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Biliary Complications Affecting Recipients Of Living Donor Liver Transplantation

Submitted in Partial Fulfillment
of the M.Sc. Degree in General Surgery

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ABSTRACT:

Conservative management was only suitable for 9 out of 51 patients (17.6%) and 3 cases (5.8%) U\S guided aspiration for biloma & intra-abdominal collections. All these patients improved.
Endoscopic therapies were successful in 28 of 40 patients (70 %) in the LDLT group.
Percutaneous transhepatic therapies were successful in 7 of 12 patients (58.3 %).
Surgery was needed for 8 out of 51 biliary complications
(15.7%) . For those 8 who underwent surgery, desired outcomes were seen in 6 patients (75%).

KEY WORDS:

Biliary complications – recipients – living donor – liver transplantation

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Abbreviations

ALF, acute liver failure
CT, computerized tomography
DD, duct-to-duct reconstruction
DDLT, deceased donor liver transplantation
ERC, endoscopic retrograde cholangiography
ERCP, endoscopic retrograde cholangiopancreatography
ESLD, end stage liver disease
HAT, hepatic artery thrombosis
HCC, hepatocellular carcinoma
HIDA, hepatic dimethyl iminodiacetic acid.
LDLT, living donor liver transplantation
MELD, model for end stage liver disease
MMF, Mycophenolatemofetil.
MRC, magnetic resonance cholangiography
MRI, magnetic resonance imaging
NASH, non alcoholicsteatohepatitis.
OLT, orthotopic liver transplant
PBC, primary biliary cirrhosis
PPD, purified protein derivatives
PSC, primary sclerosing cholangitis
PTC, percutaneous transhepatic cholangiography
PTD, percutaneous transhepatic drainage
TOF, time of flight
UW, University of Wisconsin

Chapter 1
Anatomy

Anatomic lobes

Based on external appearance, four lobes are traditionally described: right,left, quadrate, and caudate (1).

The liver is divided into right and leftanatomic lobes by the attachment of the falciform ligament on theantero-superior surface (Porto umbilical fissure). On the visceral surface ofthe liver, the fissures for the ligamentum venosum and ligamentum teresprovide the demarcation. The quadrate lobe is demarcated in the visceralsurface of the liver by the gallbladder fossa, porta hepatis, and the Porto umbilical fissure. The caudate lobe is demarcated by the groove for the IVC and the fissure of the venous ligament. The right portion of the caudate lobe is continuous with the right lobe by the caudate process, which forms the superior boundary of the epiploic foramen. The quadrate lobe has been considered as a subdivision of the right anatomic lobe(2).

Functional lobes and segments

The plane of division is not the obvious falciform ligament but rather a plane passing through the bed of the gallbladder and the notch of the IVC, without other surface indications (3).

Based on arterial blood supply, portal venous blood supply, biliarydrainage, and hepatic venous drainage, the liver is divided into functionallobes and segments (Fig. 1). The best-known and most widely employedconceptions of hepatic segmentation are those of Couinaud (1954) (4).

Couinaud's liver segmentation

The Couinad segmentation (Fig. 1C, D) system is based on the distribution in the liver of both the portal vein and the hepatic veins and shows a specific consideration for the caudate lobe. Fissures of the three hepatic veins (portal scissurae) divide the liver into four sectors (segments), lateral and Para median, on the right and left sides, respectively. The planes containing portal pedicles are called hepatic scissurae. Eight segments are described, one for the caudate lobe (segment I), three on the left (segments II, III, and IV), and four on the right(segments V, VI, VII, and VIII) (5).

