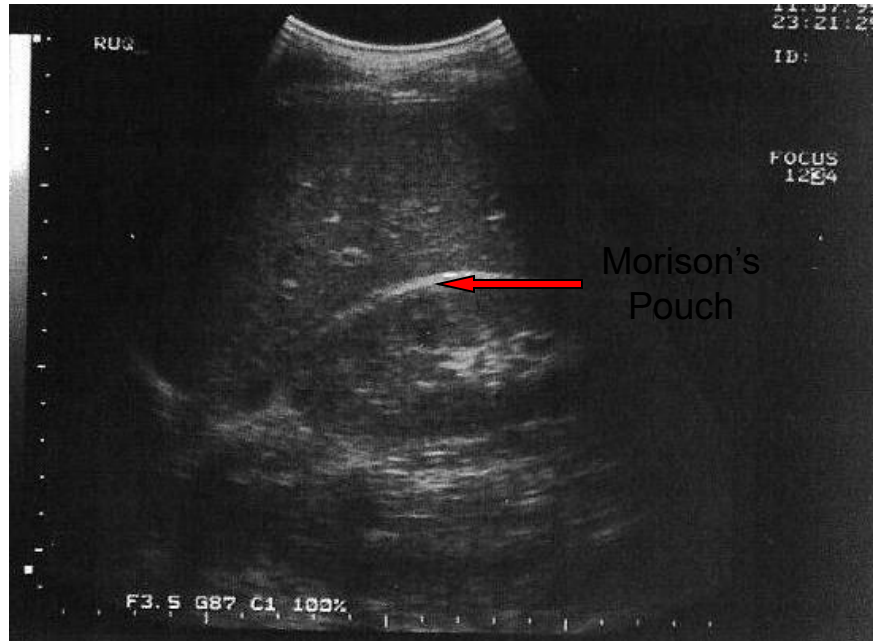
Evaluating

- Hepatorenal interface
- Possibility of fluid in Morison's pouch - Right Supramesocolic space

Technical Problems

- Body habitus
- Bowel gas
- Rib artifact

FAST: RUQ EXAM



Normal Anatomy

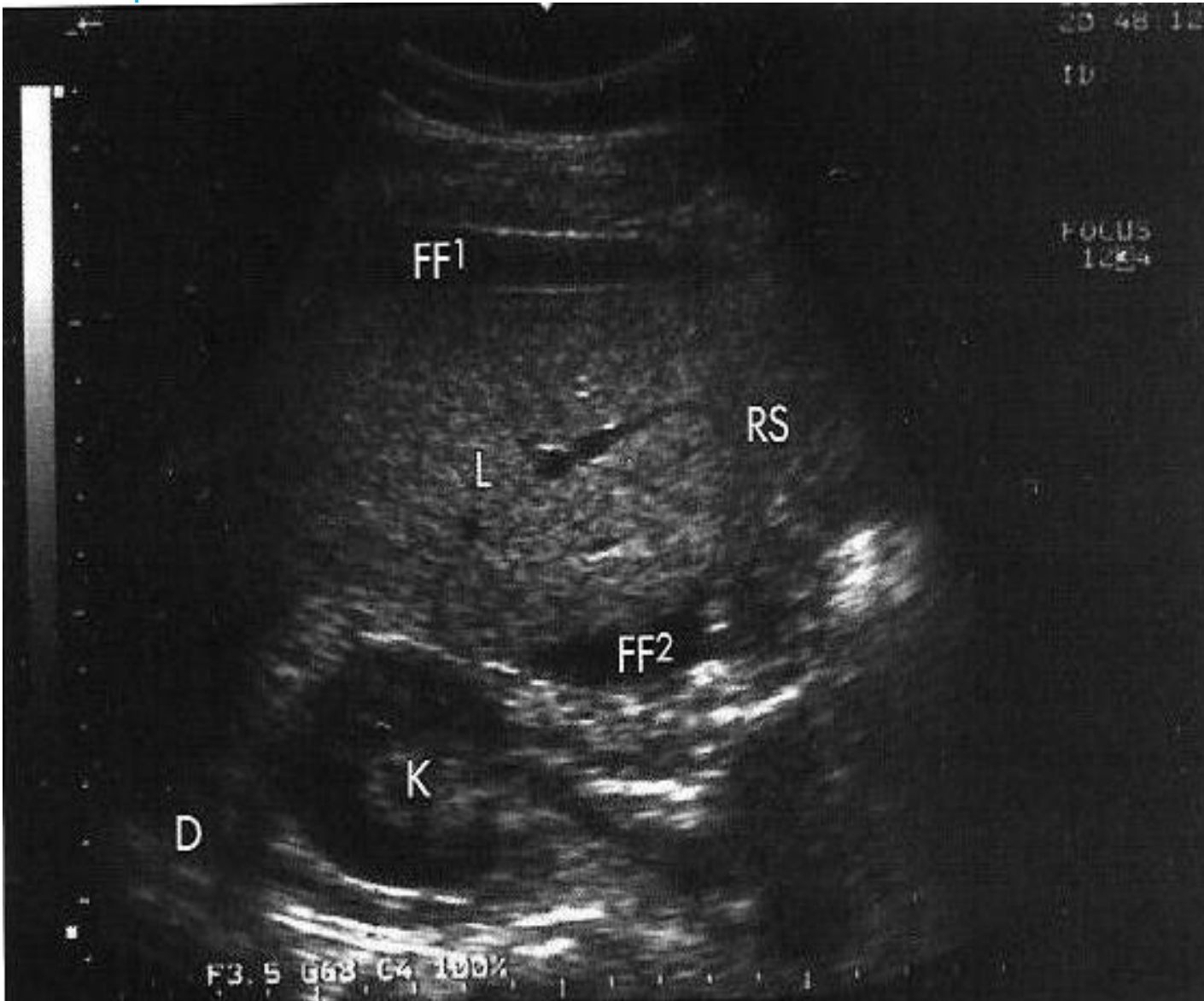
In the supine patient, the hepatorenal space is the most dependent area

