

# Variations in the Branching Pattern of Hepatic Artery: A Cadaveric Study with Clinical and Embryological Relevance

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## Abstract

**Introduction:** The hepatic arterial anatomy is variable. Pre-operative evaluation of extra-hepatic arterial pattern is relevant for the surgeons during hepatic surgery and the radiologists while doing different procedures. The study's main purpose was to identify the normal and variable branching pattern of the common hepatic artery (CHA).

**Methodology:** A total of 50 properly embalmed and formalin-fixed cadavers were dissected in the abdominal region, and viscera were mobilized to expose the origin of important branches of the CHA.

**Results:** Classical branching pattern of CHA was seen in 90 % of cases. In 2(4%) cases replaced left hepatic artery (LHA) originated from the left gastric artery (LGA). In an additional 2 (4%) cases, it was reported that accessory LHA arose from LGA. In 1 (2%) specimen, the CHA quadri-furcated into LHA, right hepatic artery, cystic artery, gastroduodenal artery.

**Conclusion:** Knowledge of such variations will play a significant role in avoiding technical difficulties during infusion therapy and chemoembolization of neoplasm in the liver. It is also valuable in carrying out surgical interventions safely in the abdomen and interpreting angiographic reports.

**Key words:** Cadaveric study, Common hepatic artery, Hepatic artery, Left hepatic artery, Right hepatic artery

## INTRODUCTION

The liver is the second largest organ of the human body occupying the right hypochondrium of the abdominal cavity. The usual arterial supply of the liver is by common hepatic artery (CHA) arising from the celiac trunk (CT). The CT is a ventral branch of the abdominal aorta that trifurcates into the left gastric artery (LGA), splenic and CHA. The CHA is one of the three classic branches of the celiac artery. It takes a course to the right along the upper border of the pancreas and divides into two limbs, an ascending limb, the proper hepatic

artery (PHA) and a descending limb, the gastroduodenal artery (GDA). The PHA reaches the porta hepatis and divides into the right hepatic artery (RHA) and the left hepatic artery (LHA), which supplies the corresponding lobes of the liver.<sup>[1,2]</sup>

Variations in the branching pattern of hepatic arteries are common. Knowing the anatomy and the possible variations pre-operatively reduces iatrogenic injury. Knowledge of the hepatic arterial branching pattern is of supreme importance in liver transplantation surgeries, as it decides the plane of resection. Post-operative complications are increased in transplant recipients with variant anatomy. Such patients require extra care during pre-operative evaluation and planning of surgery.<sup>[3]</sup>

It is also essential for appropriate placement of chemotherapy pump to avoid mis-perfusion, chemo toxicity, and bleeding. Therefore a thorough knowledge about the normal and variant anatomy of the hepatic artery

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and its branches becomes indispensable in any invasive procedure of the liver and biliary tract.<sup>[2]</sup>

The present study aims at observing the hepatic artery and its branches and the variations in its branching pattern.

## METHODOLOGY

In the present study, 50 embalmed adult human cadavers from the Institute of Anatomy, Madras Medical College were enrolled. The skin incision and the dissection of the layers of the anterior abdominal wall were done as per Cunningham's manual, and the peritoneum was reflected. The greater omentum was identified and lifted. The anterior layer of the greater omentum was cut 2–3 cm inferior to the arteries, and the lower part of the lesser sac was opened. The liver was pulled superiorly. Its inferior margin was tilted anteriorly, and the lesser omentum was exposed. The attachment of the left lobe to the lesser omentum was also cut. The anterior layer of the lesser omentum was removed close to the lesser curvature of the stomach. The LGA present in the lesser omentum was traced. The RGA was traced to its origin from the PHA. The PHA and its branches, the RHA and LHA, were exposed till they reached the porta hepatis.

## RESULTS

We observed that the classic branching pattern was present in 45 cases (90%) in the present study. In 5 (10%) cases, we found unusual branching patterns. In 2 (4%) specimens replaced LHA originated from LGA. Among those 2 specimens, a rare and interesting variation was noted where accessory LGA/arteries emerged from replaced LHA [Figure 1].

In an additional 2 (4%) specimens, it was observed that accessory LHA arose from LGA [Figure 2]. In 1 (2%) specimen CHA quadri-furcated into LHA, RHA, the CA, and GDA [Figure 3].

## DISCUSSION

Abdominal organs such as the stomach, duodenum up to major duodenal papilla, liver, pancreas, and gall bladder are supplied by the branches of the CHA. Therefore, any variation from the usual branching pattern of the artery may lead to complications during various interventions in this region.<sup>[3]</sup>

Few studies on the arterial branching pattern have reported variations in the branches of the CHA.

## Embryological Relevance

Variations in the hepatic arterial anatomy are caused by events occurring during development. Initially, the embryonic LHA arises from LGA, MHA from CT, and RHA from SMA.

Later, the embryonic left hepatic and right hepatic arteries regress, and the middle hepatic artery persists as the PHA in adult life. Finally, near the hilum of the liver, the PHA divides into the right and the left hepatic arteries.<sup>[4]</sup> The persistence of these embryonic arteries may lead to variable branching patterns [Figure 4].

