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Replaced Left Hepatic Artery: Clinical Significance and Review of the Literature

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Abstract: ***Purpose: Knowledge of hepatic arterial variations is important for surgeons and interventional radiologists in various hepatic interventions, not only for appropriate planning but also to prevent complications. Incidence of hepatic arterial variations is high, however replaced left hepatic artery is a rare variant. Methods: We conducted a retrospective review of 400 abdominal CT scans of patients referred to our department for various etiologies over a period of one year excluding patients referred for post-operative evaluation of hepato-biliary, stomach or pancreatic malignancies and post-transplant patients. Results: Our study population comprised of 222 males (55.5%) and 178 females (44.5%) with age range of 18-78 years. We found 20 cases [14 males (70%) and 6 females (30%)] of replaced left hepatic artery (age range: 23-62 years; mean- 42.2 ± 11.2 years). An associated replaced right hepatic artery was noted in one patient (5%). Conclusion: Replaced left hepatic artery, though rare, is a variation in hepatic arterial branching pattern which has to be reported to prevent untoward event in surgical or interventional radiology procedures.***

Keywords: Replaced left hepatic artery, Anatomical variation, hepato-biliary interventions, replaced right hepatic artery

1. Introduction

Hepatic arterial variations are important in planning, performance and preventing potential complications of various surgical procedures like organ procurement/ transplantation, vascular dissection in surgical oncology and upper abdominal video-laparoscopic surgeries. Also prior knowledge of these variations is mandatory in trans-arterial interventional hepatic procedures, like chemo-radiotherapy and embolization techniques and managing penetrating injuries in upper abdomen, especially in perihepatic area. According to various studies, normal hepatic artery anatomy is noted in approximately 80% of cases, with as high as 20% of the population showing various anatomical variations in the hepatic arterial supply [1-3]. Hepatic arterial anatomy is described as 'normal' when the common hepatic artery (CHA) originates the proper hepatic artery (PHA) after the origin of the gastro-duodenal artery (GDA) and the PHA divides into right and left hepatic arteries within the hepatoduodenal ligament. The frequency of inadvertent hepatic vascular injury increases in the event of aberrant anatomy, and knowledge of anatomical liver vascular variants is crucial for decreasing operative and postoperative morbidity and mortality. The most common variation is the replaced right hepatic artery [1]. Replaced left hepatic artery with the left hepatic artery arising from the left gastric artery is a rare variant of hepatic arterial supply. CT scans used for the preoperative evaluation of patients are excellent in demonstrating the vascular anomalies, with the Maximum Intensity Projections (MIP) and 3D- volume rendering techniques [4-6].

2. Method

Subjects: We conducted a retrospective review of 400 abdominal CT scans of patients referred to our department for various etiologies over a period of one year (from January 2018 to December 2018). Patients undergoing a scan for post-operative evaluation of hepato-biliary, stomach or pancreatic malignancies and post-transplant patients were excluded from this study.

Scanning parameters and Multi-detector computed tomography evaluation:

CT scans of abdomen were performed as a part of their routine diagnostic work on 64 slice MDCT scanner (Philips Brilliance, Philips Medical Systems) or 160 slice MDCT scanner (Toshiba CT Aquilion Prime, Toshiba Medical Systems) after taking informed consent with no change in the hospital protocol.

2.5 mm reconstruction increment, and thinner if need be and viewed at standard soft tissue window settings, also using Maximum Intensity Projections (MIP) (**Fig.3**) and 3D-volume rendering techniques (**Fig.4**).

