Anatomic variations

Double hepatomesenteric artery a rare anatomical variant

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Abstract

Abstract: A case of a "double hepatomesenteric artery", i.e. two persisting hepatic arteries arising from the superior mesenteric artery, is reported. Also observed was a lack of systematisation of the pancreaticoduodenal arteries. The variant, which does not appear to have been previously reported in the literature, was observed when dissecting the vessels of the duodenal bulb in a preserved male cadaver injected with neoprene latex. Its embryological origin, as well as the clinical, radiological (diagnostic or interventional) and surgical implications, are discussed.

The arterial blood supply to the liver has become of increasing interest for a number of specialists (anatomists, radiologists, surgeons), because of the development of new techniques for vascular investigation, surgery on the stomach and pancreas, but most importantly because of liver transplantation. Consequently, variants of the hepatic aa., which are much more common than those of the portal system, have triggered new studies.

The case of an unusual arterial variant is presented, which appears not to have been previously described in literature.

Clinical case

The variant, described using the Tandler [20] classification, was observed during an investigation of the vessels of the duodenal bulb. Dissection was performed on specimens removed from cadavers, which had been preserved in Winckler's fluid and completely injected with neoprene latex specimens comprised the stomach, duodenum, pancreas, spleen, hepatic pedicle (sectioned at the porta hepatis) and abdominal aorta. The object of the investigation was to dissect and follow the arteries supplying the duodenal bulb from their origin to their termination.

Arterial variations

In one case, while dissecting the supraduodenal pedicle, a hepatic pedicle with an unusual disposition was observed. Having exposed the portal v. on its anterior aspect, the hilar segment was crossed by two hepatic aa. (right and left hepatic branches) of identical diameter. The two arteries were interconnected by a full canal anastomosis, with a calibre of 50% of the two hepatic aa. (Fig. 1a). Further dissection revealed that both arteries originated from two distinct arteries (Fig. 1b). The artery supplying the left hepatic a. was equivalent to a proper hepatic a., arising from a trunk emerging from the dorsal aspect of the isthmus of the pancreas the other terminal branch being the right gastro-omental a. The artery supplying the right hepatic branch arose from the dorsal aspect of the head of pancreas, close to the descending duodenum.

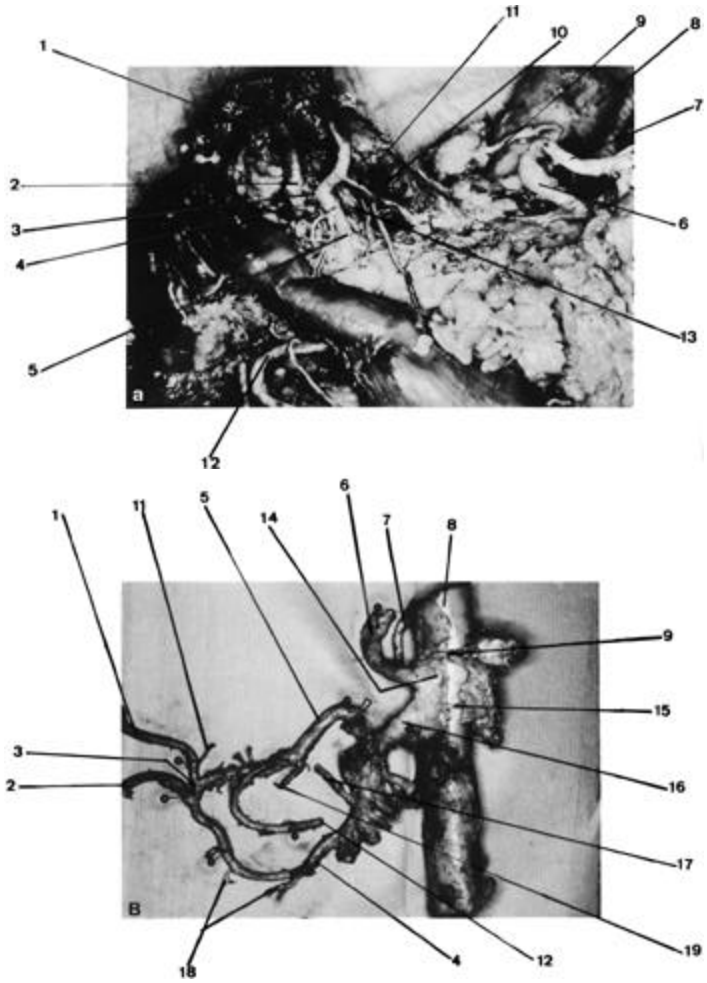


Fig. 1a, b a. Overall view of the hepatic pedicle. **b.** Dissection of the abdominal part of aorta, celiac and mesenteric branches. *1*, left hepatic branch *2*, right hepatic branch *3*, anastomosis *4*, right hepatic a. *5*, middle hepatic a. *6*, splenic a. *7*, left gastric a. *8*, aorta *9*, right inferior diaphragmatic a. *10*, portal v. *11*, right gastric a. *12*, right gastro-omental a. *13*, main bile duct *14*, celiac trunk *15*, left inferior diaphragmatic a. *16*, superior mesenteric a. *17*, dorsal pancreatic a. *18*, duodenal branches of right hepatic a. *19*, dorsal pancreatic branch

