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Combined Variations of Right Hepatic Artery and Vein in a Patient with Liver Cancer Undergoing Hepatectomy: A Case Report and Literature Review

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Abstract

Few reports describe the combined variations of hepatic artery and vein involved in liver cancer. We report a 63-year-old woman with liver cancer planed for right hemihepatectomy. The multi detector computer tomography angiography and three-dimensional construction of liver vasculature were performed. The patient was diagnosed as a Michel's type III hepatic artery variation. A replaced right hepatic artery arose from the superior mesenteric artery and had distributed into the right liver lobe. Additionally, a large inferior right hepatic vein drained segment VI and emptied into the inferior vena cava was present at the lower border of the liver. Not only the assessment of hepatic arterial variation is mandatory in patient undergoing hepatectomy, but also the variation of hepatic vein should be thoroughly assessed for hepatic surgery.

Keywords: Anatomic variations; Replaced right hepatic artery; Inferior right hepatic vein; Hepatectomy; Right hepatic vein; Liver cancer

Introduction

The liver possesses a variable arterial blood supply. In the classical anatomical arterial pattern, the celiac axis gives rise to Left Gastric Artery (LGA) and then bifurcates into Splenic Artery (SA) and Common Hepatic Artery (CHA). CHA is divided into the Proper Hepatic Artery (PHA) and Gastroduodenal Artery (GDA). PHA bifurcates into the Left Hepatic Artery (LHA) and the Right Hepatic Artery (RHA) [1]. The internationally accepted classification system concerning anatomical variation of hepatic artery was proposed by Michel [2], which reported that this classical arterial anatomy was seen at a rate of 55%. Since then, many researchers have reported diverse anatomic variations of the hepatic artery making the hepatic surgery complex and difficult [3,4].

The hepatic veins drain the deoxygenated blood from the liver into the Inferior Vena Cava (IVC). There are usually three in number, named the Right Hepatic Vein (RHV), Middle Hepatic Vein (MHV) and Left Hepatic Vein (LHV). Although the liver has a dual source of blood supply from Portal Vein (PV) and hepatic artery, the outflow is only through the hepatic veins. Just like the various variations of hepatic arteries, there are many variations in the venous drainage of the human liver [5,6]. Accurate assessment of the anomaly of the hepatic vein is indispensable for safe liver surgery. Numerous anatomical variations of the hepatic artery have been reported in the literature, however, few reports describe the combined variations of hepatic artery and vein involved in liver cancer. Here, we aimed to present a case with combined variations of the right hepatic artery and vein complicated hepatectomy. We will discuss the influence of these arterial and venous variations in a clinical setting.

Case Presentation

A 63-year-old woman was admitted to our hospital, because she was suffering from upper abdominal discomfort. The patient was a lifelong nonsmoker who did not consume alcohol and had no history of inherited diseases. There was no significant history of biliary or liver disease. Physical examination was unremarkable, and a Murphy sign test was negative. Hemogram, electrolytes, and amylase were within the normal limits. Liver function tests revealed the following: Albumin 35.2 g/L, Alanine Aminotransferase 18 U/L, Aspartate Transaminase 27 U/L, Gamma-Glutamyl Transpeptidase 25 U/L, Total Bilirubin 12.5 mmol/L, and Direct Bilirubin 3.8 mmol/L. Tumor markers revealed the following Alpha-Fetoproteins 38.9 IU/ML, Carcinoembryonic Antigen 2

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Table 1: Michel's classification of hepatic artery variations.

Type	Description	Percent
I	Classic anatomy	55
II	RLHA arising from LGA	10
III	RRHA arising from SMA	11
IV	Coexistence of Type II and III	1
V	A LHA arising from LGA	8
VI	A RHA arising from SMA	7
VII	Coexistence of Type V and VI	1
VIII	RRHA from SMA+ a LHA from LGA or a RHA from SMA+ RLHA from LGA	2
IX	CHA arising from SMA	2.5
X	CHA arising from the LGA	0.5

LHA: Left Hepatic Artery; RHA: Right Hepatic Artery; ALHA: Accessory Left Hepatic Artery; ARHA Accessory Right Hepatic Artery; RLHA Replaced Left Hepatic Artery; RRHA Replaced Right Hepatic Artery; SMA: Superior Mesenteric Artery; CHA: Common Hepatic Artery; LGA: Left Gastric Artery

Table 2: Replaced Right Hepatic Artery (RRHA) detected by MDCTA.

