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ANATOMIC VARIATIONS

Replaced right and common hepatic arteries with lienogastric trunk: a rare variant of celiaco-mesenteric anatomy

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Abstract
We report a rare variant in mesenteric arterial anatomy: replacement of the right hepatic and common hepatic arteries to the SMA in a patient treated for hepatocellular carcinoma. The potential clinical implications of this unusual variation of celiaco-mesenteric anatomy will be discussed.

Keywords Hepatic artery variants · Celiaco-mesenteric vasculature · Hepatocellular carcinoma

Introduction

Anatomic variation of the celiaco-mesenteric vasculature is common and has been described over the last two centuries based on anatomic dissections, visceral arteriography and most recently on CT angiography. Recognition of variant anatomy is important for the surgeon in planning liver resection, liver transplantation, pancreatic, gall bladder, and gastric surgery. This anatomic variation not only includes the origination of arterial branches but also variation in the course of these branches with respect to the pancreas, portal vein, bile duct, and gallbladder as well as their course through the liver. We report an anatomic variation of the hepatic arterial supply to the liver not previously described and discuss its surgical implications.

Case presentation

A 49-year-old African American male with a history of hepatitis C and cirrhosis presented with a newly discovered 4-cm right-lobe hepatocellular carcinoma. The patient declined liver transplantation and was deemed a resection candidate. Prior to resection, chemoembolization with doxorubicin was performed in conjunction with right portal vein embolization to increase the volume of the left lobe of the liver. CT angiography followed by arteriography at the time of chemoembolization demonstrated an anatomic variation of the hepatic vasculature not previously described in extensive reviews of anatomic variations of the hepatic vasculature.

The celiac axis supplied the splenic and left gastric arteries (Fig. 1). The first branch of the superior mesenteric artery was the replaced right hepatic artery. Distal to this branch was the common hepatic artery giving rise to the left hepatic and gastroduodenal artery (Fig. 2). This variation was later demonstrated by catheter angiography at the time of chemoembolization. The replaced right hepatic artery was seen on CT to course posterior to the head of the pancreas and postero-lateral to the common bile duct and portal vein as most commonly described. The common hepatic artery was seen to course anterior to the head of the pancreas with the left hepatic artery entering the liver through the fissure of the ligamentum venosum (Fig. 3). These anatomic locations were verified in the operating room at the time of resection having been appreciated on preoperative imaging.

Discussion

The earliest evidence of normal and aberrant celiac trunk anatomy dates back to Haller's text in 1756 [3]. One of the earliest attempts at classifying anatomic variants of the

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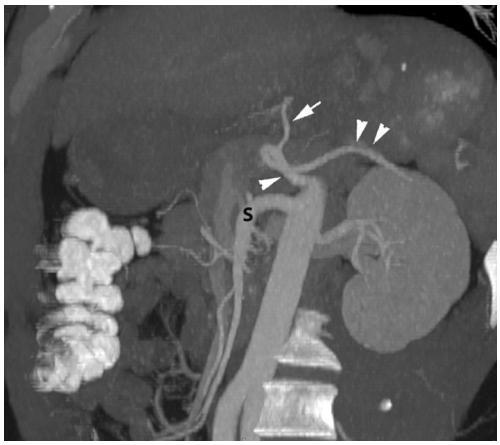

Fig. 1 Coronal MIP CTA of abdominal aorta demonstrating the celiac axis supplying the splenic artery (arrowheads) and the left gastric artery (arrow) and the superior mesenteric artery (S) arising from the aorta

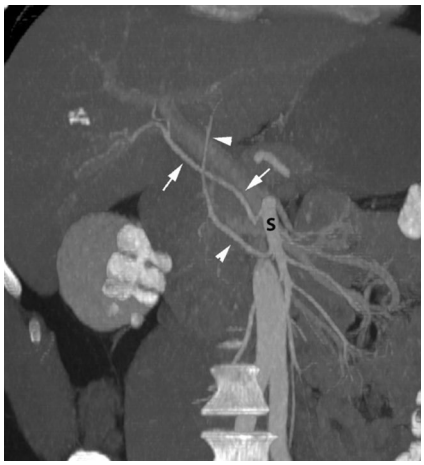

Fig. 2 Coronal MIP CTA of superior mesenteric artery anatomy. First branch of the superior mesenteric artery (S) is the right hepatic artery (arrows). The common hepatic artery (arrowheads) originates more distally off the SMA