Also is the least obstructed for fluid flow

Morison's Pouch

- Potential space between the liver and the right kidney in the hepatorenal recess

POSITIVE FAST: RUQ EXAM



Abnormal Anatomy

Pathologic Fluid - mild

L = liver

D = diaphragm

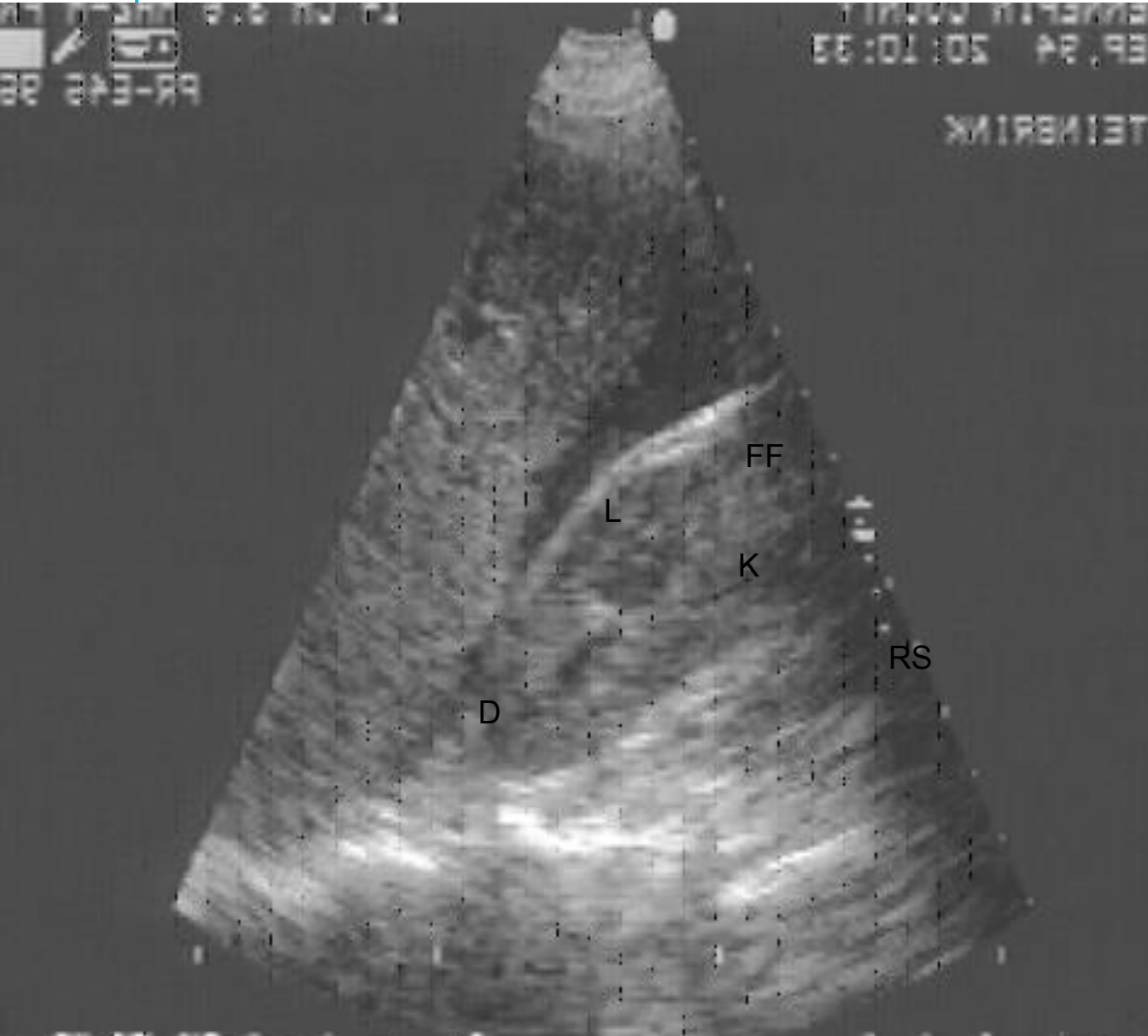
K = kidney

RS = rib shadow

FF1 = free fluid

FF2 = free fluid

POSITIVE FAST: RUQ EXAM



Abnormal Anatomy

Pathologic Fluid - moderate

L = liver

K = Kidney

FF = free fluid

RS = rib shadow

D = diaphragm

POSITIVE FAST: RUQ EXAM



Abnormal Anatomy

Pathologic Fluid - massive

L = liver

K = kidney

FF = free fluid

FAST: LUQ EXAM