Figures and Legends

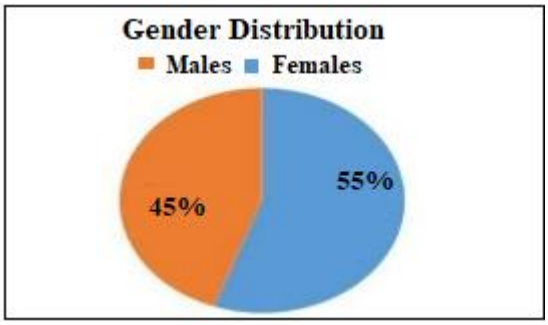

Figure 1: Gender Distribution of Study Population

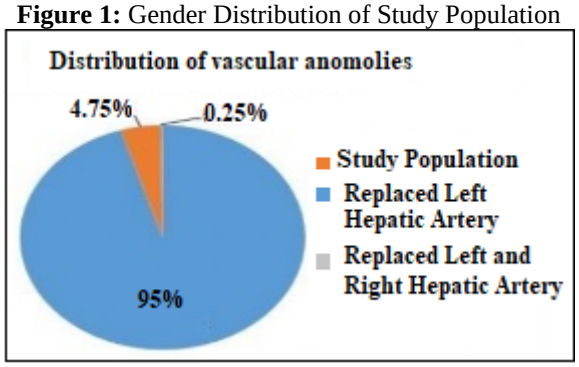

Figure 2: Distribution of vascular anomalies in study population

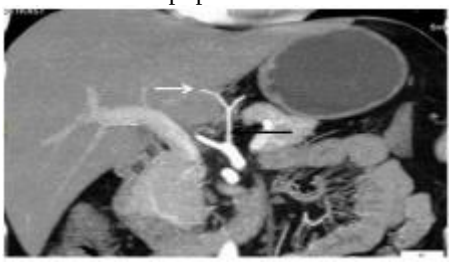

Figure 3: MIP Coronal reconstruction image sowing left hepatic artery arising from the lest gastric artery

3. Results

We analyzed 400 CT scans of the abdomen and pelvis of patients [222 males (55.5%) and 178 (44.5%) females] (**Fig.1**) referred to our department for various abdominal pathologies (age range: 18-78 years). We found 20 cases [14 males (70%) and 6 females (30%)] of replaced left hepatic artery (5%); age range of 23-62 years (mean- 42.2 $\pm$ 11.2 years) (**Fig.2**). One of these patients showed both replaced left and right hepatic arteries (1/400 i.e. 0.25%) (**Fig.5**), with isolated replaced left hepatic artery noted in 19 patients (4.75%).

Figure 4: Volume rendered image showing left hepatic artery arising from left gastric artery

Figure 5: MIP coronal reconstruction image showing left hepatic artery from the lest gastric artery and right hepatic artery arising from the superior mesenteric artery

4. Discussion

Celiac trunk arterial variations can be embryologically explained. The celiac trunk derives from six pairs of ventral splanchnic vessels (subphrenic, upper, middle, lower ventricular and upper and lower intestinal). During the fetal development, these pairs span and disappear. However, the persistence of longitudinal channels between primitive vessels may lead to vascular anomalies or variation [2].

Various international classifications describing the variations in the hepatic vascular anatomy have been proposed [1, 3].

Michels [1] described 10 types of hepatic arterial anatomy using the results of 200 cadaveric dissections : type I: normal pattern; type II: a replaced LHA from the left gastric artery; type III: a replaced RHA from the SMA; type IV: replaced RHA and LHA; type V: an accessory LHA; type VI: an accessory RHA; type VII: accessory RHA and LHA; type VIII: a replaced RHA or LHA with other hepatic artery being an accessory one; type IX: the hepatic trunk as a branch of the SMA; and type X: the CHA from the left gastric artery.

Hiatt [3] put forth six categories of the hepatic arterial anatomy - Hiatt type I- the LHA arising from the left gastric artery, Hiatt type II- the RHA arising from the SMA, Hiatt type III- every combination of a double replaced pattern, Hiatt type IV- the CHA originating as a branch of the SMA, Hiatt type V- isolated aortic origin of the CHA, which Hiatt introduced as type VI instead of including the rare variant with a CHA arising from the left gastric artery.

Various studies have been done to analyze the branching pattern of the celiac trunk by using spiral computed tomography (CT). Sureka B et al. [5] analyzed the variations of celiac axis, common hepatic artery and its branches in 600 patients. Replaced origin of RHA was seen in 15.16% cases and Accessory origin of RHA was seen in 5.16% cases. Replaced LHA origin was seen in 10.8% cases and Accessory LHA origin seen in 7.6% cases. LoschnerC et al [6] evaluated 1297 CT-angiographies and assessed the hepatic arterial anatomy categorized according to Michels's classification. Type I (normal study) according to Michels was seen in 72.2%, LHA arising from the LGA in 4.2% while RHA arising from the SMA in 6.4%. Lopez et al [7] investigated the surgical anatomy of the extra-hepatic arterial

vascularization in 1,081 donor cadaveric transplanted livers, and classified according to Michels description. The most common variant was a replaced left artery arising from the left gastric artery (9.7%), followed by a replaced right hepatic artery arising from the superior mesenteric artery (7.8%).

It is imperative for surgeons and interventional radiologists to have prior knowledge of these hepatic arterial variations for appropriate planning and performance of various hepato-biliary, pancreatic, gastric procedures and other interventions in peri-hepatic area. The frequency of inadvertent hepatic vascular injury increases in the event of aberrant anatomy, and knowledge of anatomical liver vascular variants is crucial for decreasing operative and postoperative morbidity and mortality.

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