Case Report

Chemoembolization via the right inferior phrenic artery in a patient with celiac stenosis: usefulness of angiography at full inspiration

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A B S T R A C T

The present report describes a case of successful chemoembolization via the right inferior phrenic artery (RIPA) in a patient with hepatocellular carcinoma and celiac stenosis due to the median arcuate ligament sling. The RIPA, which was not visualized on celiac angiography obtained at full expiration, was evidently visualized on angiography performed at full inspiration, followed by successful catheterization. Angiography at full inspiration can visualize and facilitate the catheterization of the RIPA in patients with celiac stenosis due to the median arcuate ligament sling.

Keywords: Celiac stenosis, Median arcuate ligament, Right inferior phrenic artery

Introduction

When celiac angiography is required in patients with celiac axis stenosis (e.g., hepatic artery chemoembolization or coronary artery bypass using right gastroepiploic artery as a graft), catheterization of the celiac trunk may not be easy.1–3 The level of difficulty would be even higher for catheterization of a branch, such as the inferior phrenic arteries or left gastric artery arising immediately distal to the celiac stenosis. One of the major causes of celiac stenosis includes extrinsic compression by the median arcuate ligament (MAL)1,4–6 and it is known that the degree of celiac stenosis caused by the MAL is relieved during inspiration.6–8

If celiac artery stenosis is caused by the MAL compression, the degree of compression varies with respiration, usually increasing with expiration and decreasing or disappearing with inspiration. This respiratory variation in the degree of compression can be demonstrated by the digital subtraction lateral aortogram with contrast medium or carbon dioxide performed in both full inspiration and full expiration. Catheterization of the celiac artery and its branches such as the inferior phrenic arteries and left gastric artery can be facilitated if the attempt is made during deep inspiration. Herein, we present a case of a 55-year-old man with MAL compression of the celiac artery and recurrent hepatocellular carcinoma (HCC) who underwent successful chemoembolization via the right inferior phrenic artery (RIPA) arising just distal to the celiac stenosis, exploiting the respiratory variation in the degree of compression.

Case report

A 55-year-old man was referred to our interventional radiology department for chemoembolization for recurrent HCC. After undergoing segmentectomies of segments IV and VI 2 years earlier, the patient has received nine sessions of chemoembolization for tumor recurrence. A computed tomography (CT) angiogram and arteriograms of the celiac artery and the superior mesenteric artery (SMA) showed replaced common hepatic artery from the SMA. The celiac artery gave rise to the left gastric and splenic arteries. The sagittal CT reconstruction of the aorta showed a characteristic hooked appearance of the celiac artery just beyond the origin of the MAL compression (Fig. 1A). Axial CT scans showed multiple hypervascular HCC nodules in both lobes of the liver and at the liver dome (Fig. 1B). The RIPA arising from the celiac artery was dilated (Fig. 1B and C).

The replaced common hepatic artery was catheterized using a 5F Rosch hepatic catheter (RH; Cook, Bloomington, IN, USA) and the arteriogram showed diminutive intrahepatic arterial branches as a result of previous multiple chemoembolization (Fig. 2A). The gastroduodenal and its branches including the posterior superior pancreaticoduodenal and right gastroepiploic arteries were dilated, reconstituting the inferior phrenic, pancreatic, and left gastric arteries. The splenic artery did not fill, as it was filled from the stenotic celiac artery. The omental branches of the gastroduodenal artery supplied hypervascular tumors in the liver. A celiac arteriogram was performed in full expiration, and showed stenosis of the...
Fig. 1. Contrast-enhanced computed tomography (CT) study of a 55-year-old male patient. (A) A sagittal reconstruction image of computed tomography (CT) shows that the proximal portion of the celiac axis (arrow) has a typical hooked appearance with focal narrowing, suggestive of compression by the median arcuate ligament. Note the left gastric artery (arrowhead) arising from the celiac trunk. (B) An axial CT image of arterial phase taken 1 month prior to chemoembolization demonstrates hypervascular nodular lesion (arrowhead) at the liver dome. Note the hypertrophied right inferior phrenic artery (arrow). (C) An axial CT image at the lower level of Fig. 1B shows small enhancing nodule (arrowhead) and the right inferior phrenic artery (arrow) arising from the celiac trunk just proximal to the origin of the left gastric artery.

