ANATOMICAL AND VASCULAR VARIATIONS OF THE BILIARY SYSTEM

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Upper abdominal organs consists of various anatomical arrangements. This variety is derived from developmental anomalies.

It has been stated that considering the celiac and aortic origin of main branches, less than half of the subjects conform to the textbook descriptions, whereas arterial vascularizations pattern of any of the organs above the transverse colon are ever the same (1). Therefore, during cholecystectomy, cholangiojejunostom, partial hepatectomy, total or subtotal gastrectomy and pancreaticoduodenal resections for carcinoma of the head of the pancreas, the surgeon must acquaint himself with the arterial and anatomic pattern and attempt to identify them.

These variations can be of two types:

1. Replaced type, which is from a source different from the standard and substitudes for it.

2. Accessory structures, which are from a source different from the standard and additional to it (1-3).

The anomalous anatomy of the biliary system is very common, each vessel or duct may vary, not only in respect to its immediate source but also from a variation of its source or origin.

The biliary system consists of:

1. Common hepatic duct (formed by the union of right and left hepatic ducts).

2. Gall bladder (a reservoir for bile).

3. Cystic duct (duct of the gall bladder).

4. Common bile duct (formed by the junction of the common hepatic and the cystic ducts) (4,5).

Common hepatic duct:

It is about 3-4 cm long, formed by the union of the main right and left hepatic ducts which issue from the liver and unite near the right end of the porta hepatis as the common hepatic duct. It then descends within the free edge of the lesser omentum. It is joined on the right side by the cystic duct in an acute angle. The common hepatic duct is to the right of the hepatic artery and anterior to the portal vein (4,6,7).

Beside these textbook knowledge, variations of the common hepatic duct frequently occur and often predispose injuries during the operations.

In some cases there may be no common hepatic duct (7) owing to the lower union of the left and right hepatic ducts, which is close to the union of the cystic duct (Fig. 1). Further, careful attention should be paid to the prescense of an accessory hepatic duct; the frequency being between 14.5% - 18.0% (1,2,8). The diameter of the accessory hepatic duct approximates to the diameter of the common hepatic duct.

The accessory bile duct may join the right hepatic duct (3.5%) common hepatic duct (10 %), common bile duct (1 %), cystic duct or anastomoses between the right hepatic duct and the common hepatic duct (Fig. 2). Two accessory ducts (1%) may be present; one joining the right hepatic duct,while the other joins the common hepatic duct (2,7,9).

The arterial relations to the accessory ducts are often surgically dangerous and difficult to analyse. The accessory ducts joining the right branch of the hepatic duct are usually away from receiving surgical harm during cholecystectomy but those joining the cystic duct or running parallel to it of great danger, these variations can result in causing a disconcerting postoperative leakage of bile.

Mostly the common hepatic artery lies entirely to the left of the common bile duct (10). The right hepatic branch mostly crosses the hepatic duct. Posterior and approximately 7 - 12 % ventral crossing have been observed (2,3). Also two hepatic arteries have been traced and both may cross the hepatic duct posteriorly, anteriorly or one crossing anteriorly while the other posteriorly.

The relation of the cystic artery to the common hepatic duct depends on the origin of the cystic artery. If it arises from an artery other than the right hepatic artery (middle hepatic, left hepatic, common hepatic or gastroduodenal artery), it must cross the common hepatic duct to reach the gallbladder (2,3).

These variations should be kept in mind during the surgery of the region.

Gall bladder:

It is a pear shaped sag, lying on the visceral surface of the liver. It extends forwards from a point near the right end of the porta hepatis to the inferior hepatic border. It is completely invested by peritoneum except its upper surface, where it is attached to the liver by connective tissue. It consists of fundus, body and a neck. The fundus; comes in contact with the anterior abdominal wall, the boy; lies in visceral surface of the liver, the neck; becomes continious with the cystic duct (4,5). Important anomalies of the gallbladder relate to number, position and form. Congenitaly absence of the gallbladder is extremely rare, (0,03 %). Duplication of the gallbladder with two seperate cavities and two seperate cystic ducts or a common duct occurs with an incidence of approximately 1 in 4000. The accessory gallbladder may be situated on the left side, and its cystic duct may empty into the left hepatic duct (Fig. 3).

The gallbladder maybe found in a variety of abnormal positions. The floating gallbladder occurs when there is an increase in the peritoneal investment. Organ maybe completely invested by peritoneum with no mesentery. It can also be suspended from the liver by a complete mesentery (11).

TABLE 1. Variations of the origin of the cystic artery presented by different researchers.

