Doppler Ultrasound of the Liver, Portal Hypertension, and Transjugular Intrahepatic Portosystemic Shunts

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KEYWORDS

• Doppler ultrasound • Portal hypertension • Portal vein thrombosis • Budd-Chiari syndrome • Right heart failure • TIPS

KEY POINTS

- Doppler ultrasound is more than 90% accurate for diagnosing portal and hepatic vein thrombosis and is the screening modality for evaluating transjugular intrahepatic portosystemic shunt patency.
- Doppler findings in portal vein stenosis include turbulence, high velocity at the site of stenosis, and poststenotic dilatation.
- Portal venous thrombosis results from stagnant flow due to portal hypertension, neoplasms, or inflammation in organs drained by the portal circulation, such as the pancreas, and hypercoagulable states may cause portal venous thrombus.
- Normal portal venous flow is always unidirectional (hepatopetal or toward the liver). Normal hepatic venous flow has forward and reversed components.
- Ultrasound can accurately diagnose portal hypertension. Portal hypertension leads to reduction in hepatopetal portal venous flow, and diversion of blood into porto-systemic collaterals, changes that can be detected with Doppler.

Videos of Color Doppler scan of the liver accompany this article at http://www.ultrasound.theclinics.com/

INTRODUCTION

Doppler ultrasound is the first-line modality for imaging a wide range of liver disease. It is quick, can be performed portably, and has no adverse effects. Flow velocity and direction in the hepatic arteries, hepatic veins, and portal and splenic veins are evaluated. It is the study of choice for evaluating portal hypertension. Color (and power) Doppler ultrasound is more than 90% accurate for diagnosing portal and hepatic vein thrombosis.[1]

Liver disease, vascular obstruction, or congestive heart failure leads to alterations in hemodynamics that can be detected with hepatic Doppler ultrasound. In this article, we review normal hepatic waveforms and how they are altered in the setting of portal hypertension, congestive cardiac failure, and portal vein pathology. We also discuss the

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evaluation of and potential complications involving transjugular intrahepatic portosystemic shunts (TIPS).

DOPPLER ULTRASOUND TECHNIQUE

The Doppler Effect is the change in frequency of a reflected wave from a moving object. An increase in frequency is seen if the object is moving toward the observer, whereas a decrease in frequency occurs if the source is moving away. Frequency shift translates into blood velocity, allowing depiction of flow in the hepatic vasculature.[2]

A 2-MHz to 5-MHz probe is typically used for evaluating the hepatic vasculature. A lower frequency can be used in larger patients to increase penetration. The left lobe of the liver is evaluated through a subcostal approach. The right lobe can also be evaluated subcostally or by an intercostal approach, with the patient in the right anterior oblique position.

In patients with portal hypertension, the following should be assessed:

- Echotexture of the liver parenchyma for signs of cirrhosis and masses. The contour of the liver is evaluated for nodularity. This is best seen by using a linear high-frequency transducer focused on the liver surface.
- Patency and flow direction in the hepatic artery, and portal, splenic, and superior mesenteric and hepatic veins.
- Size of the hepatic artery, portal vein, and hepatic veins.
- Doppler waveforms from the right, left, and main portal veins, and right, middle, and left hepatic veins. Angle-corrected velocities are obtained from the main portal vein.
- Spleen size (longitudinal diameter and/or cross-sectional area).
- Presence or absence of porto-systemic collateral vessels.
- Presence or absence of ascites.
- Assessment of respiratory variation of the diameter of splenic vein and superior mesenteric vein (SMV).

Flow in the portal venous system may be slow or stagnant in portal hypertension. Doppler parameters should therefore be optimized to detect small frequency shifts. A small velocity range, setting the focal zone to the level of the portal vein, using a small Doppler angle and color box, minimizing the wall filter, and reducing the distance from transducer to the portal vein as much as possible will increase sensitivity to slow flow.

HEPATIC ARTERIES

Approximately 25% of the liver's blood supply comes from the proper hepatic artery.[3] The proper hepatic artery courses left of the bile duct and anterior to the portal vein, dividing into the left and right hepatic arteries in the hepatic hilum. At the hilum, the hepatic artery is posterior to the common hepatic duct.

The normal hepatic artery has a low-resistance waveform with forward flow throughout the cardiac cycle. The normal hepatic artery resistive index is 0.5 to 0.7 (**Fig. 1**). Velocities within the hepatic artery range between 30 and 60 cm/s[2].

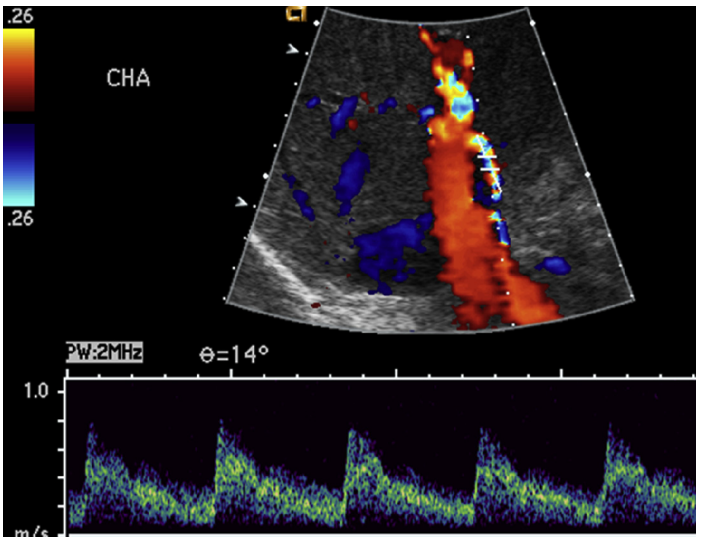

Fig. 1. Normal common hepatic artery spectral Doppler evaluation. The hepatic artery is the multicolored vessel over which the Doppler cursor is placed. The portal vein (*red*) lies adjacent. The hepatic artery has a low-resistance waveform with forward flow throughout the cardiac cycle.