ANATOMIC VARIATIONS OF ORIGIN AND BRANCHES OF COMMON HEPATIC ARTERY - A CADAVERIC AND PEROPERATIVE STUDY

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ABSTRACT

Objective: To find out the variational pattern of common hepatic artery and to contribute to the knowledge of the hepatic vascular anatomy with the experience obtained in the dissection of the hepatic vascularization on cadavers as well as during peroperative procedures.

Study design: A Descriptive study.

Place and duration of study: Study was of six months duration conducted at the department of Anatomy, Army Medical College Rawalpindi, in collaboration with the departments of Anatomy of medical institutes on cadavers and in hospitals, where surgeries were performed on patients on hepato-biliary-pancreatic areas.

Materials and methods: A total of 70 cases were included, out of which 60 cadavers were dissected in various medical institutes while ten cases were assisted/observed during surgery in various hospitals. After identifying common hepatic artery, any abnormality or variation in its course/branching pattern were noted and pictures were taken with Nikon coolpix 4 Megapixel digital camera with 3 X optical zoom. Significance of the results was determined by comparing the results with the classification of origin of hepatic artery, its relations and branching pattern in relation to studies already conducted.

Results: Common hepatic artery was present and originated from celiac trunk in all 70 (100%) specimens. In all cases, common hepatic artery was entirely to left of common hepatic duct and common bile duct and was ventral to portal vein. Forty eight (68.5%) cases had typical classic textbook branching pattern. Overall result showed variational pattern in 22 (31.4%) cases, observed in branching pattern and relations. Regarding the aberrant arteries a total of 18 (25.7%) were present in relation to common hepatic artery and its branches, out of which 9 (12.8%) were present as single (accessory/replaced) and 9 (12.8%) were present as more than one (accessory/replaced). In 13 (18.6%) cases, aberrant arteries originated from common hepatic artery directly.

Conclusion: This study highlight the fact that the hepatic arterial supply is variable and that different anatomic variants can occur in a high percentage of cases.

Keywords: Cadaver, Common hepatic artery, Hepato-biliary- pancreatic surgeries, Pancreaticodoudenectomy, Whipples.

INTRODUCTION

In the last few years substantial improvements have been achieved not only in general and laproscopic surgeries but also in liver transplantation. The knowledge of hepatic artery and its branches has considerable importance in day to day practice of wide range of practitioners including surgeons specialized in hepato-biliary-pancreatic areas and also radiologists Rafael et al[1].

The hepatic arterial anatomy, as considered normal by the classic textbook description, is only found in 52 – 80 % of the cases and is aberrant in almost 33-41% of individuals (Michels[2], Michels[3], Hiatt et al[4]., Bergman et al[5]., Suzuki et al[6], Makisalo et al[7], Varotti et al[8].

There are various classifications of hepatic artery. Michels[3]. reported a classification of 10 possible anatomical variants of the extrahepatic arterial distribution that was based on a study of 200 autopsy cases. After Michels[3], initial classification, several authors described their own observations. From a surgical point of view, some surgeons still consider, Michels initial classification more complete since it establishes the differences between an accessory

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and a replaced artery, concepts not explained in more recent classifications[1]. Thompson, provided a listing of probable or estimated frequencies of what has been described as the most important anatomic arrangements in the hepatic arterial system[5]. With the advent of the development of liver transplantation, Hepatic arterial anatomy represents one of many "lessons for the general surgeon". This is possible in the developed countries as this aspect of surgery is gaining popularity with the advent of time but is not possible in our scenario as the facilities and expertise in this field are absent and no data in this regard is available. In our setup cholecystectomy is one of the most common procedures performed and surgeons do encounter variants of the hepatic artery that do not match to that of the ideal descriptions given in the text book.

A thorough knowledge of the anatomy of the hepatic artery, and its variations regarding its branching pattern and relations are essential for the accomplishment of successful, uncomplicated surgical and radiological procedures performed in the upper abdominal region. With laparoscopic surgery the need has arisen for exact descriptions of the hepatic vascularization to avoid iatrogenic vascular lesions[9].

