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HEPATOBILIARY

Aberrant left gastric vein is associated with hepatic artery variations

Emre Ünal[1] · **Musturay Karcaaltincaba**[1]

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Abstract

Objective To investigate the imaging findings and hepatic artery variations encountered in patients with aberrant left gastric vein (ALGV).

Methods A retrospective database search between January 2014 and November 2018 was carried for ALGV. The course and types (1–3) of ALGV, the presence of associated liver lesions, and coexistence of hepatic artery variations were reviewed on CT images.

Results A total of 32 patients (22 men, 68.7%) with a mean age of 52.5 years (range 22–76 years) were found to have ALGV. The prevalence of ALGV was 0.073%. The most frequent type of ALGV was type 1 ($n=22$, 68.7%), followed by type 3 ($n=7$, 21.8%) and type 2 ($n=3$, 9.3%). We noticed mild-to-severe parenchymal hyperdensity at the posterior aspect of segments II and III in patients with type 1 ($n=20/22$) and type 2 ($n=2/3$) ALGV consistent with fat sparing due to third inflow effect. Two out of seven patients with type 3 ALGV had main portal vein thrombosis; however, the presence of ALGV maintained left portal vein flow in these patients. Twelve (37.5%) patients had accompanying hepatic artery variation. Left hepatic and right hepatic artery variations were detected in 8 (25%) and 2 (6.25%) of the patients, respectively. In 2 patients, Michels type IV variation was detected.

Conclusion Aberrant left gastric vein is associated with hepatic artery variations, which can be important for preoperative and pretransplant planning.

Keywords Aberrant left gastric vein · Hepatic artery variation · Pseudolesions of liver · CT

Introduction

Venous drainage of the stomach into liver is an important entity particularly for patients who are candidates for liver or gastric surgery. Anomalous course of gastric veins and their association with portal venous system have been previously mentioned [1–6]. Aberrant left gastric vein can be associated with pseudolesions of the liver [3, 5]. Three different types of aberrant left gastric vein (ALGV) have been reported in 1986 [7]. In a recent study, authors identified three different types of ALGV on CT images depending on the course of veins [3]. There is still limited data in the literature obtained from small number of patients [3–5, 8, 9]. No data have been reported regarding the prevalence of ALGV types and their association with anatomic variations of the hepatic arteries [10–13]. The aim of our study was to investigate the imaging findings and hepatic artery variations encountered in patients with ALGV.

Materials and methods

Patients

A retrospective database search between January 2014 and November 2018 was carried for the study using three phrases as keywords: "aberrant left gastric vein," "ALGV," and "aberrant gastric vein." Medical records and CT examinations of patients were reviewed for the study. The study has been approved by the local ethics committee. Informed consent was waived because of the retrospective nature of the study.

✉ Musturay Karcaaltincaba
musturayk@yahoo.com

Emre Ünal
emreunal.rad@gmail.com

[1] Liver Imaging Team, Department of Radiology, Hacettepe University School of Medicine, 06100 Ankara, Turkey

CT technique and image analysis

All patients had abdominal CT scans and CT examinations were performed by 16-MDCT scanner (Somatom Sensation 16, Siemens, Germany). All patients received 100 ml of iodinated contrast material (Ultravist 300/100 mg/ml; Bayer Schering Pharma, Berlin, Germany) at a flow rate of 4 ml/s by a power injector. CT images were obtained 70 s after the injection of contrast for portal venous phase images. Technical parameters were detector collimation 1.5 mm, pitch 1.5, gantry rotation time: 0.5 s. Axial images were reconstructed at 2- and 5-mm-thick images and were transferred to PACS.

The course of ALGV, presence of associated liver lesions, and coexistence of hepatic artery variations were reviewed on CT images for each patient. The types of ALGV were classified as follows: (i) type 1 vein, acting as a pure accessory portal vein branching through the parenchyma; (ii) type 2 vein, has a parenchymatous distribution and also anastomosis to left intrahepatic portal vein; and (iii) type 3 vein, has anastomosis to left intrahepatic portal vein branch. Also, the presence of upper abdominal MRI was checked from hospital and radiology information systems in patients with ALGV.

