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Original Research Article

Anomalous anatomical variation in extrahepatic biliary tree and pancreas and its related vessels: a cadaveric study

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ABSTRACT

Background: Congenital anamolies of extrahepatic biliary apparatus and pancreas have long been recognized and are of clinical importance because when present may surprise the surgeon during surgery and lead to iatrogenic injuries. Surgeries on extra-hepatic biliary apparatus and pancreas are regularly performed throughout the world. Thus insight into the normal anatomy and congenital variations will reduce complication and definitely improve outcome.
Methods: Study was conducted in department of surgery GMC Bhopal and dissection was carried out in Department of Forensic Medicine on 100 cadavers with approval from ethical committee.
Results: In 100 cases 70 were male and 30 female. The most common variation in extra hepatic biliary apparatus was short cystic duct was found in 6% cases then formation of common hepatic duct by union of right hepatic duct and left hepatic duct was intrahepatic in 3% cases. There was low insertion of cystic duct with common hepatic duct in 1% case. Cystic artery originating from left hepatic artery in 1% case, in 1% case cystic artery was anterior to common hepatic duct. In Pancreas anterior arterial arcade was absent in 2% cases and its origin varied in 2% case. Posterior pancreatic arcade absent in 1% cases and variation in origin was present in 1% case. The variation in pancreatic duct course was present in 22% cases.
Conclusions: Thus significant variation was seen and it could definitely be helpful to hepatobiliary, laproscopic surgeons, radiologist and will further contribute to literature on variation of extrahepatic biliary apparatus and pancreas and its related vessels.

Keywords: Common hepatic duct, Pancreatic arcade, Cystic artery, Cholecystectomy

INTRODUCTION

Congenital anomalies of extra hepatic biliary tree and pancreas have long been recognized but are rare and may be of clinical importance because they may provide surgeons with unusual surprises during surgeries

In recent times the trend in surgical procedure is to move toward minimal invasive surgery to reduce morbidity and mortality. If patient is selected carefully, investigated properly and the thorough knowledge of normal anatomy can give surgeon a sense of security and it can help in reducing complications.

Gall bladder surgery is commonly performed biliary surgery and laparoscopic cholecystectomy has become the new gold standard for management of gall stone disease.[1] The incidence of biliary tract injury by laparoscopic cholecystectomy has been found to be higher than open cholecystectomy.[2,3] Aberrant anatomical course of extrahepatic biliary system & pancreas is a well-established fact of iatrogenic injuries.

Presence of arterial variations may result in erroneous interpretation of angiograms, the topograhicic anatomy of such variation is important for interventional radiologist. Pre-operative assessment of potential liver donor requires

hepatic vascular and biliary anatomy delineation. In adult right hepatic lobe transplantation is usually the procedure of choice to provide adequate liver volume to recipient.[4] Recognition of congenital anomalies and normal variant may avoid diagnostic error, and in surgical planning and prevent inadvertent ductal injuries.[5]

The objective of this study was to study the incidence of anatomical variations of extra hepatio-biliary duct and pancreas and its related vessels in 100 cadaveric dissections.

METHODS

Study design and place

This was an observational study conducted at Department of Surgery and Department of Forensic Medicine and Toxicology at GMC Bhopal with prior permission from ethical committee from period March 2017 to August 2018.

Selection criteria

All cadavers of age group 13 years onwards were included and cadavers with decomposed and mutilated bodies, malignancy were excluded.

This study followed cadaveric dissection by opening the abdomen by midline and exploring, dissecting the hepato-pancreatico-biliary area.

First of all gallbladder was identified and details were noted, then cystic duct was dissected and its accompanying cystic artery was identified. Cystic duct was followed till its junction with common hepatic duct and then common bile duct was dissected and delineated. Length and angulations of cystic duct was noted. Length of CBD and its variation if any was noted. Then common hepatic duct was traced caudally till its branching and length was noted. Cystic artery was carefully followed till its origin and details were noted. At the same time course of cystic artery in relation to hepatic ducts was noted and search for any accessory cystic artery was made, dissection was carried out till delineation of proper hepatic artery, anatomical course and it's branching in relation to portahepatis, pancreatico- duodenal artery identified by its origin. Different arteries supplying different parts of pancreas identified and dissected , main and accessory pancreatic duct , their course and their communication identified , after noting above details, any gross anatomical variations if present were noted and photos were taken.