Having identified this unusual arrangement, dissection was continued to the aorta in an attempt to identify the territories supplied by each trunk. Two persisting hepatic aa. with identical diameter were found, both arising from the superior mesenteric a. (SMA). The celiac trunk was represented by the left gastric and splenic aa., together with a right inferior diaphragmatic a. arising from its side. Less than 1cm below the origin of the celiac trunk was the origin of a very large SMA, which divided into two parts. The nearly horizontal proximal part passed anteriorly, while at 90° a vertical descending part with an anterior concavity passed along the posterior aspect of the body of the pancreas. The left inferior diaphragmatic a. arose at the level of the ostium of the SMA from the left side of the aorta.

From the angle between the two parts of the SMA arose the hepatic a., which, after a short vertical course, turned through 90˚ to lie horizontally behind the pancreas. The hepatic a. passed toward the hepatic pedicle, crossing the anterior aspect of the retroduodenal pancreatic portion of the portal v., to reach the porta hepatis. The artery was equivalent (Tandler classification) to a middle hepatic a. (MHA) that continues as a left hepatic branch (LHB).

Branches of the preportal part of the hepatic a. were a posterior pancreatic a. passing toward the head of the pancreas, and a right gastro-omental a., which followed the usual course of the gastroduodenal a., supplying numerous small branches to the anterior aspect of the pancreas. Branches of the pedicular part of the artery included several small duodenal and pancreatic branches. Near its anastomosis with the second hepatic a. it gave off a group of branches, namely ventral transverse pancreatic and ventral vertical pancreatic aa., and a biliary a. for the main bile duct. The left hepatic branch gave the right gastric a.

From the left side of the second part of the SMA arose the intestinal aa. and from the right side a dorsal pancreatic a. Near the

lower margin of the pancreas the SMA gave rise to a second hepatic a., which passed behind the pancreas and the superior duodenal flexure before terminating with the right hepatic branch. Based on its course, this artery was identified as being a right hepatic a. (RHA), since it supplied branches to adjacent parts of the duodenum during its retropancreaticoduodenal course. Near its origin the right hepatic branch supplied the cystic a.

