

Ultrasound Pearls

Compiled by:
Isabel Newton (2008) *of lessons from Meg, DP, MOB and others*

Updated by:
Julie An and Luke Wojdyla (2021)

Recommended Reading: *Ultrasound, The Requisites* by Middleton

PHONE NUMBERS

	Thornton/JMC	Hillcrest
	858-657-****	619-543-****
	858-249-****	619-471-****
	858-246-****	
Resident	7-6142	3-2621
Sonographers	7-6663	3-2620
	7-6664	
ED	7-7660	3-2130
		3-2140
		3-3618
		3-1852
General	7-6779	
PACS		1-0244

Info for the Rotation

“Rule out” “Concern for” etc are not billable histories. We need a sign or symptom to document the need for the study. You can obtain that info from the patient, the sonographer, the EMR, etc.

Example: “rule out acute cholecystitis” does not work. “Right upper quadrant pain, rule out acute chole” does.

- b) Remove negatives. It is all too easy to leave items in the template that do not belong. Example:
Gallbladder: normal.....but the patient does not have a gallbladder. So be sure to take out the parts that are not accurate for your patient.

Doppler: Another confusing part of the dictation. Simply seeing color and/or Duplex doppler doesn't warrant a Doppler addition to the technique. So when should you add the doppler charge to the technique? Many templates will have it included but you will need to add it if doppler is done to rule out torsion in the ovaries or if doppler is done in the liver.

- Complete liver doppler includes the 3 hepatic arteries, 3 hepatic veins, 3 portal veins
- Limited liver doppler includes 3 portal veins, at least one hepatic vein, proper hepatic artery

Notifications: we need to alert the ordering provider of any unexpected significant finding. Acute cholecystitis, ovarian torsion etc etc we must get ahold of someone. You can Secure Chat them in Epic, page them or have the operator page them. You can page the resident covering the service that ordered the study. If nothing else, you can tell the patient. But we must notify someone. We have macros in Fluency that help you indicate when you saw the abnormality and when and to whom you communicated the results. We have macros for when the ordering team already knows about the finding, as evidenced by notes in Epic. See 2001 Verbal, 2001 Epic, 2002 Verbal, 2002 Epic, 2003 Verbal, and 2003 Epic macros to see the different macros.

GENERAL

1. Keep in mind patient's body habitus.

"A radiologist with a ruler is a radiologist in trouble" - Dr. Leopold

Organ	Normal sizes
Thyroid lobe	~ 1.5 - 3 cm
Thyroid isthmus	< 3 cm
Liver	< 17 cm
Gallbladder wall	< 3 mm
Intrahepatic bile ducts	~ 6mm or <40% of adjacent portal veins
CBD	< 5 mm and +1 mm decade of life after 50 (can inc post chole)
Pancreatic duct	< 3 cm (can increase with age)
Spleen	< 13 cm
Aorta, Iliac, Popliteal	< 3 cm, <2 cm, <1 cm (proximal abdominal aorta can be <3.5)
Kidney	~ 9-13 cm
Ovaries	< 10 ml, see PCOS section below
Endometrium	< 16 mm premenopausal < 8 mm postmenopausal < 5 mm postmenopausal if bleeding
Prostate	< 30 ml
Postvoid Residual	< 50 ml
Testicle	~3-5 x 2-4 x 1 cm

1. Ectopic pregnancy
2. Torsion of testicle or ovary
3. Intrauterine growth restriction in the third trimester
4. No flow in hepatic artery of liver transplant/renal transplant
5. New deep venous thrombosis
6. New occluded internal carotid artery

1. $RI = (\text{peak systolic velocity} - \text{end diastolic velocity}) / \text{peak systolic velocity}$
2. High resistive index – muscular arteries (eg. superficial femoral artery, posterior tibial artery, common femoral artery, external carotid artery)
3. Low resistive index – arteries feeding organs that need flow even during diastole (internal carotid artery,

renal artery, testicular artery, babies, tumors)

4. Normal RI = 0.6 – 0.7
5. Elevated RI = 0.8 – 1.0

1. Color:

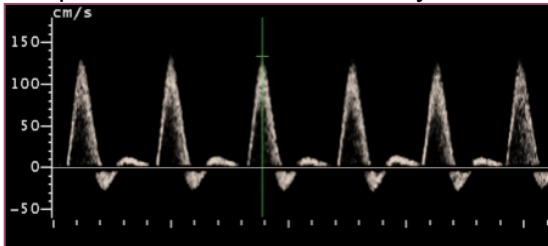
- a. Shows direction of flow. Check the color bar far left to see which color is towards the transducer
- b. Spectral doppler is more reliable than color doppler. So if there is spectral flow, the vessel is patent. Understand that it can miss 7% residual flow so if no flow seen in the internal carotid artery, it does not definitively mean that the vessel is occluded. Need CTA, MRA, DSA.
- c. Be sure that the sonographer is using a scale appropriate for the organ/vessel of interest.

Examples:

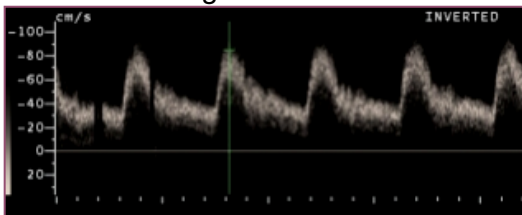
- i. Scale of 2-5 cm/sec to look for flow in the testicles
- ii. Scale of 15-18 cm/sec for MPV

2. Spectral:

- a. Make sure the scale is appropriate to the vessel. If the scale is set too low, you will see aliasing.
- b. But you don't want the scale to high either, obscuring the shape of the waveform
- c. Muscular arteries should have a very resistive waveform with a component of reversal and 2 components of forward flow in systole but no flow in diastole.



- d. Anything you want to protect (ICA, renal, hepatic art, premenopausal ovaries, testicles) should have flow throughout the entire cardiac cycle with no reversal and with good flow in diastole.



3. Power:

- a. Most sensitive to presence of flow but does not show velocity or direction
- b. Especially useful in looking for flow in testicular torsion or to see if vessel is occluded

1. Straited:

- a. Tumor, infection, fibrosis

2. Echogenic:

- a. Calcifications (sharp flashlight shadow), air (dirty shadow), blood, tumor (depends in the type)

3. Lymph Nodes:

a. Benign:

- i. Elliptical, fatty hilum, <1 cm in short axis

b. Malignant:

- i. Round, loss of fatty hilum, >1 cm in short axis

CAROTIDS

Stenosis	ICA Velocities		ICA/CCA	ECA Velocities	
	PSV (cm/s)	EDV (cm/s)	Ratio	Stenosis	PSV (cm/s)
50%	125	40-100	2:1	Moderate	200-300
70%	230	>100	4:1	Severe	> 300

You must keep insonation angle at 60 degrees or less or you can falsely elevate velocity. Line of insonation should be parallel to flow, not to the vessel itself.

Use Ratios When...

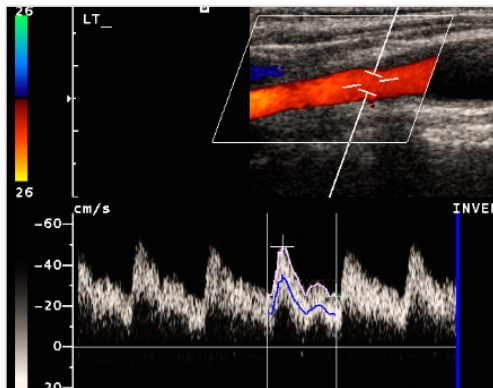
1. CCA velocity < 50: low outflow state (i.e. CHF)
2. CCA velocity >100: hyperdynamic (i.e. HTN, young people)

Appearance of Plaques

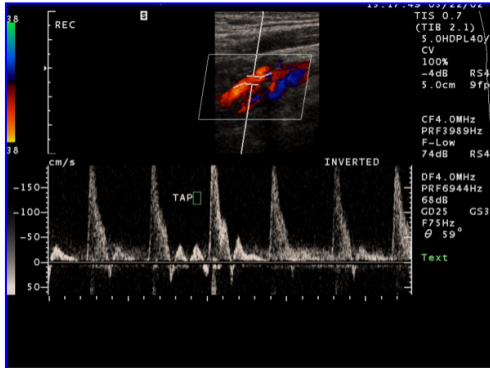
1. Ulcerated: (will see flow within plaque) – very dangerous; do not wait for $\geq 70\%$ stenosis as these patients need urgent intervention if they have $\geq 50\%$ stenosis
2. Soft: hypochoic - isochoic to lumen on grayscale, seen only on color doppler
3. Calcified: hyperechoic

Carotid Doppler Waveforms:

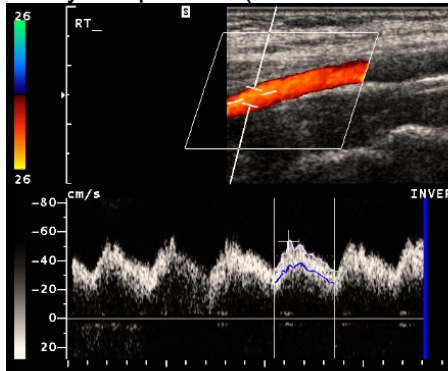
1. ICA: low resistance waveform (high diastolic flow), which makes sense, since you want there to be flow to the brain even during diastole. Clean spectral window (the black under the waveform) indicates laminar flow without stenosis. If you start seeing filling in of the spectral window, look for curve/bend to explain it or look for narrowing that is causing it.