The major strength of the current study was the material of study, an extremely meticulous dissection of the hepatic arterial vascularization was carried out with a systematized technique not only on cadavers in medical institutes and cadavers brought for autopsy in different hospitals but also experience of surgeons was sought to identify and recognize the arterial pattern.

MATERIAL AND METHODS

This descriptive study was carried out at the department of Anatomy, Army Medical college, Rawalpindi from15 Feb 2010 to 15 Aug 2010. The dissection and data collection from cadavers, specimen collection from autopsy cases and data collection from surgery cases were performed in compliance with the recommendations of the Ethics Committee of Center for Research in Experimental and Applied Medicine (CREAM), Army Medical College, Rawalpindi. Consent was obtained from relatives in case of autopsy cases and from the patients in case of surgical procedures.

A total of 70 cases were used for data collection through convenience sampling, out of which 60 cadavers were dissected and 10 cases were assisted/observed during surgery for data collection in District Headquarerts Hospital Rawalpindi and Combined Military Hospital Rawalpindi. Out of 60 autopsies, 5 were dissected in Forensic medicine departments Allama Iqbal Medical college Lahore, 20 in King Edward Medical college Lahore and 10 cases in Khyber Medical College Peshawar. Out of 20 cadavers, 3 were dissected in Continental Medical College Lahore, 6 in Shareef Medical and Dental college Lahore, 2 in Foundation Medical College Rawalpindi, 3 in Rawalpindi Medical College Rawalpindi and 5 were dissected in Khyber Medical College Peshawar. The cadavers used in study were kept in cold storage at $+2^0$C to $+4^0$C until the time of autopsy / dissection[10,11].

Inclusion criteria was any cadaver or patient of local population, of any age preferably between eighteen to eighty years of age and of any gender. Any cadaver showing signs of trauma, surgical scars on abdomen and cirrhosis was excluded. In case of cadavers from medical institutes, a midline incision extending from the xiphoid process to the umbilicus was given. For autopsy cases a midline incision was given from the symphisis menti to symphisis pubis. The skin, superficial and deep fascia were incised. Stomach and greater omentum were identified and lifted to reveal the omental bursa. The anterior layer of the peritoneum was removed from the lesser omentum and right gastric artery was identified which was traced to the common hepatic artery. Common hepatic artery was carefully exposed by blunt dissection through retroperitoneal fat and upper margin of the pancreas upto the porta hepatis, exposing its branches[12,13].

Surgeries were assisted/observed in Combined Military Hospital and District Headquarter Hospital Rawalpindi, on patients in hepato-biliary-pancreatic region. After

making a midline incision (extending from xiphoid process till umbilicus), the skin, superficial and deep fascia were incised. Securing the hemostasis the peritoneum was incised and the greater omentum identified and lifted. For stomach related procedures (subtotal / total gasterctomy), stomach was mobilized by incising gastrosplenic omentum and left gastroepiploic vessels were identified. Posterior gastric wall was separated from transverse mesocolon and vessels of the lesser curvature and right gastric artery were ligated. After ligating left gastric artery, Kochers clamp was applied and duodenum was divided distal to it. With the stomach mobilized common hepatic artery and its branches were identified and data noted.

For pancreato-doudenal procedures (Pancreatodoudenectomy, Whipples operation), mobilization of the duodenum was carried out by incising peritoneum lateral to duodenum from the epiploic foramen downwards. The duodenum and the underlying pancreas were raised from the underlying vena cava and a laparotomy pad was placed behind them. The common hepatic artery and its branches were identified and data noted down. Hemostasis was secured and after ligating gastrodoudenal artery, effected part of pancreas and duodenum were resected. Drains were placed and abdomen was closed in layers[14]. During data collection pictures were taken with digital camera.

Significance of the results was determined by comparing the results with the classification of origin of hepatic artery, its relations and branching pattern in relation to studies conducted by Michels[2,4,5].

RESULTS

Common hepatic artery originated from celiac trunk in all 70 (100%) specimens, was entirely to left of common hepatic duct and common bile duct and ventral to portal vein. Forty eight (68.6%) cases had typical classic textbook branching (Fig. 1). Considering the variational pattern in branching and relations, overall result showed variational pattern of 22 (31.4%) cases.