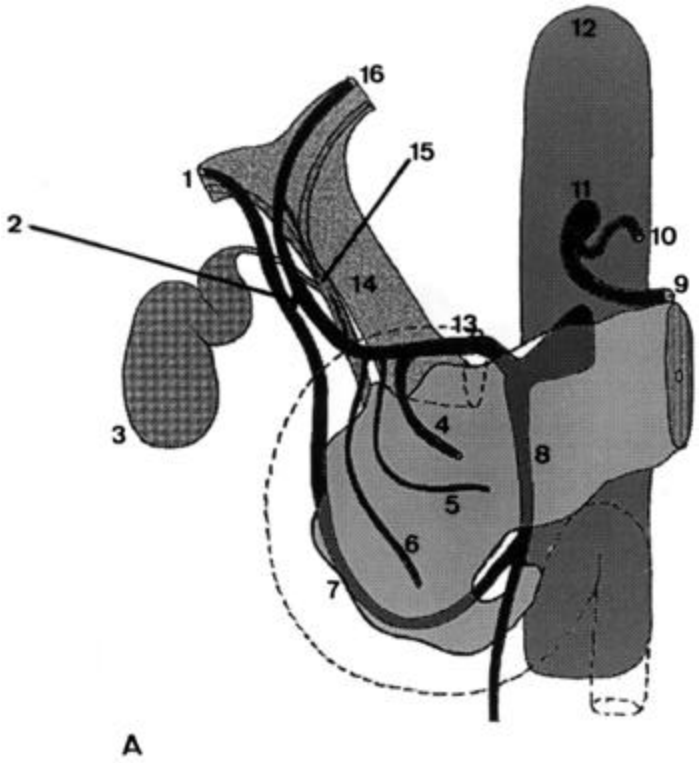
Unusual findings in the hepatic pedicle

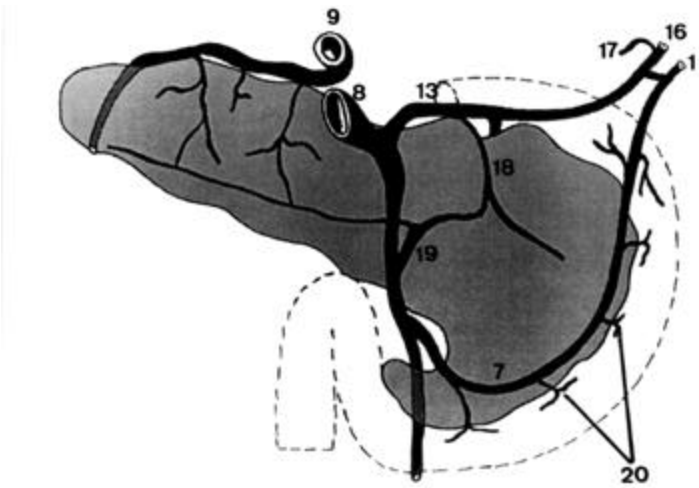
The portal v. was almost entirely visible, being crossed only in its hilar portion by the bile ducts and branches of the hepatic a. The main bile duct was to the right of the portal v. being crossed anteriorly by the MHA and left hepatic branch (LHB). The right hepatic a. and LHB were on the right of the main bile duct, which received two groups of arteries a superior pedicle from the LHB and an inferior pedicle from the MHA.

Unusual findings in the arteries of pancreas

Arteries of the pancreas were not systematised in this subject, however two peculiarities were noted the lack of pancreaticoduodenal arcades, and the arterial blood supply for the duodenum and pancreas being entirely separate. According to previous descriptions the duodenum is supplied by the right hepatic a.

The head of the pancreas was supplied by branches arising directly from the middle hepatic and right gastro-omental aa. The dorsal aspect of the isthmus of the pancreas was crossed by a dorsal pancreatic a., which supplied both the head and body. The body and tail were supplied by splenic branches that anastomosed with the ventral transverse pancreatic a. posteriorly and the posterior pancreatic a., both of which originated from the MHA, and with the dorsal pancreatic a. (Fig. 2A, B). From a macroscopic viewpoint both the liver and pancreas were morphologically normal, as were the other intraperitoneal abdominal organs.





B

Fig. 2a, b a. Anterior view of the hepatic pedicle and pancreaticoduodenal specimen. **b.** Posterior view of pancreaticoduodenal specimen. *1*, right hepatic branch *2*, anastomosis *3*, gallbladder *4*, right gastro-omental a. *5*, transverse pancreatic branch *6*, vertical pancreatic branch *7*, right hepatic a. *8*, superior mesenteric a. *9*, splenic a. *10*, left gastric a. *11*, celiac trunk *12*, aorta *13*, middle hepatic a. *14*, portal v. *15*, main bile duct *16*, left hepatic branch *17*, right gastric a. *18*, dorsal pancreatic branch *19*, dorsal pancreatic a. *20*, duodenal branches of right hepatic a.

Discussion

The multiplicity of hepatic aa. is well known, however the implications vary widely. For some investigators a common or middle hepatic a. is normal regardless of its origin, the other arteries supplying the liver being considered in this case as anomalies [7, 8, 10, 22]. For others, the common hepatic a. is the main artery, with the smaller arteries being considered as accessory [7, 17]. In contrast to both of the above some investigators believe that arteries supplying the liver should all be considered as being hepatic aa. with different functional roles [8, 13, 21]. These discordant opinions highlight the diverging embryological concepts in the derivation of arteries supplying the liver, and also explain the wide range of reported statistical data (Table 1). Finally, there are some who consider that arteries originating from the common hepatic or gastroduodenal aa. are accessory hepatic aa. [13, 17], while others consider them to be collateral branches of a main artery [7].

	1 artery (%)	2 arteries (%)	3 arterie
Rio Branco (250 cases) [18]	55	20	2
Adachi (252 cases) [1]	70	19.7	3.9
Lamarque et al. (1000 angiographies) [12]	74.2	21.5	4.3
Laude et Libersa (50 angiographies) [13]	51	47	2
Michels (200 cases) [15]	55	28	-
Rigaux et al. (120 cases) [17]	66.6	29.2	4.2
Sohier et al. [19]	17.7	80.6	1.6
Goldlewski et al. (56 fœtus et embryon) [10]	25	55	12.

