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Original Research Article

STUDY OF ABERRANT HEPATIC ARTERIES AND ITS RELEVANCE IN TRANS-ARTERIAL EMBOLIZATION THERAPY IN HEPATIC TUMOURS

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ABSTRACT

Background: The liver is the largest gland in the body and has a wide variety of functions . It receives a double blood supply via the hepatic artery and the portal vein. The portal vein provides about 50% to 70% of the liver's oxygenation and the hepatic artery gives about 30% to 50% oxygenation to the liver. Unlike portal vein anatomy, the hepatic arterial anatomy is extraordinarily variable . The incidence of aberrant hepatic artery is quite high . So the knowledge about hepatic vascular distribution and its variations is important to plan and to make trans arterial embolization therapy successful in the patients with metastatic liver tumors.

Aim : To find out the incidence of aberrant arterial variation of right hepatic artery and left hepatic artery in cadavers .

Materials and Methods: 60 adult specimens from cadavers were studied by using conventional dissection method in Institute of Anatomy , Madras medical college , Chennai . Age & sex of these cadavers were not determined.

Results: 4 specimens were showing both aberrant right hepatic artery and aberrant left hepatic artery. In addition to these, one specimen had an aberrant left hepatic artery only. Middle hepatic artery was seen in three of these five specimens.

Conclusion : Knowledge about the aberrant hepatic arteries is important in the field of trans arterial embolization therapy in hepatic tumours .

KEY WORDS: Aberrant right hepatic artery, Aberrant left hepatic artery, Middle hepatic artery, Trans arterial embolization therapy.

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INTRODUCTION

The liver is the largest gland in the body and has a wide variety of functions such as secretion of bile and heparin, filtration of the blood, detoxicating function, and involvement in metabolism of carbohydrate, fat, protein [1].

This wedge shaped organ occupies most of the right hypochondrium and epigastrium. It weighs approximately 1500 gms and receives about 1500 ml of blood per minute [2].

The Liver possesses a double blood supply, in that it receives its blood from both the hepatic

artery and the portal vein. The portal vein provides about 75% of hepatic blood flow, and although it is post capillary and largely deoxygenated, its large-volume flow rate provides 50% to 70% of the liver's oxygenation. The hepatic artery, representing high-flow oxygenated systemic arterial flow, provides about 25% of the hepatic blood flow and 30% to 50% of its oxygenation [3].

The common hepatic artery is a medium-sized branch of the celiac trunk that runs to the right and divides into its two terminal branches, the hepatic artery proper and the gastroduodenal artery . The hepatic artery proper ascends towards the liver in the free edge of the lesser omentum. It runs to the left of the bile duct and anterior to the portal vein, and divides into the right and left hepatic arteries near the porta hepatis. As the right hepatic artery travels near the liver, it gives off the cystic artery to the gallbladder [4].

Aim: Carcinoid tumors and pancreatic endocrine tumors often metastasize to the liver. Surgical resection is generally the procedure of choice for patients with localized hepatic metastases, and Cryotherapy and radiofrequency ablation are the modalities effective for treating small, localized hepatic metastases. But these methods are rarely an option for patients with disseminated or multifocal disease. Bulky liver metastases are frequently associated with poor survival and reduced quality of life.

Hepatic artery embolization (HAE), also known as trans-arterial embolization (TAE), is one of the several therapeutic methods to treat these bulky metastases to the liver, and this therapy can reduce the size of the tumor, and decrease the tumor's impact such its hormone production, effectively decreasing symptoms. This treatment was initially developed in the early 1970s. The theoretical rationale for hepatic artery embolization is based on the observation that these hypervascular tumors derive the majority of their blood supply from the hepatic artery. Conversely, the normal cells of the liver get about 70-80 percent of their nutrients and 50% their oxygen supply from the portal vein, and they can survive even with the effectively blocked hepatic artery. So hepatic artery embolization occludes the blood flow to the tumors, and achieving significant tumor shrinkage in over 80% of people.

