ORIGINAL RESEARCH

Hepatic Artery Variations in a single center in Sri Lanka: A Computerised Tomographic Angiogram-Based Study

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Abstract

Objectives: Hepatic arteries (HA) are an important source of blood supply to the liver and the biliary system. The HA is associated with anatomical variations that have implications for surgical procedures. The purpose of this study is to identify the HA variations on computed tomographic angiography imaging in patients presenting to a single tertiary care centre in Sri Lanka. The reported incidence of variations in the hepatic arterial anatomy varies from 20.0 % to 49.0%.

Methods: This is a cross-sectional descriptive study. Patients undergoing computed tomographic scan (CT) of the abdomen with CT angiogram were included in this study. Data on the patient's age, gender, details on branching pattern variations of the HA were obtained. Incomplete records, images with artefacts, patients with pathologies distorting the hepatic arterial anatomy and the patients who have undergone previous interventions near the area of study were excluded from the analysis. HA variations were classified according to the Michael classification system. 100 images were included in the analysis.

Results: There were 63 [63.0%] males and 37 [37.0%] females. The mean age was 49.8 years (17-100). 74 (74.0%) had type I (normal pattern) anatomy. HA variations were found in 26 (26.0%) images. The commonest variation observed was an accessory LHA in 12 (12.0%) followed by a replaced LHA in 7 (07.0%). The variations occurred in 7 females (7/37 - 18.9%) and 19 males (19/63 - 30.2%) however, this difference was not statistically significant (p-0.3168).

Conclusions: This CTA-based study gives insight into the hepatic artery variations in the study population. This is likely to be the case with the Sri Lankan population. A countrywide study from multiple centres with a larger sample size is needed to know the actual pattern in Sri Lanka.

Keywords: Hepatic Artery Variations, Computerised Tomographic Angiogram, Sri Lanka

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Introduction

The hepatic arteries (HA) are an important source of blood supply to the liver and the biliary system. The hepatic arteries exhibit considerable anatomical variations that have implications for surgical procedures, particularly in hepato-biliary and pancreatic surgeries. Typically, the HA branches from the proper hepatic artery (PHA) which is a branch of the common hepatic artery (CHA). CHA arises from the coeliac axis (CA). CA is an anterior aortic branch that usually begins at the level of the twelfth thoracic vertebra (T12) level (1). The CHA runs along the upper border of the pancreas and divides into the gastroduodenal artery and the proper hepatic artery (PHA). The PHA divides into right and left hepatic arteries (RHA, LHA).

The reported incidence of variations in the hepatic arterial anatomy varies from 20.0 % to 49.0% (2) (3). Understanding these variations is essential for planning surgeries thus minimizing surgical complications and improving patient outcomes. Therefore, the purpose of this study is to explore the HA variations on computed tomographic angiography imaging in patients presenting to a single tertiary care centre in Sri Lanka.

Methods

This is a cross-sectional descriptive study. The study was done at the department of radiology at the National hospital of Sri Lanka, Colombo (NHSL). The patients undergoing computed tomographic scan (CT) of the abdomen with CT angiogram were included in this study. The CT was performed with multi-detector (640 slices) Cannon Aquilion one CT machine at the department of radiology, NHSL. 100 ml of low osmolar iodine based intravenous contrast agent was used. Arteriogram was acquired following bolus tracking after 5 seconds delay from the time when the HU value of the region of interest (at the renal artery level in the aorta) reached 150 HU. All images were transferred to the working station [console room]. HA anatomy was evaluated using multi-planar reconstruction and maximum intensity projection.

The CTA images were analysed by both the surgeon and the radiologist. Data on the patient's age, gender, and details on branching pattern variations of the hepatic arteries were obtained. Incomplete records, non-clear images and images with the non-identifiable arteries due to lack of contrast and images with artifacts were excluded. In addition, patients with pathologies distorting the hepatic arterial anatomy and the patients who have undergone previous interventions near the area of study e.g. previous pancreatico- duodenectomy were also excluded from the analysis.

The HA variations were classified according to the Michael classification system, which includes the following types (4):

- Type I: Normal pattern (Figure 1)
- Type II: Replaced left hepatic artery (LHA) from the left gastric artery
- Type III: Replaced right hepatic artery (RHA) from the superior mesenteric artery (SMA) (Figure 2)
- Type IV: Replaced RHA and LHA
- Type V: Accessory LHA (Figure 3)

- Type VI: Accessory RHA
- Type VII: Accessory RHA and LHA
- Type VIII: Replaced RHA or LHA with the other hepatic artery being an accessory one
- Type IX: Hepatic trunk as a branch of the SMA(Hepato-mesenteric trunk) (Figure 4)
- Type X: Common hepatic artery (CHA) from the left gastric artery

Results

100 images were included in the analysis. There were 63 (63.0%) males and 37 (37.0%) females. The mean age was 49.8 years (17-100). 74 (74.0%) had type I (normal pattern) (Figure 1) anatomy. HA variations were found in 26 (26.0%) images.