Statistical analysis

Statistical Package for Social Sciences (SPSS) version 19.0 (Chicago, IL, USA) was used for statistical analysis. Descriptive statistics were given as median (minimum–maximum). Statistical significance is deemed to occur when a p value is less than 0.05.

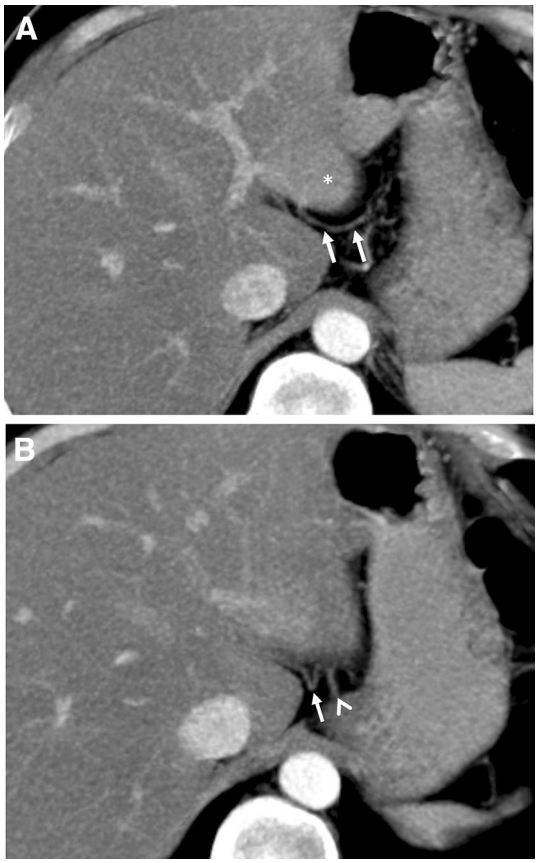

Fig. 1 A forty-three-year-old man with a previous history of adrenocortical cancer underwent CT examination for screening of distant metastases. **a** Axial contrast-enhanced reformatted CT image demonstrates the type 1 aberrant left gastric vein (ALGV) (arrows) and associated pseudolesion (asterisk) at the posterior aspect of segments II and III of liver. **b** Axial reformatted CT image from upper slice shows the presence of accessory left hepatic artery (arrows) originating from left gastric artery (arrowhead)

Results

A total of 32 patients (22 men, 68.7%) with a mean age of 52.5 years (range 22–76 years) were found to have ALGV among 43679 patients who underwent abdominal CT examination between January 2014 and November 2018. The most common indication for CT was to evaluate the disease progression in cancer patients ($n=21$, 65.6%). The most frequent type of ALGV was type 1 ($n=22$, 68.7%), followed by type 3 ($n=7$, 21.8%) and type 2 ($n=3$, 9.3%). There was no parenchymal attenuation difference (pseudolesion) in patients with type 3 ALGV. However, we noticed mild-to-severe parenchymal hyperdensity at the posterior aspect of segments II and III in patients with type 1 ($n=20/22$) and type 2 ($n=2/3$) ALGV. The hyperdensity at these areas corresponded to fat sparing due to third inflow effect (Fig. 1). In 18 of 32 patients, liver MRI confirmed parenchymal fat sparing related to ALGV (Fig. 2). In two out of seven patients with type 3 ALGV, main portal vein thrombosis was evident at CT. However, the presence of ALGV maintained left portal vein flow in these two patients.

