Society of Radiologists in Ultrasound
2011 Toshiba Resident Teaching Case

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Clinical History: 50 years old male recently underwent Whipple resection (classic pancreaticoduodenectomy) for an insulinoma in the pancreas. His postoperative course was complicated by bleeding at the anastomosis, for which he had an arteriogram to identify the source of bleeding and possible embolization. The angiogram was complicated by dissection of the proper hepatic artery. A hepatic duplex ultrasound was subsequently requested to assess for patency of the hepatic artery.

Figure 1. Transabdominal color and spectral Doppler ultrasound image of the proper hepatic artery. The hepatic artery is patent with a parvus tardus waveform. This was confirmed to be secondary to a combination of post-surgical narrowing and dissection on conventional angiography.

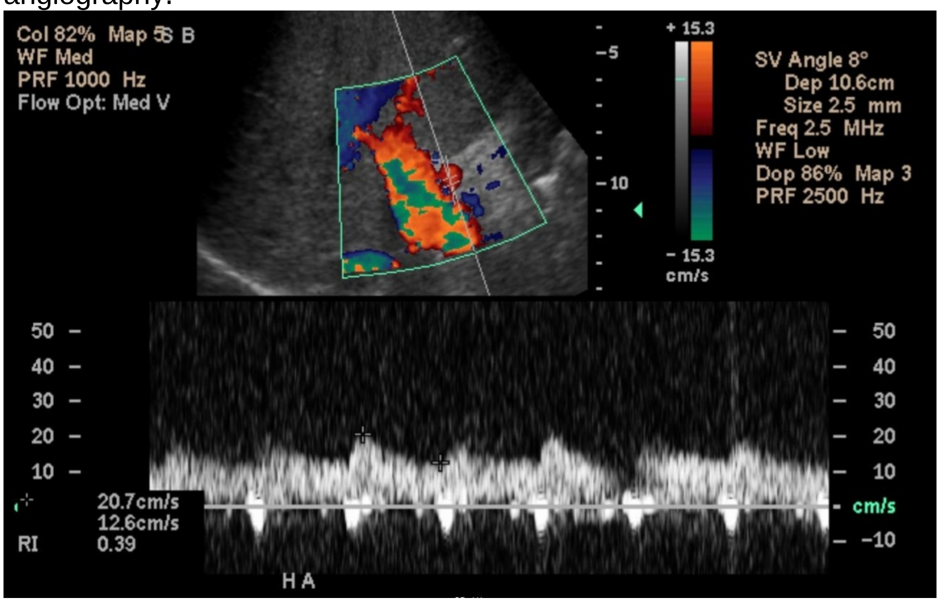

Figure 2. Transabdominal color and spectral Doppler ultrasound image of the right hepatic artery. As expected, the right hepatic artery also exhibits a parvus tardus waveform.

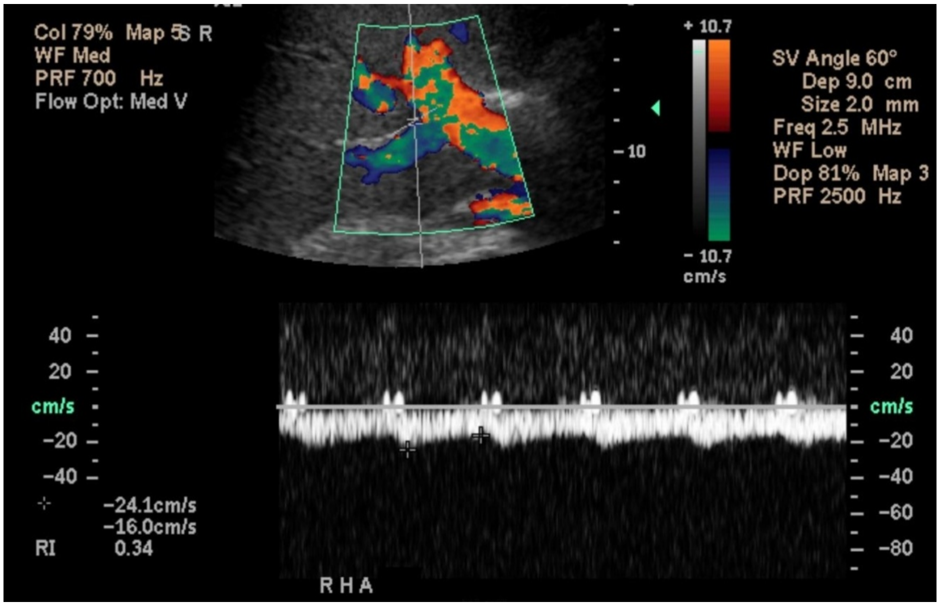

Figure 3. Transabdominal color and spectral Doppler ultrasound image of the left hepatic artery. The left hepatic artery demonstrates normal flow and waveform pattern. Flow in the left hepatic artery is not affected because of its aberrant origin as shown in figure 5.