Table 1. Prevalence of hepatic a. variations as reported in literature

The development of new investigative techniques, such as angiography and ultrasonic tomography [9, 12, 13, 16], may have accentuated the divergence of opinion, especially when investigators do not use classic dissection anatomy as their reference [12, 16]. The new techniques cannot be considered to be definitive studies of the hepatic aa. due the possibility of false identifications. The problem is further compounded by the fact that investigators from different specialties use different nomenclatures.

However, despite the differences three arteries regularly appear in the descriptions of most studies [2, 7, 11, 12, 13, 17, 20]. Firstly, a left hepatic a. arising from the left gastric a., running in the pars condensa of the lesser omentum and reaching the liver in the left part of the porta hepatis. Secondly, a middle (or common) hepatic a. arising from the celiac trunk, aorta or SMA, running in the pars vasculosa of the lesser omentum anterior to the portal v. It gives two terminal branches, the gastroduodenal and proper hepatic aa. the latter usually dividing into two terminal branches as it enters the liver [1]. Finally, a right hepatic a. arising from the SMA running behind the pancreas and duodenum, passing behind or to the right of the portal v., becoming anterior again near the porta hepatis.

The previous conclusions that have been drawn tend to be based on the findings of Tandler [20] and Vincens [23] on the origins of the arteries of the digestive system. According to Tandler [20], these arteries are derived from the rearrangement of segmental arteries arising from the anterior aspect of the aorta that are united via a ventral longitudinal anastomosis. All three previously mentioned hepatic aa. are, according to Tandler [20], the main arteries supplying the liver. After a series of regressions and obliterations, only a single artery remains, usually the middle artery, however two or three of the arteries may persist.

This mechanism does not, however account for all variants described in the literature. Vincens [23], therefore suggested a slightly more elaborate model according to which the liver is initially formed as two separate entities, each being supplied by a different group of arteries. A superior group for the left lobe, comprising branches of the left gastric a. (gastric hepatocoronary a.) and the inferior diaphragmatic a. (hepatodiaphragmatic a.). An inferior group for the right lobe, with the arteries originating from the celiac trunk or the aorta (hepatogastroduodenal a.) and the SMA (hepatomesenteric a.). All other origins, whether from the renal, inferior diaphragmatic or splenic a., fits into one of these groups. It should be noted, however that in human and comparative embryology the liver is not classically described as being derived from two separate precursor organs. At best a horizontal development of right and left lobes is mentioned [13, 14], but these have never been shown to be supplied by different segmental arteries.

The present observation of two persisting hepatic aa. (right and middle) can be explained by Tandler's theory [20], by shifting the origin of the middle hepatic a. to the SMA. However, the additional findings of variant pancreatic aa., the lack of pancreaticoduodenal arcades and a separate blood supply to the duodenum and pancreas cannot be explained by this theory, because the theory states that arteries for the digestive system and liver have separate segmental origins, while those for the pancreas originate from neighbouring segmental arteries for other organs [3, 4, 6]. Neither does Vincens' [23] theory provide a basis for understanding the present case, as it only applies to the arteries of the liver.

Most studies on the arteries of the digestive system consider a single organ at a time [3, 4, 5, 17]. There appears to be no report in the literature which includes descriptions of variants of the arteries of the entire superior celiac and mesenteric area, as well as morphological variants of the associated organs. Such a study would prove invaluable in the understanding of the embryological origin and development of the arteries based on the morphological variations of a single organ, as well as of the entire region.

Not only do the present findings raise questions concerning the origin of variants, it also highlights the technical problems that may occur in abdominal surgery and interventional radiology. Ligature of the right gastro-omental a. for total or distal gastrectomy may jeopardize the blood supply to the head of pancreas. Vascular dissection and ligatures in cephalic duodenopancreatectomy may prove difficult and seriously endanger the blood supply to the liver, especially if the variant is not identified preoperatively. Because of the close relationship between the bile ducts and the hepatic aa., the surgical approach may prove particularly difficult and dangerous. In liver transplantation, for example, if the subject with the variant is the donor, reconstruction of the arteries on the recipient may be a problem, e.g. anastomosis with a single hepatic a., however if the subject with the variant is the recipient anastomosis with the artery on the transplanted liver will also be a problem.

In interventional radiology selective catheterisation of the right hepatic a. may present technical difficulties, especially, for example, if the catheter needs to be advanced into the right branch for chemical embolization. If the embolizing agent is released before the anastomosis with the hepatic a., it may affect the duodenal territory of the right hepatic a. causing pain, ischemia and perforation. The same may occur if the embolizing agent is released into the middle hepatic a. before it anastomoses with the right hepatic a.

In conclusion, persisting hepatic aa. originating from the SMA do not have a satisfactory explanation according to current embryological theories. An awareness of the variation presented here is essential because of its clinical implications.

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