Study	Cases	Classic anatomy, n (%)	RRHA arising from SMA, n (%)
DeCecco et al. [8]	250	165 (66.0)	23 (9.2)
Loschner et al. [9]	1297	1156 (89.1)	103 (7.9)
Anwar et al. [10]	500	306 (61.2)	42 (8.4)
Saba et al. [11]	1629	992 (60.9)	172 (10.6)
Winston et al. [12]	371	347 (93.5)	15 (4.0)
Total	4047	2966 (73.3)	355 (8.8)

ug/L, Carbohydrate Antigen 19-9 39.7 U/mL abdominal ultrasound scan revealed a large hyper echoic lesion measuring 6 cm in maximal diameter located in the central of right liver lobe, and the patient was referred to the in-patient department for further assessment.

From a Multidetector Computer Tomography Angiography (MDCTA) examination, a tumor measuring 5.2 cm × 5.7 cm located in the central of right liver lobe and a variation of the hepatic artery were detected. The patient was diagnosed as a Michel's' type III hepatic artery variation. A Replaced Right Hepatic Artery (RRHA) arose from the Superior Mesenteric Artery (SMA), traversed posterior to the PV and rose along the right posterior side of the Common Bile Duct (CBD) before entering the right liver lobe. At the same time, a classical LHA originated from the CHA fed into the left liver lobe. A three-dimensional reconstruction was performed to better study the anatomy preoperatively. Additionally, it was demonstrated that a comparatively large Inferior Right Hepatic Vein (IRHV) drained segment VI was present, while the classic RHV dominantly drained in segment VII. The IRHV ran posterior to the right branch of PV and emptied into the IVC at the lower border of the liver. The diagnosis of liver malignant tumor and artery variation was further suggested based on imaging findings of selective hepatic arteriography.

Then, under the clinical diagnosis of T3bN0M0 stage III B primary liver cancer according to the 8th edition of the Union for International Cancer Control staging manual, the patient underwent right hemihepatectomy. Intraoperative the variation of RRHA derived from SMA and the aberrant course of RRHA anticipated by three-dimensional reconstruction was observed after hilar dissection. As well as the large IRHV was confirmed at the lower border of the liver when dissection of the third hepatic port is conducted, the ligation of the IRHV was safely completed without injury. The postoperative

Table 3: Prevalence of Inferior Right Hepatic Vein (IRHV) detected by MDCTA.

Study	Cases	Present of IRHV, n (%)
Fang et al. [16]	200	42 (21.0)
Kalaycı et al. [17]	100	58 (58.0)
Sharma et al. [15]	224	126 (56.3)
Sureka et al. [5]	500	185 (37.0)
Watanabe et al. [6]	307	197 (64.2)
Yang et al. [19]	299	103 (34.4)
Cawich et al. [18]	118	53 (44.9)
Total	1748	764 (43.7)

follow-up was uneventful and the patient was discharged on the 8th postoperative day. The histopathologic examination revealed a primary hepatocellular carcinoma. There was no recurrence of the tumor and with normal liver function during the1-year follow-up.