Twelve (37.5%) of the patients had accompanying hepatic artery variation (Figs. 1, 3, 4, 5). Left hepatic artery, right hepatic artery, and coexistence of both right and left hepatic artery variations were detected in 8 (25%), 2 (6.25%), and 2 (6.25%) of the patients, respectively. An accessory and a replaced left hepatic artery originating from left gastric artery was detected in 5 and 3 of the patients, respectively. In 2 patients a replaced right gastric artery originating from

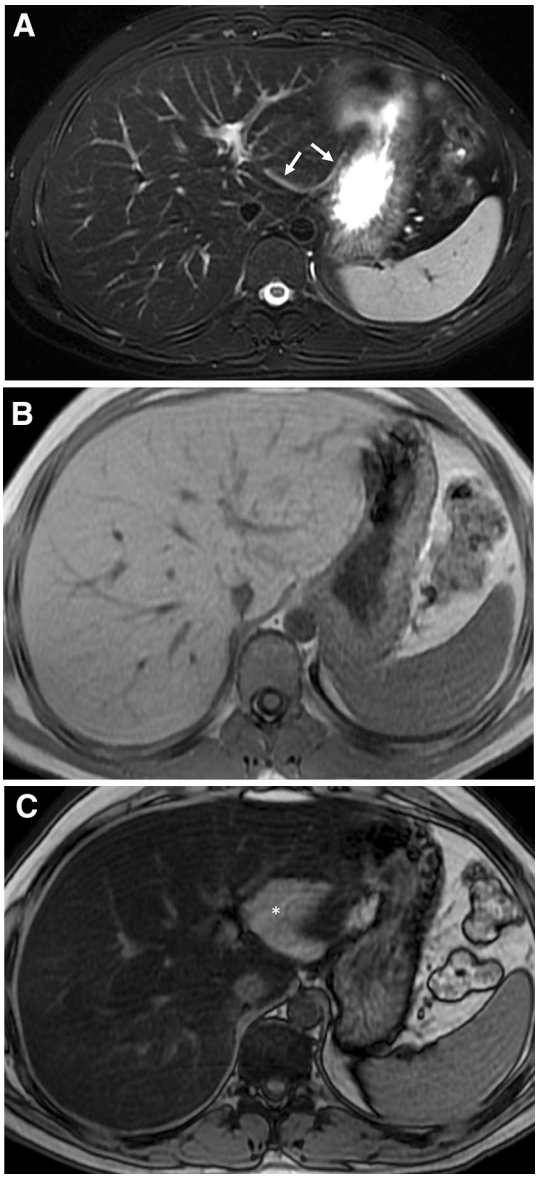

Fig. 2 A twenty-two-year-old man with elevated liver enzymes. Liver MRI was performed due to marked hepatic steatosis found on previous CT scan. **a** Axial T2 fat-saturated image demonstrates the course of type 1 ALGV (arrows). There was no sign of parenchymal signal abnormalities. **b**, **c,** In (**b**) and opposed phase (**c**) MR images reveal the fat-spared area located at the posterior aspect of segments II and III (asterisk, **c**)

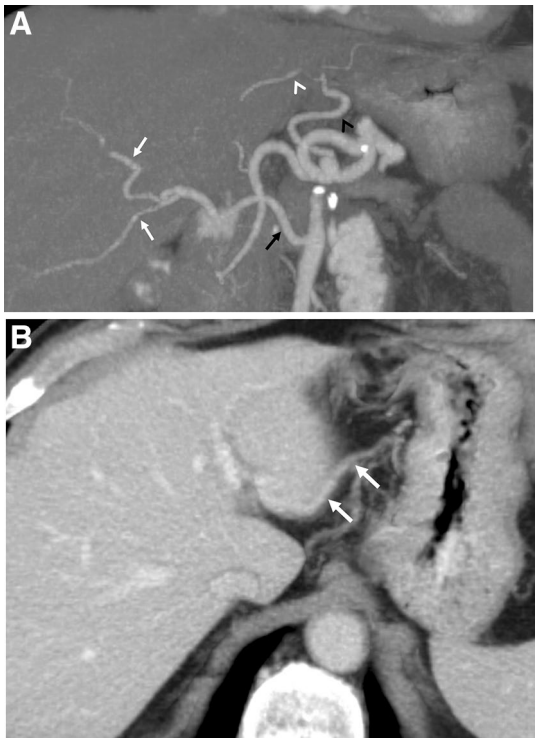

Fig. 3 A seventy-six-year-old man with colon cancer underwent CT scan for screening of distant metastases. **a** Coronal reformatted maximum intensity projection (MIP) CT image demonstrates the coexistence of replaced right (white arrows) and left (white arrowhead) hepatic arteries originating from the superior mesenteric (black arrow) and left gastric (black arrowhead) arteries, respectively (Michels type IV variation). **b** The presence of type 1 ALGV (arrows) is also noted

