

# ABDOMINAL DOPPLER ULTRASOUND PROTOCOL

UW Medicine

## **BILLING CODE TO BE USED:**

**UABDD** - This is a combined charge of UABDL and UORGDC

**UABDC & UORGDC** to be charged separately if you are doing a Complete Abdomen Exam

## **PATIENT PREP:** NPO at least 4 hours.

*Exceptions can be made for urgent and ER exams.*

*Include in the report that the patient was not NPO for exam when relevant.*

**\*\*THIS STUDY INCLUDES AN ABDOMEN LIMITED EXAM WITH COMPLETE DOPPLER EXAM EVALUATING COLOR AND SPECTRAL DOPPLER OF PORTAL VEINS, HEPATIC ARTERIES, HEPATIC VEINS, AND SPLENIC VEIN. TO BE USED FOR -**

- General Abdominal Doppler Requests
- Post liver transplant donor follow up (See additional images needed at end of protocol)
- SOS/VOD Evaluations (See additional images needed at end of protocol)
- Budd Chiari Evaluations (See additional images needed at end of protocol)

## **\*\*SEE SEPARATE PROTOCOLS FOR EVALUATION OF -**

- Liver TIPS
- Pre-liver transplant workup
- Portal vein thrombosis
- Portal hypertension

**\*\*For inpatients:** If a recent abdominal ultrasound was done on the patient in the last 72 hours and an abdomen doppler is ordered, all images of the liver, biliary system, spleen and an assessment for collaterals and ascites should still be performed in addition to the liver dopplers requirements.

**\*\*If a patient is coming in for pain,** document within the indication section what the current status of pain is. For instance, how long the patient has had pain, if it's getting worse or better, and where exactly the pain is. Always take an image where the patient is hurting the most, labeled as area of pain. When describing the pain, write "per patient, ..." in the indication. Example: Per the patient, his pain is now in the RUQ and getting worse.

**\*\*"Not well seen"** to be stated if structure is not able to be completely evaluated. Include the reason why in relevant section of the report.

**\*\*Any masses, cysts, stones or abnormalities** should be measured in three dimensions and have a 2D picture and a color image documented. MFI should be routinely used to evaluate perfusion and low flow structures as needed. Measure the 2 largest or most worrisome masses/cysts in any given structure and comment on the presence of additional if relevant.

**\*\*Cine clips** to be added as needed for any abnormality seen.

# IMAGES TO OBTAIN

## PANCREAS *subcostal/epigastric approach*

Transverse images:

- Pancreas head, body, and tail.
- Pancreatic head showing porto-splenic confluence.
- Pancreatic body showing splenic vein
- Pancreatic body showing splenic vein with color
- Document and measure pancreatic duct if visible.

Sagittal images:

- Pancreatic head, body, and tail.

*Take image of "Pancreas Area" if not well seen.*

## LEFT LIVER - *subcostal/epigastric approach*

Sagittal images:

- Left lobe with left portal vein and ligamentum teres.
- Left lobe with hepatic vein
- Cine clip sweeping through LHL in sagittal from medial to lateral

Transverse images:

- Left lobe visualizing dome of liver
- Left hepatic vein confluence into IVC with and without color
- Left lobe at left portal vein with and without color assessing for thrombus and direction of flow
- Cine clip sweeping through LHL in transverse from superior to inferior

## CAUDATE LIVER - *subcostal/epigastric approach*

- Sagittal image of the caudate lobe.
- Transverse image of the caudate lobe.

## RIGHT LIVER - *subcostal or intercostal approach*

Transverse images:

- Right lobe to visualize dome of liver
- Right and middle hepatic veins confluence into IVC with and without color
- Right lobe at right portal vein with and without color assessing for thrombus and direction of flow
- Right lobe and right kidney
- Cine clip sweeping through RHL in transverse from superior to inferior

Sagittal images:

- Right hemidiaphragm to assess for pleural effusions and ringdown.
- Right lobe and right portal vein
- Main interlobar fissure with gallbladder CHD and MPV
- Right lobe showing echotexture between liver and right kidney.
- Right lobe and right kidney documenting approximate liver size. Measurement of length of the liver is not needed unless requested.
- Cine clip sweeping through RHL in sagittal from medial to lateral

*NOTE: If lateral edge or dome of liver is not seen in its entirety with patient in supine position, turn patient in LLD or raise head of bed and repeat RHL cine clips to visualize better.*

## MAIN PORTAL VEIN -

- 2D image through MPV evaluating for thrombus
- Color image of MPV showing patency, filling and direction of flow

## BILE DUCTS

- Sagittal image of CBD and CHD with measurements at the level of the porta hepatis. Color doppler should be used to distinguish ducts from vessels.
- If dilated, follow CBD as distal as possible to look for stones/mass and measure as distal as possible as well.
- Document and measure any intrahepatic bile duct dilatation with 2D and color imaging.