Figure 1: Type I: Normal pattern

The prevalence of each variation according to the Michael classification system within the study population were as follows. Type II variation i.e. a replaced left hepatic artery (LHA) from the left gastric artery was found in 07 (7.0%) images.

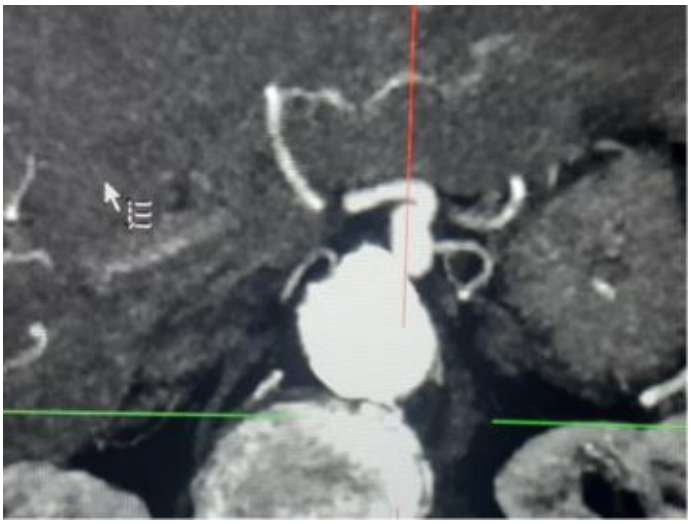

Figure 2: Type III: Replaced RHA from the SMA

Type III Variation (replaced right hepatic artery (RHA) from the superior mesenteric artery (SMA) (Figure 2) was found in 2 (2.0%). Type V variation (accessory LHA) (Figure 3) was found in 12 (12.0%). This was the commonest variation in this series. Type IX variation (hepatic trunk as a branch of the SMA- hepatico-mesenteric trunk) (Figure 4) was found in 02 (02.0%) images (Table 1).

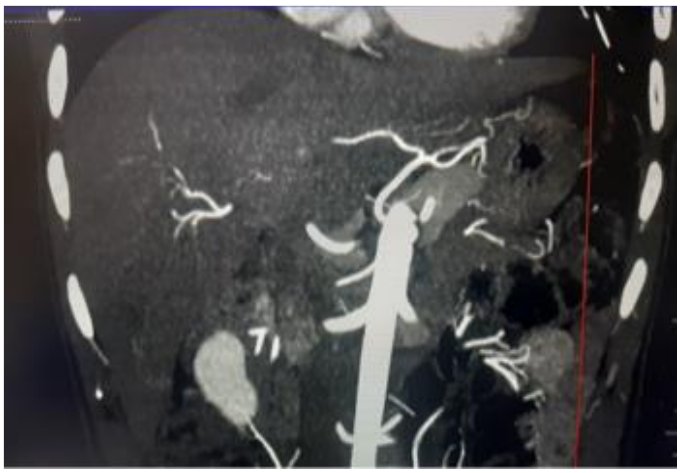

Figure 3: Type V: Accessory LHA

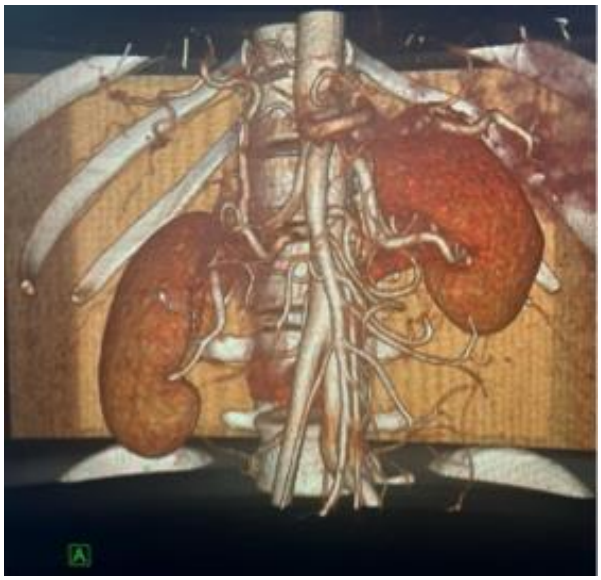

Figure 4: Type IX: Hepatic trunk as a branch of the SMA (Hepato-mesenteric trunk)

Table 1 Summary of the hepatic artery variations

Types		Number (%)
Type I: Normal pattern (Figure 1)		74 (74.0%)
Type II: Replaced LHA from the left gastric artery		07 (07.0%)
Type III: Replaced RHA from the SMA (**Error! Reference source not found.**)		02 (2.0%)
Type V: Accessory LHA (**Error! Reference source not found.**)		12 (12.0%)
Type IX: Hepatic trunk as a branch of the SMA (Hepato-mesenteric trunk) (**Error! Reference source not found.**)		02 (2.0%)
Other variations	1. CHA from SMA, accessory RHA from CT 2. LHA from SMA 3. Small accessory RHA from the aorta	03 (3.0%)