Fig. 2. Angiographic findings and a follow-up CT scan of this patient. (A) Common hepatic angiography performed with a 5F catheter (Rosch hepatic (RH); Cook, Bloomington, IN, USA) reveals the multinodular tumor staining (white arrows) in the liver. The posterior arcade and right gastroepiploic arteries are dilated due to celiac stenosis, and reconstitute the right inferior phrenic artery (black arrowhead), left gastric, pancreatic and gastric branches. Tumor staining at the liver dome (black arrows) is supplied by the right inferior phrenic artery. (B) A celiac angiogram performed at a full-expiratory phase. Contrast media was injected at a rate of 5 mL/second. The right inferior phrenic artery and the left gastric artery are not visualized due to collateral circulation. Dorsal pancreatic and pancreatica magna did not fill due to collateral circulation, either. (C) Selective angiography of collateral branches coming from the superior mesenteric artery shows the reconstructed right inferior phrenic artery. (D) A celiac angiogram performed at a full-inspiratory phase with the same catheter location as Fig. 2B. Contrast media was injected at a rate of 5 mL/second. The right inferior phrenic artery (arrow) and the left gastric artery are well demonstrated. (E) Selective angiography of the right inferior phrenic artery reveals multiple hypervascular nodules (arrows) supplied by the right inferior phrenic artery. The mixture of doxorubicin and iodized oil was administered at the ascending branch of the right inferior phrenic artery. (F) An unenhanced computed tomography image taken 2 weeks after chemoembolization shows accumulation of iodized oil in the tumor (arrowhead), which was noted in Fig. 1B.
celiac artery and the splenic artery. There was no filling of the RIPA or left gastric artery (Fig. 2B). The attempts to catheterize the RIPA through the celiac artery and coaxially using a microcatheter through the collateral vessels of the SMA were unsuccessful (Fig. 2C).

A repeat celiac arteriogram was performed in full inspiration, which filled the RIPA (Fig. 2D). A microcatheter (Progreat 2.0; Terumo, Tokyo, Japan) was advanced into the RIPA using a guidewire (Transend; Boston Scientific, Natick, MA, USA) while the patient held his breath in deep inspiration. During coaxial catheterization, RH catheter was engaged at the orifice of celiac trunk and a guidewire was shaped in a J tip. Angiography of the RIPA revealed two hypervascular nodules (Fig. 2E), corresponding to the tumors seen on CT. Chemoembolization was performed via the right hepatic artery, omental branch from the gastroduodenal artery, and the RIPA, using an emulsion of iodized oil (Lipiodol; Laboratoire Andre Guerbet, Aulnay-sous-Bois, France) and doxorubicin hydrochloride (Adriamycin RDF; Ildong, Seoul, Korea) and absorbable gelatin sponge particles (Gelfoam; Upjohn, Kalamazoo, MI, USA) 1 mm in diameter. A total of 20 mg of doxorubicin and 4 mL of iodized oil was administered and approximately 30% of the doxorubicin/iodized oil mixture was administered via the ascending branch of the RIPA. A follow-up unenhanced CT scan performed 2 weeks after the chemoembolization showed dense accumulation of iodized oil in the nodules, which had been formerly supplied by the RIPA (Fig. 2F). A CT scan taken 3 months after the 10th session of procedure revealed multiple recurrent tumors in the liver, and the patient received an 11th session of chemoembolization.

Discussion

It is widely appreciated that extrahepatic collateral vessels play a major role in tumor recurrence after receiving repeated chemoembolization. Among them, the RIPA is one of the most common extrahepatic collateral arteries. The right and the left inferior phrenic arteries usually originate from the celiac trunk or directly from the aorta as a common trunk or independent origins. They may also arise from the renal arteries, left gastric artery, or hepatic arteries. Selection of the RIPA originating from the celiac axis becomes far more challenging in a patient with celiac stenosis. Relentless efforts have been made by many interventional radiologists to find effective techniques to select the RIPA under the special circumstance.

The MAL is a fibrous band connecting bilateral diaphragmatic crura across the aortic hiatus. The ligament usually traverses superiorly to the origin of the celiac axis. When the insertion of this ligament is low, thereby crossing against the celiac axis, this may cause clinically significant symptoms such as abdominal pain. Park et al suggested that compression by the MAL sling is the most common cause for celiac stenosis in the Korean population.

Miyayama et al demonstrated that when the RIPA is occluded, it tends to be reconstructed through the retroperitoneal branches, and that selective chemoembolization of the RIPA through the anastomosing branch is possible at a high success rate. Baek et al have proposed a shepherd’s hook technique, which facilitates selection of a side branch vessel arising at an acute angle. In the presented case, the RIPA was reconstructed through the anastomosing branches derived from the SMA; however, the branches were too small to select. As an alternative, we adopted Baek’s method of using the micro-guide wire preshaped into a shepherd’s hook form; nonetheless, selection of the orifice of RIPA arising from the celiac axis with stenosis was still challenging.

Deep inspiration relieves the stenosis of celiac axis caused by the MAL, because the celiac axis assumes a more caudal orientation as the lungs expand during inspiration, and the angulation between the RIPA opening and celiac axis becomes more obtuse. Therefore, the maneuver enhances the opportunity to perform selective catheterization. In the presented case, the effect of inspiration on the dynamic occlusion of the RIPA angiography was easily reproduced on two separate angiographies obtained at full inspiration and expiration. Our findings indicate that angiography at full inspiration may facilitate selection and successful chemoembolization of the RIPA in a patient with celiac stenosis caused by the MAL sling.

Conflicts of interest

All contributing authors declare no conflicts of interest.

References