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Morphological And Variational Aspects Of Common Hepatic Artery With Its Clinical Anatomy In Blood Supply Of Pancreas.

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ABSTRACT

Pancreas is an organ supplied by branches of coeliac trunk and superior mesenteric artery. From coeliac trunk common hepatic artery arises; which gives major blood supply to head of pancreas. This study was carried out to study pattern of common hepatic artery in blood supply of pancreas, to find out the variations in arteries, to compare the findings with available literature and establish a data record for this region. The study was carried out on 50 specimens of pancreas by gross dissection and the origin, length, branches and termination of arteries were noted. All the specimens were studied for branching and variations. It was noted that common hepatic artery showed a variable origin, length and termination. The data received were studied and compared with available literature.

Keywords: common hepatic artery, branches, variation, pancreas

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INTRODUCTION

Pancreas is an organ that develops at the boundary between foregut and midgut. The area of foregut is supplied by the celiac trunk and the midgut by superior mesenteric artery. Major supply to head of pancreas comes from common hepatic artery and its branches. The hepatic artery gives off right gastric, gastroduodenal and cystic branches as well as direct branches to the bile duct from the right hepatic and sometimes the supraduodenal artery. After its origin from the coeliac axis, the hepatic artery passes anteriorly and laterally below the epiploic foramen to the upper aspect of the first part of the duodenum. It may be subdivided into the common hepatic artery, from the coeliac trunk to the origin of gastroduodenal artery and the hepatic artery proper, from that point to its bifurcation [1]. Considering variable pattern of origin and branching of common hepatic artery and having known its surgical importance in liver and pancreatic surgeries we have planned to study this artery in detail using dissection method [1-9].

MATERIALS AND METHODS

The study was carried out on 50 specimens removed enbloc from the cadavers, available in the department of Anatomy of Rural Medical College, Loni, Maharashtra, from August 2010 to August 2012. The approval of the Institutional Ethical and Research Committee was sought before beginning the study.

Inclusion criteria: Formalin embalmed adult cadavers with normal anatomy of pancreas irrespective of sex were used in this study. These were the cadavers meant for utilization by first year medical students for routine dissection.

Exclusion criteria: The cadaveric specimens with obvious abdominal pathology or operative procedures were excluded from the study.

The enbloc removal, along with pancreas included the duodenum, the spleen, the related part of the abdominal aorta and portal vein. The dissection necessary to study the arterial supply of head of the pancreas was carried out. A hand lens was used wherever necessary.

After removal and cleaning the dissected specimen all parameters were noted. The data collected was analyzed and expressed as percentage. Wherever required the data was subjected to statistical analysis. Other incidental observations in the course of study were recorded and discussed in the light of existing literature.

Abbreviations

(AA- Abdominal Aorta ,CT- Celiac trunk ,CHA- Common Hepatic Artery, HA- Hepatic Artery Proper, RHA - Right Hepatic Artery ,LHA - Left Hepatic Artery, GDA- Gastroduodenal Artery , ASPDA- Anterior Superior Pancreaticoduodenal Artery PSPDA-Posterior Superior Pancreaticoduodenal Artery, RGEA- Right Gastroepiploic Artery ,IPDA- Inferior Pancreaticoduodenal Artery , AIPDA- Anterior Inferior Pancreaticoduodenal Artery , PIPDA- Posterior Inferior Pancreaticoduodenal Artery, APAr- Anterior Pancreaticoduodenal Arcade/Anterior arcade , PPAr- Posterior Pancreaticoduodenal Arcade /Posterior arcade, CA-Cystic Artery)

OBSERVATIONS

All the arteries and their branches involved were studied. The major heads for the study were origin, course and extent, termination and organs / parts of organs under supply. The data was obtained, compiled and subjected to statistical analysis for comparison with available literature.

Common hepatic artery (CHA): Present in all specimens (100%).

Origin

In 98% specimens (49/50) it originated from celiac trunk and in 2% specimen (1/50) directly from abdominal aorta (Figure 1 and Photograph1).

Length: Average Length = 2.99 cm;
Range = 1.5-5cm.