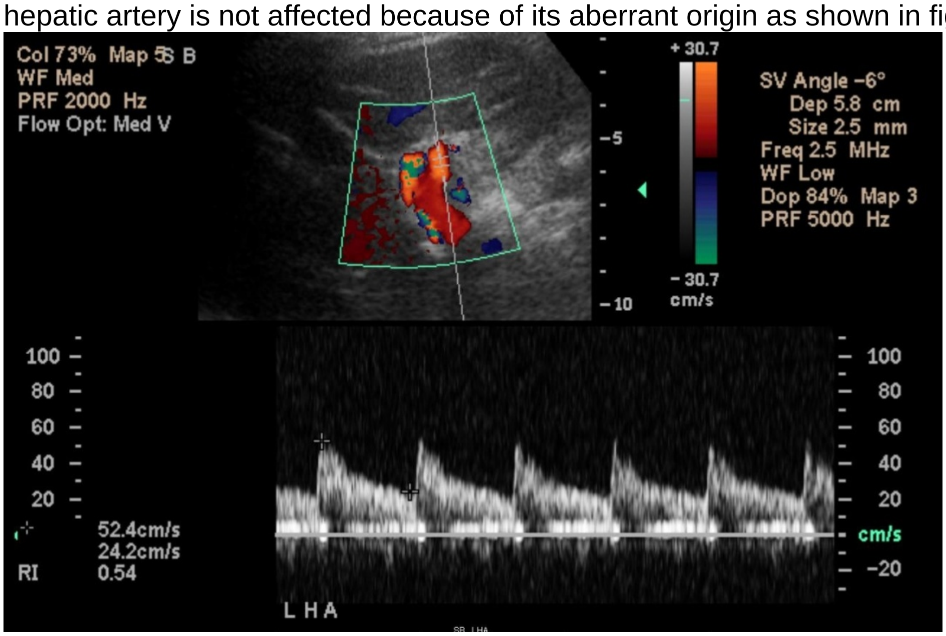

Figure 4. Transabdominal gray-scale ultrasound image through the liver. It demonstrates mild-moderate biliary ductal dilatation and pneumobilia (arrows), consistent with history of Whipple resection.

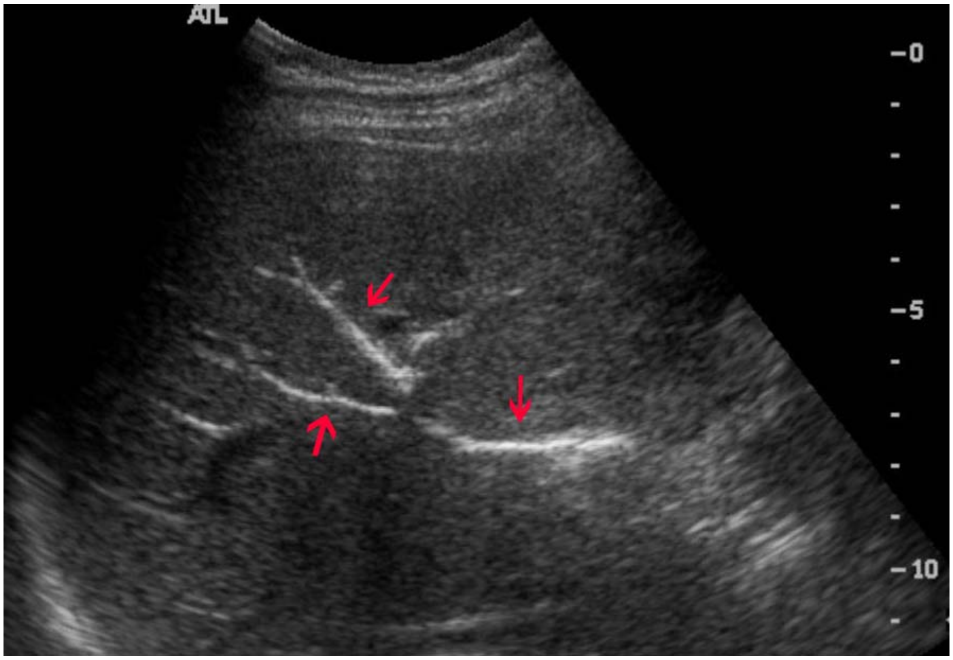

Figure 5. Arteriogram of the celiac axis. There is a filling defect in the proper hepatic artery just distal to the expected location of the origin of the gastroduodenal artery, compatible with dissection of the proper hepatic artery (arrow). Also noted is a replaced left hepatic artery (arrowhead), likely arising from the left gastric artery.