## GALLBLADDER

- Sagittal image
- Transverse image
- Measurement of gallbladder wall in sagittal section only. Do not include liver surface. If liver edge is edematous, try to measure free GB wall. Normal wall thickness is <3mm.
- Take image and cine through GB if there is any abnormality (stones, polyp, adenomyomatosis.)
- Take color image of any mass seen.
- LLD POSITION: Transverse and sagittal image of gallbladder with patient in LLD position to check for stones/polyps and mobility.
- If evaluating for cholecystitis, or if suspicious GB findings such as thickened wall or distension:
  - Evaluate for Murphy's sign and include in the report.
  - Gallbladder length measurement. Normal <8cm
  - Color doppler of gallbladder wall to assess for hypervascularity
  - Spectral doppler velocity of the cystic artery which can be seen within wall of anterior gallbladder.
    - Normal velocity <40cm/s
    - If artery cannot be visualized, include color doppler of area and comment in report that it could not be seen.
    - Add code UORGDL if cystic artery is sampled.



## RIGHT KIDNEY

- Sagittal image of right kidney in medial, middle, and lateral views.
- Sagittal measurement of right kidney.
- Transverse images of superior, mid, inferior right kidney.
- Demonstrate calculi, hydronephrosis or pelviectasis with a color image of the renal pelvis if present.
- **IF RENAL STONES ARE PRESENT:**
  - Measure renal stones in one largest dimension.
  - Demonstrate acoustic shadowing if possible.
  - Image with color to look for twinkle (can still be a stone if no twinkle shows).
- **IF HYDRONEPHROSIS, PELVIECTASIS, OR DILATED URETER PRESENT:**
  - Patient should void bladder and images should be taken to reassess degree of dilation with 2D and color images.

## SPLEEN

- Sagittal and transverse images through spleen
- Sagittal length measurement of spleen
- Color Doppler image of any abnormality.

## ASSESS FOR COLLATERALS

- Color image documenting any collaterals or varies if present in periportal area, LUQ, epigastric region, or the presence of a recanalized umbilical vein. If collaterals are seen, the splenic vein velocity and direction of flow should be documented.

## LOWER QUADRANTS:

- Document RLQ and LLQ to check for ascites.

## COLOR & SPECTRAL DOPPLER IMAGES TO OBTAIN

*SWEEP SPEED should be set to SLOW (36cm/s) on the Philips machines and 2 or 3 on the GE machines.  
You will be asked to repeat images if this is not the case. It is critical for comparison to priors to have the settings consistent.*

### PORTAL VEINS - LPV, RPV, MPV **VELOCITY with angle correction**

- Color images of MPV, Right PV and Left PV showing direction of flow or any filling defects
- Direction of flow should be hepatopetal, towards the liver.
- The waveform should be continuous, monophasic flow.
- Some velocity variation from respiration is expected, measure where waveform is most consistent.
- Mild undulation or phasicity in the waveform is normal and can be seen especially if the patient is thin or has eaten a large meal recently.
- A pulsatile portal vein is defined as one that has >50% variation in velocities between the minimum and maximum velocity within the waveform. This can be seen with right heart failure, tricuspid regurge, HV and PV fistula, PHTN, malignant tumor invasion, and cirrhosis
- Normal diameter of MPV is 13-16mm
- Normal MPV velocity is >30-60 cm/s
- Normal RPV and LPV velocity is >10cm/s.
- Velocity should always be measured with angle correction.

### HEPATIC ARTERY - LHA, RHA, PHA **RESISTIVE INDEX with angle correction**

- Measurement of RI with angle correction, showing a linear segment of the artery.
- Normal RI range is 0.5 -0.8

### HEPATIC VEINS- LHV, RHV, MHV **WAVEFORM ONLY with angle correction**

- Document waveform and assess for phasicity.
- Sample should be taken within 2 cm from IVC
- LHV can often be difficult to separate from artifact from heart motion, it is okay to come farther out into liver if needed to eliminate doppler artifact.
- Velocity is not needed except for:
  - In the presence of hepatic vein stent.
  - In cases where color flow is seen aliasing
  - A narrowing is suspected
- Phasicity of the hepatic veins should be assessed during normal respiration. Deep inspiration may dampen hepatic flow. If necessary, use suspended/mid respiration or shallow breathing.
- If monophasic waveforms are seen, use LLD positioning to reassess. This can sometimes be positional and due to compression.