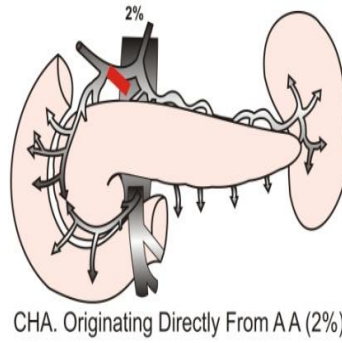


Figure 1: Abnormal origin of Common Hepatic Artery



Photo 1: common hepatic artery originating from abdominal aorta(2%)

Table 1: Showing details of termination of Common Hepatic Artery.

Termination	Number	Percentage
Into Hepatic artery proper (HA) and Gastroduodenal artery(GDA)	46/50	92%
Into Right hepatic artery (RHA), Left hepatic artery (LHA) and Gastroduodenal artery(GDA)	2/50	4%
Into Right hepatic artery (RHA) and Gastroduodenal artery (GDA)	1/50	2%
Into Cystic artery (CA) and Gastroduodenal artery(GDA)	1/50	2%
Total	50/50	100%

Figure 2: Termination of Common Hepatic Artery



Photograph 2: Showing termination of hepatic artery as above figures

Organs / parts under supply: Head of pancreas, first and second part of duodenum, right and left lobe of liver along with gall bladder, greater curvature of stomach.

As we are considering blood supply to pancreas the terminating branches on pancreas are studied in detail; whereas the hepatic branches showed regular pattern with blood supply to liver.

Gastrooduodenal artery (GDA): Present in all specimens (100%)

Origin: It originated from common hepatic artery in all specimens.

Length: Average Length = 3.83 cm; Range = 2.5-5.5 cm.

Termination: The termination of artery showed variations as shown in table 2(Figure 3 and Photograph 5,6,7).

Table 2: Details of termination of Gastrooduodenal Artery

Termination	Number	Percentage
Anterior superior pancreaticoduodenal artery (ASPDA), Posterior superior pancreaticoduodenal artery (PSPDA) and Right gastroepiploic artery (RGEA).	44/50	88%
Anterior superior pancreaticoduodenal artery (ASPDA) and Right gastroepiploic artery (RGEA)	4/50	8%
Anterior superior pancreaticoduodenal artery (ASPDA), Posterior superior pancreaticoduodenal artery (PSPDA), Right gastroepiploic artery (RGEA) and an additional branch to left side to neck and body of pancreas.	1/50	2%
Anterior superior pancreaticoduodenal artery (ASPDA), Posterior superior pancreaticoduodenal artery (PSPDA), Right gastroepiploic artery (RGEA) and Cystic artery(CA)	1/50	2%
Total	50/50	100%

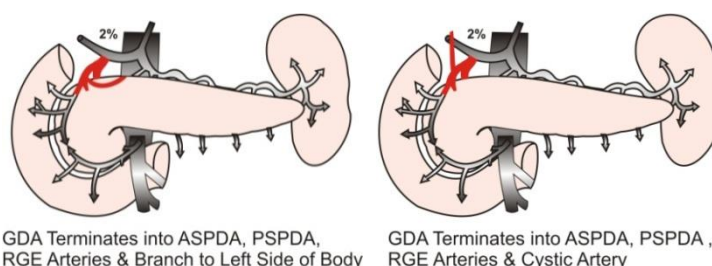


Figure 3: Termination of Gastrooduodenal Artery



Photograph 3: GDA terminates into ASPDA, PSPDA, RGE & Cystic artery

Organs / parts under supply: Head of pancreas, first and second part of duodenum, greater curvature of stomach and the gall bladder.

Anterior Superior Pancreaticoduodenal Artery (ASPDA): The artery was present in all the specimens (100%).

Origin: In all specimens it originated from gastroduodenal artery (100%).

Length: Average Length =4.7 cm; Range = 3 - 10.5 cm.

Termination: The artery terminates by joining with anterior inferior pancreaticoduodenal artery in 94% (47/50) specimens, terminates into branches and forms arcade on its own in 4%, and with posterior inferior pancreaticoduodenal artery in 2% specimens (Figure 4 and Photograph 8,9).