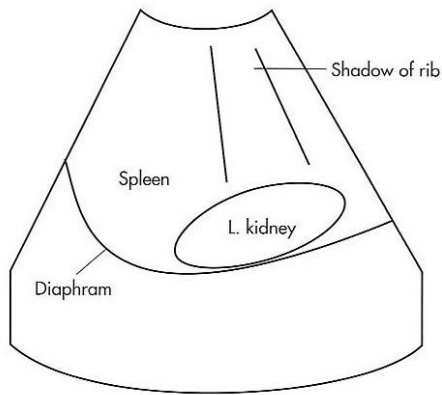
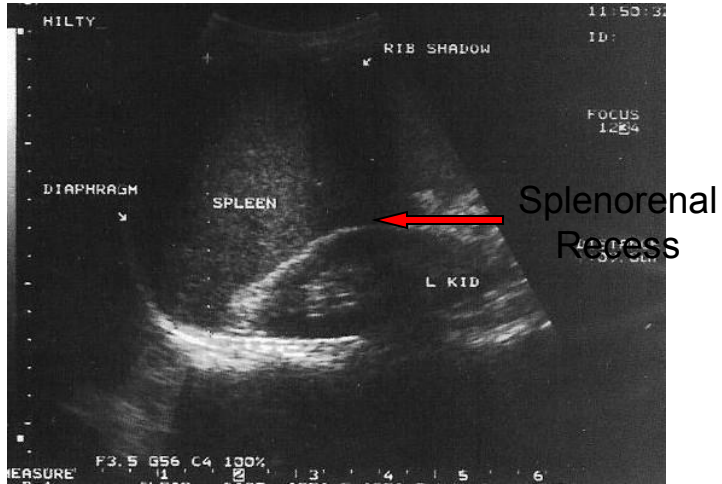
Evaluating

- Spleno-renal interface
- Possibility of fluid in splenorenal recess
- Inferior pole of left kidney
- Sub-phrenic space
- Pleural space 'eFast'

Technical Problems

- Body habitus
- Bowel gas, splenic flexure gas
- Rib artifact

FAST: LUQ EXAM



Normal Anatomy

More difficult to evaluate than RUQ

Left kidney more superior than right

Do not have liver as acoustic window

Splenorenal Recess

- Potential space between kidney and spleen

NEGATIVE FAST- NORMAL LUQ

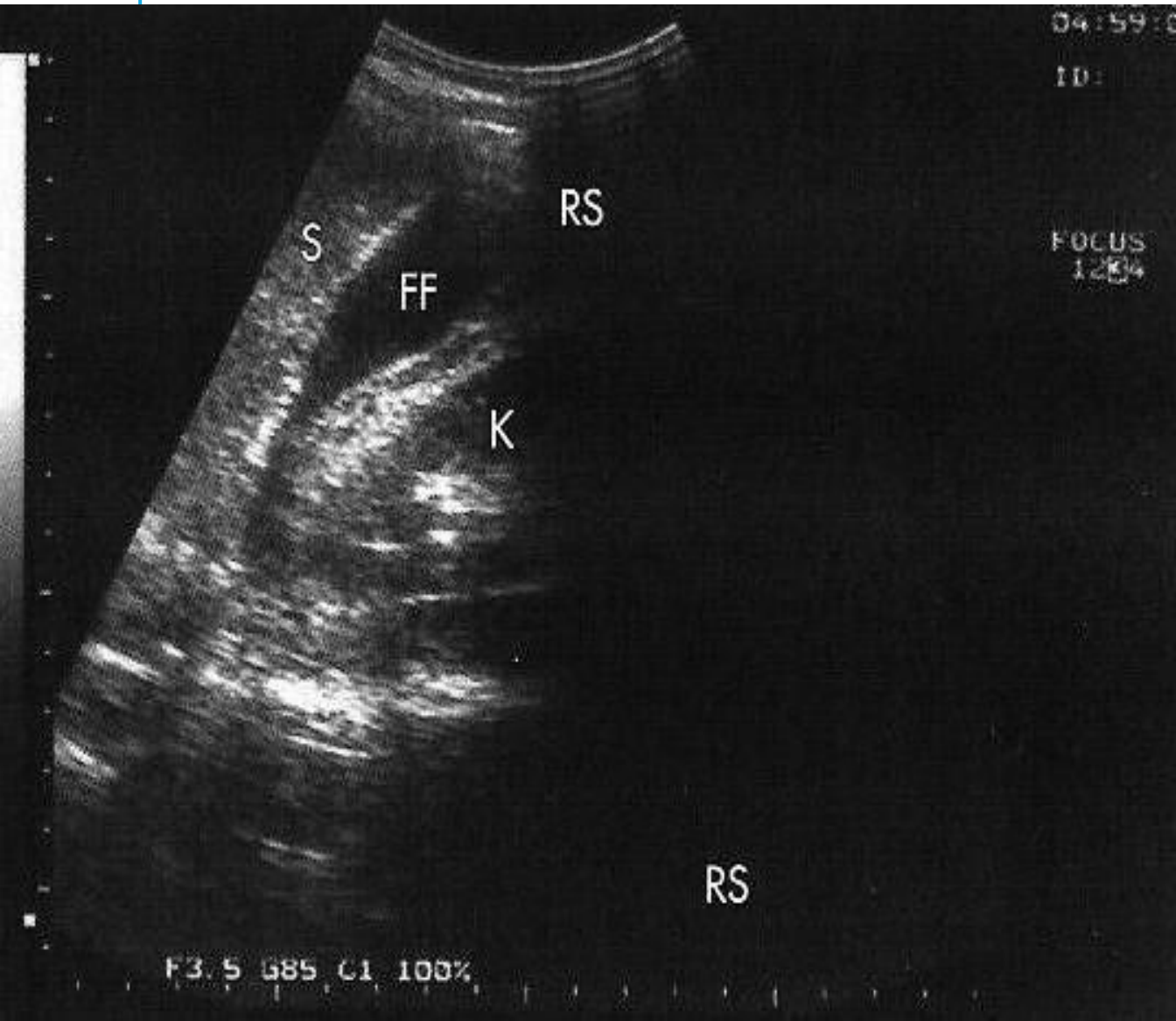
In the **LUQ VIEW**, we look into 4 sites