Final diagnosis: Dissection of the proper hepatic artery with a replaced left hepatic artery.

Discussion:

Color doppler ultrasound with spectral waveform analysis provides important diagnostic information about the vessels imaged as well as the proximal vasculature. The doppler resistive index ([peak systolic velocity – end diastolic velocity] / peak systolic velocity) is an useful parameter for quantifying the vascular resistance as well as the effect of vascular compliance (1). The resistive index of a normal hepatic artery is 0.5–0.8 (1). The normal hepatic artery waveform shows a rapid systolic upstroke and a continuous diastolic blood flow.

In practice, for instance, the use of doppler ultrasound for routine postoperative monitoring of liver transplants has altered the clinical management and the detection of postoperative complications. In the early postoperative period (<72 hours), increased hepatic artery resistance (resistive index of >0.8) is a frequent finding, but resistance typically normalizes within a few days (1). In the case of hepatic artery stenosis, duplex doppler imaging is estimated to indicate the correct diagnosis in approximately 92% of cases because of its capability of detecting focal increase in peak systolic velocity and poststenotic turbulent flow (2). In the case of hepatic artery thrombosis or dissection, the hepatic arterial waveforms typically demonstrate a tardus parvus pattern, which is characterized by a prolonged acceleration time to peak velocity (tardus) and a diminished peak systolic velocity (parvus) (1). With proximal vessel narrowing, there is decreased flow with low flow resistance (RI of <0.5). Other causes of tardus parvus waveform, in addition to hepatic artery thrombosis, include hepatic edema, systemic hypotension, or peri-portal arterial collateral vessels in chronic thrombosis (2).

The vascular anatomy of the liver is variable. The incidence and pattern of different types of hepatic arterial anatomy can require specialized intraoperative strategies in upper abdominal surgeries, such as those of the pancreas, upper intestinal tract, gallbladder and the liver (3). Hence the knowledge of these abnormalities is important for the surgeon and the radiologist as well.

The dominant scheme describes a liver receiving its total arterial supply from a common hepatic artery arising from the celiac axis, and this normal anatomy occurs in 79.1% of the cases seen on a large scale angiographic study (4).

The first description of aberrant hepatic arteries was published in 1756 by Haller (5). Later, Michels proposed an internationally recognized classification of these vascular abnormalities in 1966 (6). This classification was modified by Hiatt in 1994 (7). Variant vessels can be categorized as replaced, in which case the entire arterial supply to the side of the liver arises from an aberrant location; or accessory, which occurs in addition to the normal arterial supply. With regards to the incidence of aberrant vessels, there is some numerical variation among the studies. Approximately 15-19.8% of people have accessory or replaced left hepatic artery arising from the left gastric artery (8). Approximately 14.8-20% of people have a accessory or replaced right hepatic artery arising from the superior mesenteric artery (8). The replaced right hepatic artery is almost invariably the first branch from the SMA in such cases (8).

The consequences of variant hepatic arterial anatomy vary with different surgical procedures and types of abnormality. For example, the presence of a replaced left hepatic artery with a larger diameter may allow a rapid dissection of the porta hepatis and may be used for anastomosis in left liver lobe transplantion because of its length (4). In gastrectomy and gastroesophageal hernia repairs, the aberrant left hepatic artery is endangered due to its abnormal course through the lesser omentum (4). The aberrant right hepatic artery often runs in a twisted and low course near the gallbladder and cystic duct, leading to increased risk of hepatic infarction and bleeding complications during laparoscopic cholecystectomy. Similarly, in surgery of the pancreas, the aberrant right hepatic artery from SMA passes through the pancreatic head, resulting in higher incidence of hepatic ischemia (4).

The knowledge of variant hepatic artery anatomy is of most importance for the planning and execution of the surgical and radiological procedures of the upper abdomen. Many of the described complications can be prevented and overcome with modern surgical techniques.

References:

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