## Clinical Relevance

### Origin of replaced LHA from LGA

We observed that the classic branching pattern was present in 45 cases (90%) in the present study. In 5 (10%) cases, we found unusual branching patterns. Koops *et al.*<sup>[5]</sup> 2004 reported that in 94%, the LHA arose from PHA, and in 4.3%, it arose from LGA. Winston *et al.* 2007<sup>[6]</sup> reported that in 87.9%, the LHA arose from PHA; in 7.6%, it arose from LGA, and in 4.3%, it arose from CHA. Accessory LHA arose from LGA in 4%. Therapeutic embolization of LGA for gastric carcinoma or hemorrhage might result in ischemia of the liver segments it irrigates when LHA arises from LGA as replaced LHA. It can

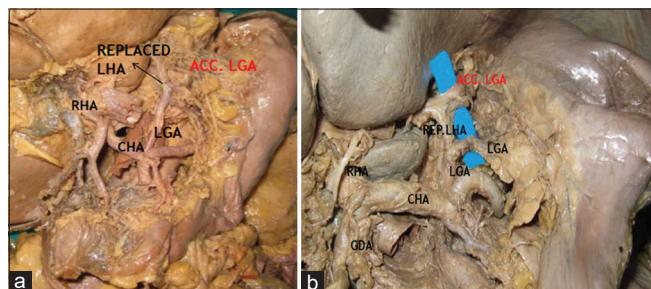


Figure 1: Accessory left gastric artery from replaced left hepatic artery (a and b)

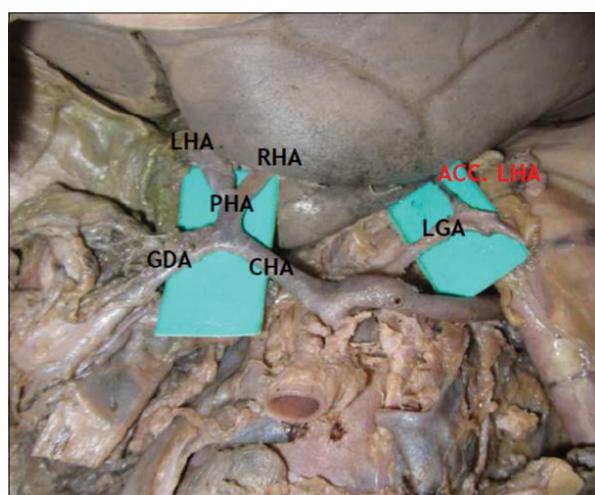
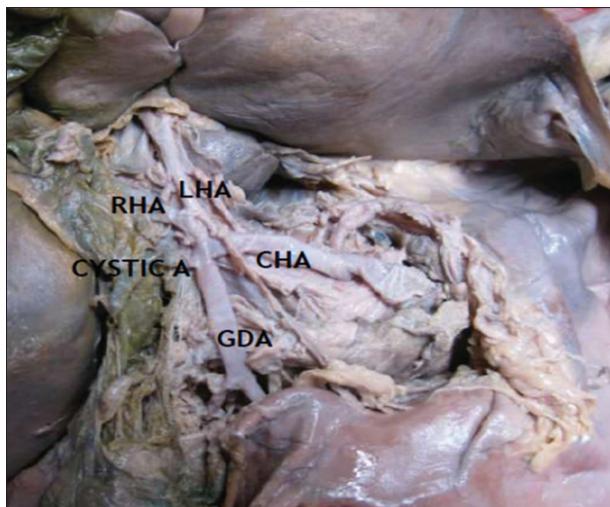
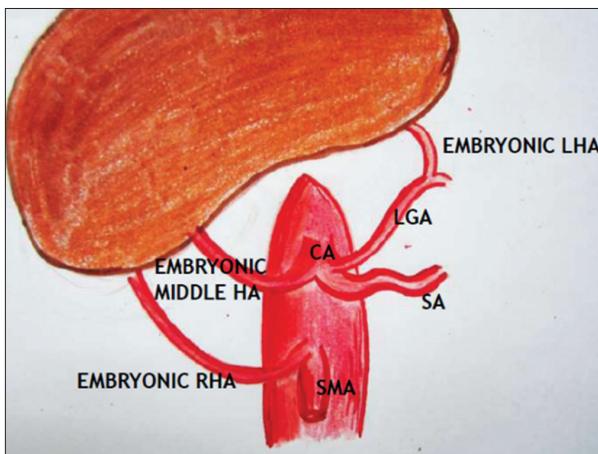


Figure 2: Accessory left hepatic artery from left gastric artery



**Figure 3: Quadrifurcation of common hepatic artery**



**Figure 4: Embryological relevance**

become a source of non-target exposure when doing chemo infusion therapy for gastric carcinoma.

#### **Origin of accessory LGA from replaced LHA**

When doing procedures such as hepatic arterial infusion chemotherapy, transcatheter arterial chemoembolization, or radioembolization for hepatic neoplasms, the accessory LGA arising from LHA is a potential source for non-target embolization. Prophylactic embolization of accessory vessels is required to prevent non-target embolization and sequelae. The presence of this anomalous vessel may affect both the angiographic diagnosis and treatment of distal esophageal and proximal gastric hemorrhage.<sup>[7,8]</sup>

Recognition of vascular anomalies is very important to guide the surgeon during regional lymphadenectomy in oncologic gastrectomies and prevent complications such as ischemic necrosis of gastric stump and liver. Furthermore, gastric cancer fed by accessory LGA has been reported.<sup>[9]</sup>

#### **Quadrifurcation of CHA**

Of all five variations, 1(2%) specimen was observed with the CHA quadri-furcating into LHA, RHA, CA, and GDA. Standring<sup>[10]</sup> in 2008 stated that the CHA might trifurcate into LHA, RHA, and GDA. This variant anatomy increases the complexity of liver transplantation surgery.

## **CONCLUSION**

The variant arterial anatomy recognized during cadaveric dissection offers great learning potential. Such findings provide an alternate perspective on common morphology and its structural and functional importance. Furthermore, these impart the concept of patient individuality and subsequent individualization of medical and surgical therapies.

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