Author	Year	R. hep.A %	Com. hep.A %	Lhep .A %	Gastro duo.A %	Others %
Anson (7)	1963	63.9	26.9	5.5	2.6	1.5
Kehr (12)	1903	80	3	1	3	0.5
Halvorsen(13)	1971	81	10	2	3	-
Shwarts (11)	1985	95	-	-	-	-
Daseles (14)	1947	69.8	2.2	6.2	2.6	-
Browne (15)	1940	54.7	3.5	1.8	-	-

Anomalies of the arterial supply of the gallbladder (cystic artery) occurs frequently (50%). Variations of the arlery's origin are of surgical interest. The cystic artery has great variations in the origin (common hepatic, left hepatic, gastroduodenal, coeliac trunk, superior mesenteric) and the freqency of these variations are stated in Table I by different researches (Fig. 4).

In about 15% the cystic artery passes anterior to the common hepatic duct rather than posterior. (15). Anterior crossing occured 22% in Halvorsen (13), 13.1% in Daseles's (14) studies. Then reaches the Calot's triangle (10); the boundries of this triangle are formed inferolaterally by the cystic duct, medially by the hepatic duct, superiorly by the liver, the right hepatic artery and the cystic artery being prevailingly located in the upper part of the triangle (Fig. 5).

Double cystic arteries occur in about 11-25% of cases (Lipshuts (17) 11%, Daseles (14) 14%, Flint (8) 15%, Belou (18) 19%, Brewer (19) 20%, Browne (15) 21%) as superficial and deep branches. Frequently the two branches come off seperately, the superficial arising low, the deep high (2,3,11-16). The superficial branch is distributed to the free peritoneal surface of the gallbladder, the deep to the attached non-peritoneal surface of the gallbladder bed (13-16). The double cystic artery may arise separately from the same artery or from different sources. Both cystic arteries may arise from the right hepatic (1,15). Other fairly common pattern is that the deep arises from the right hepatic the superficial from the gastroduodenal or its retroduodenal branches.

The cystic arteries arising from intestinal arteries are very important in surgical point of view (1,7,15).

The cystic duct

It is 3-4 cm long, passes backwards, downwards and to the left from the neck of the gallbladder and joins the common hepatic duct to form the common bile duct. The junction is usually immediately below the porta hepatis (3,4). The major variations of the cystic duct are in the types of union between the cystic and the common hepatic duct (Fig. 6). In 75% of the cases, angular union occurs. However in 17% parallel and adherent cystic and common hepatic duct union occurs. This parallel union maybe short, less than 5 cm in 11%, long parallel union greater than 5 cm 6% (3). Also very important for possible injury of the common hepatic duct is the spiral union of the cystic

The cystic duct can be extremely long, short or absent. High union occurs with the right hepatic duct (3,15).

Common bile duct:

It is formed near the porta hepatis by the junction of the cystic and the common hepatic duct. It is 8-15 cm in length. According to the relationship with the intestinal viscera, the term "suprapancreatic", "infrapancreatic" and "intraduodenal" have been applied to its pattern. The suprapancreatic portion is situated in the free edge of the lesser omentum, to the right of the hepatic artery and anterior to the portal vein. Infrapancreatic portion of the duct curves to the right behind the first portion of the duodenum. Intraduodenal portion curves more to the right behind the head of the pancreas which grooves to enter the duodenum at the ampulla of Valter, where it is frequently joined by the pancreatic duct.

The union of the bile duct and main pancreatic duct occurs in three different patterns:

A. Unites outside the duodenum and traverse the duodenal wall and papilla as a single duct.

B. Joins within the duodenal wall, and have a short, common, terminal portion.

C. Exit independently into the duodenum (15,21).

Arterial and structural variations cannot be ignored. It can be dangerous unless one realizes the frequent anomalous anatomy of the upper abdominal organs during surgery of the region.

and the common hepatic (15,20). This type of union was present in 8% of Stemples (3) studies.