RESULTS

In our study of 100 cases, 70 were male 30 were females. Normal anatomy of extrahepatic biliary apparatus was shown in Figure 1. Formation of common hepatic duct by union of right hepatic duct and left hepatic duct was extrahepatic in 97 cases and intrahepatic in 3 cases (Figure 2).

Table 1: Union of right hepatic duct with left hepatic duct.

Union of right hepatic duct with left hepatic duct	Number of cadavers (n=100)	Percentage (%)
Extrahepatic	97	97
Intrahepatic	3	3

Table 2: Origin of cystic artery.

Origin of cystic artery	Number of cadavers (n=100)	Percentage (%)
Right hepatic artery	99	99
Left hepatic artery	1	1

Table 3: Relation of cystic artery with common hepatic duct.

Relation of cystic artery with CHD	Number of cadavers (n=100)	Percentage (%)
Anterior	1	1
Posterior	99	99

Table 4: Pancreatic duct course.

Course of pancreatic duct	Number of cadaver (n=100)	Percentage (%)
Descending	78	78
Sigmoid	20	20
Vertical	02	02

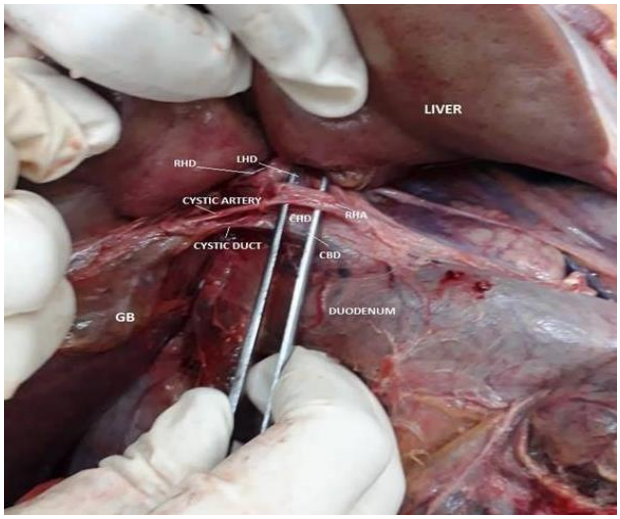

Figure 1: Normal anatomy of extrahepatic biliary apparatus and its related.

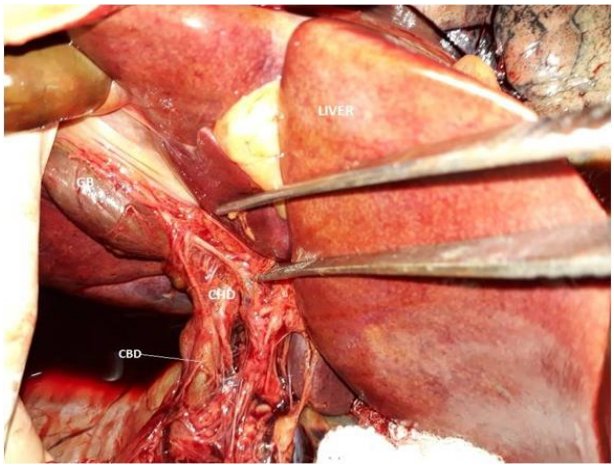

Figure 2: Intra-hepatic union of left hepatic duct and right hepatic duct.