LHA - Left Hepatic Artery, RHA - Right Hepatic Artery, SMA - Superior Mesenteric Artery

Three other variations which were not described in the Michael classification system, were also found in this series. There was one image (1-1.0%) with a CHA arising from the SMA and an accessory RHA from the coeliac trunk. Another image i.e.1(1.0%) demonstrated LHA from SMA and another image demonstrated (1-1.0%) small accessory RHA arising from aorta.

Types IV, VI, VII, VIII and X variations in the Michael classification system, were not found in this series.

Overall, the hepatic artery variations occurred in 26 (26.0%) in this study. The variations occurred in 7 females (7/37 - 18.9%) and 19 males (19/63 - 30.2%). Even though males had a higher percentage of hepatic arterial variations, this difference was not statistically significant (p-0.3168). Similarly, there were 4/63(6.3%) males and 3/37 (8.1%) females with type II variations. This difference was also statistically not significant (p-0 .74). Similarly, there was no statistically significant difference ($p<0.5$) in the occurrence of other types of hepatic arterial variations between the males and the females in this series.

Discussion

During embryological development, the HA starts developing at 8 weeks. Then the artery branches out from the central to the peripheral areas from 10th to the 15th weeks.

During the embryological development the CA and SMA develop by a series of ventral branches (Omphalo Mesenteric Arteries [OMA] or vitelline or ventral splanchnic arteries) form the dorsal aorta (Figure 5).

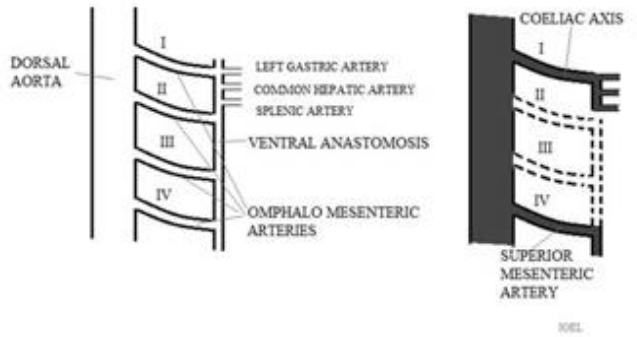

Figure 5: Embryological development the CA and SMA

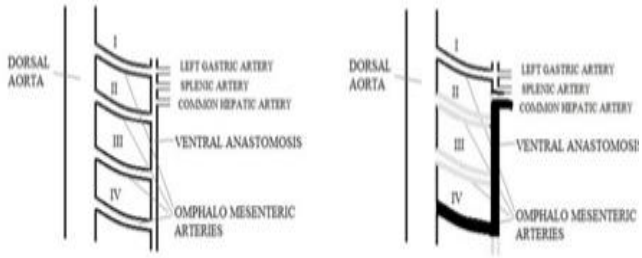

Figure 6: Hepato-mesenteric trunk development

A ventral longitudinal vessel connects the OMA (ventral longitudinal anastomosis). First OMA develops into CA. The Common Hepatic (CHA), Left gastric and Splenic arteries branch out from the longitudinal anastomosis. The pattern of disappearance and persistence of the OMA and the segments of the ventral longitudinal vessel, results in hepatic arterial anatomic variations (5).

For example, the Hepato-mesenteric trunk develops when the ventral longitudinal anastomosis persists between the common hepatic artery and the SMA.

According to the standard anatomical description, an accessory hepatic artery is defined as the one which occurs in addition to normally occurring right and left hepatic arteries i.e. an individual with an accessory right hepatic artery will also have an additional normal right hepatic artery. Whereas the replaced hepatic artery has an abnormal origin and is associated with absent normally dividing hepatic artery.

Overall hepatic artery variations were observed in 26 (26.0%) images in this study. The commonest variation observed was an accessory LHA in 12 (12.0%) (Figure 3) followed by a replaced LHA in 7 (07.0%). Surgeons and radiologists must be aware of these variations to enhance the precision and safety of interventions. This study hopefully will contribute valuable data to the limited literature on hepatic artery variations in Sri Lanka.

Conclusions

This CTA-based study gives insight into the hepatic artery variations in the study population. This is likely to be the case with the rest of the Sri Lankan population. The identified variations underscore the need for detailed evaluation of the hepatic arterial anatomy prior to hepatobiliary and pancreatic surgeries. Smaller number of images analysed and samples taken only from the NHSL are limitations of this study. A countrywide study from multiple centres with a larger sample size

is needed to know the actual pattern of HA variations in Sri Lanka.

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