1. Pleural space “in eFast”
2. Sub-phrenic Space
3. Spleno-renal recess
4. Area near between the **spleen** and the **inferior pole** of kidney, as it resembles the beginning of the left paracolic gutter.

NORMAL LUQ



POSITIVE FAST: LUQ EXAM



Pathologic Fluid

K = kidney

S = spleen

RS = rib shadow

FF = free fluid

FAST: SUBXIPHOID EXAM



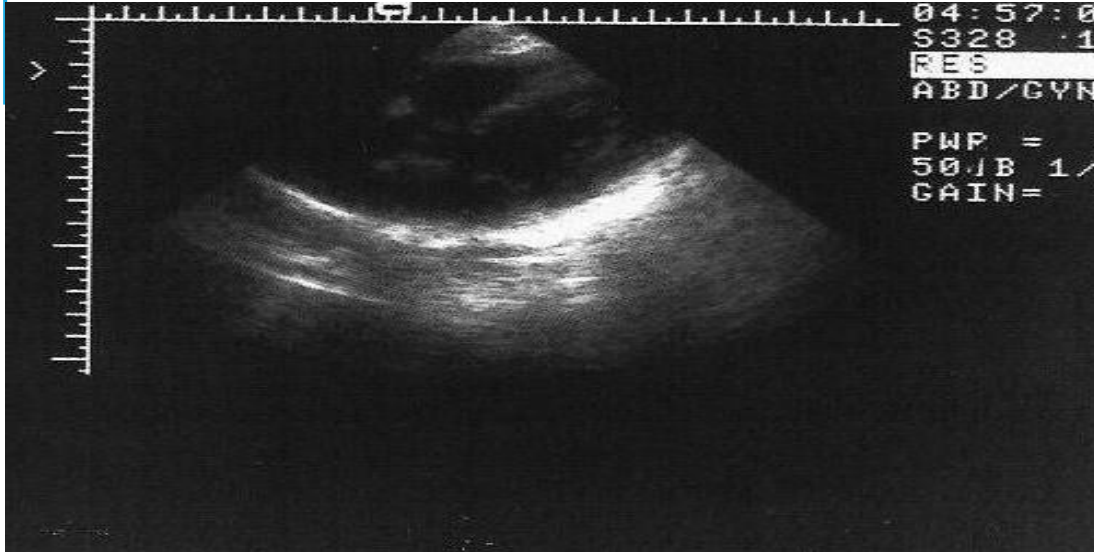
Evaluating

- Fluid in the pericardium
- Wall dysfunction
 - R heart strain
 - Septal “bowing”