Unlike portal vein anatomy, hepatic arterial anatomy is extraordinarily variable. A more common variety of right and left hepatic arteries arise as terminal branches of the hepatic artery proper of coeliacal in origin . but rarely it may arise as aberrant artery , and this aberrant artery may be accessory artery or replaced artery. A vessel which supplies a lobe of the liver in addition to its normal vessel is defined as an accessory artery. A replaced hepatic artery is a vessel that does not originate from an orthodox position and is the sole supply to that lobe [5]. The most common source of an aberrant right hepatic artery is the superior mesenteric artery, and the most common source of an aberrant left hepatic artery is the left gastric artery [6].

Prior to embolization, a celiac angiogram is performed to identify the hepatic vasculature and ensure patency of the portal vein. Superior mesenteric artery angiogram also is performed if needed to evaluate for accessory or replaced hepatic arteries supplying the liver.

The incidence of aberrant hepatic artery is quite high, which necessitates a thorough knowledge about this variation for the surgeons to do this trans arterial embolization procedure successfully by avoiding incomplete embolization in patients with bulky hepatic metastasis. The responsibility for teaching these arterial variations to surgeons lies with the anatomists. These reasons motivated me to develop interest in analyzing the incidence of aberrant hepatic arteries in my study.

MATERIALS AND METHODS

60 adult specimens from cadavers were studied by using conventional dissection method as given in Cunninghams manual of practical anatomy, and variations of hepatic arteries were noted . This study was conducted in Institute of Anatomy, Madras medical college , Chennai - 03. Age & sex of these adult cadavers were not determined .

OBSERVATIONS

In my present study of 60 cadavers, I observed the presence of aberrant hepatic arteries in five

cadaveric specimens. In these five specimens aberrance was seen in both right & left hepatic arteries in four specimens, and only the left hepatic artery (not the right hepatic artery) shows aberrance in the fifth specimen .

Cadaveric specimen 1: This specimen shows the origin of replaced (aberrant) right hepatic artery from superior mesenteric artery and replaced (aberrant) left hepatic artery from left gastric artery. Single cystic artery is emerging from this replaced (aberrant) right hepatic artery. Middle hepatic artery arises from common hepatic artery.

Cadaveric specimen 2: This specimen shows the origin of right hepatic artery & middle hepatic artery from proper hepatic artery. Accessory (aberrant) right hepatic artery from superior mesenteric artery and replaced (aberrant) left hepatic artery from left gastric artery are seen. Single cystic artery is emerging from this accessory (aberrant) right hepatic artery.

Cadaveric specimen 3: In this specimen replaced (aberrant) right hepatic artery and replaced (aberrant) left hepatic artery are arising as direct branches of celiac trunk. Single cystic artery is emerging from this replaced (aberrant) right hepatic artery. In addition accessory (aberrant) left hepatic artery arises from left gastric artery. So this specimen shows both replaced LHA & accessory LHA.

Cadaveric specimen 4: This specimen shows the origin of replaced (aberrant) right hepatic artery from superior mesenteric artery and replaced (aberrant) left hepatic artery from left gastric artery. Middle hepatic artery arises from proper hepatic artery which is a direct branch of celiac trunk.Double cystic arteries are seen as the branches of replaced (aberrant) right hepatic artery.

Cadaveric specimen 5: In this specimen right hepatic artery and left hepatic artery are seen as the branches of proper hepatic artery. Both right & left hepatic arteries are giving a cystic branch to gallbladder. In addition accessory (aberrant) left hepatic artery arises from left gastric artery.

So the present study shows the incidence of aberrant right hepatic artery as 6.66 % (4 specimens) , of which replaced right hepatic artery

Fig. 1: Origin of replaced (aberrant) right hepatic artery from superior mesenteric artery and replaced (aberrant) left hepatic artery from left gastric artery. Single cystic artery is a branch of replaced right hepatic artery. Middle hepatic artery arises from common hepatic artery.