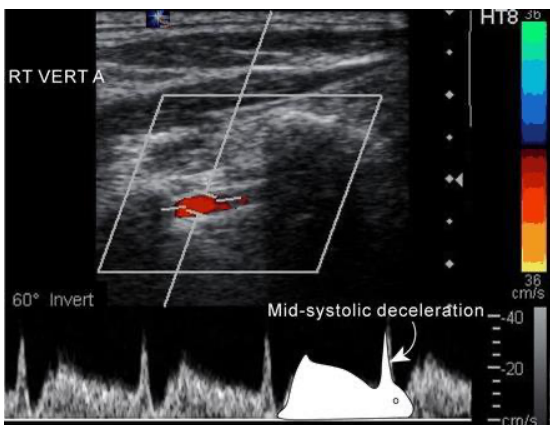
2. CCA: waveforms hybrid between ICA and ECA
3. ECA: high resistance waveform (low diastolic flow). Temporal tap on side of forehead should be reflected in the waveform. Can also look for branches as only ECA will have branches in the neck.



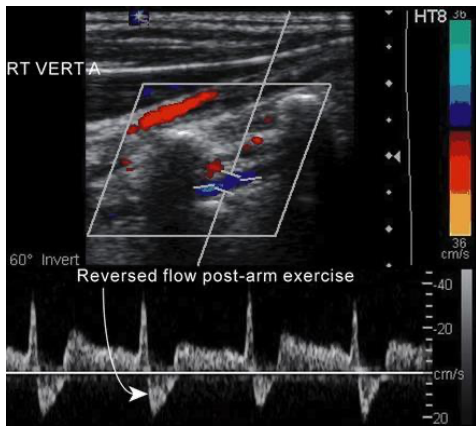
4. Delayed upstroke (slowed acceleration time) may indicate a proximal stenosis



1. Subclavian artery steno-occlusive disease proximal to the origin of the vertebral artery, associated with directional flow reversal in the vertebral artery (subclavian steal syndrome)
2. Severe subclavian steno-occlusion: Parvus tardus waveform (prolonged systolic acceleration time with decreased PSV) in the distal subclavian artery and brachial artery
3. Presteal: 4 different presteal waveforms with notch in systole
 - a. Type 1: small notch in systole can be normal or indicates less than <40% stenosis
 - b. Type 2: presteal: bunny ears or buffalo pattern (see image below)
 - c. Type 3: notch in systole reaches the baseline
 - d. Type 4: notch crosses the baseline (see image below)
4. Can do evocative maneuvers (blood pressure cuff insufflation then release or biceps curls)

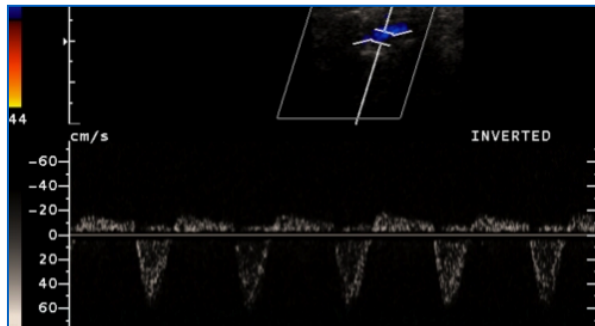


Type 2 presteal waveform

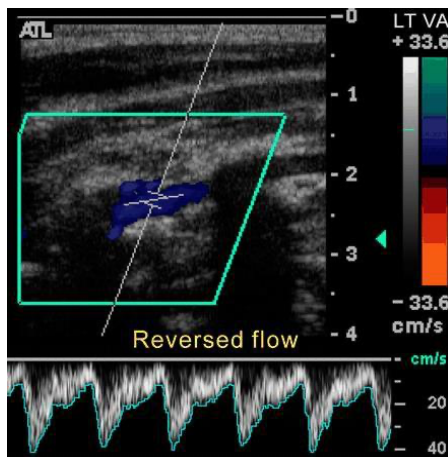


Type 4 presteal waveform after evocative maneuvers

5. Partial



6. Complete Steal: sonographers often invert the waveform to keep angle at 60 or less so look at color to see true direction of flow

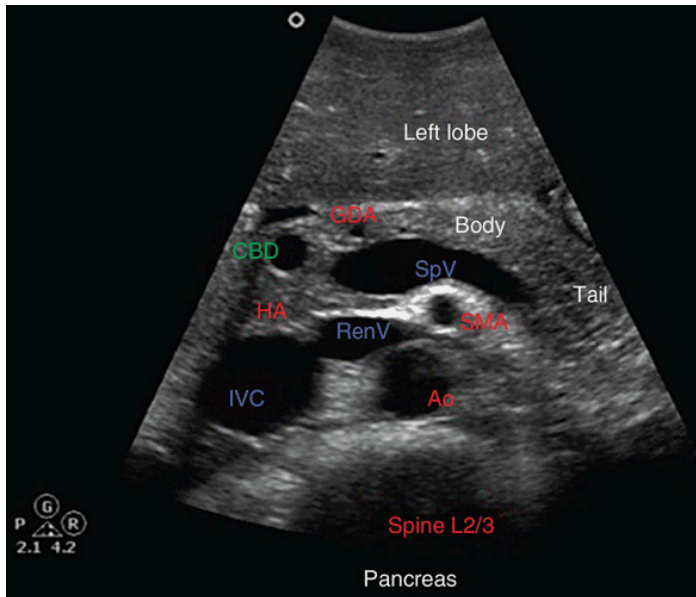


GALLBLADDER

1. Sonographic Murphy sign is the most sensitive and specific for acute chole
2. Gallbladder wall thickening >3 mm is a nonspecific finding, other causes include:
 - a. Hepatic dysfunction, heart failure, or renal failure → elevated portal venous, systemic venous pressure, decreased intravascular osmotic pressure
 - b. Hypoproteinemia
 - c. Pericholecystic fluid
 - d. Gallbladder hyperemia

- e. Gallbladder calculi

LIVER



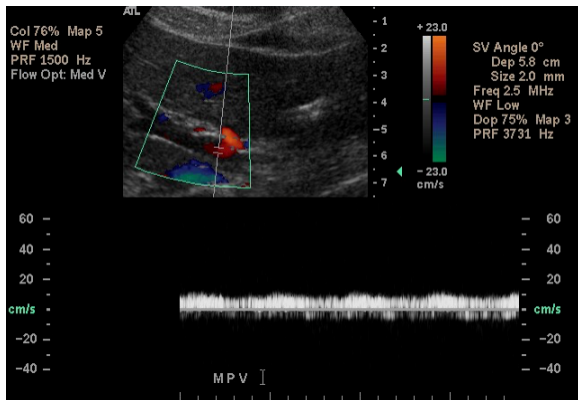
Cirrhosis

- Heterogenous echogenicity
- Coarse echotexture
- Nodular contours (seals the deal)
- +/- dilated main portal vein >13mm

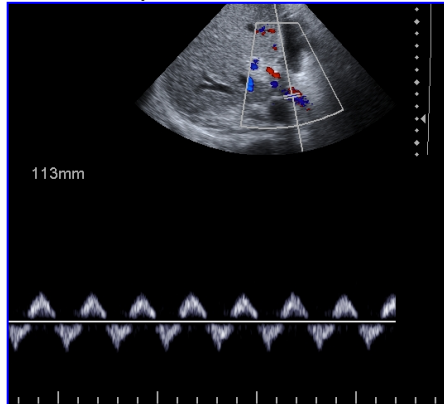
Hepatic Steatosis

- Increased echogenicity
- Decreased penetration
- Decreased conspicuity of vascularity and diaphragm
- +/- focal fatty sparing in gallbladder fossa

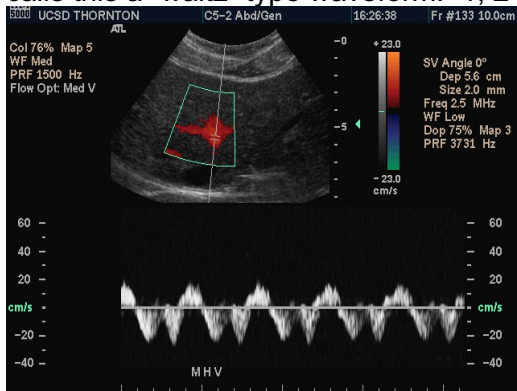
1. Links
 - a. [Doppler US of the Liver Made Simple](#)
2. Hepatic vasculature
 - a. The edges around the portal veins are echogenic
 - b. Hepatic veins are not echogenic
3. Hepatopedal vs hepatofugal
 - a. Confusing terms to describe direction of vascular flow of the **portal vein**
 - b. Hepatopedal = Normal (blood flow towards the liver)
 - c. Hepatofugal = Reversed (blood flow away from the liver) (Think "F word" for portal vein flow=bad)
 - d. Some prefer to use "Expected direction of flow" or "Reversed direction of flow" instead
4. Normal portal vein: towards the liver with flow above the baseline and no pulsatility or reversal



5. Abnormal portal vein: could be no flow, partial or complete reversal, or significant pulsatility

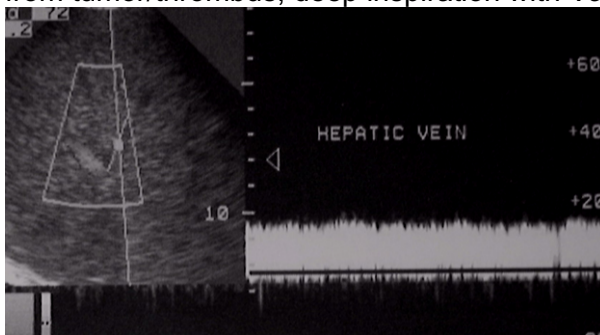


6. Normal hepatic vein: Should indicate normal right atrial activity with flow towards the heart during atrial filling, again during ventricular filling, and small component of reversal during atrial systole. Dr. Richman calls this a “waltz” type waveform: 1, 2 up, 1, 2 up

