Anatomy of the extra-hepatic biliary tract & the pancreas

Embryogenesis

Normal Development

The genesis of the extrahepatic biliary duct system and gallbladder may, perhaps, be the responsibility of the distal portion of the hepatic diverticulum. By the end of the 4th week, it has produced the cystic duct and gallbladder primordium. The common bile duct and the hepatic ducts may be seen at the beginning of the 5th week. The solid stage of the ducts takes place during the 5th week. The ducts elongate to reach the liver, progressively forming at this time. Slow ductal recanalization occurs approximately from the 6th through 12th weeks. Human fetal gallbladder contractility in the second half of pregnancy has been reported, although its physiological role is unknown ***(Tanaka et al., 2000).***

Surgical Anatomy

Extrahepatic Triad and Extrahepatic Hepatic Veins

The extrahepatic triad consists of the hepatic artery, hepatic portal vein, and hepatic duct ***(Michels, 1995).***

Blood Vessels

Hepatic Artery, Common Hepatic Artery, and Proper Hepatic Artery

The hepatic artery provides 25% of the afferent blood supply to the liver, as well as about 50% of the oxygen. The hepatic arterial supply is derived from the celiac trunk in 55% of subjects. In 45%, the common hepatic artery, the right hepatic, or the left hepatic may arise from vessels other than the celiac trunk (aberrant hepatic arteries) ***(Michels, 1995).***

The common hepatic artery takes origin from the celiac trunk in the majority of individuals: In other cases, it may arise from the superior mesenteric artery (2.9%), from the aorta (1.1%), from the left gastric artery (0.54%), or even from more rare sources ***(Van Damme & Bonte, 1985).***

Aberrant Hepatic Arteries

There is confusion in the literature regarding the terms aberrant, replacing, and accessory arteries. Aberrant or atypical hepatic arteries are often described as "replacing" arteries if the artery arises entirely from some source other than the celiac arterial distribution. In such cases, the replacing artery can supply the entire liver or an entire lobe of the liver. Atypical hepatic arteries are often, if erroneously, referred to as "accessory" hepatic arteries if they arise from some aberrant source and are additive to lobar branches derived from the celiac hepatic arteries ***(Healey et al, 1953).***

The common hepatic artery may arise from the superior mesenteric, the aorta, and the left gastric or other sources, as noted above. The left hepatic artery arises in 25-30% of cases from the left gastric artery. These include a totally "replacing" left hepatic artery in 10% and an "accessory" left hepatic artery in about 15% of cases. The right hepatic artery originates from the superior mesenteric in about 17% of cases. The middle hepatic artery arises with nearly equal frequency from the left or right hepatic artery, although it is more often depicted as arising from the left hepatic artery (***Michels, 1966).***

Hepatic Portal Vein

The hepatic portal vein provides 75% of the blood and about 50% of the oxygen reaching the liver. The portal vein is formed by the confluence of the superior mesenteric vein and the splenic vein behind the neck of the pancreas. However, the inferior mesenteric vein may enter the splenic vein, superior mesenteric vein, or their junction. In these cases the portal vein is thought of as being formed by the junction of all three ***(Healey & Schwartz, 1964).***

Toward the liver, the portal vein lies in front of the inferior vena cava. The common bile duct is on the right, and the proper hepatic artery is on the left. In the absence of disease, the portal vein and the superior mesenteric vein can be easily separated from the posterior surface of the pancreas. The portal vein is 7-10 cm long and 0.8-1.4 cm in diameter and is without valves. At the porta hepatis, it bifurcates into right and left portal veins ***(Healey & Schwartz, 1964).***

The inferior mesenteric vein ends with approximately equal frequency in the splenic vein, the superior mesenteric vein, or the portal vein. Either the splenic vein or the portal vein receives the coronary (left gastric) vein as well. The portal vein receives an accessory pancreatic vein on the left and the superior pancreaticoduodenal and the pyloric veins on the right ***(Healey et al, 1953).***

Hepatic Veins

The liver is drained by a series of dorsal hepatic veins. They are located in the area aptly called "the upper hilum" by Rodney Smith. There are 3 major veins —the right, middle, and left hepatic— and from 10 to 50 smaller veins opening into the inferior vena cava ***(Nakamura & Tsuzuki, 1981).***

The extrahepatic length of the three major veins varies from 0.5 cm to 1.5 cm. The right hepatic vein is the largest. It lies in the right segmental fissure, draining the entire posterior segment and the superior area of the anterior segment of the right lobe. The middle hepatic vein lies in the main lobar fissure. It drains the inferior area of the anterior segment of the right lobe and the inferior area of the medial segment of the left lobe ***(Nakamura & Tsuzuki, 1981).***