superior mesenteric artery was noted. The presence of hepatic artery variations is summarized in Fig. 6.

Discussion

The most common type of ALGV was type 1 followed by type 3 and type 2, in our study. This was the first study that evaluated the imaging-based incidence of ALGV types in the literature. The prevalence of ALGV was 0.073%. The low incidence of type 2 ALGV in this study could be attributed to limitation of CT scans that we might have failed to detect anastomosis of submillimeter veins to portal vein in patients with type 1 and 3 ALGV. Although this study comprises the largest patient population reported in the literature, we acknowledge that a CT-based study has limitations in the assessment of anatomical variations of vessels and is not a gold standard in this regard compared to an autopsy study. However, all patients reported here had multidetector CT scans with 2 mm slice thickness. The accuracy of multidetector CT in the evaluation of anatomical variations of hepatic arterial system and coeliac trunk has been reported in the literature [12, 14]. Type 1 ALGV acts as an accessory portal vein with no communication to the portal venous system [3, 7]. Therefore, it has its own parenchymal distribution in the liver. The most common site for type 1 ALGV insertion was at the posterior aspects of segments II and III of liver in this study. Liver

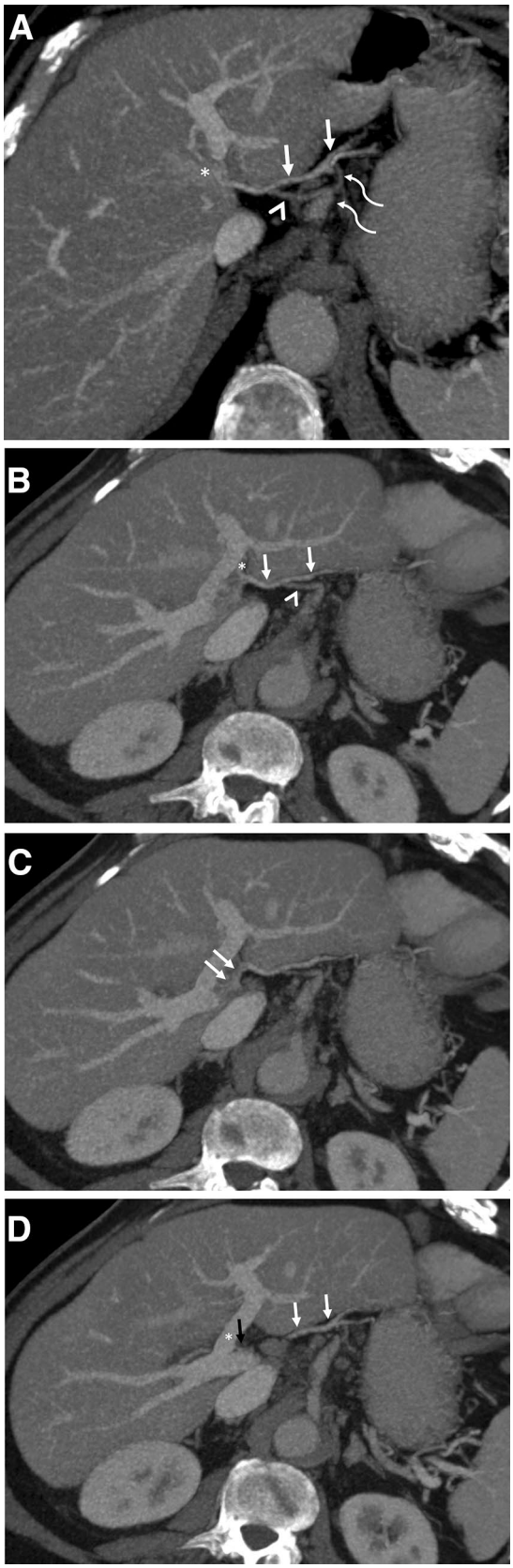

Fig. 4 A sixty-five-year-old man with lung cancer underwent CT scan for screening of distant metastases. **a–d,** Axial reformatted MIP CT images demonstrate type 2 ALGV (arrows, **a–d**) acting as a pure accessory portal vein branching through the parenchyma (asterisks, **a**, **b**) and also anastomosis (black arrow) to left intrahepatic portal vein (asterisk, **d**). The coexistence of replaced left hepatic artery (arrowheads, **a**, **b**) originating from left gastric artery (curved arrows) is also noted

parenchyma at the site of aberrant venous drainage may demonstrate different attenuation values on CT images of patients with type 1 ALGV (pseudolesions). The reason for this appearance was fat-spared area in our study, which was also in line with previously published literature [2, 3, 5, 8]. Altered parenchymal attenuation in these areas may cause