

ANATOMICAL VARIATIONS IN THE ORIGIN OF HEPATIC ARTERY IN PATIENTS UNDERGOING HEPATOBILIARY SURGERY AT KHYBER TEACHING HOSPITAL PESHAWAR

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ABSTRACT:

Objectives: The aim of this study was to contribute to the knowledge of the hepatic vascular anatomy and its variations in people belonging to our part of the world mainly Khyber Pakhtunkhwa and adjoining areas of Afghanistan.

Design: descriptive study

Setting and duration: This study was of one year duration conducted at the Surgical B unit of Khyber Teaching Hospital, Peshawar in collaboration with other surgical units where hepatobiliary surgeries were performed.

Methodology: A total of 139 cases both male and females of all ages were included in the study who underwent different hepatobiliary surgeries. After identification of the common hepatic artery, its course any abnormality or variation in its course was noted and recorded.

Results: Common hepatic artery was present and originated from Celiac trunk in all 100% of cases and was entirely to the left of common bile duct and ventral to portal vein, ninety five (68.6%) cases had typical textbook branching pattern i.e common hepatic artery giving gastroduodenal artery and then dividing into right hepatic artery and left hepatic artery with right gastric artery. Aberrant arteries were present in 60(42.8%) of cases all of which were present either as replaced arteries or accessory aberrant arteries. In 18 (12.8%) cases there was a single aberrant artery, present as either replaced or accessory while in 18 (12.8%) had more than one aberrant artery present as either replaced or accessory replaced or accessory, 16 (11.8%) cases had two aberrant arteries while 2 (1.4%) cases had three aberrant arteries.

Conclusion: The findings of the present study highlight the fact that the distribution of common hepatic artery, its origin, its branching pattern is variable and that anatomic variations in its anatomy occur in high percentage of cases.

INTRODUCTION

The last three decades of the last century saw a tremendous growth of knowledge not only in laparoscopic and general surgeries but also in liver transplantation. Therefore the knowledge of hepatic arterial anatomy and its variations is of considerable importance to medical practitioners, radiologists and surgeons in particular.^{1,2,4,7} The celiac artery, superior mesenteric artery and inferior mesenteric artery are the representative arteries of the vitelline arteries initially supplying the yolk sac. In adults all these arteries supply the derivatives of the foregut, midgut and hindgut respectively³. The celiac trunk is an anterior branch of aorta supplying liver, stomach, pancreas and superior part of duodenum. Variations in the anatomy of these structures are therefore really important for the surgeons

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as well as other medical professionals^{5,6}. In classical anatomical situation the celiac trunk is divided into three branches over the upper border of the pancreas. This division of the celiac trunk was first described by Haller in 1956 and is still considered to be the normal pattern.^{2,8,9} However the classic textbook description of the hepatic artery is found in only 50-80% of the cases and the variations in the anatomy are found in 33 to 41 % of cases.^{7,8,10,29} Hepatic artery was classified by various scholars. Michels reported in 1990 that there are at least 10 possible anatomical variations in the hepatic arterial system based on a study of 200 autopsy cases. Many classifications were later described but Michels classification is still considered by many surgeons to be the most inclusive.

A thorough knowledge of the anatomy of hepatic artery anatomy and its variation regarding its branching pattern are essential for successful surgical and radiological procedures. With laparoscopic surgery on the rise the need for the knowledge of exact description of hepatobiliary surgery has increased more to avoid iatrogenic vascular injuries.²⁷

In developing countries the facilities for hepatic transplantation are increasing with the passage of time however cholecystectomy is one of the commonest operation undertaken by surgeons during which they encounter different variations in anatomy that do not

match the text book description of the anatomy.

A good knowledge of the understanding of normal hepatic artery distribution and possible anatomic variation is significant in liver transplantation and other hepatobiliary operations in order for the vascularity not to be disturbed and to cause necrosis of the liver parenchyma postoperatively. The major strength of current study was extremely meticulous dissection of the hepatic arterial system in open surgical procedures seeking the experience of surgeons to identify and recognize the arterial pattern.

MATERIAL AND METHODS

This study was carried out at surgical "B" ward of the department of general surgery at Khyber Teaching hospital, Peshawar in collaboration with other surgical wards of the department where surgeries were performed on patients on hepato-biliary-pancreatic areas. All patients with indications for hepatobiliary surgery were included in this study. Informed consent was taken from patients along with detail history and complete physical examination was performed before the operation.

All the relevant information was entered into a proforma specially designed for this purpose. Strict exclusion criteria were followed so as to avoid any confounders and bias in our study. All patients who would undergo open surgery on the hepatobiliary system were included in the study, both sexes and all age groups. Exclusion were all those patients in whom anatomy was not clearly defined during an operation, like patients with empyema gall bladder, pancreatitis, obstructive jaundice, carcinoma gall bladder and those undergoing laproscopic cholecystectomy.