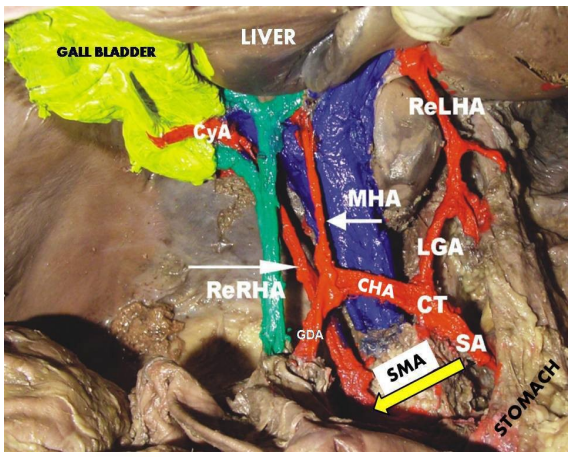


Fig. 2: Origin of right hepatic artery & middle hepatic artery from proper hepatic artery . Accessory (aberrant) right hepatic artery from superior mesenteric artery and replaced (aberrant) left hepatic artery from left gastric artery. Single cystic artery is a branch of Accessory right hepatic artery.

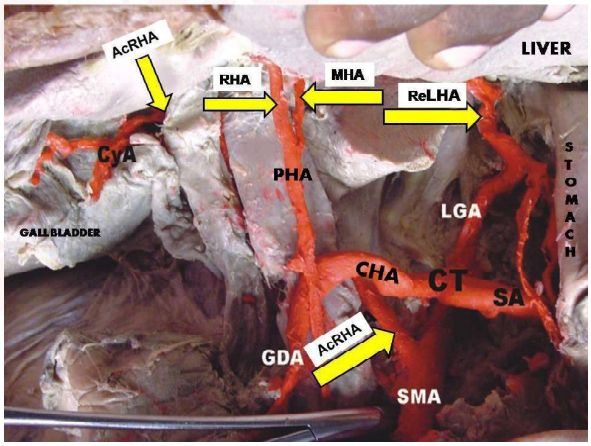
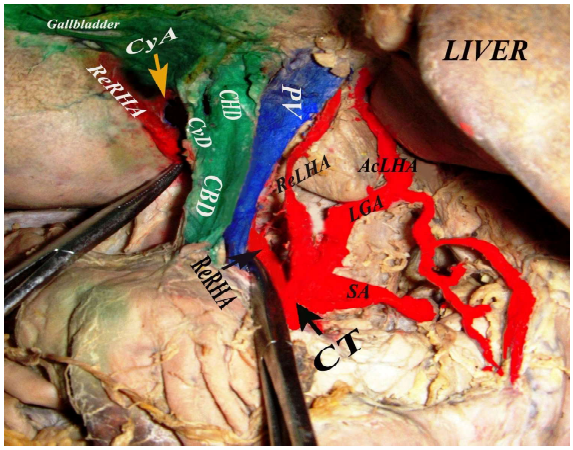


Fig. 3: Replaced (aberrant) right hepatic artery and replaced (aberrant) left hepatic artery are the direct branches of celiac trunk . Single cystic artery comes from replaced (aberrant) right hepatic artery. In addition accessory (aberrant) left hepatic artery arises from left gastric artery.



(ReRHA) is seen in 5 % (3 specimens) and accessory right hepatic artery (AcRHA) is in 1.66 % (1 specimen). The incidence of aberrant left hepatic artery is 8.33 % (5 specimens), of which replaced left hepatic artery (ReLHA) is seen in 6.66 % (4 specimens) and accessory left hepatic artery (AcLHA) is in 3.33 % (2 specimens) , because specimen no 3 shows both ReLHA & AcLHA . Middle hepatic artery (MHA) is seen in three of these five specimens in the study of 60 specimens (5 %).

Fig. 4: Origin of replaced (aberrant) right hepatic artery from superior mesenteric artery and replaced (aberrant) left hepatic artery from left gastric artery. Middle hepatic artery arises from proper hepatic artery which is a direct branch of celiac trunk. Double cystic arteries are the branches of replaced (aberrant) right hepatic artery.