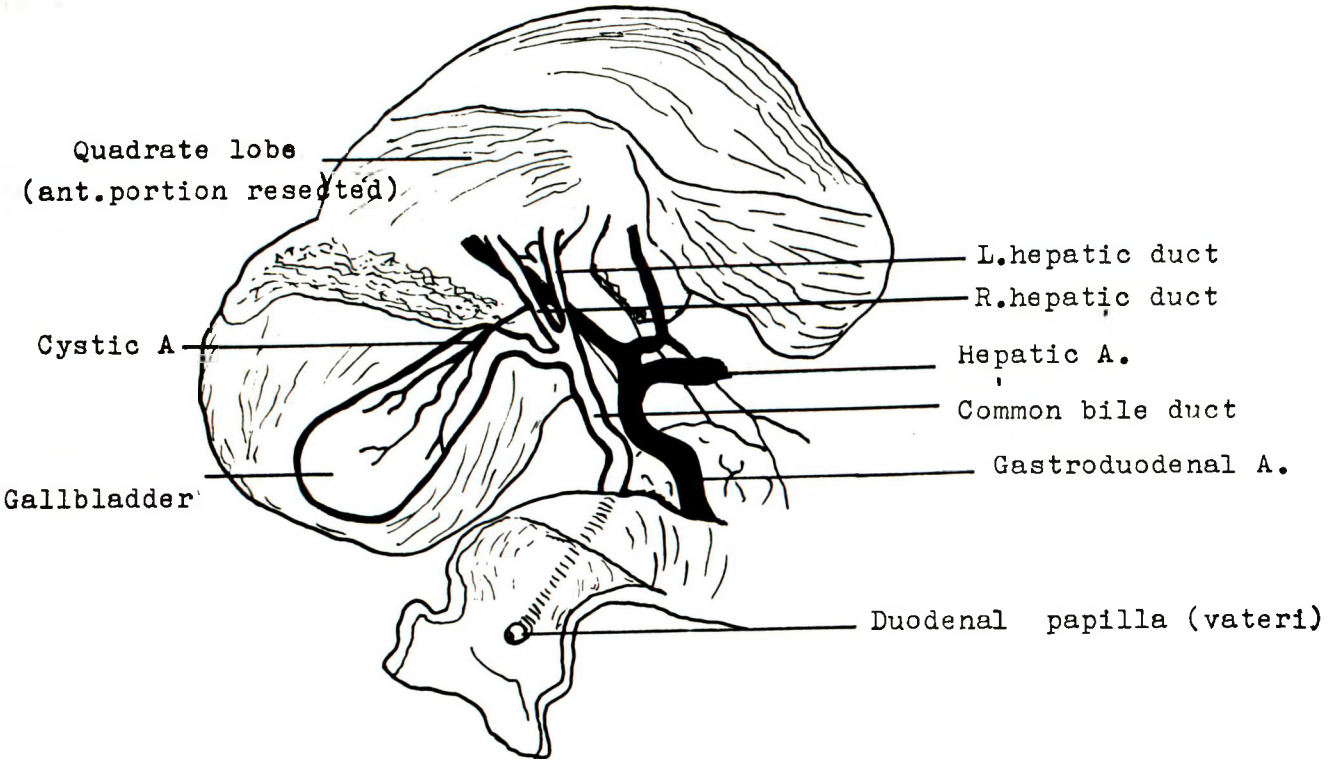


Fig 1: Low union of left and right hepatic duct results in "no common hepatic duct".