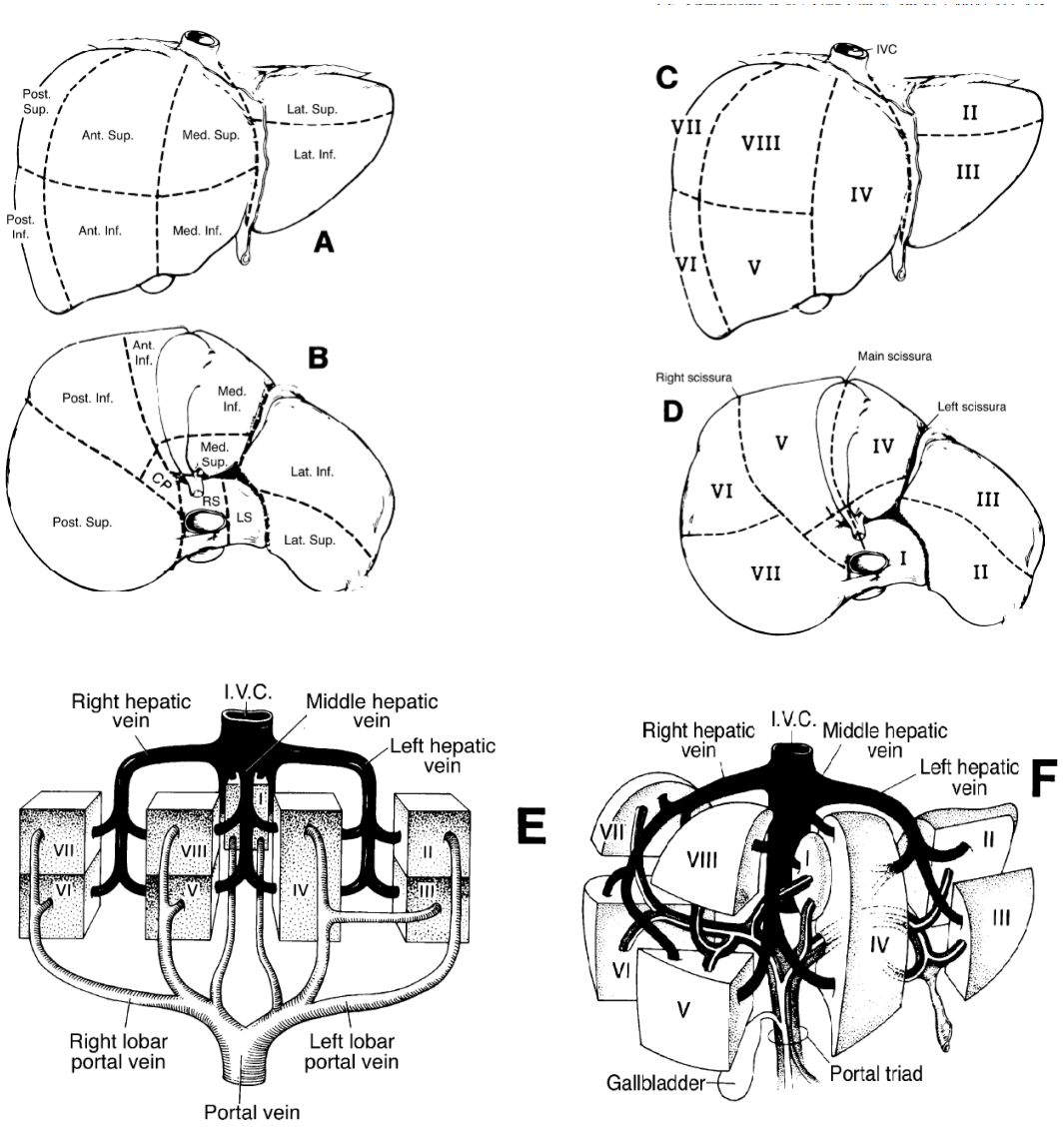

Fig. 1.Projection of the liver lobes and segments based on the distribution of intrahepatic ducts and blood vessels. (A, B) Terminology of Healey and Schroy (1959). (A) Ant. Inf., anterior inferior subsegment; Ant. Sup., anterior superior subsegment; Lat. Inf., lateral inferior subsegment; Lat. Sup., lateral superior subsegment; Med. Inf., medial inferior subsegment; Med. Sup., medial superior subsegment; Post. Inf., posterior inferior subsegment; Post.Sup., posterior superior subsegment. (B) CP, caudate process; LS, left subsegment; RS, right subsegment. (C, D) Terminology of Couinaud (1954). (E) Highly diagrammatic presentation of the segmental functional anatomy of the liver emphasizing the intrahepatic anatomy and hepatic veins. IVC, inferior vena cava. (F) Exploded segmental view of the liver emphasizing the intrahepatic anatomy and hepatic veins. (From Skandalakis JE, Gray SW, Skandalakis LJ, et al. Surgical anatomy of the liver and associated extrahepatic structures. Part 2 – surgical anatomyof the liver.ContempSurg 1987;30:26)

Extra hepatic and intrahepatic vasculature

The liver has a dual blood supply from the portal vein and commonhepatic artery. The portal vein is responsible for approximately 70% and thehepatic artery for 30% of the blood flow of the liver. In the liver, arteries,portal veins, and bile ducts are surrounded by a fibrous sheath, theGlissonian sheath (6). Hepatic veins in the hepatic parenchyma lack suchprotection (5).

