



RIGHT HEPATIC ARTEY: CLINICAL SIGNIFICANCE OF VARIATIONS IN THE ORIGIN AND ITS RELATIONS WITH THE COMMON HEPATIC DUCT

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ABSTRACT

The right hepatic artery is an end artery and contributes sole arterial supply to right lobe of the liver . It also supplies the gall bladder, cystic duct, common hepatic duct and upper and middle part of common bile duct. Normal hepatic arterial anatomy occurs in approximately in 80% of cases, for the remaining 20% multiple variations have been described. Misinterpretation of anatomical variations of the right hepatic artery contribute to the major intraoperative mishaps and complications in hepatobiliary surgery.

Materials and Methods: This descriptive study conducted on 50 cadavers in Department of Anatomy, Govt Medical College, Kozhikode to document the normal anatomy and different variations of right hepatic artery regarding its origin and relation with the common hepatic duct.

Results : Right hepatic artery had its origin from proper hepatic artery in 47 (94%) cases, in one case the artery came from common hepatic artery, aberrant origin of right hepatic artery was seen in 4% cases, one case from celiac trunk directly and the other from superior mesenteric artery.

Relation with common hepatic duct : In 46 cases (92%) the artery (normal and aberrant) passes posterior to common hepatic duct. In 6%, the artery was related anterior to common hepatic duct. In one case the artery was medial to the common hepatic duct.

Conclusions : This study highlights the importance of knowledge of such anomalies since their awareness will decrease morbidity and help to keep away from a number of surgical complications.

KEYWORDS : Right Hepatic Artery, Origin, Relations

INTRODUCTION

The right hepatic artery arises from the proper hepatic artery, which is a branch from common hepatic artery. The common hepatic artery gives off branches to the bile duct and gallbladder from its right hepatic branch. It arises from the coeliac trunk and divides into the gastroduodenal artery and the hepatic artery proper. The hepatic artery proper ascends anterior to the portal vein and medial to the bile duct within the free margin of the lesser omentum in the anterior wall of the epiploic foramen. It divides into right and left branches at a variable level below the porta hepatis. The right hepatic artery usually crosses posterior (occasionally anterior) to the common hepatic duct. This close proximity risks the right hepatic artery to be involved in bile duct cancer earlier than the left hepatic artery. Occasionally, the right hepatic artery crosses anterior to the common hepatic duct and is more vulnerable to injury in biliary surgery^{1,9,19}.

The right hepatic artery gives off branches to the bile duct and gallbladder . It almost always divides into an anterior branch supplying segments V and VIII, occasionally provides a branch to segment I and the gallbladder and a posterior branch supplying segments VI and VII. The hepatic artery proper sometimes divides at a low level close to its origin and, occasionally, it divides at a higher level, well to the left of the porta hepatis. In early division the right hepatic branch may pass behind the portal vein. When the RHA does not arise from the PHA or CHA, its origin is shifted to the aorta or any of the arteries whose normal course is towards right side of the aorta like superior mesenteric artery (SMA), gastroduodenal artery (GDA), right gastric artery, or celiac trunk (CT). When the hepatic artery arises from a source other than the terminal end of the CT, it is considered as an aberrant hepatic, usually found in one-third of the cases. These aberrant hepatic arteries are of two types: replaced and accessory. An accessory hepatic artery appears in addition to one that is normally present. A replaced hepatic artery is a substitute for the normal hepatic artery and that does not originate from an orthodox position and provides the sole supply to that part of the liver. The most common anatomical variants are a replaced or accessory left hepatic artery that arises from the left gastric artery, or a replaced or accessory right hepatic artery that arises from the superior mesenteric artery, both occurring in 10–20% of individuals. A replaced hepatic artery proper may arise from the superior mesenteric artery and passes behind the portal vein. More often, a replaced or accessory right hepatic artery arises from the superior mesenteric artery. In such cases, the variant artery runs in the lesser omentum behind the portal vein and bile duct. An accessory right hepatic artery may be injured during resection of the pancreatic head because the artery lies in close proximity to the portal vein. Rarely, an accessory left or right hepatic artery may arise from the gastroduodenal

artery or directly from the aorta^{7,11,12,18}. Knowledge of these variations is also essential when performing whole and split liver transplantation. Injury to the RHA is more common in presence of aberrant arterial anatomy⁴. So adequate knowledge of normal and variant hepatic arterial anatomy is crucial for hepatobiliary surgery and liver transplantation. The aim of this observational, quantitative, and descriptive study was to record the normal and variant anatomy of the RHA to contribute to the existing knowledge of RHA to improve surgical safety.