During all relevant surgeries the surgeon was assisted or observed and the findings were noted and data collected and entered into a proforma. Upper Right Subcostal Incision, Kocher's Incision, modified Kocher's incision or transverse incision were given according to surgeon's preference. Following two common methods were used for removal of gall bladder, duct first method, fundus first method:

In case of surgery on the gastrointestinal tract a midline incision was given extending from the xiphoid process to the umbilicus. For stomach related procedures such as gastrectomy and total gastrectomy stomach was mobilized by incising gastro splenic omentum and left gastro epiploic vessels were identified. Posterior gastric wall was separated from the transverse mesocolon and vessels of the lesser curvature and right gastric artery were ligated. When the stomach was mobilized common hepatic artery and its branches were identified and data noted on the proforma.

During pancreaticoduodenectomy (Whipple's procedure) right hepatic artery and portal vein were identified. At this step special care was taken to iden-

tify and safeguard accessory or replaced right hepatic artery. This artery was easily found postero-lateral to the portal vein. The Right hepatic artery is traced back and its anomalies if any were noted and just above the duodenum gastro duodenal artery was tied off.

RESULTS

Common hepatic artery was present and originated from celiac trunk in all 100% of cases, and was entirely to the left of common bile duct and ventral to portal vein, in ninety five (68.6%) cases it had typical textbook branching pattern i.e common hepatic artery giving gastroduodenal artery and then dividing into right hepatic artery and left hepatic artery with right gastric artery and cystic artery arising from hepatic artery proper and right hepatic artery respectively. Variational pattern was observed in branching pattern and relations. Overall results showed variational pattern in 44 (31.4%) cases. In two (1.4%) cases common hepatic artery and gastroduodenal artery seems to be separated by a sulcus on the superior aspect giving the impression of two arteries, with anastomosis between each other in the same case. In 4 (2.8%) of cases accessory right hepatic artery arising from common hepatic artery and in 2 (1.4%) accessory right hepatic artery and cystic artery originating from common hepatic artery. In 2 (1.4%) cases common hepatic artery entered the porta hepatis directly without dividing into right hepatic artery and left hepatic artery. Replaced right hepatic artery arising from common hepatic artery in 4 (2.8%) cases, replaced cystic artery and accessory cystic artery arising from common hepatic artery each in 2 (1.4%) cases respectively. Right gastric artery arising from common hepatic artery in 12 (4.2%) of cases and replaced right gastric artery arising from common hepatic artery in four (2.8%) cases. Regarding the branching pattern, right hepatic artery and left hepatic artery arising directly from common hepatic artery in 2 (1.4%) cases with no hepatic artery proper, in 4 (2.8%) cases common hepatic artery had three terminal branches, 18 (12.5%) cases showed six branches, 4 (2.8) cases had seven branches and 113 (81.6%) cases showed five terminal branches.

Aberrant arteries were present in 60(42.8%) of cases all of which were present either as replaced arteries or accessory aberrant arteries. In 18 the (12.8%) cases there was a single aberrant artery, present as either replaced or accessory while in 18 (12.8%) had more than one aberrant artery present as either replaced or accessory replaced or accessory, 16 (11.8%) cases had two aberrant arteries while 2 (1.4%) cases had three aberrant arteries. RCA was present in 6 (4.3%) cases with four each arising from common hepatic artery, accessory right hepatic artery and between right hepatic artery and left hepatic artery respectively. Accessory cystic artery was present in 8 (5.75%) cases with three (2.45%) cases originating from common hepatic artery, three (1.5 %) cases from right hepatic artery and two(1.4%) cases from gastroduodenal artery. All accessory artery

Table. 1 Variations in the origin of Common Hepatic artery

Present	Absent	Origin from CT	Branches				Relation	Classic Pattern	Variationa Pattern
			3	5	6	7			
139 100%	Nil	139 100%	4 2.8%	113 81.6%	18 12.5%	4 2.8%	A.139 100 %	95 68.6%	44 31.4%

Fig .2 Variations in the Aberrant arteries

Name	Number of cases	Origin							
		CHA	HAP	RHA	LHA	GDA	CT	ARHA	b/w RHA & LHA
RCA	6 4.36%	2 1.4%	-	-	-	-	-	2 1.4%	2 1.4%
ACA	8 5.75%	3 2.4%	-	3 1.4%	-	2 1.4%	-	-	-
ARHA	9 6.47%	3 3.23%	2 1.4%	2 1.4%	-	2 1.4%	-	-	-
RRGA	30 22%	16 11.15%	-	-	-	12 8.5%	3 1.4%	-	-
RGDA	2 1.4%	-	-	-	-	-	2 1.4%	-	-
RLGA	4 2.8%	-	-	-	4 2.8%	-	-	-	-
Total	60 42.8%	25 18.35%	2 1.4%	4 2.8%	4 2.8%	16 11.5%	5 2.8%	2 1.4%	2 1.4%

and cystic artery were seen supplying the gall bladder. Accessory right hepatic artery was present in 9 (6.47%) cases with 3 (2.4%) cases taking origin from common hepatic artery, three from hepatic artery proper, four from right hepatic artery and four from gastroduodenal artery. Replaced right gastric artery was present in 30 (22%) cases with 16 (11.55%) taking origin from common hepatic artery, 12 (8.8%) from gastroduodenal artery and 3 (1.6%) from celiac trunk respectively. Right gastroduodenal artery was present in 2 (1.4%) of cases originating from celiac trunk, recurrent left gastric artery was present in 4 (2.8%) of cases all 100% originating from left hepatic artery. All right recurrent gastric artery and right gastroduodenal artery were seen running downwards towards the first part of duodenum.