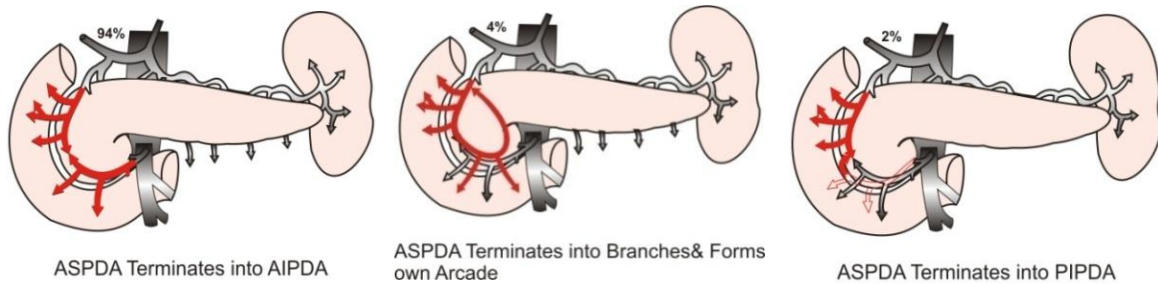


Figure 4: Termination of Anterior Superior Pancreaticoduodenal Artery

Organs / parts under supply: Head and uncinete process of the pancreas, duodenum (first and second part).

Posterior Superior Pancreaticoduodenal Artery (PSPDA): The artery was present in 48/50 specimens i.e.96% and absent in 4% cases.

Origin: It originated from gastroduodenal artery in 92%, hepatic artery proper in 4% and is absent in 4% cases (Figure 5 and Photograph 10).

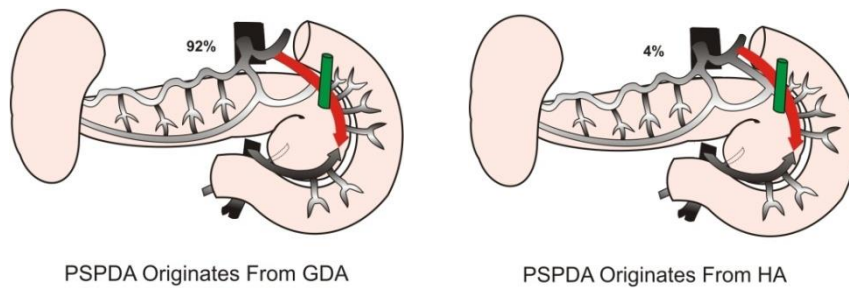


Figure 5: Origin of Posterior Superior Pancreaticoduodenal Artery

Length: Average Length =4.3 cm; Range = 2.5 - 8.3 cm.

Termination: The artery terminates by joining with posterior inferior pancreaticoduodenal artery in 88%, with posterior inferior pancreaticoduodenal artery and extra branch from superior mesenteric artery in 4%, forms an arcade on its own in 2%, with anterior inferior pancreaticoduodenal artery in 2% and absent in 4% (Figure 6 and Photograph 11,12,13).

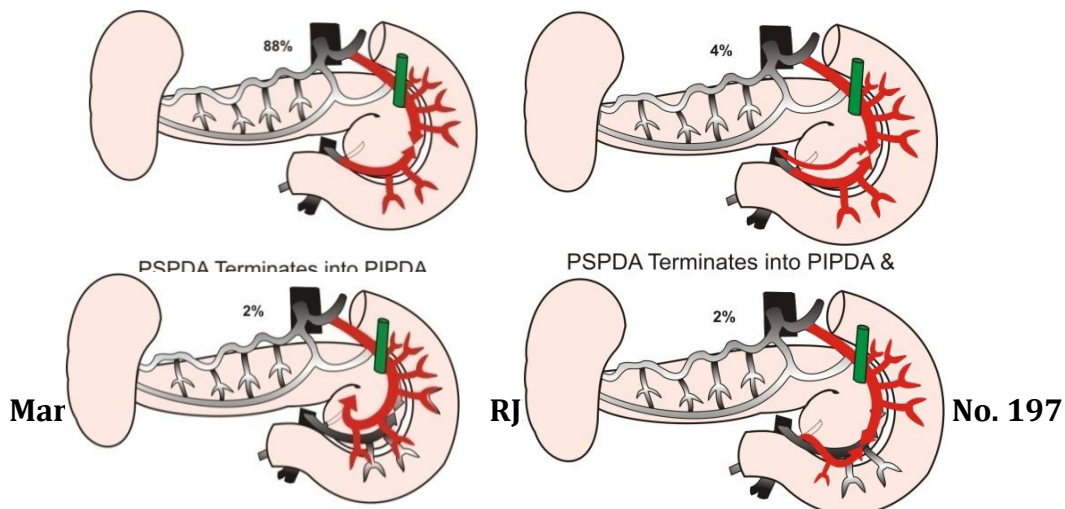


Figure 6: Termination of Posterior Superior Pancreaticoduodenal Artery

Organs / parts under supply: Head and uncinata process of the pancreas, duodenum (first, second and third part). Aberrant accessory posterior superior pancreaticoduodenal artery was present in 1/50 specimens i.e. 2%, and supplies head of the pancreas, duodenum (first and second part).

