ABDOMINAL HEPATIC DUPLEX WITH TIPS

I. Patient Preparation:
   a. NPO for 8 hours prior to exam.

II. Equipment:
   a. Performed with a real-time scanner using a sector or curved linear transducer with frequencies ranging from 3.5 to 5.0 MHz. On occasion, large patients may require a lower frequency 2.5 MHz. Doppler frequencies range from 3.5 to 5.0 MHz.

III. Procedure Protocol:
   a. Sonographic Role:
      i. Evaluation of shunt for patency stenosis or occlusion.
      ii. Determination of flow velocities within shunt and main, right and left portal veins.
      iii. Evaluation of main, right and left portal veins (and intraparenchymal branches when possible) for direction of flow.
      iv. Evaluation of main, right and left hepatic veins for patency, stenosis and direction of flow.
      v. Detection of complications of TIPS procedures including, but not limited to: hematobilia, hematomas, intrahepatic bile collections, infarction. *Small transient areas in peripheral liver parenchyma may be evident immediately post TIPS procedure (this echogenicity may represent microbubbles introduced during procedure).
      vi. Serial evaluation for changes in flow velocities and direction.

   b. Scanning Criteria:
      i. The ultrasound examination obtained immediately after initial TIPS procedure is used as a baseline for comparison studies, unless there has been an interval TIPS revision, at which time the post-revision sonogram is used as the baseline exam.
      ii. Review any previous post TIPS sonogram prior to performing current examination.
      iii. Maintain similar sonographic scan planes and Doppler insonation angles (60 degrees or less) for continuity between examinations.
      iv. Use both subcostal and intercostals approach during ultrasound examination in order to obtain a full and accurate assessment of the shunt and surrounding anatomy.

   c. **Liver**
      i. Image the liver in the sagittal (longitudinal) and transverse planes. At least 3 images of the left and right lobes in **both** sagittal and transverse planes must be acquired.
      ii. Record mid-sagittal view of liver with calipers measuring maximum hepatic length.
      iii. Record image of Morrison's pouch and evaluate for any evidence of ascites.
      iv. Evaluate porta hepatic and periportal region for any evidence of varices.

   d. **Hepatic Veins**
      i. Obtain grayscale images of the **right, left and main hepatic veins.**
      ii. Perform PD or Color Doppler evaluation of **right, left and main hepatic veins** in the longitudinal plane.
      iii. Record color Doppler with spectral Doppler velocity tracing for **right, left and main hepatic veins**.
      iv. Evaluate flow pattern and direction.
         1. The flow pattern may be monophasic or biphasic.

2. Flow direction in the draining hepatic vein (usually the right hepatic vein) should be hepatofugal (away from the liver).
3. The presence of reversed flow in the proximal portion of the draining hepatic vein is suggestive of a possible isolated hepatic vein stenosis or stent stenosis limited to the hepatic venous end of the stent.

e. **Portal Veins**

i. Obtain grayscale images of **right, left and main portal veins**.

ii. Perform PD or color Doppler evaluation of **right, left and main portal veins** in the longitudinal plane.

iii. Record color Doppler with spectral Doppler velocity tracing for each vein evaluated. ***Angle correction required on Main Portal Vein velocity***

iv. Evaluate or flow pattern and direction:

1. The normal flow direction pre-TIPS procedure in the main portal vein and its branches is hepatopedal (towards liver).
2. The majority of patients will exhibit reversal of flow within the intrahepatic portal veins (post-TIPS) from reversed (hepatofugal), owning to the lower pressure within the stent.
3. Interval change in direction of flow within the intrahepatic portal vein (post-TIPS) from reversed (hepatofugal) to forward (hepatopedal) flow is considered an indirect sign of sign of stent malfunction or hepatic vein thrombosis.
    a. **Looking at intrahepatic portal blood flow direction as an impending sign of shunt failure can only be used in patients who demonstrate total diversion of portal venous blood flow at Doppler ultrasound after TIPS insertion.**
4. A decrease in the peak systolic velocity of the main portal vein of a least 33% from the baseline value is suggestive of shunt malfunction.
5. Measure the peak systolic velocity in each segment of the portal vein evaluated. Maintain an angle insonation of 60 degrees or less for velocity measurement.
6. Peak systolic velocities elevate after a TIPS procedure to approximately 40-60 cm/sec.
7. A decrease in the portal vein peak systolic velocity to <30 cm/sec post-TIPS procedure may indicate a shunt failure.