MATERIALS AND METHODS

50 adult embalmed cadavers (males: 46; females: 4) with normal subhepatic anatomy were studied in the department of anatomy. The study of the adult cadavers was undertaken in the specimens assigned for dissection of undergraduate students of Government Medical College, Kozhikode for a period of 2 years.

Study method : Dissection method

Cadavers with operative procedure in subhepatic region or any subhepatic pathology like tumors were excluded. A total number of 50 human livers with Gallbladder and its duct system with related ligaments, duodenum and head of the Pancreas were collected from the cadavers. All the specimens were cleaned thoroughly under running water. The hepato-duodenal ligament was opened by tracing the bile duct upwards to common hepatic duct. Common hepatic duct was then traced upwards to locate the right and left ducts emerging from porta hepatis. Lateral to the duct system towards left, the common hepatic artery was identified and traced towards its division to gastroduodenal artery and proper hepatic artery. Then proper hepatic artery was traced upwards where it divides into right and left hepatic arteries. Then right hepatic artery was identified and studied for its origin and relation with common hepatic duct.

This study was limited only to the variations in the origin and relation with common hepatic duct of right hepatic artery.

RESULTS

Right hepatic artery had its origin from proper hepatic artery in 47 (94%) cases, in one case the artery came from common hepatic artery (Fig.1). Aberrant origin of right hepatic artery was seen in the remaining 4% cases. Replaced right hepatic arteries (RRHAs) in one case was from celiac trunk directly (2%) (Fig.2) and the other from superior mesenteric artery (2%) (Fig.3). Accessory right hepatic artery was seen in one case along with RHA from common hepatic artery (Fig.1). Considering the relationship to the common hepatic duct, the RHA crossed anteriorly to CHD in 6% (Figure 4) , posterior (normal and aberrant) to it in 92% specimens (Figure 5) and in one case RHA lies medial to CHD & passes posterior to LHD (Figure 6) .

Table 1. Origin of right hepatic artery

Origin from	No. of cases	%
Proper hepatic artery	47	94
Common hepatic artery	1	2
Celiac trunk	1	2
Superior mesenteric artery	1	2
Total	50	100

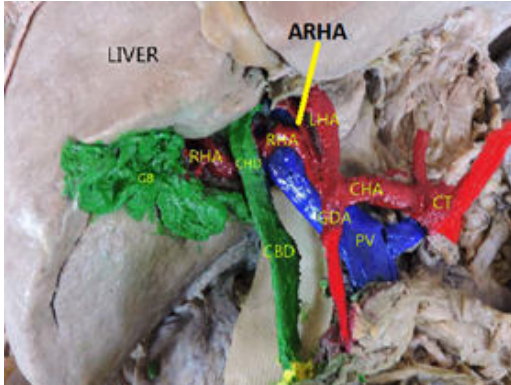


Fig.1: RHA from common hepatic artery (CHA) Accessory right hepatic artery (ARHA) is seen along with normal RHA from common hepatic artery. Here CHA gives off LHA, RHA, GDA & ARHA.

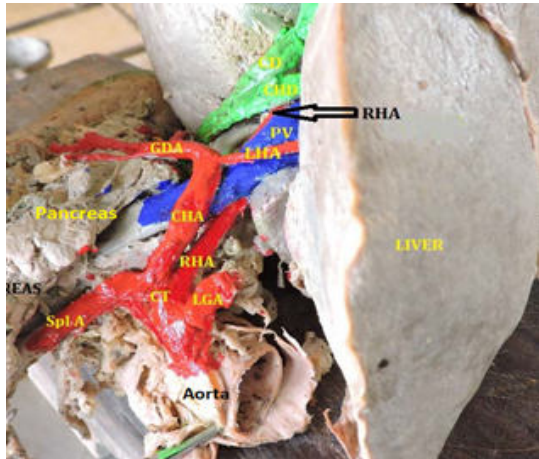


Fig.2: RHA from celiac trunk (CT)

Replaced or accessory right hepatic artery arises from the celiac trunk (CT) along with left gastric artery (LGA), common hepatic artery (CHA) & splenic artery (SplA). It courses posterior to portal vein (PV) and CHD.