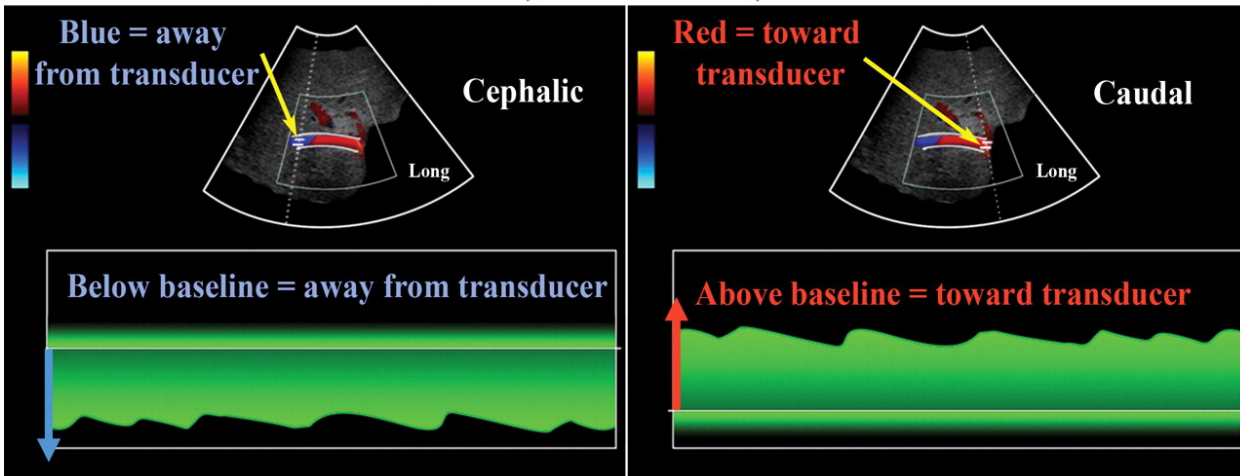
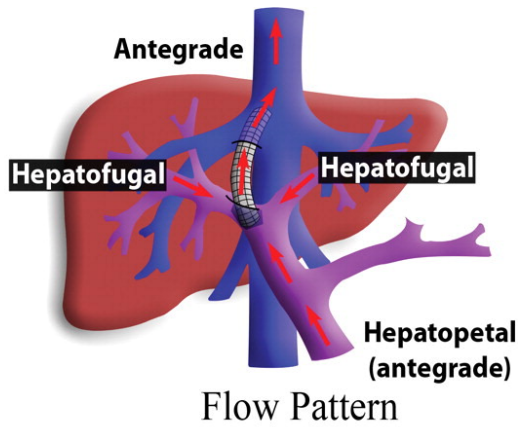
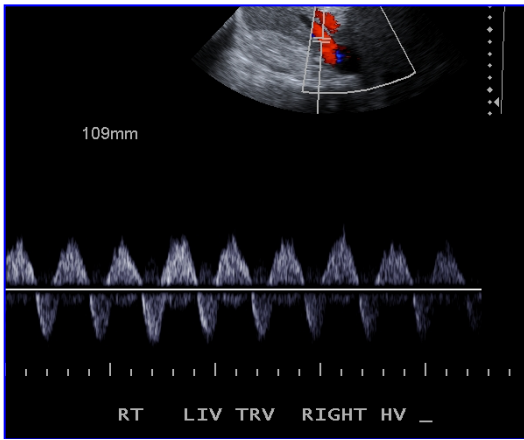


7. Abnormal hepatic vein

a. Monophasic: hepatic vein is no longer seeing right atrial movement. DDX: Budd Chiari occlusion from tumor/thrombus, deep inspiration with Valsalva, cirrhotic patient, post liver transplant



b. Biphasic: indicates cardiac abnormality: right sided heart failure, tricuspid regurgitation, or constrictive pericarditis



Cephalic TIPS flow

Caudal TIPS flow

8. Monophasic, biphasic, triphasic
 - a. Controversial and ambiguous terminology
 - i. Different radiologists, sonographers, etc will use these terms in differently

GYNECOLOGY

1. Links:

- a. [O-RADS Ultrasound Lexicon Paper](#)
- b. [O-RADS US Risk Stratification Paper](#)
- c. [O-RADS Lexicon Key Terms Table](#)
- d. [O-RADS Risk Stratification Tables](#)

O-RADS Score	Risk Category [IOTA Model]	Lexicon Descriptors		Management		
				Pre-menopausal	Post-menopausal	
0	Incomplete Evaluation [N/A]	N/A		Repeat study or alternate study		
1	Normal Ovary [N/A]	Follicle defined as a simple cyst \leq 3 cm Corpus Luteum \leq 3cm		None	N/A	
2	Almost Certainly Benign [$<$ 1%]	Simple cyst	\leq 3 cm	N/A	None	
			$>$ 3 cm to 5 cm	None	Follow up in 1 year. *	
			$>$ 5 cm but $<$ 10 cm	Follow up in 8 - 12 weeks		
		Classic Benign Lesions	See Figure 3 for separate descriptors	See Figure 3 for management strategies		
		Non-simple unilocular cyst, smooth inner margin	\leq 3 cm	None	Follow up in 1 year * If concerning, US specialist or MRI	
$>$ 3 cm but $<$ 10 cm	Follow-up in 8 - 12 weeks If concerning, US specialist		US specialist or MRI			
3	Low Risk Malignancy [1- $<$ 10%]	Unilocular cyst \geq 10 cm (simple or non-simple) Typical dermoid cysts, endometriomas, hemorrhagic cysts \geq 10 cm Unilocular cyst, any size with irregular inner wall $<$ 3 mm height Multilocular cyst $<$ 10 cm, smooth inner wall, CS = 1-3 Solid smooth, any size, CS = 1		US specialist or MRI Management by gynecologist		
4	Intermediate Risk [10- $<$ 50%]	Multilocular cyst, no solid component	\geq 10 cm, smooth inner wall, CS = 1-3	US specialist or MRI Management by gynecologist with GYN-oncologist consultation or solely by GYN-oncologist		
			Any size, smooth inner wall, CS = 4			
			Any size, irregular inner wall and/or irregular septation, any color score			
		Unilocular cyst with solid component	Any size, 0-3 papillary projections, CS = any			
Multilocular cyst with solid component	Any size, CS = 1-2					
Solid	Smooth, any size, CS = 2-3					
5	High Risk [\geq 50%]	Unilocular cyst, any size, \geq 4 papillary projections, CS = any Multilocular cyst with solid component, any size, CS = 3-4 Solid smooth, any size, CS = 4 Solid irregular, any size, CS = any Ascites and/or peritoneal nodules**		GYN-oncologist		

Lexicon Term	Definition	Suggested Management Premenopausal	Suggested Management Postmenopausal
Typical hemorrhagic cyst	Reticular pattern: Fine thin intersecting lines representing fibrin strands	≤ 5 cm None	US specialist, gynecologist or MRI
	Retracting clot: An avascular echogenic component with angular, straight, or concave margins	>5 cm but < 10 cm Follow up in 8-12 weeks If persists or enlarges, referral to US specialist, gynecologist, or MRI	US specialist, gynecologist or MRI
Typical dermoid cyst < 10 cm	<ul style="list-style-type: none"> • Hyperechoic component with acoustic shadowing • Hyperechoic lines and dots • Floating echogenic spherical structures 	Optional initial follow up in 8-12 weeks based upon confidence in diagnosis If not removed surgically, annual US follow up should then be considered *	US specialist, gynecologist, or MRI With confident diagnosis, if not removed surgically, annual US follow up should then be considered *
Typical endometrioma < 10 cm	Ground glass/homogeneous low-level echoes	US specialist or MRI if there is enlargement, changing morphology or a developing vascular component	MRI if there is enlargement, changing morphology or a developing vascular component
Simple paraovarian cyst/any size	Simple cyst separate from the ovary that typically moves independent of the ovary when pressure is applied by the transducer	None If not simple, manage per ovarian criteria	Optional single follow up study in 1 year
Typical peritoneal inclusion cyst/any size	Follows the contour of the adjacent pelvic organs or peritoneum, does not exert mass effect and typically contains septations. The ovary is either at the margin or suspended within the lesion.	Gynecologist	Gynecologist
Typical hydrosalpinx/ any size	<ul style="list-style-type: none"> • Incomplete septation • Tubular • Endosalpingeal folds: Short round projections around the inner wall of a fluid distended tubular structure 	Gynecologist	Gynecologist

In patients >8 years post menarche, and using a high-frequency endovaginal probe:

- follicle number per ovary (FNPO) ≥ 26, and/or
- ovarian volume ≥10 mL, ensuring no corpora lutea, cysts or dominant follicles are present
- remember that PCOS is still a clinical diagnosis, thus US can be used to support

Features of Dermoid (cyst or teratoma)

- 2+ of the following characteristics:
 - Fatty or calcified plug (Rokitansky) – “iceberg effect”
 - Curvilinear lines (from hair longitudinally)
 - Echogenic dots (from hair in cross section)
 - Fat/fluid level

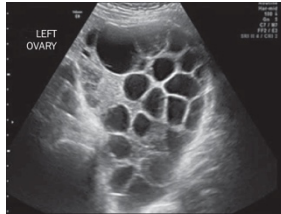
Differential diagnosis: Complex Adnexal Masses (CHEETAH'D mnemonic)

- Corpus luteal cyst
 - Cystic
 - Echogenic wall
 - Ring of fire pattern of vascular flow on color doppler
 - Low resistive waveform
- Hemorrhagic cyst
- Ectopic

4. Endometrioma (diffuse internal echoes)
5. Tubo-ovarian abscess
6. Adenoma/ adenocarcinoma
 - a. Adenocarcinoma more likely if >5 cm, septations, wall > 2mm thick, ascites, nodularity
7. Hydrosalpinx (serpentine appearance)
8. Dermoid

Theca lutein cysts are seen in:

1. Ovarian hyperstimulation
2. Molar pregnancy
3. Twins



FIRST TRIMESTER ULTRASOUND

1. [Normal and Abnormal US Findings in Early First-Trimester Pregnancy.](#)

1. Placenta Shape and Number

- a. Succenturiate: (two placentas)
 - i. The two lobes will be connected by vessels
 - ii. Important to rule out vasa previa with vessels crossing over the os.
- b. Bilobate:



2. Placenta Position

- a. Placenta previa: when the placenta is within 2 cm margin of the cervix. Sometimes seen in second trimester but resolves –monitor at 36 weeks!