confusion particularly in cancer patients, who are routinely screened for metastasis. Liver steatosis may become evident on follow-up, therefore hyperdensity related to fat sparing on CT images could be interpreted as a new finding on the follow-up of these patients. In patients with type 3 ALGV, we did not detect any parenchymal attenuation difference or fat-spared areas. This is due to lack of parenchymal drainage and type 3 ALGV has direct communication with the left intrahepatic portal vein. The most substantial finding in the latter subgroup was preserved portal vein flow in case of main portal vein thrombosis [4]. Two out of seven patients with type 3 ALGV had main portal vein thrombosis in this study. We noticed diminished periportal cavernomatous transformation through the course of left portal vein in these two patients.

The anatomical variations of hepatic arterial system have been previously reported. However, there is no study that investigated the coexistence of these variations in patients with ALGV. We found hepatic artery variation in 37.5% of the patients with ALGV. The overall incidence rate of hepatic artery variation was not higher than the results of published literature [10–12, 15]. However, we noticed that the presence of hepatic artery variation was relatively more common in patients with type 2 and 3 ALGV compared to patients with type 1 ALGV. In addition, two patients (6.25%) had coexistence of replaced right and left hepatic arteries originating from the superior mesenteric and left gastric arteries, respectively (Michels type IV variation) [16]. This type of variation is a rare entity reported to be seen in approximately 1% of the cases [11, 17].

In patients with gastric cancer, periportal spread of tumor via gastrohepatic ligament is a known pattern of

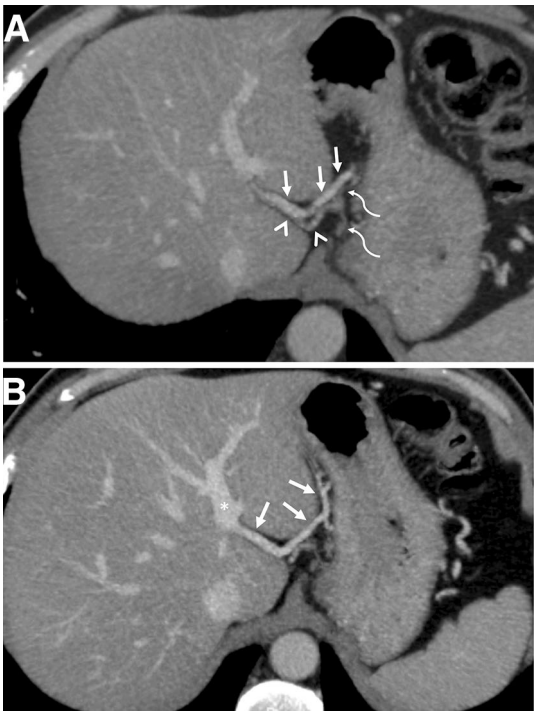

Fig. 5 A thirty-six-year-old man with a previous history of testicular cancer underwent CT scan due to elevated serum tumor markers. **a**, **b** Axial reformatted MIP CT images demonstrate the course of type 3 ALGV (arrows, **a**, **b**) draining into the left intrahepatic portal vein (asterisk). The presence of accessory left hepatic artery (arrowheads) originating from left gastric artery (curved arrows) is also noted