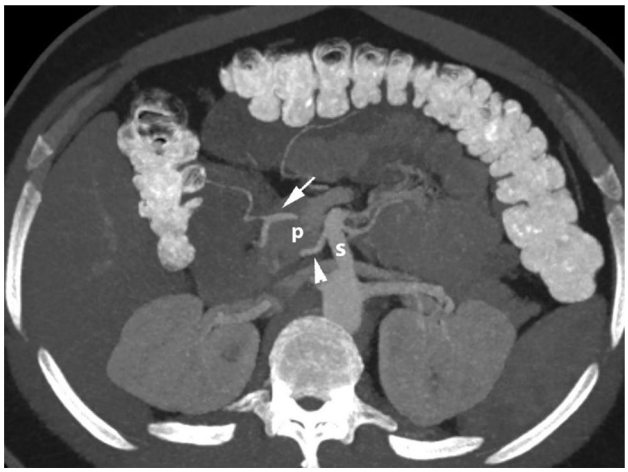

Fig. 3 Axial MIP image CTA at level of pancreatic head demonstrates replaced right hepatic artery (arrowhead) arising from superior mesenteric artery (S) and coursing posterior to the pancreatic head (P). Replaced common hepatic artery (arrow) coursing anterior to pancreatic head

celiac axis and superior mesenteric arteries was by Lipshutz [6] in 1917. In 1955, a classic paper by Michels [7], described 10 variations of hepatic artery anatomy based on dissection of 200 cadavers (Table 1) with subsequent studies by Covey [2], Koops, [5], Hassan [4] and Chen [1] describing additional variations based on angiographic findings. Classic celiac axis anatomy was identified in 55% of cadavers in Michels' cadaver study. Song's study of celiac axis and common hepatic artery variations in 5002 patients based on CT and DSA [9] described classic celiac axis anatomy in 89% of patients and went on to analyze the course of the hepatic arteries relative to the head of the pancreas and the relationship of the hepatic artery to the portal vein in classic and variant anatomy. In Noussios' [8] literature review of 20 publications and 19,013 cases of hepatic artery anatomy and variants, 81% of cases had classic celiac axis anatomy. 96% of cases could be classified as one of the ten variations described by Michels [7]. The most common variations of the hepatic artery are the replaced right hepatic artery to the SMA, and the replaced left hepatic artery to the left gastric artery reported to occur in approximately 11% and 10%, respectively, of the 200 dissections performed by Michels [7]. Although we were able to find one oblique reference to a right hepatic artery and a separate left hepatic artery replaced to the SMA [1], we could not find a report of a right hepatic artery and CHA replaced to the SMA as in our case.

The clinical implications of variant celiac anatomy can be significant. In our case, dissociation of the right and left hepatic arteries made resection of the right lobe of the liver easier. In the variant described, the length of the left hepatic artery could potentially make left lobe liver transplant easier. In our case, the right hepatic artery traveled posterior to the head of the pancreas and the common hepatic artery traveled anterior to the pancreatic head. If unrecognized pre-operatively, this variant could pose significant risk of injury to a hepatic artery during the course of pancreaticoduodenectomy or any surgical procedure adjacent to the head of the pancreas leading to intra-operative or postoperative hemorrhage, hepatic ischemia/necrosis, biliary duct ischemia or a leak at the biliary enteric anastomosis. Furthermore, foreknowledge of anatomy of the hepatic arteries and GDA is critical at the time of surgical implantation of hepatic artery pumps. These catheters are placed in the gastroduodenal artery at the junction of the gastroduodenal artery and proper hepatic artery. In this patient, placing the

Table 1 Michels' classification of celiaco-mesenteric artery variants (adapted from ref [7])

Type I	Classic anatomy
Type II	Replacement of left hepatic artery to the left gastric artery
Type III	Replacement of right hepatic artery to SMA
Type IV	Replacement of left hepatic artery to left gastric artery and replacement of right hepatic artery to SMA
Type V	Accessory left hepatic artery arising from left gastric artery
Type VI	Accessory right hepatic artery arising from SMA
Type VII	Accessory left hepatic artery from left gastric artery and accessory right hepatic artery from SMA
Type VIII	Combination patterns of replaced right hepatic artery from SMA and accessory left hepatic artery or replaced left hepatic artery from left gastric artery and an accessory right hepatic artery
Type IX	Common hepatic artery replaced to SMA
Type X	Replaced common hepatic artery arising from left gastric artery

catheter in the gastroduodenal artery would have resulted in misperfusion.

Knowledge of the variant anatomy prior to chemoembolization will result in diminution of fluoroscopic time and radiation dose to the patient and operators.

Variation in anatomy of the celiaco-mesenteric vasculature is common. Multidetector CT scanning provides an opportunity for procedure planning both with respect to the presence of and anatomic course of anatomic variants. It is crucial for both the interventional radiologist and surgeon to appreciate both the variation in the classic anatomy and course of the anatomic variant.

Author contributions LB: manuscript writer/editor interventional radiology attending. JN: manuscript writer/editor interventional radiology attending, participated in the interventional radiology portion of the case. GK: manuscript writer. SC: interventional radiology fellow and participated in chemoembolization. MSG: attending surgeon for hepatic resection.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest.

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