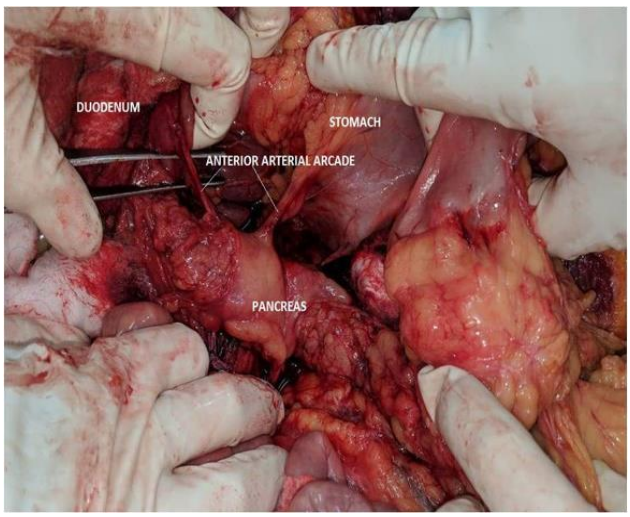

Figure 3: Arterial supply to the pancreas: Anterior arterial arcade.

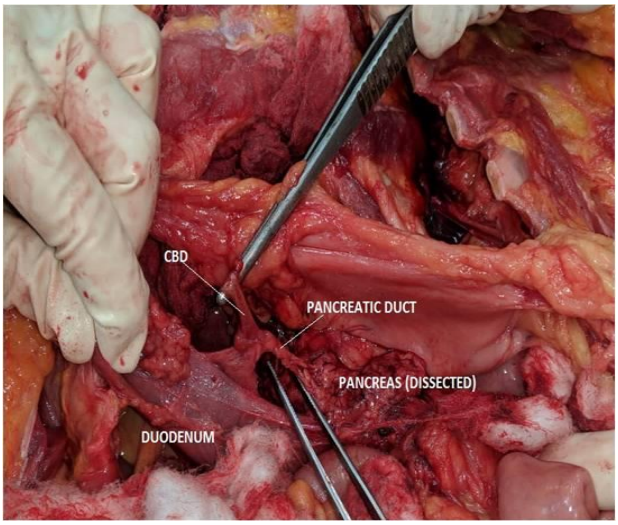

Figure 4: Union of pancreatic duct and common bile duct opening into duodenum.

Union of cystic duct with common hepatic duct was of normal type i.e., angular type in 99 cases, and in 1 cases union was parallel type (Table 1). There was low insertion of cystic duct with common hepatic duct in 1 case. Short cystic duct was found in 6 cases (8%) i.e., <1.6 cm. Cystic artery originating from right hepatic artery in 99 cases and in 1 case cystic artery originating from left hepatic artery found (Table 2). In 99 cases cystic artery was posterior to common hepatic duct, and in 1 case cystic artery was anterior to common hepatic duct (Table 3). Average length of cystic duct was 3.1 cm, and common hepatic duct 2.67 cm and length of common bile duct was 7.18 cm. There was incidental finding of gall bladder calculus in 6 cases. An arcade of an artery supplying branches to anterior surface of head of pancreas was present in 98% cases and was absent in 2% cases. Another arcade artery supplying posterior surface of pancreas was present in 99% of cases in this study and was absent in 1% cases. Anterior arterial arcade was present in 98% specimens and absent in 2% (Figure 3). It was formed by anterior superior pancreaticoduodenal artery (ASPDA) and anterior inferior pancreatico-duodenal artery (AIPDA) in 96%, ASPDA, AIPDA and Right dorsal pancreatic artery (Rt. DPA) in 2%, arcade was absent and ASPDA gave branches in 2%. Similarly posterior arcade also showed variations with presence in only 99% specimens. Posterior superior pancreatico-duodenal artery (PSPDA) and posterior inferior pancreaticoduodenal artery (PIPDA) formed posterior arterial arcade in 98% and by PSPDA, PIPDA and extra branch from superior mesenteric artery (SMA) in 1 % case. Arcade was absent and right hepatic artery (RHA) gave branches in 1%. The course of the pancreatic duct was assessed and the descending course was the most common one in 78% cases (Figure 4). Other courses included sigmoid (20%), vertical (2%) (Table 4-6). No developmental anomalies of pancreas such as pancreatic divisum or annular pancreas were found in any cases.

Table 5: Origin of anterior pancreaticoduodenal arcade.