DISCUSSION

Pancreas is an organ involved in the highest degree of specialized secretory activity. This specialization is found in endocrine as well as exocrine function. This activity is brought by virtue of its abundant blood supply both in terms of the amount of blood it receives and the number of branches it receives from three different sources. The number of sources in addition to networking of the vessels in the form of arcades and collateral circulation provide a guaranty against blood flow obstruction that is functional or physiological in nature. In our study we found variation in branching of arteries, difference in their area of distribution apart from those that normally supply pancreas, but we did not come across a single instance of absence of this artery.

The arterial blood supply of the pancreas is provided mainly by the celiac and superior mesenteric arteries. Common hepatic artery is surgically more important since the number of variations affecting its area of supply are many more.

Common hepatic artery (CHA): It arises from celiac trunk usually and divides into gastroduodenal artery and hepatic artery proper. It supplies pancreas via gastroduodenal artery [2]. In our study this artery originated from celiac trunk in 98% cases and from abdominal aorta in 2% cases. Origin from aorta was also reported by Mackie CR et al³ in 1%, and by Odnoralov et al in 6% cases. Origin of common hepatic artery from superior mesenteric artery was reported by Mackie CR et al [3] in 2%, by Michel et al [8] in 4.5%, by Odnoralov et al in 2%, we did not come across any such occurrence.

Gastroduodenal artery (GDA): It arises as one of the two terminal branches of the common hepatic artery branch of the celiac trunk. Shortly after it arises from the common hepatic artery branch, it gives posterior superior pancreaticoduodenal artery and ends by dividing into the right gastroepiploic and anterior superior pancreaticoduodenal arteries. Variations were previously noted in the presence, origin and branching of the artery.² The relationship of the gastroduodenal artery to the common bile duct and adjacent viscera are of paramount importance to the alimentary tract surgeon, particularly dealing with duodenal ulcer where massive hemorrhage is a complication due to erosion of this artery [4]. Embolisation of the gastroduodenal artery (duodenal hemorrhages) / left gastric artery (gastric hemorrhages) is advocated for upper gastrointestinal hemorrhages. Accurate knowledge of normal anatomy and its variants is essential for empiric embolization.⁵ Across the spectrum of various studies till date, origin of gastroduodenal artery presented a picture as detailed in the following table.

Table: Distribution of origin of Gastroduodenal artery

Origin of Gastroduodenal artery (GDA)	Present study	Bradley RL et al	Mackie CR et al	Sabat S et al
From common hepatic artery (CHA)	100%	88%	99%	79%
From normal right hepatic artery (RHA)	-	8%		6%
From variant right hepatic artery (RHA) from superior mesenteric artery (SMA)	-	4%		11%
From left hepatic artery (LHA)	-	-	1%	4%

The studies indicated in the table are from different region of the world. Food type, bodily habitus and the habitat vary from region to region leading to variations in morphology of organs associated with alimentary system and consequent rearrangement of vessels.

Gastroduodenal artery commonly gives anterior and posterior superior pancreaticoduodenal artery and right gastroepiploic artery. Apart from these branches we found cystic artery originating from gastroduodenal artery in 2%; which is also reported by Mackie CR et al [3] in 1% and Michel et al in 0.5%.⁸ Origin of cystic artery from gastroduodenal artery should be kept in mind while dealing with Gall bladder surgeries. Mackie CR et al [3] reported origin of right hepatic artery from gastroduodenal artery in 1% which we did not found in any case. Length of the gastroduodenal artery ranged between 2.5-5.5 cm with an average of 3.8 cm in our study which is comparable with Bradley RL et al [4] who reported it to be 3-4 cm.