In 1 (1.4%) case, common hepatic artery and gastrodoudenal artery seem to be separated by a sulcus on the superior aspect giving the impression of two arteries, with anostomosis between each other in the same case (Fig. 2). In 2 (2.8%) cases, accessory right hepatic artery arising from common hepatic artery (Fig. 3) and in 1 (1.4%) case accessory right hepatic artery and cystic artery originating from common hepatic artery were present. In 1(1.4%) case common hepatic artery entered the porta hepatis directly without dividing into right hepatic artery and left hepatic artery (Fig. 4). A replaced right hepatic artery arising from common hepatic artery in 2(2.8%) cases, replaced cystic artery (Fig.4 and 5) and accessory cystic artery arising from common hepatic artery each in 1(1.4%) case respectively. Right gastric artery arising from hepatic artery proper in 55 (78.5%) cases (Fig. 1) and replaced right gastric artery arising from common hepatic artery in 8 (11.4%) cases. Regarding the branching pattern, right hepatic artery and left hepatic artery arising directly from common hepatic artery in 1 (1.4%) case with no hepatic artery proper (Fig. 5). In 2 (2.8%) cases common hepatic artery had three terminal branches, 8 (11.4%) cases showed six branches, 2 (2.8%) cases had seven terminal branches and 58 (82..8%) cases had five terminal branches.

Regarding the aberrant arteries a total of 18 (25.7%) were present in relation to common hepatic artery and its branches, out of which 9 (12.8%) were present as single (accessory/replaced) and 9 (12.8%) were present as more than one (accessory/replaced). Eight (11.4%) cases had two aberrant arteries while 1 (1.4%) had three aberrant arteries. Thirteen (18.6%) aberrant arteries originated from common hepatic artery directly. Replaced cystic artery originated in 1 (1.4%) case, accessory cystic artery and accessory right hepatic artery originated in 2 (2.8%) cases and replaced right gastric artery originated in 8 (11.4%) cases from common hepatic artery.

DISCUSSION

According to Shakeri et al[15] anatomical variation may be defined as, a normal flexibility

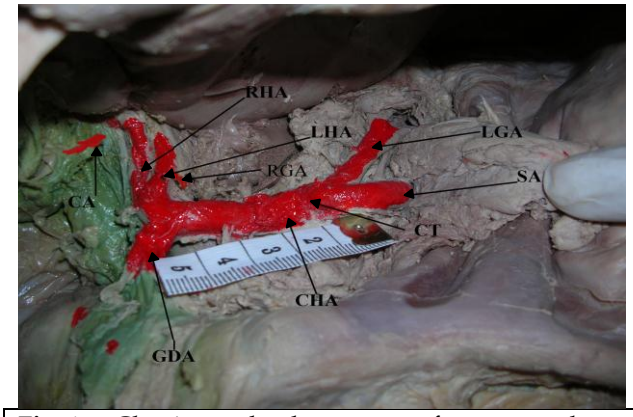

Fig. 1: Classic textbook pattern of common hepatic artery (CHA). Right hepatic artery (RHA), left hepatic artery (LHA), right gastric artery (RGA), left gastric artery (LGA), splenic artery (SA) and celiac trunk (CT) are also visible. CHA and its branches are coloured red.

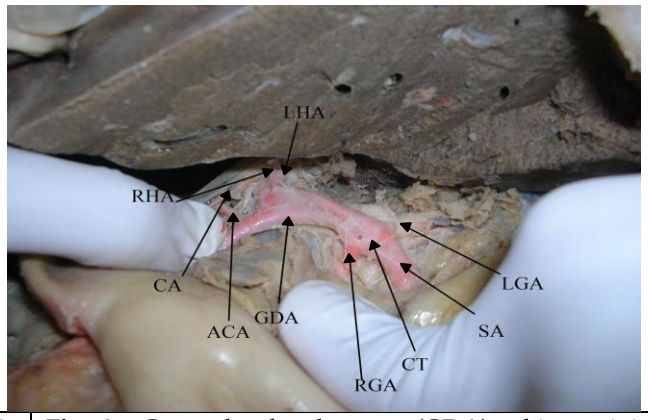

Fig. 2 : Gastrodoudenal artery (GDA) taking origin from celiac trunk (CT). Other anomalies seen, include, right hepatic artery (RGA) and accessory cystic artery (ACA) originating from GDA.