Technical Problems

- Body habitus
- Inability to get probe under xiphoid

FAST: SUBXIPHOID EXAM



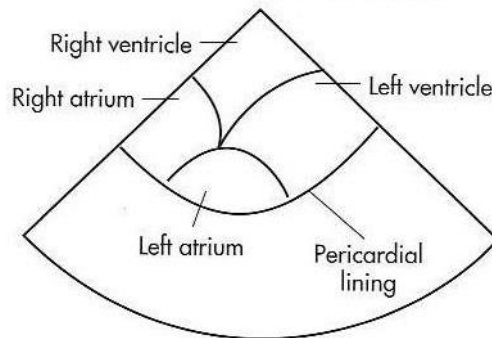
Normal Anatomy

Liver at very top of screen

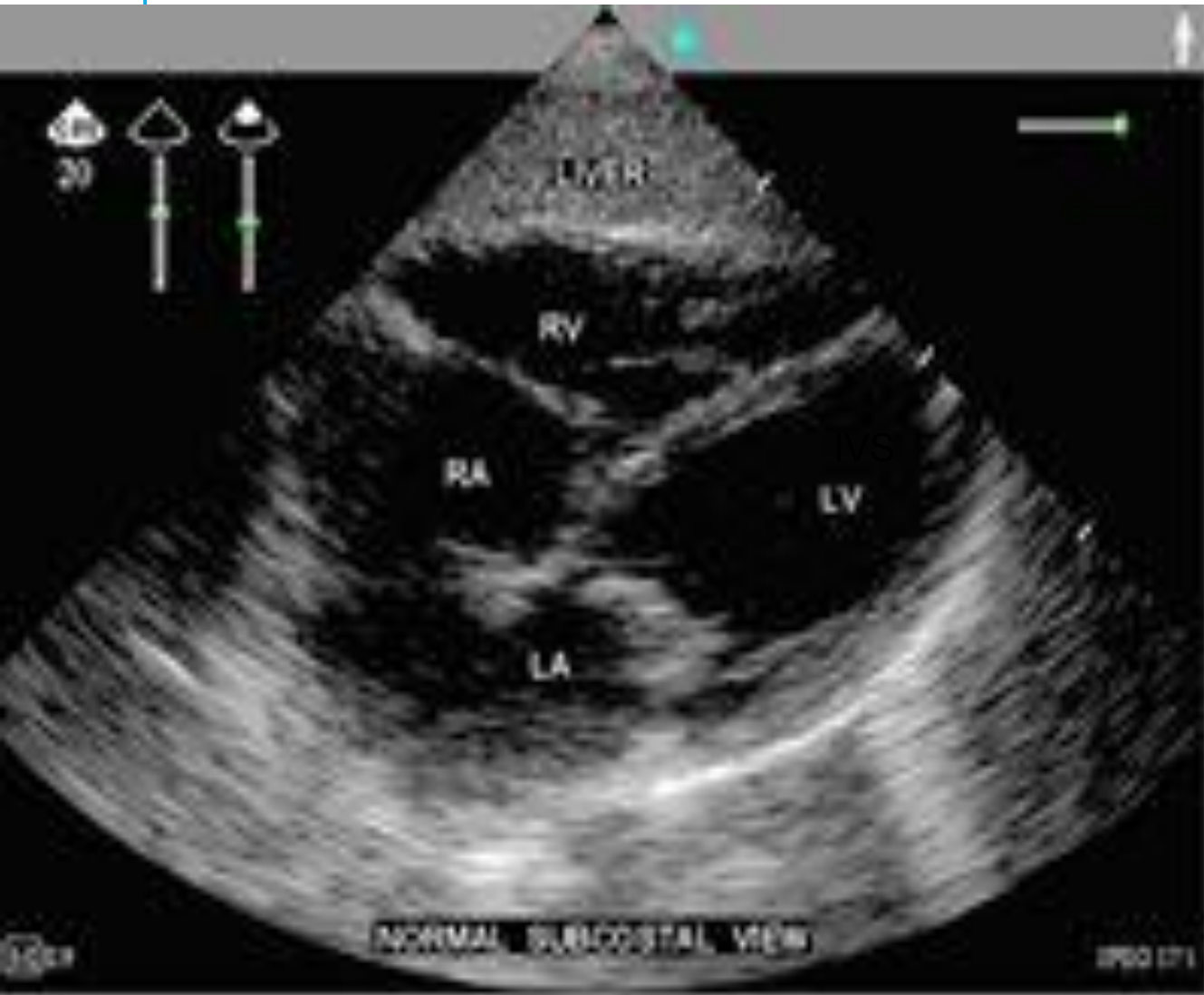
Right ventricle on top of screen

Right atrium and left ventricle line up below right ventricle

Left ventricle on bottom of screen



FAST: SUBXIPHOID EXAM



Review

Normal Subcostal view

RV = right ventricle

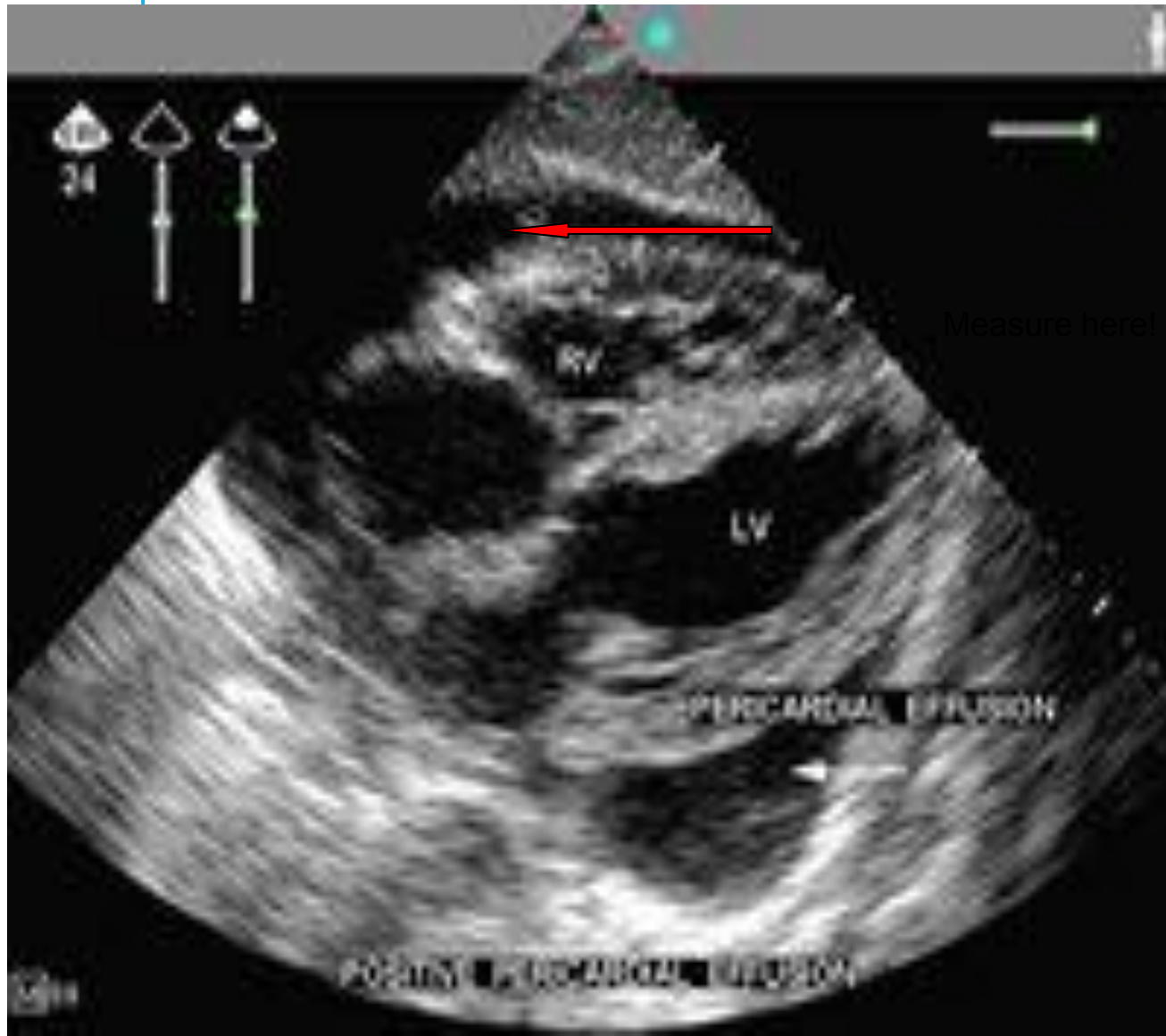
RA = right atrium

LV = left ventricle

LA = left atrium

IVS = interventricular
septum

FAST: SUBXIPHOID EXAM



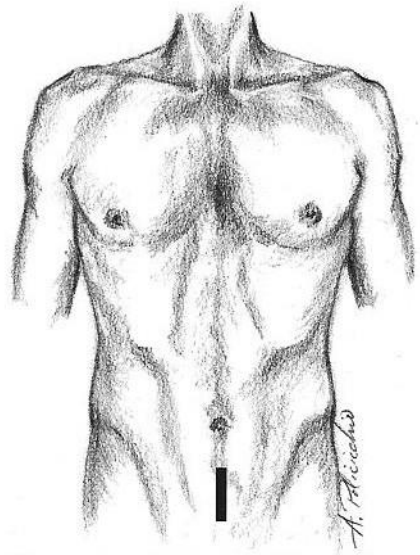