The left hepatic vein lies in the upper part of the left segmental fissure. It drains the superior area of the medial segment and the entire lateral segment. In about 60% of individuals, the left and middle veins unite to enter the inferior vena cava as a single vein. The length of the common trunk is 1-2 cm ***(Nakamura & Tsuzuki, 1981).***

The right hepatic vein enters the inferior vena cava. In some individuals a significant segment of the right vein may course in a retrohepatic position, where it is especially vulnerable to posterior incisions at the level of the 12th rib or other surgical approaches designed to treat upper posterior abdominal injuries or pathology. The left hepatic vein may also enter the inferior vena cava directly. This vein may be torn during operations at the gastroesophageal junction when the left triangular ligament is incised. The middle hepatic vein enters into the left hepatic vein ***(Nakamura & Tsuzuki, 1981).***

Of the smaller veins, one or two constant vessels drain the caudate lobe and enter the inferior vena cava on the left side. Several inconstant veins draining the posterior segment of the right lobe enter the right posterolateral aspect of the inferior vena cava ***(Kennedy & Madding, 1977).***

Extrahepatic Biliary Tract

The right and left lobes of the liver are drained by ducts originating as bile canaliculi in the lobules. The canaliculi empty into the canals of Hering in the interlobular triads. The canals of Hering are collected into ducts draining the hepatic areas, the four hepatic segment ducts, and finally, outside the liver, the right and left hepatic duct ***(Healey & Schroy, 1999).***

Right Hepatic Duct

The right hepatic duct (RHD) is formed by the union of the anterior and posterior segment ducts at the porta hepatis. The average length of the right hepatic duct, when present, is 0.9 cm ***(Healey & Schroy, 1999).***

Left Hepatic Duct

The left hepatic duct (LHD) is usually formed by the union of the medial and lateral segment ducts, although the medial segment duct sometimes enters the inferolateral duct. The union of the two area ducts is in line with the left segmental fissure (50%), to the right of the fissure (42%), or to the left of the fissure (8%) ***(Healey & Schroy, 1999).***

The average length of the left hepatic duct is 1.7 cm. Usually the right and left hepatic ducts are of equal size. In patients with chronic obstructive biliary disease, the left duct, for unknown reasons, is larger than the right duct ***(Healey & Schroy, 1999).***

Common Hepatic Duct

The common hepatic duct (CHD) is formed by the union of the right and left hepatic ducts in the porta at the transverse fissure of the liver. Its lower end is defined as its junction with the cystic duct. The distance between these points varies from 1.0 cm to 7.5 cm. The diameter of the duct is about 0.4 cm ***(Newman & Northrup, 1993).***

Cystic Duct

The cystic duct contains a series of 5 to 12 crescent-shaped folds of mucosa similar to those seen in the neck of the gallbladder. These form the so-called spiral valve of Heister. The length of the cystic duct and the manner in which it joins the common hepatic duct vary. The pressure of secretion from the mucous glands in the cystic duct is higher than the secretion pressure of bile. The intracholecystic result of prolonged obstruction of the extrahepatic biliary tree proximal to the cystic duct is white "bile," composed only of mucus. The cystic duct joins the hepatic duct at an angle of about 40° in 64-75% of individuals. In 17-23%, the cystic duct parallels the hepatic duct for a longer or shorter distance and may even enter the duodenum separately. This is called "absence" of the common bile duct. In 8-13%, the cystic duct may pass inferior to or superior to the common hepatic duct to enter the latter on the left side. In the parallel type of junction, the common duct is at risk from the surgeon attempting to ligate the cystic duct. If the long parallel portion of the cystic duct is left in place, cystic duct remnant syndrome with various sequelae may result. Less frequently, the gallbladder is sessile with little or no cystic duct. The cystic duct should be prepared well. The duct should be ligated such that it avoids a long cystic duct remnant, but at the same time avoiding ligation so close that the common bile duct is injured ***(Newman & Northrup, 1993).***

In his doctoral thesis about the cystic duct remnant and the postcholecystectomy syndrome, Droulias concluded:

1. A relatively long cystic duct remnant can be the cause of postcholecystectomy symptoms, sometimes quite severe, by being the site of chronic inflammation, lithiasis or neuroma formation. Rarely, it can cause kinking of the common bile duct or reflex spasm of Oddi.

2. Re-exploration and excision of the remnant is indicated after thorough study of the patient, provided the symptoms are severe enough to interfere with normal life and work.

3. Should the remnant be found quite long or diseased during re-operations on the biliary tree or pancreas it must be excised.

4. Prevention can be achieved by meticulous dissection of the cystic duct at cholecystectomy and ligation 2-3 mm from the junction with the common bile duct.