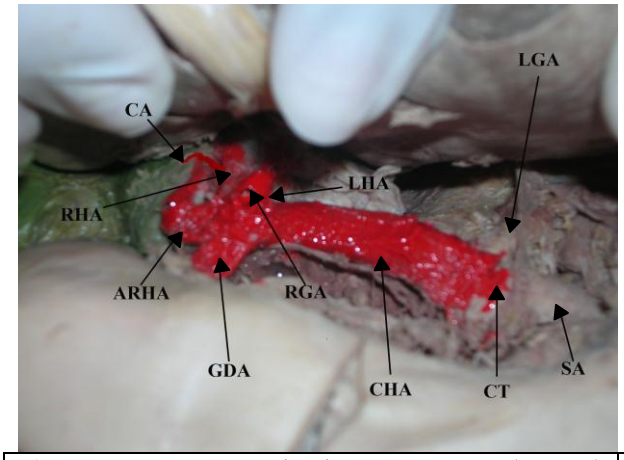

Fig. 3: Accessory right hepatic artery (ARHA) originating from common hepatic artery (CHA). Cut end of right gastric artery (RGA) can also be seen (painted red).

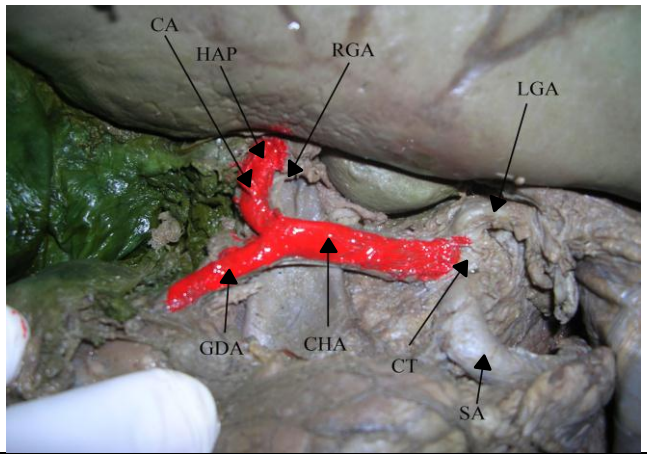

Fig. 4: Common hepatic artery (CHA) (painted red) giving rise to hepatic artery proper (HAP) without dividing into right hepatic artery (RHA) and left hepatic artery (LHA). HAP enters the porta hepatis.

in the topography and morphology of body structures.

Michels autopsy based study, which was first published in 1966[2], defined the basic anatomic variations in hepatic arterial supply and has served as the benchmark for all subsequent contributions in this area. Michels description and classification of CHA into ten anatomical variations was considered incomplete by some and consequently modified by various researchers in different studies. Most authors such as Kemeny et al[16] and Rong and Sindelar[17] contributed to surgical oncology literature, based on arteriographic data, which also give information about the intrahepatic branches. In this contest Hiatt et al[4] carried out research on 1000 cases with the aim to reflect the presence of vessels that were either

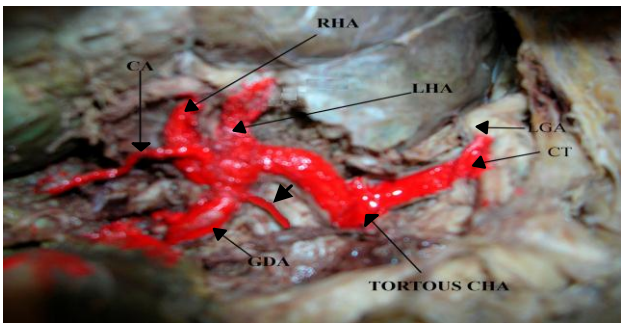

Fig. 5: trifurcation of the common hepatic artery (CHA) (painted red). CHA divides directly into right hepatic artery (RHA), left hepatic artery (LHA) and gastrodoudenal artery (GDA). Cystic artery (CA) can be seen t taking originating at the junction of origin of RHA and LHA.

accessory or replaced, so that Michels[2] original ten groups could be reduced to five major types and a most rare anomalies be place as the sixth variant. Although differences do exist between the classification of the variational pattern by the two authors which is evident during subsequent discussion. Additional very rare patterns have also been described which are not seen in every series, for instance Braun et al[18] mentioned accessory right hepatic artery originating from right renal artery.