Subcostal view

Large pericardial effusion

Where to you measure
amount of blood or fluid?

Answer: anteriorly between
the heart and liver

FAST: PELVIS LA EXAM



Pelvis: Long Axis

Probe placed

- longitudinally
- 2 cm superior to the symphysis pubis
- Midline of the abdomen
- “aimed” caudally into the pelvis

Probe facing

- Toward patient’s head

FAST: PELVIS LA EXAM



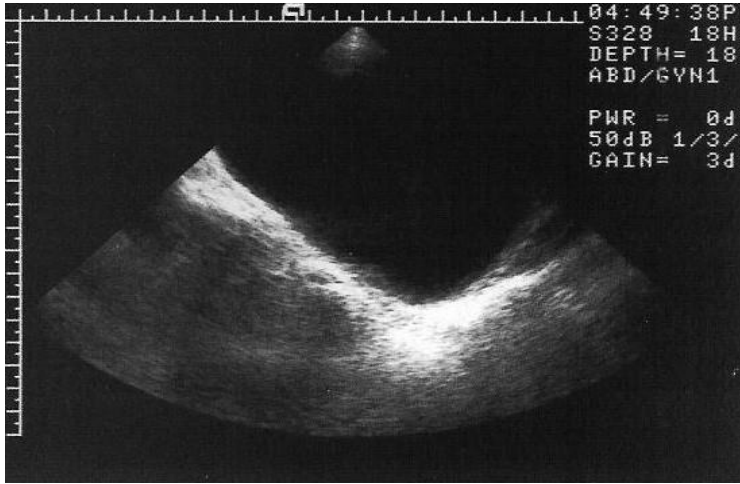
Evaluating

- Free fluid in the anterior pelvis
- Free fluid in the pelvic cul-de-sac (Pouch of Douglas)

Technical Problems

- Body habitus
- Empty bladder (no landmarks)
- Bladder trauma (no landmarks)