Posterior Superior Pancreaticoduodenal Artery (PSPDA): In about 70-80% of cases the posterior superior pancreaticoduodenal artery arises within the first 2 cm of the gastroduodenal artery, usually from its posterior aspect, as the first collateral branch. It has a spiral, descending course that surrounds the choledochus: it runs transversely from left to right in front of the common bile duct, turns around its right lateral side, then again crosses the choledochus, from right to left, to anastomose with the posterior inferior pancreaticoduodenal artery. Several variations can occur with this artery [2]. This artery was present in 96% cases in our study; similar to findings reported by Thomford NR et al [7] as 96.6%. In present study it originated from gastroduodenal artery in 92% near to Thomford NR et al [7] i.e. 93.3%. Origin of artery from hepatic artery proper in 4% cases was found by us; similar finding is reported by Skandalakis et al [2] in 2-8% cases. We noted presence of an aberrant accessory posterior superior pancreaticoduodenal artery supplying head of the pancreas and duodenum (first and second part) in one case. Posterior superior pancreaticoduodenal artery supplying all three parts of the duodenum and posterior surface of head of the pancreas is reported by Michel NA et al [8] and is also found in this study.

In ligations, explorations or transplantations of the common bile duct, especially, of its intrapancreatic portion, this artery should be taken note to avoid annoying hemorrhage. In hidden bleeding which follows spontaneous rupture of the posterior duodenal wall by ulceration, this artery may be involved more than gastroduodenal or anterior superior pancreaticoduodenal artery. In incisions for removal of gall stones, this artery is subject to quick injury with resultant hemorrhage as it crosses the supraduodenal portion of the common bile duct anteriorly [8].

Upon reaching the lower flexure of the duodenum, the anterior superior pancreaticoduodenal artery usually turns backward and courses over the posterior surface of the uncinate process, where it anastomoses with the anterior inferior pancreaticoduodenal artery. In a minority of cases, the artery may remain on the anterior aspect of uncinate process [2]. This artery was present in all the cases in our study; similar frequency of its occurrence was noted by Oslen LL et al [6]. In all cases this artery had its origin from gastroduodenal artery (100%); Thomford NR et al [7] found this to be true in 96% cases. This artery forms its own arcade in 4% cases of our study and this is not reported by any other study [10-19].

Anterior Superior Pancreaticoduodenal Artery (ASPD):

This is an almost constant artery, usually larger than the posterior superior pancreaticoduodenal artery. In more than 90% of cases it arises from the gastroduodenal artery as one of its terminal branches, behind the inferior edge of the first part of duodenum. In 5-7% cases it arises from other sources. Running downward, the anterior superior pancreaticoduodenal artery can lie either in front of the duodenum or on the surface of the pancreatic head. Sometimes it is buried in the parenchyma of the gland. At the level of the duodenal papilla, the artery occasionally can be separated from the choledochus

by only 1 mm of pancreatic parenchyma. Upon reaching the lower flexure of the duodenum, the anterior superior pancreaticoduodenal artery usually turns backward and courses over the posterior surface of the uncinate process, where it anastomoses with the anterior inferior pancreaticoduodenal artery. In a minority of cases, the artery may remain on the anterior aspect of uncinate process.² This artery was present in all the cases in our study; similar frequency of its occurrence was noted by Oslen LL et al.⁶ In all cases this artery had its origin from gastroduodenal artery (100%); Thomford NR et al⁷ found this to be true in 96% cases. This artery forms its own arcade in 4% cases of our study and this is not reported by any other study.

CONCLUSION

All the arteries supplying head of pancreas were seen to have a variable origin, length and termination. Different studies on the arterial supply of pancreas came up with a wide range of statistical records. No one particular reason can satisfactorily explain occurrence of such variations in arteries supplying pancreas. These studies are from different region of the world. Food type, bodily habitus, and the habitat vary from region to region leading to variation in morphology of organs associated with alimentary system and consequent rearrangement of vessels. The reason for variations being found in the same geographical region may lie in the many developmental probabilities and possibilities associated with two pancreatic buds approaching each other, enlarging and invading into a meshwork of blood vessels.

Following were the variations found by us that were not reported by any other author.

1. Termination of common hepatic artery into cystic artery and gastroduodenal artery in 2% cases.
2. An aberrant replaced right hepatic artery in 20% cases; This aberrant right hepatic artery gave origin to anterior inferior pancreaticoduodenal artery in 2% and posterior inferior pancreaticoduodenal artery in 4% cases; in 2% cases this artery only gave branches to posterior part of head of pancreas.

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