Origin	Number (n=100)	Percentage (%)
ASPDA and AIPDA	96	96
ASPDA, AIPDA and Rt. DPA	2	02
ASPDA gives branches	2	02

Table 6: Showing origin of posterior pancreaticoduodenal arcade.

Origin	Number (n=100)	Percentage (%)
PSPDA and PIPDA	98	98
PSPDA, PIPDA and SMA	01	01
RHA gives branches	01	01

DISCUSSION

We discuss here in detail the various anatomical variations which we came across in our present study. The right and left hepatic duct from the corresponding lobes of liver unite to form common hepatic duct either extrahepatically or intrahepatically. Rugg et al studied 43 cadavers. In that he observed extrahepatic union of right and left hepatic duct in 79% and intrahepatic union of right and left hepatic duct in 21%.[6] 43 cadavers dissected by Rugg et al reported angular type 35% parallel type 20% and spiral type 45%.[6] Flint et al worked on 200 subject and found the origin of cystic artery from right hepatic artery in 98% from left hepatic artery in 1,5% cases and from gastroduodenal in 0.5%.[7] Thompson et al dissected 50 specimen and noted 90% extrahepatic union and 10% intrahepatic union of right and left hepatic ducts.[8] Thompson et al dissected 50 cases and observed angular type-90% parallel type 6% and spiral type 4%.[8] Gray's et al stated that accessory hepatic duct is more common with right lobe of liver. In present study no accessory hepatic or cystic duct was present. The Gray's Anatomy(2008), mentioned the average length of cystic duct is 3-4 cms, length of common hepatic duct is 3 cms and length of common bile duct is 7.5cms.[9] Daseler et al worked on 500 cases and visualized accessory right hepatic duct in 8 cases (1.6%).[10] Mahim et al in their study done on 100 cadavers' extrahepatic union of right and left hepatic union noted in 97% and intrahepatic union in 3%.[11] In our study on 100 cadavers extrahepatic union of right and left hepatic union was noted in 97 % and intrahepatic union in 3 %.

Three types of union of cystic duct with common hepatic duct namely angular type, parallel type and spiral type. Eisendrath et al's study on 100 specimens showed angular type 75% parallel type- 17% and spiral type- 8%. In present study, angular types was seen in 99 %, parallel type in 1%.[12] The level of termination of cystic duct with hepatic duct can be, high level, low level, normal level. In study done by Mahim et al normal level of union of cystic duct with common hepatic duct was seen in 96% i.e., Normal and low insertion was seen in 3%, and high type insertion was seen in 1 case i.e., 1%.[11] In our study, normal level of union of cystic duct with common hepatic duct was seen in 99% i.e., normal and low insertion was seen in 1%, and high type insertion was seen not found in any case.

In study done by Mahim et al the average length of cystic duct was 2-4 cm, average length of common hepatic duct was 2-3 cm; average length of common bile duct was 6-8 cms.[11] In present study the average length of cystic duct was 1.2-4 cm, average length of common hepatic duct was 1.5-3.5 cm; average length of common bile duct was 5.5-8 cm.

There was short cystic duct in 6 out of 100 cases. Length of individual duct. Hollinshead et al stated the length of cystic duct as 2.5-7.5 cm, length of common hepatic duct as 2.5-7.5 cm, length of common bile duct as 5-15 cms. Variations in pancreatic duct course**.** In our study, the course of the pancreatic duct was assessed and the descending course was the most common one in 78 % cases. Other courses included sigmoid (20%), vertical (2%), Aysel et al found that the course of the pancreatic duct varied greatly and the most common one (50%) was a descending course. Other courses included sigmoid, vertical, and loop configurations.[12-15] Origin of cystic artery. Hollinshead et al also described that cystic artery arises from right hepatic artery. He also added it may also arise from left hepatic artery and common hepatic artery. Accessory cystic artery: Flint et al studied 200 specimens and observed accessory cystic artery in 31 cases in that in 51.6% of cases it arise from right hepatic artery, in 9.6% cases from common hepatic artery, 35.4% from gastroduodenal artery and 3.1% from gastroduodenal artery.[16] Grays anatomy also mentioned that accessory cystic artery arising from common hepatic artery. In present study no accessory cystic artery found. Gray's Anatomy it's mentioned that cystic artery arising from right hepatic artery. He also stated that cystic artery may arise sometime from common hepatic artery left hepatic artery and gastroduodenal artery. In a study done by Mahim et al, cystic artery was arising from right hepatic artery in 96% cases and from left hepatic artery in 3% cases and from hepatic proper artery in 1% cases. In present study, cystic artery was arising from right hepatic artery in 99% cases and from left hepatic artery in 1% cases. Cystic artery in relation to common hepatic duct