Discussion

Variations in the hepatic artery are commonly described in the last decades. Michel's [2] published autopsy series about hepatic artery variants in 1966, which originally divided the hepatic artery pattern into 10 types (Table 1). Nowadays, Michel's classification is still the most commonly used in clinic, it established the difference between replaced and accessory hepatic artery. An accessory hepatic artery refers to an additional artery of the liver, while a normal branch derives from the PHA. A replaced hepatic artery refers to an anomalous origin of artery supplied the liver without a normal branch derived from the PHA [7]. We reviewed the literature on the anatomic variations of the hepatic artery by MDCTA, of which 4,047 cases were analyzed for anatomic variations of the hepatic artery [8-12]. The results showed that 2,966 (73.3%) cases had standard anatomy and 355 (8.8%) cases had RRHA arising from SMA. A RRHA is most commonly branched from SMA, the incidence of RRHA branched from SMA ranged from 4% to 10.6% (Table 2). Less common rare origins of RRHA include the right gastric artery, celiac axis, abdominal aorta, and GDA [13,14].

Hepatic vein variations are commonly seen similar to variations in hepatic artery; however, hepatic venous anatomic variations are frequently underreported on routine CT [15]. The prevailing pattern of the three hepatic veins was the RHV enters the IVC separately, but the MHV and LHV share a common trunk (65% to 85%). In the remaining patients, the RHV, MHV, and LHV drained independently into the IVC. RHV variation is one of the most common hepatic venous variants included early branching of RHV and multiple RHV. In general, the hepatic venous in the right posterior lobe is primarily drained by the RHV. When an IRHV is present, the IRHV and RHV jointly drain venous blood from the right posterior lobe. The IRHV enters directly into the IVC on the right side and drains the inferior part of the right posterior section. The number of IRHV ranges from 1 to 4 per liver [16].

We reviewed the literature on the anatomic variations of hepatic vein [5,6,15-19], the prevalence of IRHV determined by MDCTA ranges from 21% to 64.2% (Table 3). The RHV and IRHV both belong to the right hepatic vasculature and have intersecting drainage areas. Thus, it is reasonable to expect that their anatomy is correlated. Several studies have determined the diameter of IRHV has a negative correlation with the diameter of RHV [6,15]. Furthermore, a negative correlation was found between RHV diameter and IRHV incidence.

A recent study suggested that IRHV is likely to absent with RHV diameter >8.86 mm, but is likely to present with RHV diameter <8.86 mm [19]. This provides a theoretical basis for surgeons to predict the presence of IRHV when performing hepatectomy or living donor liver transplantation by only measuring RHV diameter.

The clinical implications of variant anatomy of hepatic artery and vein can be significant. In our case, dissociation of the right and left hepatic arteries made resection of the right liver lobe easier. For the special derive of RRHA, the length of RRHA could potentially make right lobe liver transplant easier. However, the RRHA traversed posterior to the PV and rose along the right posterior side of the CBD. If unrecognized preoperatively, this variant could pose significant risk of injury to the hepatic artery during the course of pancreaticoduodenectomy leading to hemorrhage, hepatic ischemia, biliary stricture or a leak at the bilioenteric anastomosis. To identify the blood supply of a tumor and improve the prognosis, separate angiographies of SMA and hepatic arteries during Transhepatic Arterial Chemotherapy and Embolization (TACE) treatment of right hepatic carcinoma is obligatory [20]. Traditional precepts of liver surgery stipulate that, if the main hepatic vein cannot be preserved, the liver segment drained by that vein must be completely removed, to prevent acute necrosis or chronic atrophy of liver tissue. However, this precept changes in the presence of an IRHV. When an IRHV is present, it mainly drains segment VI of the liver. Therefore, if the RHV has to be removed, the liver tissue of segment VI can be preserved in the presence of an IRHV, thereby increasing the volume of the residual liver and decreasing the incidence of postoperative liver failure [21]. Knowledge of these variations is extremely important for surgeons.

Variation in anatomy of the hepatic vasculature is common. MDCTA provides an opportunity for surgeon to discover the anatomic variation both in the hepatic artery and vein. Not only the assessment of hepatic arterial variation is mandatory in patients undergoing hepatectomy, but also the variation of hepatic vein should be thoroughly assessed in hepatic surgery.

Author Contributions

YY and YS: Conception and design, data acquisition, and drafting the paper. YH and WY: Analysis and interpretation of data, and performed the review of literature. BW: Critical revision of the manuscript, and approved final submission. All authors contributed to the article and approved the submitted version.

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