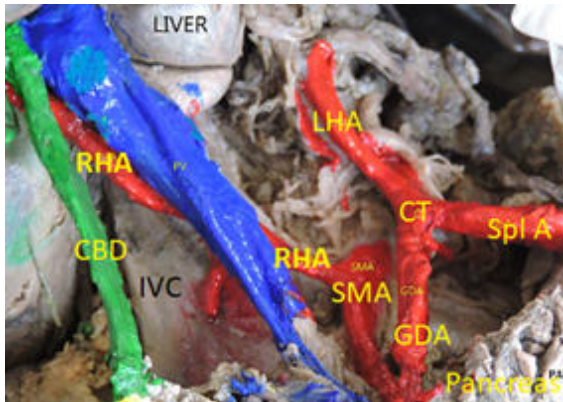


Fig.3: RHA from Superior mesenteric artery (SMA)

Here, a replaced or accessory right hepatic artery arises from the superior mesenteric artery and passes behind the portal vein and bile duct. Celiac trunk gives off left hepatic artery, gastroduodenal artery & splenic artery.



Figure 4 : RHA anterior to CHD



Figure.5 : RHA posterior to CHD

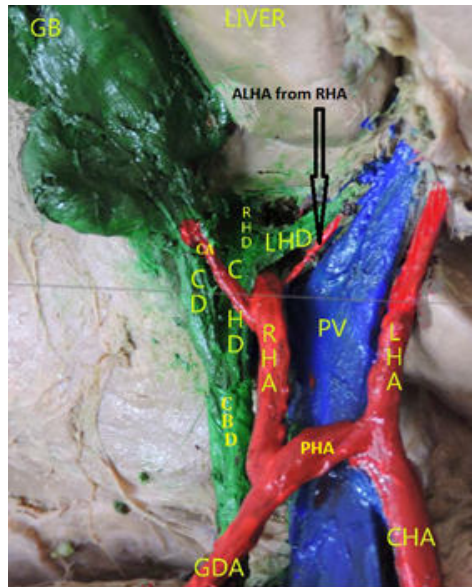


Fig.6: RHA medial to CHD

RHA lies medial to CHD & passes posterior to LHD & provides ALHA in addition to normal LHA from CHA

Table 2. Relation of RHA with CHD

Relation of RHA	No. of cases	%
Posterior to CHD	46	92
Anterior to CHD	3	6
Medial to CHD	1	2
Total	50	100

DISCUSSION

Injury to the RHA is more common in presence of aberrant arterial anatomy. So adequate knowledge of normal and variant hepatic arterial anatomy is crucial for hepatobiliary surgery and liver transplantation. A number of studies were conducted to investigate these variations in origins and relation with common hepatic duct of right hepatic artery. In the study by E.R.Flint (1922-23) in 200 subjects, the various origins of right hepatic artery, described by him

were: 1. From main hepatic artery in 158 cases (79%) 2. From Superior mesenteric artery in 42 cases (21%) 3. From hepatic proper in two cases (2%). Regarding relation to the common hepatic duct, the right hepatic artery passes behind the common hepatic duct in 136 cases (68%) and in front of the common hepatic duct in 25 cases (12.5%). In the present study also the right hepatic artery was posterior to common hepatic duct in 92% of cases and in 6% cases it was anterior to the duct, in one it passes medial to CHD, then behind the left hepatic duct and then right hepatic duct.

Edward H Daseler M.D¹⁷ et al (1947), from a study of 500 specimens found a normal right hepatic artery, originating from a normal common hepatic artery in 83.2% (416/500) of cases. In 11.2% (56) the right hepatic artery had the origin from superior mesenteric artery. In 0.8% (4 cases), the right hepatic artery arose as a direct branch of the coeliac axis. In 65% (325) cases the right hepatic artery crossed posterior to the common hepatic duct and in 11.6% (58) cases, it crossed anterior to common hepatic duct, in 3.6% (18) cases, it crossed posterior to right & left hepatic ducts.