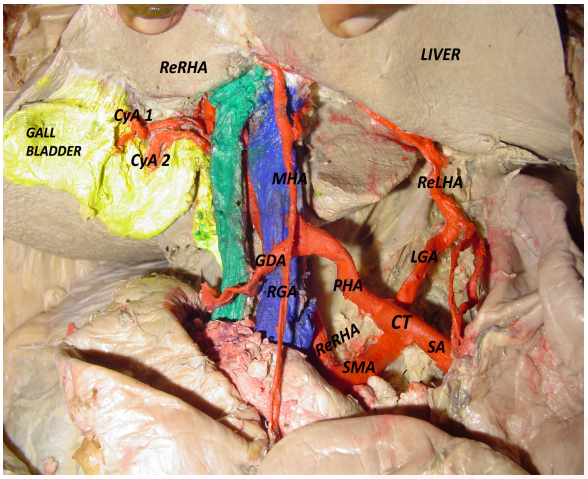
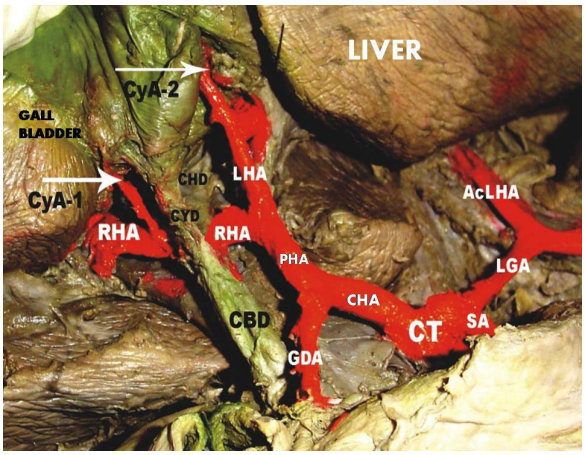


Fig. 5: Origin of accessory (aberrant) left hepatic artery from left gastric artery. Double cystic arteries arise as each one from right and left hepatic arteries respectively.



DISCUSSION

Embryological basis for aberrant hepatic arteries: At fourth week of development, both dorsal aortae give rise to multiple ventral segmental (omphalomesenteric) arteries. Fusion of the dorsal aortae occurs concurrently with regression of multiple ventral segmental arteries. The celiac axis is derived from the 10th ventral segmental artery and the superior mesenteric artery arises from the 13th segmental artery. The 11th and 12th segmental arteries normally regress.

During early stages of development, there are three hepatic arteries: (a) left hepatic artery arising from the left gastric artery, (b) middle hepatic artery arising from the celiac trunk, and (c) right hepatic artery arising from the superior mesenteric artery. In most cases, the middle hepatic artery is the only one that persists to become the classic proper hepatic artery in the adult. This artery divides into right and left branches, which supply the respective hemi-lobe of the liver [7]. Variations in regression and persistence of these three early arteries account for the so-called accessory and replaced variants [8].

Comparison with other studies: Nicholas A Michel [9] states that among 200 specimens, in 52 specimens (26%) aberrant right hepatics were encountered, of which 36 (18%) were ReRHA and 16 (8%) were AcRHA. In 54 specimens (27%) aberrant left hepatic arteries were found, including 31 ReLHA(15.5%) and 23 AcLHA(11.5%). Daseler et al [10] , in their dissection of 500 bodies they found 84 cases (16.8%) of ReRHA, 36 cases (7.2%) of AcRHA - a total of 120 cases of aberrant right hepatic artery (24%) . Regarding aberrant left hepatic artery they observed 90 cases (18 %) of ReLHA and 175 cases (35 %) of AcLHA - a total of 265 cases (53 %) aberrant left hepatic artery. Sureka et al [11] found ReRHA (15.16 %) , AcRHA (5.16%) , ReLHA (10.8%) , AcLHA (7.6%) in their study. In Adachi study [12] AcLHA arose from LGA in 17.9% and AcRHA from SMA in 10.3%. When comparing with these studies, incidence of aberrant right hepatic artery (ReRHA = 5 % & AcRHA = 1.66%) and aberrant left hepatic artery (ReLHA = 6.66 % & AcLHA = 3.33 %) of the present study is much lesser than the incidence found in the studies of Nicholas A Michel, Daseler et al, Sureka et al, and Adachi .