3. Placenta- Myometrial interface

- a. Placenta accrete spectrum: placenta grows into uterine wall and +/- beyond
- b. Increased risk in women with prior C section
- c. Look for lucencies that are perpendicular to the long axis of the placenta
- d. Watch Dr. Pretorius' youtube video on invasive placenta
https://www.youtube.com/watch?v=f90_aEd67ew

4. Abruptio placenta:

- a. placenta detaches early from trauma or drugs

5. Cervix

- a. 3 – 5 cm, if shorter then cervical incompetence. If longer, re-examine to be sure contraction is not hiding a short cervix

6. Placental Cord Insertion (PCI)

- a. Velamentous: insertion of the umbilical cord on the chorioamniotic membranes rather than on the placental mass. Associated with fetal anomalies, intrauterine growth retardation (IUGR), vasa previa

7. Fluid

- a. AFI in 3rd trimester <8 cm is worrisome, < 5 cm is an emergency

- b. No one pocket of fluid should be less than 2 cm or more than 8 cm.
- a. Polyhydramnios: 60% unknown cause, 20% fetal cause (eg. swallowing/obstruction, fetal brain anomalies [like holoprosencephaly], abdominal wall defects, atresia, dwarfs, 20% maternal cause (Rh incompatibility, diabetes)
- a. Oligohydramnios PRIC'D mnemonic.
 - a. P-PROM – ask the woman if she is leaking fluid
 - b. Post dates
 - c. R: renal anomalies including bilat MCDK, renal agenesis, UPJs, etc
 - d. IUGR and placental insufficiency
 - e. Chromosomes
- b. Some use this mnemonic (DRIPPC): fetal demise, renal abnormalities, IU CR (and placental insufficiency, PROM, Post-dates, Chromosomes
- c. (amnion fuses with chorion ~ 16 weeks, so try to do amniocentesis >16 wks because riskier before then), Growth/symmetry, Intrauterine growth retardation (IUGR) – follow-up US interval of 3-4 wks, best to exclude differences attributed to normal variance

8. Dating Parameters

Timing	1st Trimester (1-12 wks)	2nd Trimester (13-26 wks)	3rd Trimester (27-38)
Measurement	Crown-rump length	Biparietal diameter	Head circumference
		Head circumference	Femur length (if head low)
		Abdominal circumference	
Notes	Can be off by 1 week	Femur length Can be off by 2 weeks	Can be off by 3 weeks

1. Memorize this chart:

Week	Mean Sac Diameter (MSD)	Finding	BHCG (doubles q2 days)
4	4	Gestational sac	1,000
5	8 mm	Yolk sac	7,000
6	16 mm	Fetal pole	11,000

New Guidelines for Diagnosing Pregnancy Failure based on NEJM 2013 article
<https://www.nejm.org/doi/full/10.1056/nejmra1302417>

- a) 7 is Heaven: CRL \geq 7mm and no embryonic heart beat/motion (EHM)
- b) Not Alive at 25: Mean sac diameter \geq 25 mm and no EMBRYO
- c) See nothing but a sac, wait ___14___ days; if no EHM, then failed pregnancy
- d) See something (yolk sac +/- pole), wait ___11___ days; if no EHM, then failed pregnancy

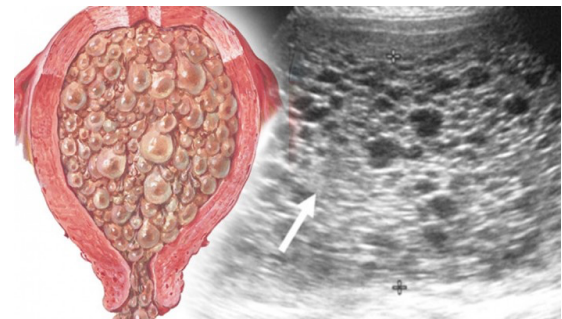
1. US Findings Diagnostic of Pregnancy Failure

Finding	Imaging Appearance
Absent cardiac activity by the time the CRL is a certain size	CRL \geq 7 mm with no heartbeat
Absent embryo by the time the gestational sac is a certain size	MSD \geq 25 mm with no embryo
Absent embryo by a certain point in time; requires two US examinations	Absence of embryo with a heartbeat 2 or more weeks after US showed gestational sac without yolk sac Absence of embryo with a heartbeat 11 or more days after US showed gestational sac with yolk sac

2. US Findings Suspicious for, but Not Diagnostic of, Pregnancy Failure

Finding	Imaging Appearance
Absent cardiac activity by the time the CRL is a certain size	CRL $<$ 7 mm with no heartbeat
Absent embryo by the time the gestational sac is a certain size	MSD of 16–24 mm with no embryo
Absent embryo by a certain point in time	Absence of embryo with a heartbeat 7–13 days after US showed gestational sac without yolk sac Absence of embryo with a heartbeat 7–10 days after US showed gestational sac with yolk sac Absence of embryo 6 or more weeks after last menstrual period
Morphology of gestational sac, amnion, and yolk sac	Empty amnion (amnion seen adjacent to yolk sac, with no visible embryo), enlarged yolk sac ($>$ 7 mm), small gestational sac in relation to size of embryo ($<$ 5-mm difference between MSD and CRL)

1. Gestational sac seen DDX:
 - a. Normal pregnancy
 - b. Anembryonic pregnancy (sac but no pole)
 - c. Embryonic/fetal demise
2. NO gestational sac DDX
 - a. Very early normal pregnancy
 - b. Spontaneous abortion
 - i. Happens to ~30% of all pregnancies $<$ 12 wks!
 - c. Ectopic
 - i. BEWARE of pseudogestational sac – endometrial reaction to the hormones of pregnancy – can mimick a normal intrauterine pregnancy, but look in the adnexae for ectopic!!!!
3. You see something strange....the MOLE!!!
 - a. Enlarged uterus
 - b. Hyperemesis
 - c. Very high beta HCG (often $>$ 100k)
 - d. 50% are accompanied by multiseptated cystic ovarian masses (theca lutein cysts) due to the severely high beta HCG level!!
 - e. On US: multiple hyperechoic and hypoechoic spaces filling the endometrial canal, without an embryo) –like grapes
 - f. Risk of malignancy



2. Not to be confused with a Partial Mole

- a. Triploid (2 sperm)
- b. Associated with maternal complications
- c. Lower malignant potential than Complete Mole
- d. Symptoms are vaginal bleeding and absence of FHT

SECOND TRIMESTER ULTRASOUND

- 4. Causes of Oligohydramnios:
 - d. "PRICK" (Dr Richman's teaching. In the order of most to least frequent)
 - i. Premature rupture of membrane (PROM)
 - ii. Renal abnormalities
 - iii. IUGR, Torch infections
 - iv. Chromosomal abnormalities
 - v. Demise (fetal demise)
- 5. Health of the Fetus: things to check
 - a. Size = Dates: if size << dates, need to be worried about IUGR; if > dates; worry about macrosomia
 - b. EFW (Estimated fetal weight) if < 10%, need to be worried about IUGR; if > 90%; worry about macrosomia
 - c. AFI
 - e. Umbilical cord doppler: check Systolic/diastolic ratio. If abnormal, worry about IUGT. There should be a LOT of diastolic flow in the umbilical cord

WEEK	Normal S/D Ratio
20	4.0
24	3.5
28	3.0
>32	2.5

- i. should be coming into left atrium
- 6. Middle cerebral artery (MCA) RI – very resistive waveform

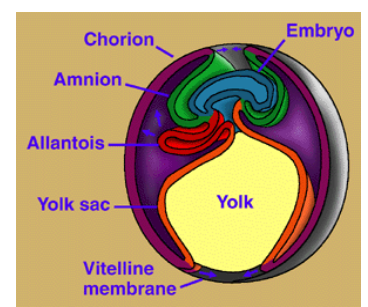
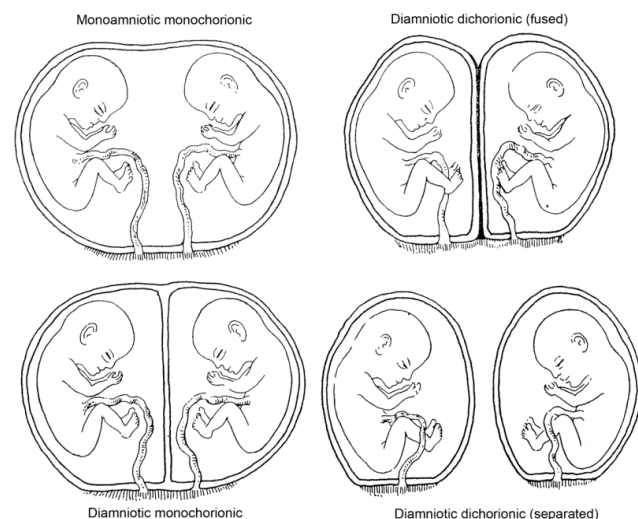
7. Fetal Cardiac: 4 Chamber heart view