In our study, we considered it important to identify hepatic artery, all its branches and its variants if any and further to classify them as "accessory" or "replaced" as defined by Michels[2]. Importance of classification into accessory/replaced is evident from the fact that replaced arteries must be always preserved; in contrast, accessory arteries do not necessarily need to be reconstructed if adequate blood flow is present through the other branch or if arterial flow in an organ is demonstrated by intraoperative doppler ultrasonography as highlighted by Lurie[19]. Edoga and Willekes[20] and Klingler[21] in their studies observed that during surgery, a thick artery is usually considered as ''replaced'' and a thin one regarded as ''accessory''. Furthermore, it is only possible to confirm the presence of an accessory artery by pulsation and inspection inside the lesser omentum in a living during surgery and despite this, sometimes thin accessory arteies (e.g. Accessory left hepatic artery) are overlooked by the surgeons, especially in obese patients.

In our study 48 (68.6%) cases had typical classic textbook branching pattern (Grays[22]) i.e. common hepatic artery giving rise to gastrodoudenal 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, considered as type 1 in both Michels[2] and Hiatts[4] classification. Our results were not significantly different from Hiatts studies which showed 75.5% type 1 pattern but slight difference is present regarding Michels[3] classification where type 1 pattern is present in fewer (55%) cases. In addition comparison of Michels[2] data with the current series shows a somewhat higher incidence of variant pattern in Michels[2] patients.

CHA in our study originated from celiac trunk in all (100%) cases which also falls into type 1 category by both the authors. Similar studies by various authors showed type 1 pattern as 75.5% by Rygaard et al[23], 76% by Daly et al[24], 76% by Niederhuber and Ensminger[25], and 59% by Kemeny et al[16]. Common hepatic artery vascularizing the entire liver but not originating from the celiac trunk, has been reported in other studies, and accounts for 2–5% of cases as reported by Rong and Sindelar[17], Tono. et al[26] and Vandamme et al[27]. If common hepatic artery originates from the superior mesenteric artery, it is classified as type IX according to the classification of Michels[2] (accounting for 2.5% of cases in his series) or as type V according to the classification of Hiatt (1.5% of the series). Similarly if common hepatic artery originates from the left gastric artery, it is classified as type X according to the classification of Michels[3] (0.5% of cases in his series, not mentioned in Hiatts[4] studies) or arising from aorta as type VI according to the classification of Hiatt[4] (0.2% of the series, not mentioned by Michels[2]). All these types were not found in our studies.

We found 2 (2.8%) cases in which common hepatic artery divided to form gastrodoudenal, right hepatic and left hepatic artery, this pattern termed as "trifurcation" has been described by both Kemeny et al[16] and Niederhuber and Ensminger[25]. This trifurcation of common hepatic artery with no hepatic artery proper has been regarded as a subtype of the normal type 1 scheme.

According to Scott and Hall[28] the anatomy of the hepatic artery is of great importance in general surgery, hepatic surgery especially in liver transplantation, as well as in many radiological procedures such as trans-arterial chemoembolization for hepatic tumors. Furthermore the introduction of laparoscopic surgeries has stimulated a renewed interest in

anatomy of the hepatic arteries and bile ducts. In this context variations in the origin and course of the cystic artery are of particular importance to the laparoscopic surgeons. The variant patterns of the vessels in the operative field are relevant because they will affect the laparoscopic appearance of the porta hepatis as mentioned by Price and Holden[29] in their studies.

CONCLUSION

The findings of the present study highlight the fact that the distribution of CHA regarding its origin and branching pattern is variable and that different anatomic variants can occur in a high percentage of cases which has already been observed in previous studies. Knowledge of this high variability highlighted in our study will likely help in planning and performing general and abdominal surgeries especially in the hepato-biliary-pancreatic areas, with less risks of serious surgery complications as these arterial patterns are relevant in the planning and performance of all types of liver surgical and radiological procedures.

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