FAST: PELVIS LA EXAM

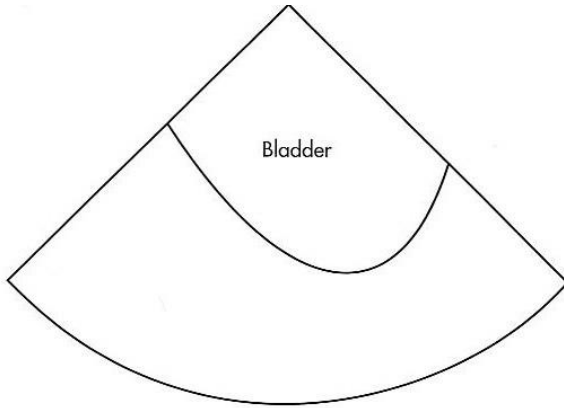


Pelvis: Long Axis

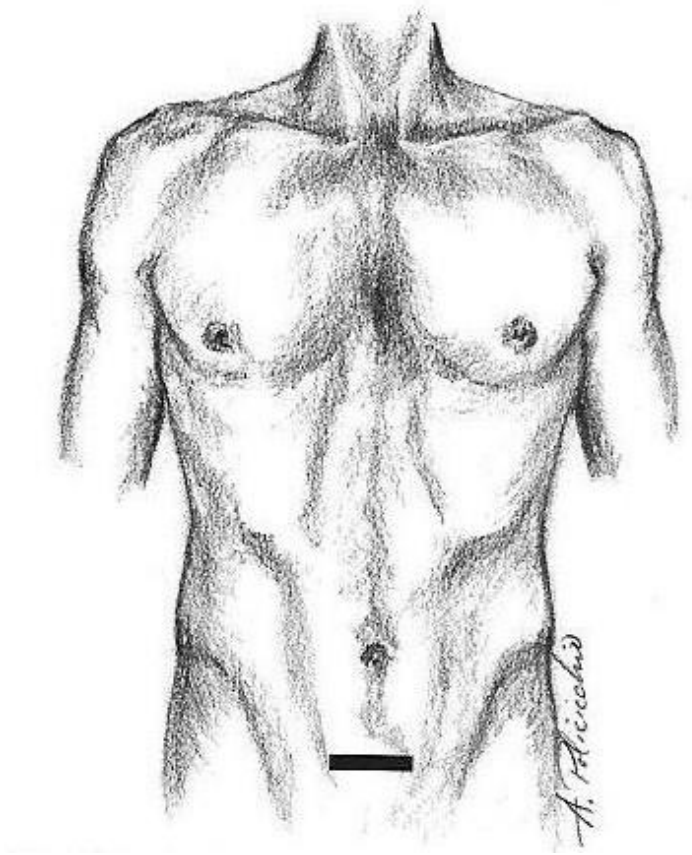
- Normal Anatomy

Evaluating

- Bladder
- Uterus in female: usually superior to bladder
- Prostate in male: usually posterior to bladder



FAST: TV PELVIS EXAM



Pelvis: Transverse

Probe placed

- 2 cm superior to the symphysis pubis
- Midline of the abdomen

Probe facing

- Toward patient's right
- Probe rotated 90 degrees counterclockwise from longitudinal

FAST: TV PELVIS EXAM



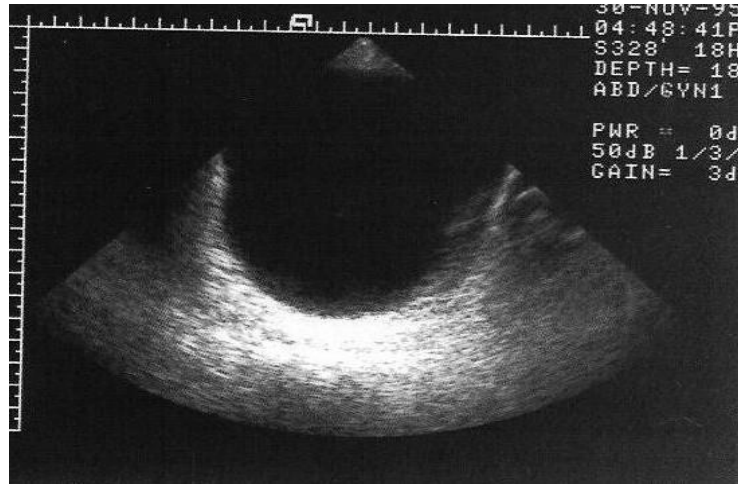
Evaluating

- Free fluid in the anterior pelvis
- Free fluid in the pelvic cul-de-sac (Pouch of Douglas)

Technical Problems

- Body habitus
- Empty bladder (no landmarks)
- Bladder trauma (no landmarks)