8. Twins

- f. Diamniotic Dichorionic
- g. 1 (fused) or 2 placentas, look for placental peak
- h. Thick membrane because 2 chorions and 2 amnions
- i. 10% mortality
- j. Diamniotic Monochorionic
- k. 1 placenta
- l. Thin membrane and no placental peak. No chorion to see between the sacs and only 2 amnions
- m. 25% mortality
- n. risk of twin-twin transfusion syndrome
- o. risk of stuck twin

9. Monamniotic Monochorionic

- p. 1 placenta
- q. 50% mortality
- r. risk of cord entanglement
- s. Telling amnion from the chorion:
- t. Sex
- u. Placenta
- v. Membrane



10. Yolk sac

- w. Involuting around week 12-16
- x. Provides nutrients
- y. Primary site of hematopoiesis at the beginning
- z. Resorbed into the small intestine
- aa. → site of Meckel's diverticulum

FETAL CARDIAC

Four Chamber Heart View

Dr. Richman's mnemonic: **33-45% of Energetic Sonographers Create Mini TV Episodes About Pregnancy patients**

- i. **33:** Heart should be **33%** size of thorax
- ii. **45: 45** degree angle between line from belly button to spine (bisection line) and another line down to septum
- iii. **Energetic: Equal** size ventricles and atria, look for hypoplastic LV or RV
- iv. **Sonographers: Septum** intact, look for VSD
- v. **Create: Crus** (can be absent in trisomy 21)
- vi. **Mini: Moderator** band should be in right ventricle (can have transposition and ventricles can be reversed)
- vii. **TV: Tricuspid valve** can be inferiorly displaced in Epstein's anomaly
- viii. **Episodes: Effusion** (pericardial, can be seen in trisomy and TORH)
- ix. About: Descending **aorta** should be on same side of heart
- x. Pregnant Patients: look for pulmonary veins that are absent in anomalous pulmonary venous return

NEONATE

1. Links

- a. [Radiology Assistant: Neonatal Brain US](#)
- b. [Radiopaedia Germinal matrix hemorrhage \(grading\)](#)

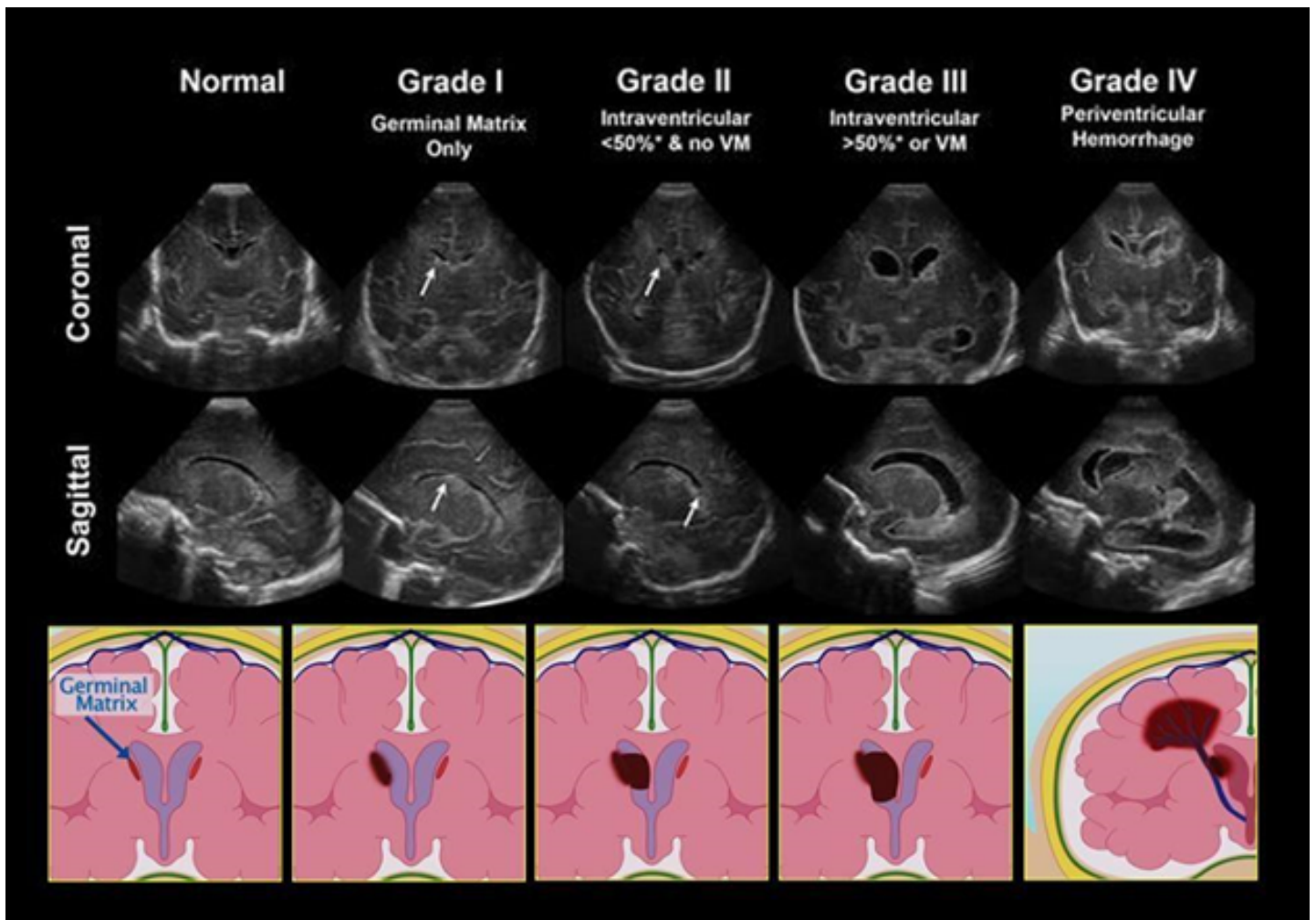
2. Performed for neonates with risk of germinal matrix hemorrhage = PREMIES (<38 wks)!

- a. Important to report the grading scale
- b. Can move to Grade 4 without having had grade 2-3
- c. Also look for increased echogenicity in the periventricular white matter that could indicate periventricular leukomalacia

Intracranial hemorrhage

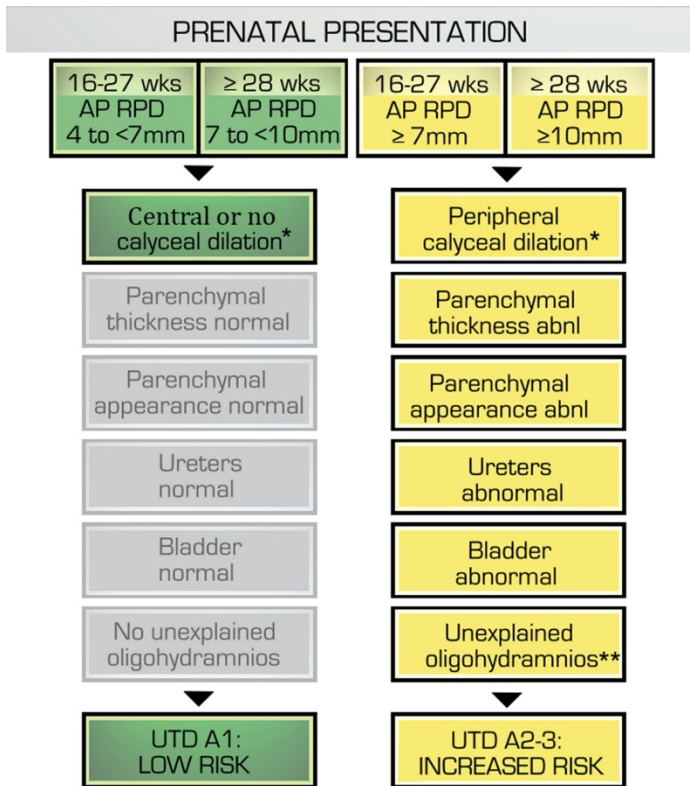
Classification according to Papile

- Grade 1.** Hemorrhage limited to subependymal matrix
- Grade 2.** Hemorrhage extending into ventricular system, < 50%, without acute ventriculomegaly
- Grade 3.** Hemorrhage extending into ventricular system, with acute dilatation because of flooding of 50% or more of one or both lateral ventricles
- Grade 4.** Hemorrhage grade 1, 2 or 3 with extension into brain tissue

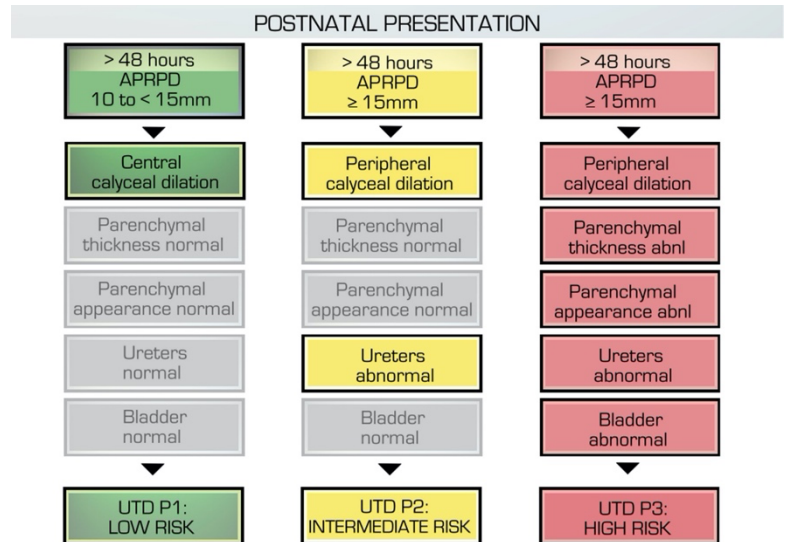


Urinary Tract Dilation (UTD) Classification:

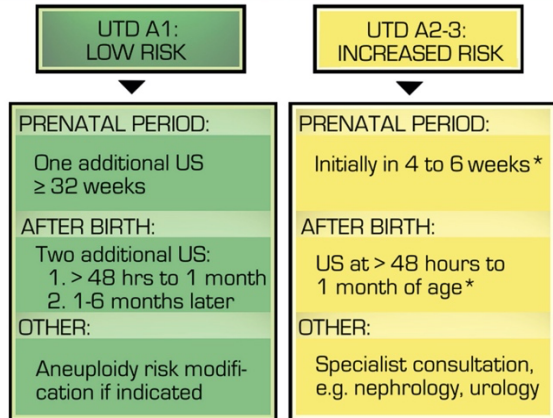
1. Link:
 - a. [Multidisciplinary consensus on the classification of prenatal and postnatal urinary tract dilation \(UTD classification system\) \(2014\)](#)
2. Definition
 - a. Unified classification system with an accepted standard terminology for the diagnosis and management of prenatal and postnatal UT dilation.
3. Key terms:
 - a. Anterior-posterior renal pelvis diameter (AP RPD)
4. Fetal Pyelectasis/Pelviectasis/Hydronephrosis
 - a. For follow up of in-utero hydronephrosis, most cases will resolve after delivery
 - b. Neonatal kidneys are a bit more echogenic, it's normal and expected
 - c. Radiologists at Rady's say the presence of dilated calyces is more important than AP diameter



*Central and peripheral calyceal dilation may be difficult to evaluate early in gestation
 **Oligohydramnios is suspected to result from a GU cause

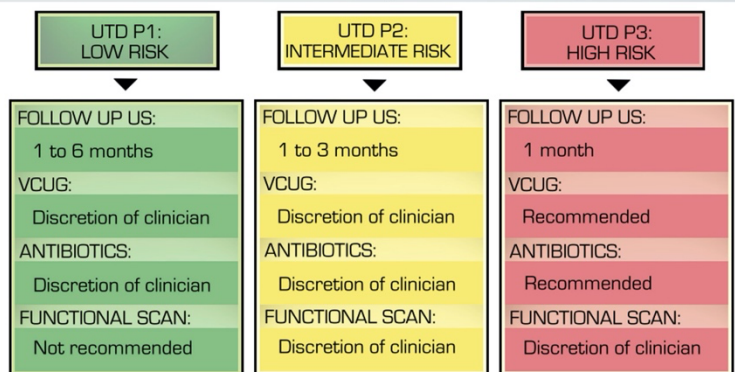


RISK-BASED MANAGEMENT, PRENATAL DIAGNOSIS



*certain situations (e.g. posterior urethral valves, bilateral severe hydronephrosis) may require more expedient follow up

RISK-BASED MANAGEMENT, POSTNATAL DIAGNOSIS

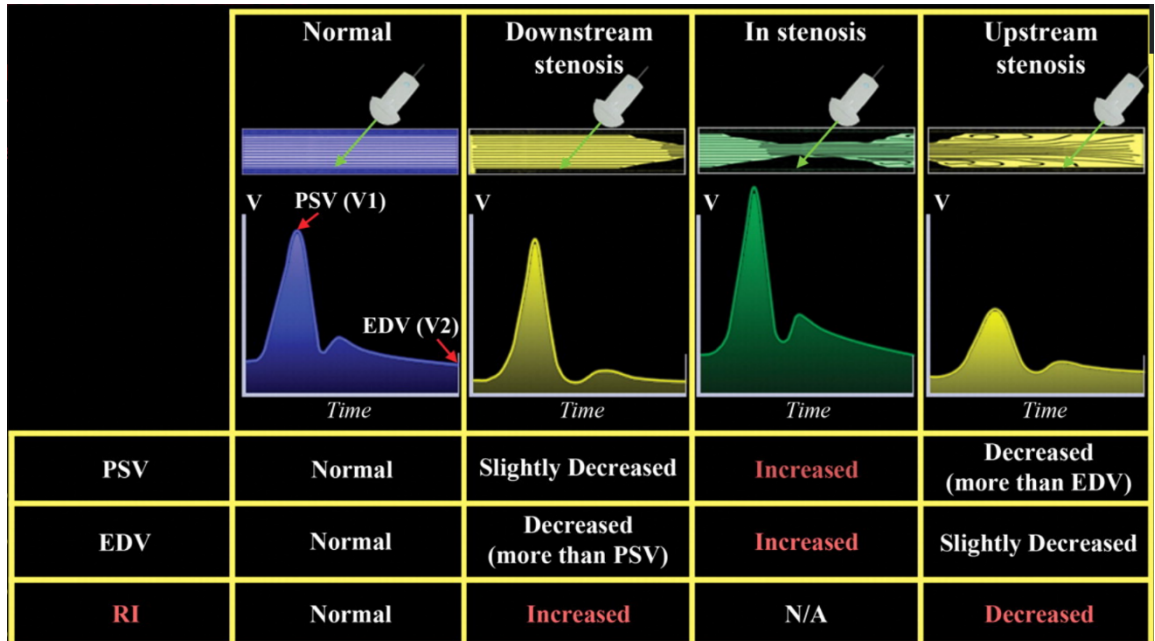


The choice to utilize prophylactic antibiotics or recommend voiding cystourethrogram will depend on the suspected underlying pathology

RENAL

1. Normal renal artery waveform
 - a. Acceleration time < 0.07
2. Stenotic renal artery waveform
 - a. Pre-stenosis → high resistive waveform
 - b. Post-stenosis → parvus-tardus waveform
 - c. Slowed acceleration time > 0.07

- d. Renal artery (at takeoff of the aorta)/Aorta ratio $\geq 3.5/1$ is abnormal
- e. Resistive Index
- 3. Interlobar/segmental arteries
 - a. PSV > 200 cm/second



1. Peripelvic cysts
2. Papillary necrosis
3. Extra-renal pelvis
4. Reflux

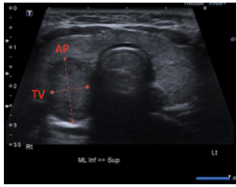
THYROID

Only report up to 2 nodules that require biopsy and up to 4 nodules to follow

SHAPE

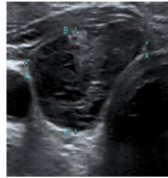
Taller-than-wide: 3 points

- Should be assessed on a transverse image with measurements parallel to sound beam for height and perpendicular to sound beam for width.
- Visual inspection is adequate for this.
- Anteroposterior (AP) length should be greater than the transverse (TV) length.



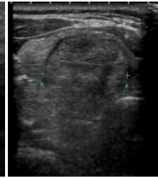
MARGIN

Smooth: 0 Points



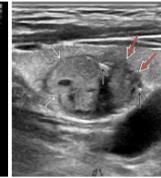
- Well defined, smooth, curvilinear edge.

Ill-defined: 0 Points



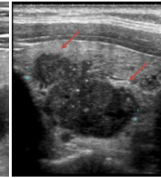
- Note the posteriorly disappearing margin (halo) in this image.
- Assign zero points if border is difficult to discern from thyroid parenchyma.

Irregular: 2 Points



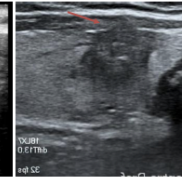
- Jagged, spiculated, or sharp angles.
- Can be present in part of, or all of the nodule.

Lobulated: 2 Points



- Protrusions into adjacent tissues.
- These may be single or multiple.

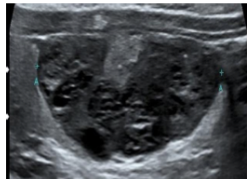
Extra-thyroid Extension: 3 Points



- Obvious invasion = malignancy.
- Nodule will be seen to extend beyond the thyroid capsule.

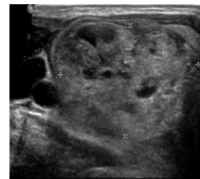
COMPOSITION

Spongiform: 0 Points



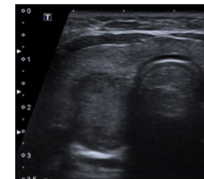
Composed predominantly (>50%) of small cystic spaces. NB: Do not add further points for other categories.

Mixed cystic and solid: 1 Point

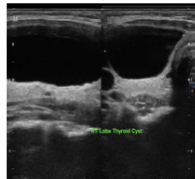


Assign points for predominant solid component.

Solid: 2 Points



Entirely or nearly entirely soft tissue with only a few tiny cystic spaces.



Cystic: 0 Points
Cystic or almost completely cystic nodule.

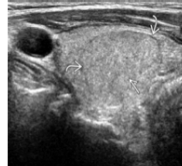
ECHOGENICITY

Hyperechoic: 1 Point



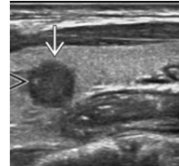
Increased echogenicity relative to the thyroid tissue

Isoechoic: 1 Point



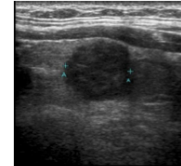
Similar echogenicity relative to the thyroid tissue

Hypoechoic: 2 Points



Decreased echogenicity relative to the thyroid tissue

Very Hypoechoic: 3 Points



Decreased echogenicity relative to the adjacent neck musculature

Anechoic: 0 Points
Applies to cystic or almost completely cystic nodules.