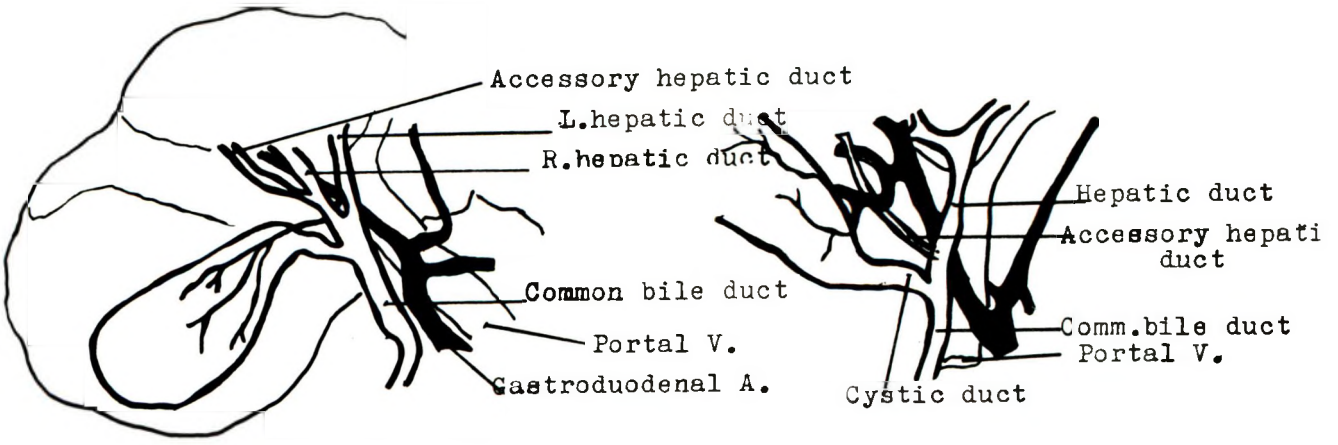
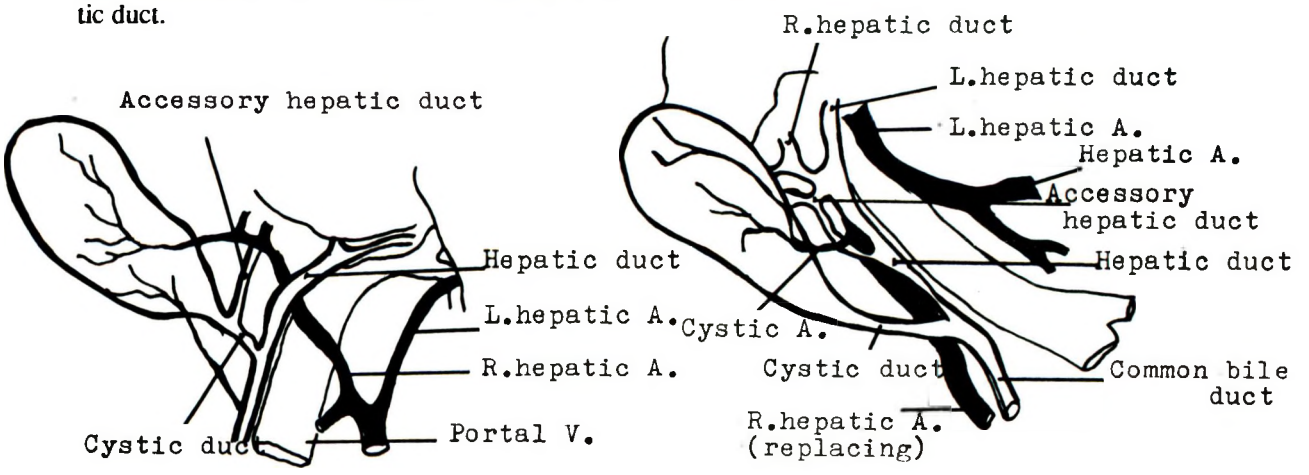


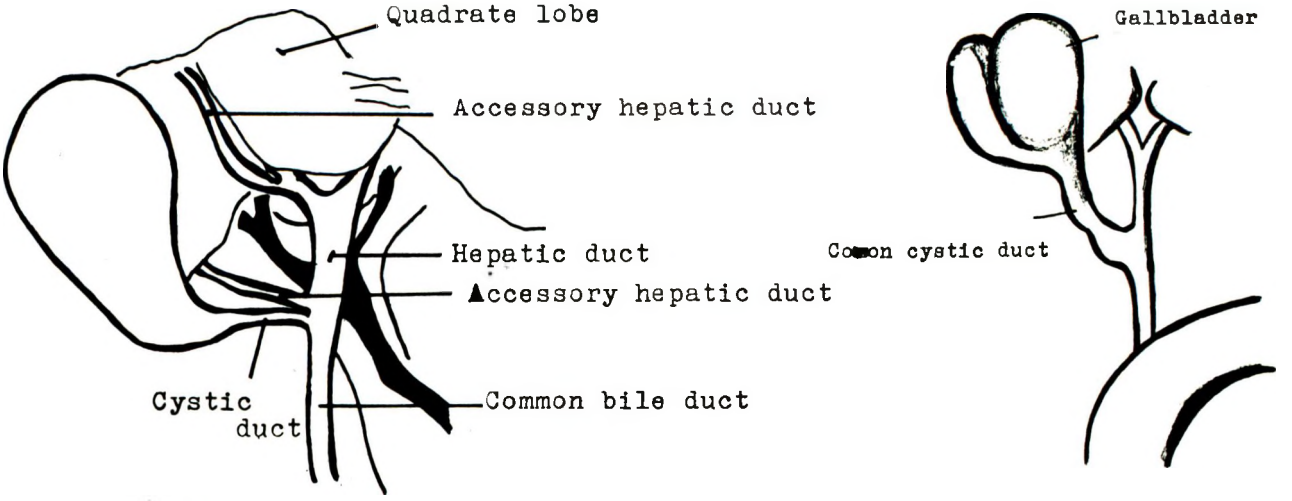
Fig 2:Variations of the accessory hepatic duct.
A. The accessory hepatic duct joining the right hepatic duct.