In Nicholas A. Michels⁵ study, 88% of cases right hepatic artery crossed posterior to common hepatic duct and in 12% cases it was anterior to common hepatic duct.

R.M. Jones and K.J. Hardy² (2001) in their dissection on 180 cadavers found that the right hepatic artery took origin from the main trunk of the common hepatic artery in 135 instances (75%), the superior mesenteric in 32 (18%), and gastroduodenal artery in 10 (6%) cases; it arose from the right gastric artery or aorta in three instances. These anomalous right hepatic vessels from the superior mesenteric and gastroduodenal arteries had a course to the right of the portal vein. In the present study, right hepatic artery had the origin from proper hepatic artery in 94% cases, one from common hepatic artery, in one case the artery came from celiac trunk directly and the other from superior mesenteric artery.

Study by Sehgal G¹⁴ et al (2013) in 50 subjects by Multislice CT angiography showed the origin of RHA from the PHA in 83.72% cases. Variant origins of the RHA were observed from SMA in 11.62%, CA (2.33%) and the GDA in 2.33% subjects. RHAs passing posterior to the common hepatic duct were seen in 81.40% (n=35) cases whereas variant course of the RHA where it was anterior to the common hepatic duct was seen in 18.60% (n=8) cases. The present study findings were similar to the study by Sehgal G, et al where the right hepatic artery had its origin from PHA in most of the cases (94%).

In a study by Usha Dandekar et al¹⁸ on 60 cadavers revealed aberrant replaced right hepatic artery in 18.3% and aberrant accessory right hepatic artery in 3.4%. Considering the course, the right hepatic artery ran outside Calot's triangle in 5% of cases. The right hepatic artery (normal and aberrant) crossed anteriorly to the common hepatic duct in 8.3% and posteriorly to it in 71.6%. It has posterior relations with the common bile duct in 16.7% while in 3.4% it did not cross the common hepatic duct or common bile duct

Table 3. Comparison of origins of right hepatic artery

Author	Origin of right hepatic artery					
	CHA	PHA	CT/ Aorta	SMA	GDA	
E.R.Flint ⁶	158	2	-	42	--	
Edward H Daseler et al ¹⁷	416	-	4	56	--	
Sehgal G et al ¹⁴	-	42	1	6	1	
Usha Dandekar et al ¹⁸	78.3	-	5	13.3	-	
Present study	1	47	1	1	-	

Table 4. Comparison of relations of RHA to CHD

Author	Relation of RHA to CHD		
	Posterior	Anterior	Medial
1 .E.R.Flint ⁶	136	25	-
2. Edward H Daseler et al ¹⁷	325	58	-
3. Nicholas A. Michels ⁵	176	24	-
4. G Nigamet al ¹⁶	86	3	-
5. Sehgal G et al ¹⁴	35	8	-
6. Present study	46	3	1

In their study in 89 cases, G Nigam¹⁶ et al (2012) described that the right hepatic artery was related posterior to the common hepatic duct in 86% cases (n=69) to enter the cysto-hepatic triangle. In 3 cases (4%) the artery crossed anterior to common hepatic duct and in 8 cases

(10%), the right hepatic artery was to the right of common hepatic duct. The present study had also the similar results where in 92% of cases the right hepatic artery was posterior to common hepatic duct and in 6% cases it was anterior to the duct.

CONCLUSION

This study is done in 50 cadavers to record the normal and variant anatomy of the RHA to contribute to the existing knowledge of RHA to improve surgical safety. The dissection of subhepatic region was performed carefully to display the RHA and its related structures. Variation in the origin and course of the RHA as well as its relations with the common hepatic duct were recorded and appropriate photographs were taken. The findings of the present study stress the need for a sound knowledge of common anatomical variations in this region while performing hepatobiliary surgery and liver transplantation.

Abbreviations

- RHA: Right hepatic artery
- PHA: Proper hepatic artery
- CHA: Common hepatic artery
- CHD: Common hepatic duct
- CBD: Common bile duct
- SMA: Superior mesenteric artery
- GDA: Gastroduodenal artery
- CT: Celiac trunk
- CA: Cystic artery
- CD: Cystic duct
- RRHA: Replaced right hepatic artery
- ARHA: Accessory right hepatic artery.

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