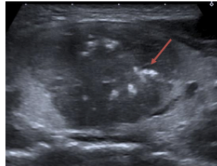
ECHOGENIC FOCI

Comet-tail artefacts: 0 Points



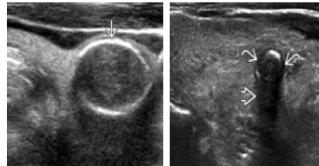
V-shaped, >1 mm, in cystic components.

Macrocalcifications: 1 Point



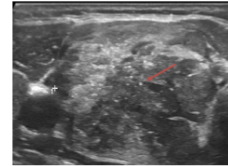
Calcifications with posterior acoustic shadowing

Peripheral Calcifications: 2 Points



Calcifications at periphery of the nodule. Complete or incomplete along margin.

Punctate Calcifications: 3 Points



< 1 mm with no posterior acoustic shadowing

ACR TI-RADS

COMPOSITION (Choose 1)

Cystic or almost completely cystic	0 points
Spongiform	0 points
Mixed cystic and solid	1 point
Solid or almost completely solid	2 points

ECHOGENICITY (Choose 1)

Anechoic	0 points
Hyperechoic or isoechoic	1 point
Hypoechoic	2 points
Very hypoechoic	3 points

SHAPE (Choose 1)

Wider-than-tall	0 points
Taller-than-wide	3 points

MARGIN (Choose 1)

Smooth	0 points
Ill-defined	0 points
Lobulated or irregular	2 points
Extra-thyroidal extension	3 points

ECHOGENIC FOCI (Choose All That Apply)

None or large comet-tail artefacts	0 points
Macrocalcifications	1 point
Peripheral (rim) calcifications	2 points
Punctate echogenic foci	3 points

Add Points From All Categories to Determine TI-RADS Level

0 Points

TR1

Benign
No FNA

2 Points

TR2

Not Suspicious
No FNA

3 Points

TR3

Mildly Suspicious
FNA if ≥ 2.5 cm
Follow if ≥ 1.5 cm

4 to 6 Points

TR4

Moderately Suspicious
FNA if ≥ 1.5 cm
Follow if ≥ 1 cm

7 Points or More

TR5

Highly Suspicious
FNA if ≥ 1 cm
Follow if ≥ 0.5 cm*

COMPOSITION	ECHOGENICITY	SHAPE	MARGIN	ECHOGENIC FOCI
<i>Spongiform:</i> Composed predominantly (>50%) of small cystic spaces. Do not add further points for other categories. <i>Mixed cystic and solid:</i> Assign points for predominant solid component. Assign 2 points if composition cannot be determined because of calcification.	<i>Anechoic:</i> Applies to cystic or almost completely cystic nodules. <i>Hyperechoic/isoechoic/hypoechoic:</i> Compared to adjacent parenchyma. <i>Very hypoechoic:</i> More hypoechoic than strap muscles. Assign 1 point if echogenicity cannot be determined.	<i>Taller-than-wide:</i> Should be assessed on a transverse image with measurements parallel to sound beam for height and perpendicular to sound beam for width. This can usually be assessed by visual inspection.	<i>Lobulated:</i> Protrusions into adjacent tissue. <i>Irregular:</i> Jagged, spiculated, or sharp angles. <i>Extrathyroidal extension:</i> Obvious invasion = malignancy. Assign 0 points if margin cannot be determined.	<i>Large comet-tail artefacts:</i> V-shaped, >1 mm, in cystic components. <i>Macrocalcifications:</i> Cause acoustic shadowing. <i>Peripheral:</i> Complete or incomplete along margin. <i>Punctate echogenic foci:</i> May have small comet-tail artefacts.

*Refer to discussion of papillary microcarcinomas for 5-9 mm TR5 nodules.

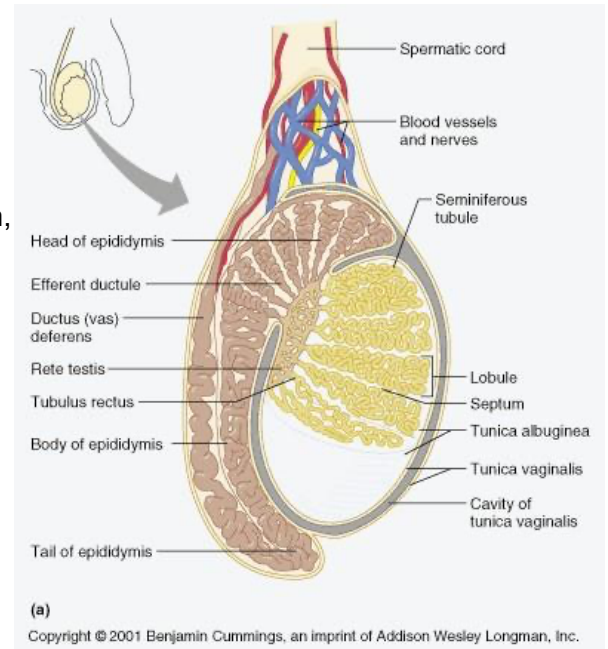
TESTES

1. Echotexture – uniform
2. Size – should be equivalent bilaterally (make sure the sonographers give you a side-by-side view)
3. Flow – should be symmetric (if increased → inflammation, tumor). RI should be 0.6-0.7. RI \leq 0.5 suggests inflammation or infection

1. Leukemia/Lymphoma
2. Fibrosis- older patients, testicles not enlarged or small
3. Orchitis- increased vascularity, look at UA and semen labs if available
4. Could just be normal- 😊 😊

5. Seminoma (well- defined, focal)
6. Nonseminomatous (ill-defined)
7. Teratoma
8. Embryonal
9. Metastasis
10. Adults – NHL
11. Children – leukemia
12. Focal infection infarct/ hematoma
13. Ectasia of rete testis
14. Epidermoid cyst (benign, laminated)
15. Ectopic adrenal rests
16. Congenital torsion

1. Spermatocele / epididymal cyst (not definitively able to be differentiated on US)
2. Tumor
3. Adult – adenomatoid, lipoma
4. Kids – rhabdomyosarcoma
5. Cystadenoma (Von-Hippel Lindau)
6. Lipoma (spermatic cord)
7. Leiomyoma
8. Scrotal Skin Thickening
9. Trauma
10. Cellulites and Fournier's gangrene (look for gas/echogenic foci with hazy shadowing)
11. Edema



TRAUMA

1. Links

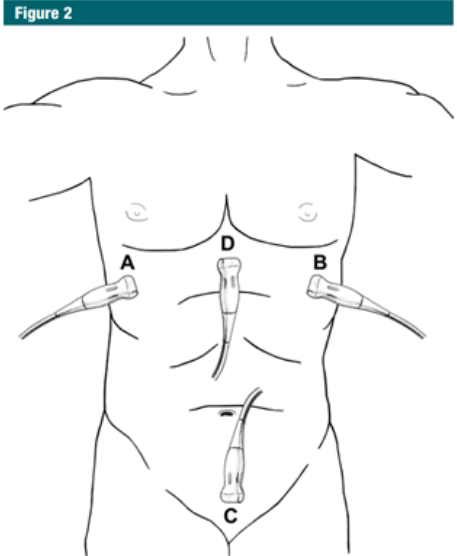


Figure 2: The four views for the original FAST scan: A = right upper quadrant, B = left upper quadrant, C = suprapubic view, D = subxiphoid view of the heart.

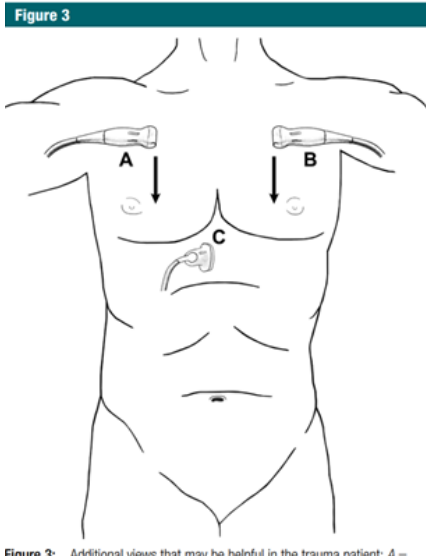


Figure 3: Additional views that may be helpful in the trauma patient: A = right parasagittal view of the lung for pneumothorax, B = left parasagittal view of the lung for pneumothorax, C = a longitudinal view of the IVC.

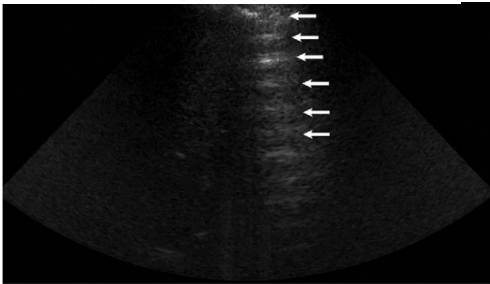


Figure 7: Pneumothorax. Note the presence of multiple echogenic A-lines (arrows) but lack of anterior echogenic "sliding lung" interface of parietal/visceral pleura in this small pneumothorax.