f. **Shunt Evaluation**

i. Perform a PW and color Doppler evaluation of the entire shut, evaluating for flow velocity and direction. A careful evaluation of the shunt position is performed from the entry point in the hepatic vein to the distal point in the portal vein.

1. Flow pattern is normally monphasic, with turbulence.
2. Flow direction is hepatofugal (away from the liver) towards the draining hepatic vein (usually the right hepatic vein).

ii. Record a spectral Doppler tracing and color Doppler image for the proximal, mid and distal shunt.

iii. Measure the peak systolic velocity in the proximal, mid and distal portions of the shunt, maintaining an insonation angle of 60 degrees or less.

1. Doppler flow characteristics within the shunt may be turbulent and pulsatile (representing cardiac pulsations); the flow pattern may also be continuous.
2. Normal peak systolic flow velocities in the shunt range from 60- 270 cm/sec.
3. A peak systolic velocity of less than 60 cm/sec may be indicative of shunt failure.
4. An interval change in the PSV of greater than 50 cm/sec from the baseline may be indicative of shunt failure (more important than absolute values).

5. Absence of detectable flow through a shunt is indicative of thrombosis. Increased echogenicity within the shunt may also be seen (the lumen of this should measure approximately 8 – 10 mm).
6. Color flow should fill the lumen of the stent, turbulence with a mosaic color pattern is seen normally, but may increase with stenosis.
7. Occlusion results in the absence of color flow.
8. Changes in flow velocities may be focal or diffuse.

g. **Hepatic Artery**
   i. Perform PD or color Doppler evaluation in the longitudinal plane, in the region of the porta hepatis.
   ii. Record color Doppler with spectral Doppler velocity tracing. ***Angle correction required on for Hepatic Artery velocity***
   iii. Evaluate flow pattern.
      1. Normal hepatic artery flow shows continuous forward, diastolic, low resistance waveform.

IV. Required images for TIPS:

Long liver left (lateral, mid, medial)
Long liver right (lateral, mid, medial)
Long mid sagittal liver with hepatic length
Long Liver/Right Kidney
Trans liver left (superior, mid, inferior)
Trans liver right (superior, mid, inferior)
Hepatic veins grayscale (left, mid, right)
Long left hepatic vein with color Doppler
Long left hepatic vein with color and Spectral Doppler (measure PV)
Long middle hepatic vein with color Doppler
Long middle hepatic vein with color and Spectral Doppler (measure PV)
Long right hepatic vein with color Doppler
Long right hepatic vein with Color and Spectral Doppler (measure PV)
Long Main Portal Vein with color Doppler
Long Main Portal Vein with color and Spectral Doppler (measure PV with appropriate angle correct)
Long left Portal Vein grayscale
Long left Portal Vein with color Doppler
Long left Portal Vein with color and Spectral Doppler (measure PV)
Long right Portal Vein grayscale
Long right Portal Vein with color Doppler
Long right Portal Vein with color and Spectral Doppler (measure PV)
Long Hepatic Artery grayscale
Long Hepatic Artery with color Doppler
Long Hepatic Artery with color and Spectral Doppler (measure PV with appropriate angle correct)
Long proximal shunt (MPV end) with color Doppler
Long proximal shunt (MPV end) with color and spectral Doppler (measure PSV)
Long mid shunt with color Doppler
Long mid shunt with color and spectral Doppler (measure PSV)
Long distal shunt (hepatic vein end) with color Doppler
Long distal shunt (hepatic vein end) with color and spectral Doppler (measure PSV)