DISCUSSION

Variations in the anatomy of the hepatic artery is also not very uncommon and is of greater importance in general surgery and hepatic surgery and especially in liver transplant surgery as well as in many radiological procedures such as trans arterial chemoembolization for hepatic tumours.^{11,12} Michels in 1966 classified common hepatic artery into ten anatomical variations. In 1994 Hiatt, conducted his most remarkable study on 1000 cases modifying the original classification by Michels to five major types and the rare anomalies were grouped as the sixth variant. In our study we first identified hepatic artery proper and later its branches. In our study 95 (68.6%) cases had the typical textbook branching pattern common hepatic artery giving rise to gastroduodenal artery and then dividing into right and left hepatic arteries, with right gastric artery and

cystic artery arising from hepatic artery proper and right hepatic artery respectively. Similarly in our study in all cases common hepatic artery originated from the coeliac trunk in all cases which also falls into type 1 category by both Michels and Hiatt. Similarly studies by different authors showed different results, i.e: 75.5% by Regaard et al...1986, 76% by Daly et al...1984, 76% by Niederhuber and Ensminger...1983 and 59% by Kemeny et al 1986 respectively. Common hepatic artery vascularizing the liver but not originating from the celiac trunk has been reported in many studies and accounts for 2-5% of cases.^{14,15,16} If common hepatic artery originates from the superior mesenteric artery, it is classified as type IX according to the classification of Michels or as type V according to Hiatt classification. Similarly if common hepatic artery originates from the left gastric artery it is classified as type X according to the classification proposed by Michel and is not mentioned in Hiatt, similarly if it arises from aorta as type VI according to Hiatt which is not mentioned in classification of Michels and all these types were not found in our study. In our study we found four (2.8%) cases in which common hepatic artery divided to form gastroduodenal artery and left hepatic artery. This pattern is termed trifurcation has been described by both Kemeny et al 1986 and Niederhuber and Ensminger 1983. In our study in only 2 (1.4) cases gastroduodenal artery originated from celiac trunk and in 137(98.5%) cases it took origin from common hepatic artery which is similar to studies conducted by other researchers. Lipshutz reported origin of gastroduodenal artery from the common hepatic artery in 92.3% of cases.^{15,16,17} and from celiac trunk in six (3.61%) of cases. In our study accessory cystic arteries were present in 8(5.7%) cas-

es, each 1.4% originating from accessory right hepatic artery, common hepatic artery, hepatic artery proper and gastroduodenal artery respectively as per Michels (1953) classification. In addition unusual anatomy of the right hepatic artery can affect the course of right hepatic artery with the most frequent of the variation resulting from an aberrant origin of the right hepatic artery^{18,19}. In our study we also found one case in which a single cystic artery originated from the right hepatic artery and the hooks around the cystic duct from behind and reappeared near the neck of the Gall bladder. This has been named as cystic artery syndrome by²⁰. Right hepatic artery anatomy is one of the most common anomalies which are given important consideration during surgical procedures near the pancreas and liver especially during Whipple's procedures.

Replaced or accessory arteries are given due consideration during liver transplantation and smaller grafts make arterial anastomosis more difficult to reconstruct. One of the leading cause of postoperative graft loss is hepatic artery thrombosis hepatic artery thrombosis (HAT). HAT is more common in places where there exist a diameter discrepancy between the recipient and graft arteries.^{3,21}

While the replaced arteries are usually larger and longer thereby decreasing the chances of HAT (Marcos 2003). One study reported a higher incidence of post operative HAT and stenosis in liver transplant recipients possessing a recurrent right hepatic artery.

The liver is one of the major organ commonly involved in metastatic neoplasms and the extent of its involvement determine the patient survival (Jaffer et al 1968, Lee 1978). Hepatic artery infusion chemotherapy (HAIC) has been recognized as the treatment of choice for treating unresectable hepatic metastasis.^{22,23,24} Since the celiac trunk is the main source of arterial supply to the stomach, duodenum, gall bladder and pancreas, during HAIC unavoidable infusion of the gastroduodenal artery and the right gastric artery may occur and may result in gastrointestinal complications such as dyspepsia, gastritis and ulceration.^{25,26,27} Failure to pre-operatively recognize these anomalies poses increased risk of accidental transaction and vascular compromise of the liver and biliary ducts, resulting in ischemia of the liver or biliary enteric anastomosis leakage^{28,30} (John et al 2009).

CONCLUSION

The findings of the present study highlighted the fact that the distribution of common hepatic artery, its origin, its branching pattern is variable and that anatomic variations in its anatomy shall occur in high percentage of cases. Knowledge of the variation in hepatic arterial supply are important and has been highlighted in our study will likely help in planning and performing general and abdominal surgeries specially in surgeries of the hepatobiliary and pancreatic regions, therefore

decreasing the chances of serious vascular injuries.

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