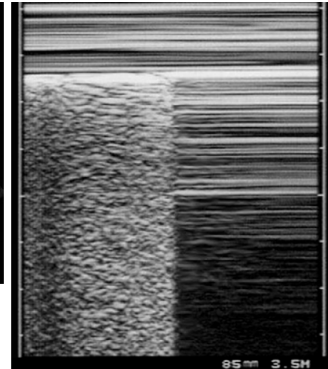


Figure 10: Lung point in M-mode. On the left the echogenic interface between the parietal and visceral pleura is seen, and posteriorly there is a granular appearance to the normal lung, the "sea-shore sign." To the right are numerous lines, termed the "barcode sign," representing pneumothorax. The interface between the normal lung and pneumothorax is the "lung point." (Reprinted, under a CC BY license, from reference 57.)

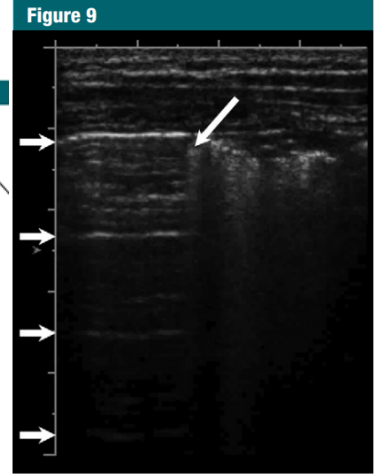


Figure 9: Lung point. Normal lung to the left with multiple, equally spaced A-lines (short arrows) and with normal "sliding lung" in real time. A "lung point" (long arrow) separates the normal lung from the abnormal lung to the right.

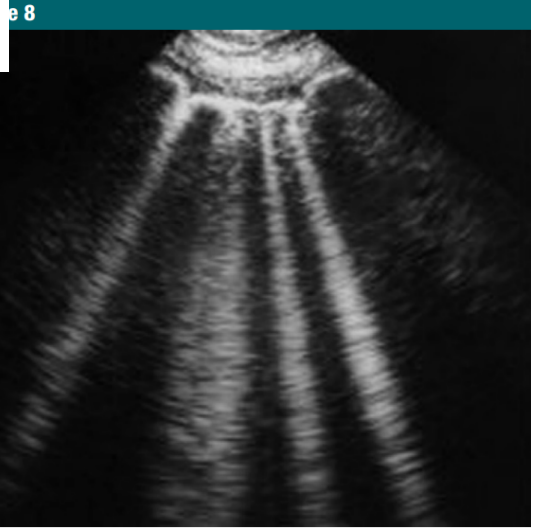


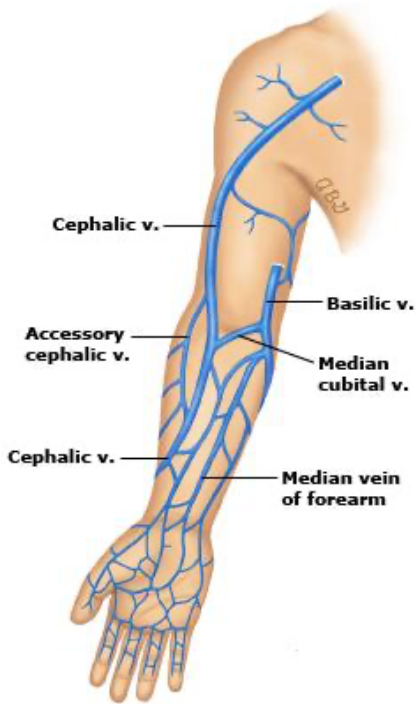
Figure 8: Lung rockets. These more numerous B-lines are identified in patients with parenchymal lung disease. If present, these exclude a pneumothorax, especially if "sliding lung" is seen. (Reprinted, under a CC BY license, from reference 57.)

a. [Focused Assessment with Sonography in Trauma \(FAST\) in 2017: What Radiologists Can Learn](#)

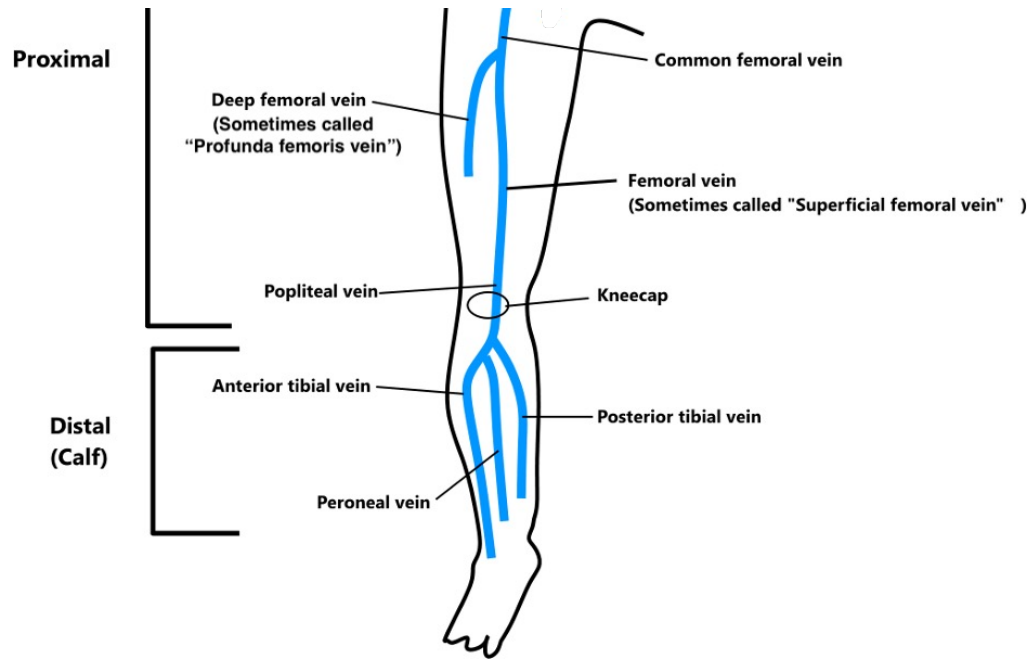
VASCULAR

1. Anatomy

a. Upper Extremity



Lower Extremity



2. Call a DVT When There's...

- a. Loss of compressibility of the vein (#1 sign)
- b. Echoes within the lumen / color void on color Doppler
- c. Loss of vascular flow (call it occlusive or non-occlusive)

3. Clues to determine age of thrombosis:

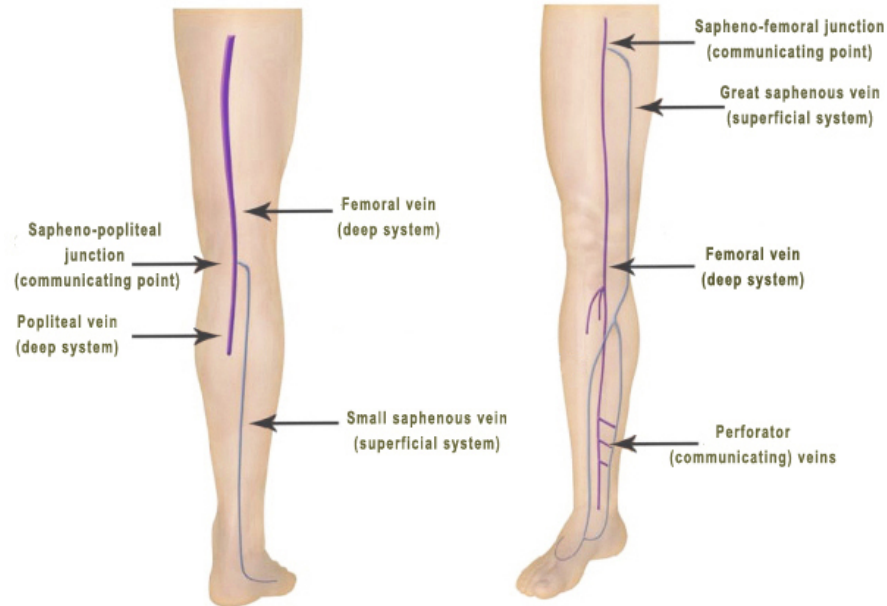
Acute Thrombus

- No compression
- Engorged vessel
- Anechoic or hypoechoic
- Concentric and central

Chronic Thrombus

- Compresses slightly
- Not engorged
- Echogenic
- Eccentric, often along the wall or linear

1. Anatomy



2. Superficial veins that require treatment (sometimes)
 - a. Great saphenous vein
 - b. Accessory saphenous vein
 - c. Small saphenous vein
3. Half-dose anticoagulation (45 days):
 - a. 3-5 cm of saphenofemoral junction or saphenopopliteal junction
 - b. > 5 cm in length of thrombus (for great saphenous vein, this only applies if thrombus is above the knee)
 - c. Progressive thrombus despite conservative management
4. Full-dose anticoagulation (90 days)
 - a. < 3 cm away from saphenofemoral junction or saphenopopliteal junction
5. Include distance of thrombus from junction

RELEVANT LINKS

1. Carotid
2. Deep vein thrombosis/Superficial vein thrombosis
3. Gallbladder
4. Liver
5. Neonatal
 - a. Brain
 - i. [Radiology Assistant: Neonatal Brain US](#)
 - ii. [Radiopaedia Germinal matrix hemorrhage \(grading\)](#)
 - b. Renal
 - i. [Multidisciplinary consensus on the classification of prenatal and postnatal urinary tract dilation \(UTD classification system\)](#)
6. Renal
7. Obstetrics
 - a. [Normal and Abnormal US Findings in Early First-Trimester Pregnancy.](#)
8. Ovary
 - a. [Ovarian-Adnexal Reporting & Data System \(O-RADS™\)](#)
9. Testes

10. Thyroid

- a. [Thyroid Imaging Reporting & Data System \(TI-RADS™\)](#)

11. Trauma

- a. [Focused Assessment with Sonography in Trauma \(FAST\) in 2017: What Radiologists Can Learn](#)