FAST: TV PELVIS EXAM

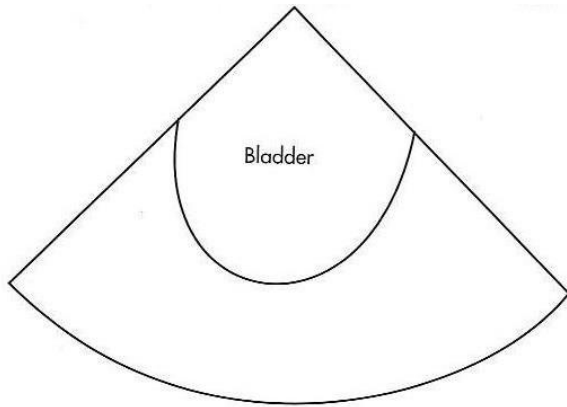


Pelvis: Transverse Axis

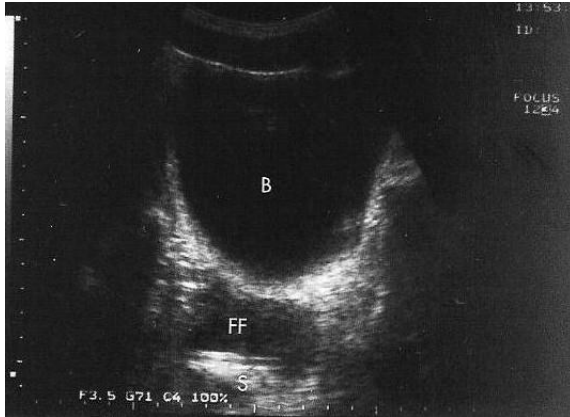
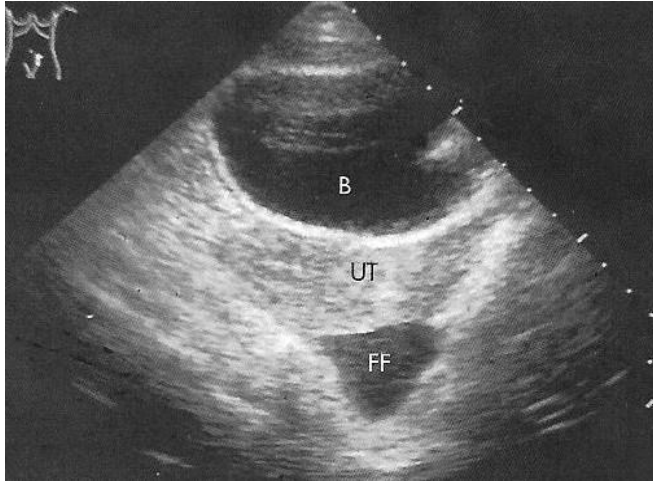
- Normal Anatomy

Evaluating

- Bladder
- Well circumscribed
- Contains fluid that appears anechoic



FAST: PELVIS EXAM - PATHOLOGY



Transverse scans with free fluid in pelvis

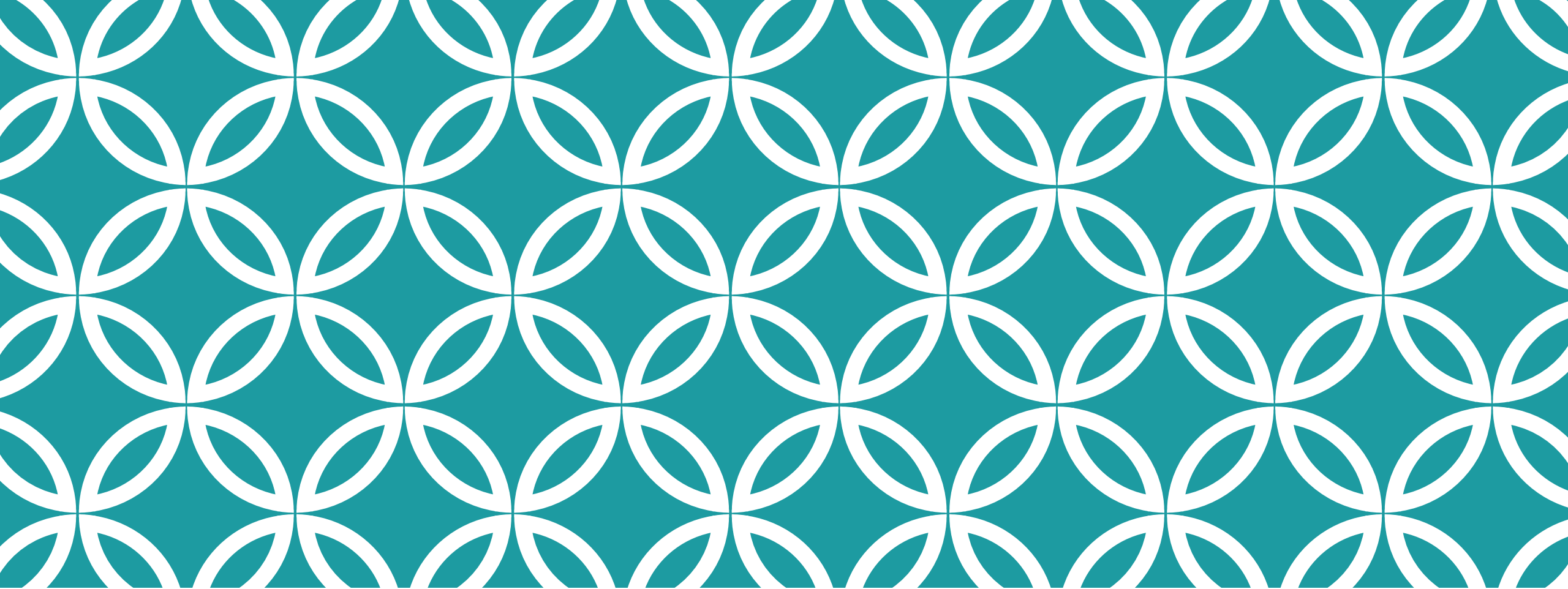
- Female (top): uterus posterior to bladder
- Male (bottom)

B = bladder

UT = uterus

FF = free fluid

S = spine



الحمد لله