Eisendrath et al studied about 100 specimens. He described in both the studies artery passing dorsal to common hepatic duct is found to be high in number. Ventral to CHD in 27% and dorsal to CHD in 73%.[12] In present study the cystic artery passing posterior to common hepatic duct was seen in 99 % and anterior in 1% cases.

Pancreatic vascular supply: pancreatic arterial arcades

In a study done by Chavan et al found that in 92% cases arterial arcade was formed by ASPDA and AIPDA was found. Another arcade artery supplying posterior surface of duodenum and pancreas was present in 98% of cases in their study. Variable origin of the two source arteries for arcade was noted in their study; arcade formation by PSPDA and PIPDA was seen in 86% cases.[17] Kimura et al also found in their study that an arcade of an artery supplying branches to anterior surface of both duodenum and head of pancreas was present in 98% cases. They also found in 92 % cases that this arcade was formed by ASPDA and AIPDA.[13] In 88% cases another arcade artery supplying posterior surface of duodenum and pancreas was found in their study. Anterior arterial arcade was present in 98% specimens and absent in 2%. It was formed by ASPDA and AIPDA in 92%, ASPDA, AIPDA and Rt. DPA in 2%, ASPDA only in 2%, ASPDA, PIPDA in 2%, arcade was absent and ASPDA gave branches in 2%. Similarly posterior arcade also showed variations with presence in only 98% specimens.

In our study, an arcade of an artery supplying branches to anterior surface of head of pancreas was present in 98% cases and was absent in 2% cases. Another arcade artery supplying posterior surface of pancreas was present in 99% of cases in this study. Anterior arterial arcade was present in 98% specimens and absent in 2%. It was formed by ASPDA and AIPDA in 96%, ASPDA, AIPDA and Rt. DPA in 2%, Arcade was absent and anterior superior pancreatico-duodenal artery (ASPDA) gave branches in 2%. Similarly posterior arcade also showed variations with presence in only 99% specimens. PSPDA and PIPDA formed posterior arterial arcade in 98% and by PSPDA, PIPDA and extra branch from SMA in 1% case.

CONCLUSION

Hence we can see that there are significant variation in extra-hepatic billary tree and pancreas, and these variations observed could definitely be useful to Hepatobiliary, laparoscopic, general surgeons, and radiologists. It further reinforces our knowledge as well as the literature available on the topic suggesting that extrahepatobiliary system and pancreas has got the most variations from the normal anatomical course in the body.

Though congenital anomalies of the pancreas and pancreatic duct are relatively uncommon and they are often discovered as an incidental finding in asymptomatic patients, some of these anomalies may lead to various clinical symptoms such as recurrent abdominal pain, nausea and vomiting. Recognition of these anomalies is important because these anomalies may be a surgically correctable cause of recurrent pancreatitis or the cause of gastric outlet obstruction. Modern day minimal invasive surgeries involves complex and technically demanding hepatobiliary procedures it can further prevent morbidity and mortality which occurs due to intraoperative injuries arising from ignorance or improper knowledge of anatomy and its related anatomical variations. Congenital anamolies of extrahepatic biliary apparatus have been long been recognized but are rare and are of clinical importance because when present may surprise the surgeon during surgery. Also the wide spectrum of biliary tree malformation along with the pancreas can be recognized by the modern Radiological evaluation like MRI, MRCP and Multi Detector Helical CT. Having the knowledge of these anatomical variations in mind may prevent inadvertant injuries during routine and complex hepato pancreaticobiliary procedures.

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