### INFERIOR VENA CAVA – IVC **VELOCITY with angle correction**

- **Not needed unless assessing for Budd Chiari or post liver transplant donation**
- Color image of IVC
- Velocity with spectral doppler and angle correction

### SPLenic VEIN – **VELOCITY with angle correction**

- Color image of the splenic vein at the pancreas showing direction of flow.
- Splenic vein at splenic hilum - angle corrected velocity measurement. If patient has had a splenectomy no spectral is needed.

**\*\*Additional Doppler information on image optimization and abnormal flow patterns can be found on the website in Guidelines and References.**

## ADDITIONAL IMAGES AS NEEDED

### SEE SEPARATE PROTOCOLS FOR EVALUATION OF :

- Liver TIPS
- Pre-liver transplant workup
- Portal vein thrombosis
- Portal hypertension

### POST LIVER TRANSPLANT DONOR EVALUATION

- Color and velocity images of IVC, these patients are at risk for post-surgical stenosis

### BUDD CHIARI ADDITIONAL IMAGES NEEDED:

- 2D and color images of the hepatic veins looking for thrombus and size
- Sagittal and transverse 2D images of IVC
- Spectral doppler of IVC.
- 2D and color doppler cine clips showing any intrahepatic collateral pathways from hepatic veins to portal veins or hepatic veins to hepatic veins.

#### SONOGRAPHIC FINDINGS IN BUDD CHIARI:

- Small hepatic veins
- Thrombosis or tumor invasion of the hepatic veins
- Absent, reversed or monophasic in the hepatic veins
- Intrahepatic collateral pathways
- Enlargement of the caudate lobe
- Ascites
- Splenomegaly

### VOD/SOS ADDITIONAL IMAGES NEEDED:

- Craniocaudal measurement of liver
- MPV diameter
- HV diameters, measure within 2 cm of IVC
- Elastography of liver if requested

#### VOD (or SOS) CHECKLIST:

1. **Liver craniocaudal size** increase >2cm
2. **Spleen size** >1cm increase relative to baseline
3. **Gallbladder wall thickening** >6mm
4. **PV diameter** (at MPV) - >12mm
5. **HV diameter** (close to IVC) <3mm
6. **Paraumbilical vein** – presence and flow within
7. **PV spectral doppler** <10cm/s
8. **Hepatic artery RI** > 0.75
9. **Hepatic vein** monophasicity
10. **Ascites**

Variable	Lassau's criteria
<b>Gray-scale ultrasound</b>	
Hepatomegaly	Liver enlargement: increase in 2 of 3 measurements of > 2 cm in adults and >1 cm in children relative to baseline
Splenomegaly	Spleen enlargement: increase >1 cm relative to baseline measurement of the greatest axis
Gall bladder wall thickening	>6 mm
Portal vein diameter	>8 mm in children; >12 mm in adults
Hepatic vein diameter	<3 mm
Ascites	Presence
Paraumbilical vein	Visualization
<b>Color Doppler ultrasound</b>	
Absence/presence of flow	Flow recorded in paraumbilical vein
Flow direction	Reversed flow in the main portal vein
<b>Spectral Doppler ultrasound</b>	
Portal vein velocity/density/congestion	Flow demodulation (disappearance of velocity variations with breathing); decreased spectral density in portal vein; maximal flow in the main portal vein <10 cm/s; portal vein congestion index $\geq$ .1; monophasic flow in hepatic veins
Hepatic artery resistive index	$\geq$ .75