involvement. Gastric cancer may invade the arteries, veins, nerves, and lymphatic channels within ligaments [18]. The imaging findings may vary depending on the tumoral invasion of different gastric veins [19]. Tumoral invasion of ALGV may mimic gastrohepatic ligament invasion. Particularly in patients with type 3 ALGV, tumor spread may result in direct left liver lobe invasion via left portal vein [19]. Lack of biliary dilatation and periportal thickening may differentiate ALGV invasion from gastrohepatic ligament spread in patients with gastric cancer.

Although this study comprised the largest patient population with ALGV, we acknowledge that the retrospective nature and also low number of patients in each ALGV types are the main limitations of our study.

In conclusion, the presence of ALGV may result in various imaging features including pseudolesions of liver due to fat sparing, preserved left portal venous flow in case of main portal vein occlusion, and associated anatomical variations of hepatic arterial system. Types of ALGV and associated hepatic artery variations should be cautiously evaluated in patients who are candidates for surgery and transplantation.

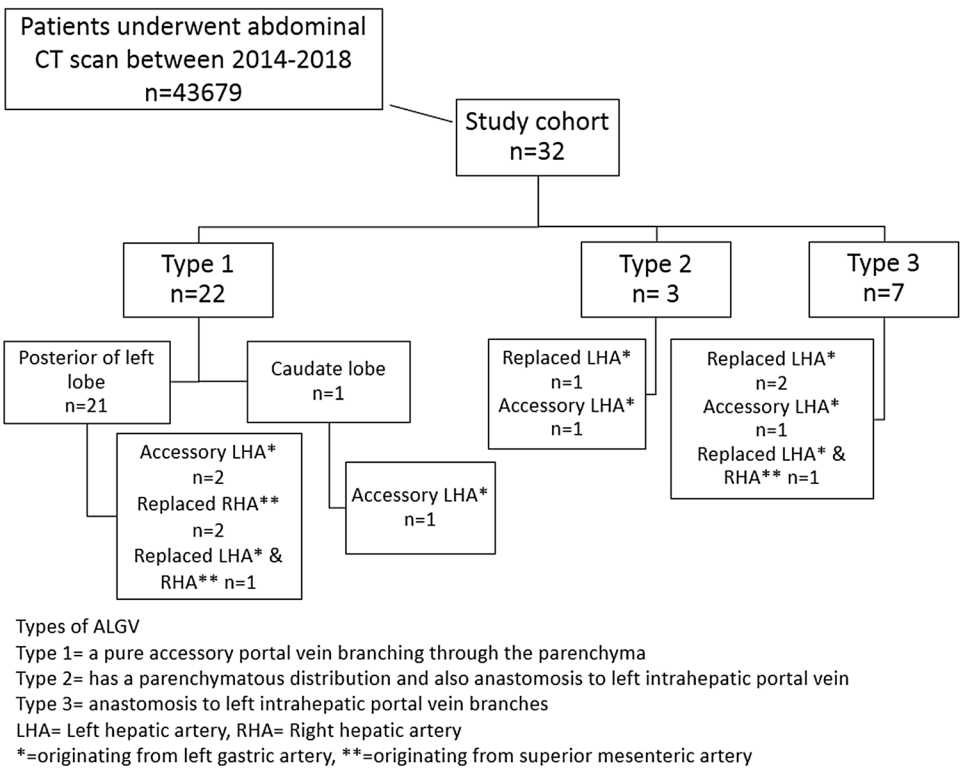

Fig. 6 Distribution of hepatic artery variations in the study population

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

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