B. The accessory hepatic duct joining the common hepatic duct.



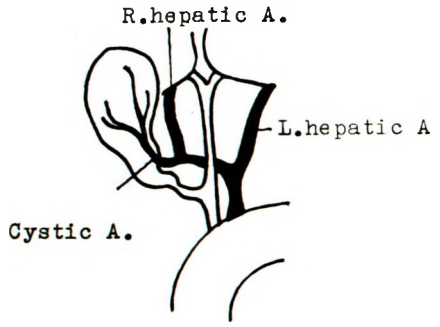
C. The accessory hepatic duct joining the cystic duct.

D. The accessory hepatic duct anastomoses between the right hepatic duct and the common hepatic duct.



E. Two accessory hepatic ducts, one joining the right hepatic duct the other common hepatic duct.

Fig 3:Congenital duplication of gallbladder with two seperate cavities and a common duct.



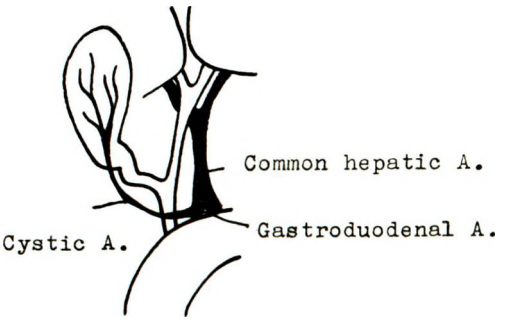
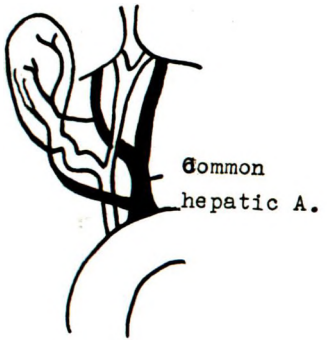
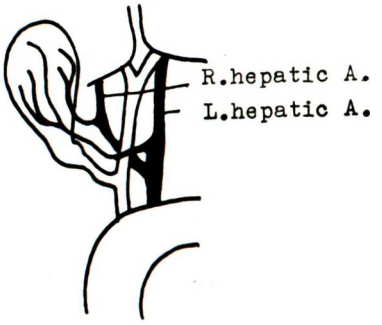


Fig 4: Variations of the cystic artery.
A. The cystic artery arising from the right hepatic artery.

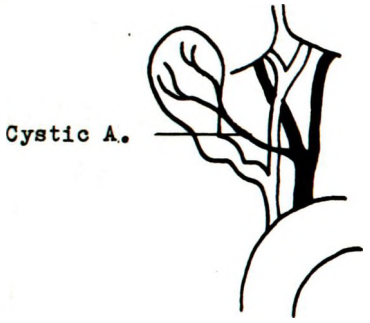
B. The cystic artery arising from the gastraduodenal artery.

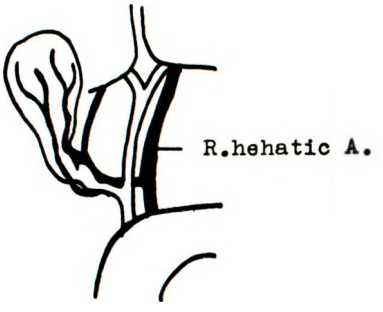




C. Two cystic arteries one arising from the right hepatic artery and the other from the common hepatic artery.

D. Cystic artery arises from the left hepatic artery and crosses the common bile duct anteriorly.





E. Cystic artery arises from the right hepatic artery and crosses the common bile duct anteriorly.

F. Two cystic arteries arising from the right hepatic artery.

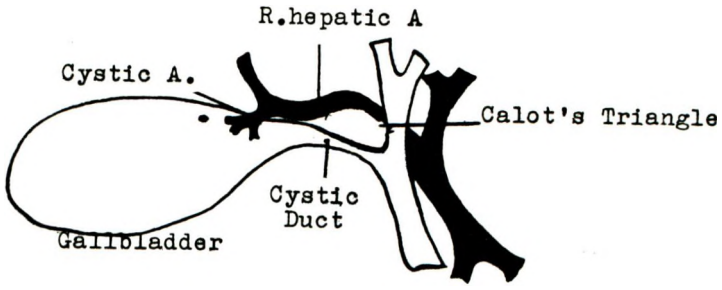


Fig 5 : Calot's triangle is a surgical landmark for tracing the cystic artery.

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