5. It seems probable that regeneration of the gallbladder after complete cholecystectomy in humans, dogs and monkeys does not take place ***(Droulias, 1979).***

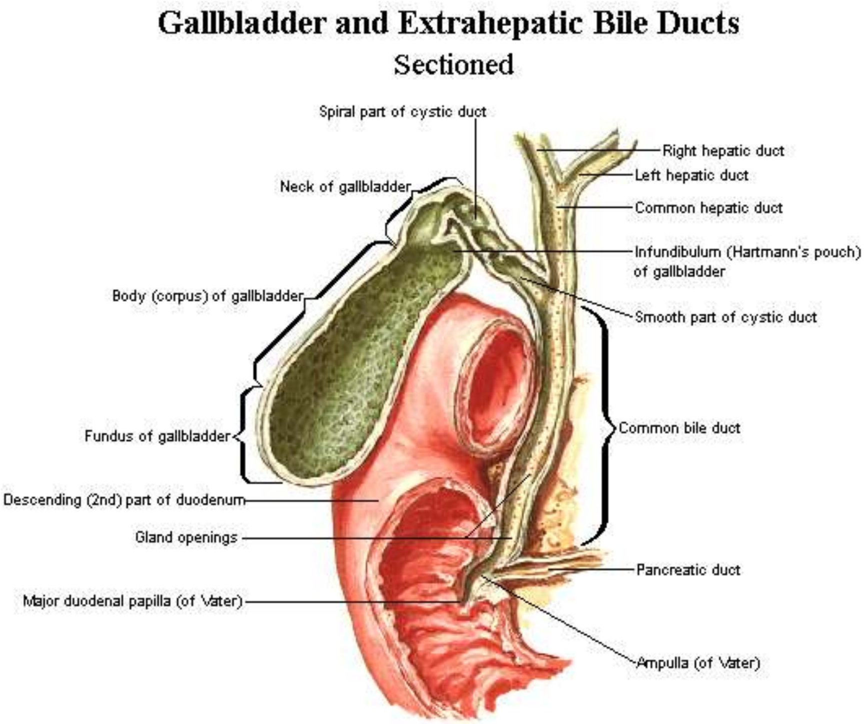

Fig. 1: Gall bladder and extrahepatic bile ducts

(Fuzhou et al, 1995)

Gallbladder

The gallbladder (GB) is 7-10 cm long and has a capacity of 30-50 ml. It is located on the visceral surface of the liver in a shallow fossa at the plane dividing the right lobe from the medial segment of the left lobe (the GB-IVC line). In other words, the gallbladder fossa is found at the junction of the quadrate lobe (segment IV) and the right lobe of the liver. The gallbladder is separated from the liver by the connective tissue of Glisson's capsule. Anteriorly, the peritoneum of the gallbladder is continuous with that of the liver. The gallbladder can be divided into fundus, body, infundibulum, neck, and cystic duct ***(Kaiser, 1961)***.

Fundus

The fundus is usually located at the angle of the ninth costal cartilage with the right border of the rectus sheath and to the left of the hepatic flexure of the colon. It is completely covered by peritoneum, because it projects beyond the lower border of the liver. A partial folding of the fundus may result in the "Phrygian cap" deformity ***(Kaiser, 1961).***

Body

The body of the gallbladder is in contact with the first and second portions of the duodenum and occupies the gallbladder fossa of the liver. The body is also related to the transverse colon. Only in the rare presence of a mesentery (wandering gallbladder), a prerequisite for acute torsion, is the body completely covered by peritoneum. The peritoneal folds may be associated with the pathway of a large gallstone ulcerating from the gallbladder into the intestinal tract. The duodenal path is the most common; the gastric path is the rarest. We do not know if there is a relationship between these folds and the corresponding fistulous tracts of gallstone ileus. However, it is possible that the folds predispose to fistulas ***(Skandalakis et al, 1987).***

Infundibulum

The infundibulum is the angulated posterior portion of the body between the neck and the point of entrance of the cystic artery. When this portion is dilated, with eccentric bulging of its medial aspect, it is called a Hartmann's pouch. The pouch is often associated with chronic or acute inflammation due to lithiasis and often accompanies a stone impacted in the infundibulum ***(Kaiser, 1961).***

Neck

The narrow neck (cervix) curves up and forward and then sharply back and downward forming an S to become the cystic duct. The junction of the neck and the cystic duct is said to be indicated by a constriction. The cystic artery is found in this region coursing in the loose connective tissue that attaches the neck of the gallbladder to the liver ***(Williams, 1995).***

Following removal of the gallbladder, there is sometimes leakage of bile from small bile ducts in the gallbladder bed. (There has been disagreement as to