In Nicholas A Michel [9] study, the incidence of ReRHA was seen as 18%, and it arose from different origins such as SMA in 12.5%, from

celiac trunk in 3%, from aorta in 2% and from left gastric artery in 0.5% cases. In the present study I could find the origin of ReRHA from SMA in 3 specimens and also from celiac axis in one specimen (specimen no 3), but not from other arteries.

In Molmenti et al's study [13] ReLHA was seen in 15% to 20% of cases , and most frequently it arise from the left gastric artery, coeliac axis, or replaced common hepatic artery. In the present study I could find the origin of ReLHA from left gastric artery in 5 specimens and also from celiac axis in one specimen (specimen no 3) , but not from other arteries.

In Katherine E Kondratuk et al study [14] , they found a case of a replaced right hepatic artery sharing a common origin with the inferior pancreaticoduodenal artery . J.G. Mc Nulty [15] reported a case of total replacement of the arteries to the right and left lobe of liver by separate right and left hepatic arteries arising from the gastro duodenal artery, and the proper hepatic artery was absent. Michael A. Brawn et al [16] reported an unusual aberrant right hepatic artery arising from the right renal artery. These rare types of variations are not seen in the present study.

In a study of 145 subjects, Shaofa Wang et al [17] found middle hepatic artery (MHA) in 103 (71%) of the subjects. They classified these 103 cases of MHA into types I to V depending upon the type of origin. Type I MHAs accounted for 43.7% (n=45/103) cases with an MHA that originated from an RHA in patients with a normal hepatic arterial configuration.Type II MHAs accounted for 26.2% (n=27/103) of cases with an MHA that originated from an LHA in patients with a normal hepatic arterial configuration. Type III MHAs accounted for 12.6% (n=13/103) of cases with an MHA that originated from an RHA in the presence of a replaced left hepatic artery. Type IV MHAs accounted for 10.7% (n=11/103) of all cases with an MHA that originated from an LHA in the presence of a replaced right hepatic artery. Type V MHAs accounted for 6.8% (n=7/103) of all cases with an MHA that originated from a non-left and non-right hepatic arteries along the axis of the CHA, which included the common hepatic artery (CHA), the proper hepatic artery (PHA). Healey et al [18] stated that middle hepatic artery (MHA) to the quadrate lobe came from RHA in 50% of cases, and in 44% of cases from LHA, and in 6% from the coeliac, hepatic artery, gastroduodenal artery and right gastric artery. In Adachi study [12] ,MHA arose from RHA in 50%, from LHA in 40%, and from other sources in 10%. In the present study, 3 cases (5 %) of MHA arise from CHA or PHA , but not from RHA and LHA. So it is belong to type V of wang et al classification of MHA, and the incidence (5%) of MHA of the present study is lesser than these previous studies.

CONCLUSION

The promotion of the knowledge about hepatic vascular distribution and its variations to the surgeons is fundamental to plan and to make trans arterial embolization therapy successful in the patients with metastatic liver tumors. Aberrant hepatic artery is the anatomical variation to be looked carefully during this procedure to avoid failure in outcome of this method . Hence I hope this study would give a meticulous and comprehensive information about aberrant hepatic arteries to the surgeons.

ABBREVIATIONS

CyD - Cystic duct
CHD - Common hepatic duct
CBD - Common bile duct
CT - Coeliac trunk
SA - Splenic artery
LGA - Left gastric artery
RGA - Right gastric artery
CHA - Common hepatic artery
PHA - Proper hepatic artery
GDA - Gastroduodenal artery
RHA - Right hepatic artery
LHA - Left hepatic artery
MHA - Middle hepatic artery
CyA - Cystic artery
SMA - Superior mesenteric artery
ReRHA - Replaced right hepatic artery
ReLHA - Replaced left hepatic artery
AcRHA - Accessory right hepatic artery
AcLHA - Accessory left hepatic artery
PV - Portal vein

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Conflicts of Interests: None

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