## ABDOMEN DOPPLER ULTRASOUND IMAGE LIST

IMAGE	MODE	IMAGE	MODE
Panc Trans H/B/T	2D	GB Sag	
Panc Sag H/B/T	2D	GB Wall w/measurement	2D+
Splenic Vein at panc	Color	GB Sag w/ color	Color
<i>Panc Duct if dilated</i>	<i>2D +</i>	GB Trans	2D
		GB Sag LLD	2D
Left Liver Sag (at portal vein)	2D	GB Trans LLD	2D
Left Liver Sag (at hepatic vein)	2D	<i>GB length if r/o chole</i>	<i>2D+</i>
Left Liver Sag M-L	Cine	<i>Cystic duct if r/o chole</i>	<i>Spectral</i>
Caudate Liver Sag	2D		
Caudate Liver Trans	2D	CHD w/measurement and color	Color+
Left Liver Trans (at hepatic vein)	2D	CBD w/measurement and color	Color+
Left Liver Trans (at portal vein)	2D		
Left Liver Trans S-I	Cine	Right Kidney Sag Mid	2D
LPV <i>without color</i>	2D	Right Kidney Sag Mid w/ measurement	2D +
LPV <i>w/ color</i>	Color	Right Kidney Sag Med	2D
LPV <i>velocity w angle correction</i>	Spectral cm/s	Right Kidney Sag Lat	2D
LHA <i>RI w angle correction</i>	Spectral RI	Right Kidney Trans Sup	2D
LHV <i>waveform</i>	Spectral	Right Kidney Trans Mid	2D
		Right Kidney Trans Inf	2D
Right Liver Trans (at dome)	2D		
Right Liver Trans (at hepatic veins)	2D	Spleen Sag x2	2D x2
Right Liver Trans (at portal vein)	2D	Spleen Sag w/ measurement	2D +
Right Liver Trans (at RK)	2D	Spleen Trans	2D
Right Liver Trans S-I	Cine	Splenic Vein	Spectral cm/s
Right Liver Sag/Rt Chest	2D		
Right Liver Sag (at portal vein)	2D	RLQ	2D
Right Liver Sag (at main lobal fissure)	2D	LLQ	2D
Right Liver Sag / RK	2D		
Right Liver Sag L-M	Cine	Assess for collaterals	Color, 2D+
MPV <i>without color</i>	2D	<i>For cirrhosis/HCC screening: Capsule</i>	<i>Linear</i>
MPV <i>w/ color</i>	Color		
MPV <i>velocity w angle correction</i>	Spectral cm/s	<i>SOS/VOD: Elasto of liver if requested</i>	<i>Elasto</i>
PHA <i>RI w angle correction</i>	Spectral RI		
RPV <i>without color</i>	2D	<i>MFI for lesions</i>	<i>MFI</i>
RPV <i>w/ color</i>	Color		
RPV <i>velocity w angle correction</i>	Spectral cm/s	<i>Budd Chiari:</i>	
RHA <i>RI w angle correction</i>	Spectral RI	<i>2D and color images of the HVs</i>	<i>2D/Color</i>
MHV <i>waveform only unless stent</i>	Spectral	<i>Sag and trans 2D images of IVC</i>	<i>2D</i>
RHV <i>waveform only unless stent</i>	Spectral	<i>Spectral doppler of IVC</i>	<i>Spectral</i>
<i>IVC if indicated (r/o Budd Chiari or post tx donation)</i>	<i>Spectral cm/s</i>	<i>2D and color cine clips of intrahepatic collaterals</i>	<i>Cine</i>

## ABDOMEN DOPPLER PROTOCOL HISTORY

	Date	Changes made	By whom
Updated	10/25/2021		Becky Marion
Updated	03/03/22	-Added color of SV at pancreas -Added Spectral of SV at hilum -Added measure size of HVs for Budd Chiari -Added angle correction for HAs w length of artery shown -Removed pelvis/bladder area images -Created separate TIPS, PHT, PVT protocols -Changed NPO requirement to 2-6 hrs	03/03/22 Protocol Meeting Attendees Dighe, Lee, Kolokythas
Approved	3/14/2022		Manjiri Dighe
Added	5/4/2022	Elastography for VOD	Renee Betit Fitzgerald
Added	10/10/2022	Cystic duct and GB length for cholecystitis c	Renee Betit Fitzgerald
Added	10/27/2022	Cine sweeps of RHL &LHL in trv and sag	Renee Betit Fitzgerald
Removed	3/1/2024	Elastography no longer needed for SOS/VOD unless requested	Manjiri Dighe
Added	4/15/2024	Image list	Renee Betit Fitzgerald
Reviewed	6/27/2024	-Added: "For inpatients: If a recent abdominal ultrasound was done on the patient in the last 72 hours and an abdomen Doppler is ordered, a liver, spleen and doppler only study can be performed unless there are other areas are of interest in addition." -Added: assess for collaterals -Added: IVC for Post Liver Tx donation -Added: Additional Budd Chiari info and requirements Added: Additional Doppler Info link	Protocol Meeting Attendees: Manjiri Dighe, Shaun Bornemeier, Dalene Edden, Renee Betit Fitzgerald, Becky Marion