Arteries

Common hepatic artery

The common hepatic artery (Fig. 2A) takes origin from the celiac trunk(86%); other sources are the superior mesenteric artery (12.9%), the aorta(1.1%),andvery rarely, the left gastric artery (4).The gastroduodenal artery branches off the common hepatic arteryposterior and superior to the duodenum,Within the hepato-duodenal ligament theproper hepatic artery divides into right and left branches, called right andleft hepatic arteries. Arterial distribution to different functional segments isidentical to the distribution of portal vein (5).

Left hepatic artery

In 25% to 30% of cases, the left hepatic artery arises from the left gastric artery(7).

The left hepatic artery branches intoa median and a lateral segmental artery (1). The medial segmental artery supplies the quadratelobe. The lateral segmental artery divides into superior and inferior arteriesfor the respective sub segments (10).

Right hepatic artery

In about 17% of subjects, the right hepatic artery branches from the superiormesenteric artery (8).

Before entering the liver, the right hepatic artery gives off the cysticartery.Within the liver or extrahepatically in the portahepatis, the right hepatic arterydivides into anterior and posterior segmental arteries (1), which dividefurther into superior and inferior arteries to supply the respective sub segments (9).

An artery for the caudate lobe also originates from the righthepatic artery and supplies the caudate process and the right side of thecaudate lobe. These arteries are found under the respective bile ductbranches (8).

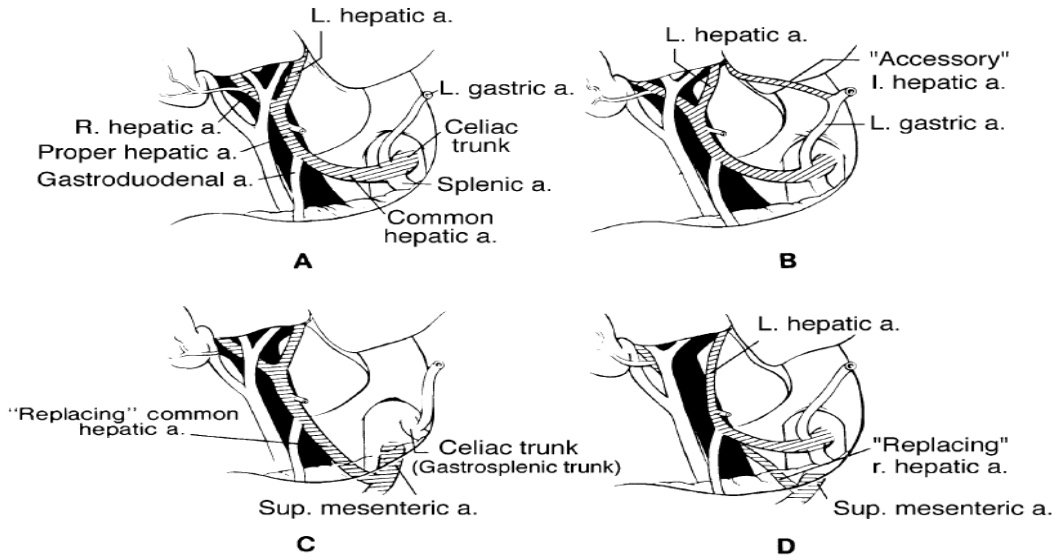

Fig. 2.Hepatic arteries. (A) ‘‘Normal’’ hepatic artery arising from the celiac trunk. (B)‘‘Accessory’’ left hepatic artery arising from the left gastric artery. (C) ‘‘Replacing’’ common hepatic artery arising from the superior mesenteric artery. (D) ‘‘Replacing’’ right hepatic artery arising from the superior mesenteric artery. (From Skandalakis LJ, Gray SW, Colborn GL, et al.Surgical anatomy of the liver and associated extrahepatic structures. Part 4 – surgical anatomyof the hepatic vessels and the extrahepatic biliary tract.ContempSurg 1987;31:2)

Veins(10).

Portal vein(10).

The portal vein (Fig. 3) is between 7 and 10 cm long and between 0.8 and 1.4 cm in diameter and is without valves. It is formed by the confluence ofthe superior mesenteric vein and the splenic vein behind the neck of the pancreas at the portahepatis, the portal vein bifurcate into right and left branches before entering the liver. In general, portal veinsare found posterior to hepatic arteries and the bile ducts in their lobar andsegmental distribution.

The right branch of the portal vein is located anterior to the caudate process and is shorter than the contralateral branch. Near its origin it givesoff a branch for the caudate lobe. It follows the distribution of the righthepatic artery and duct and bifurcates into anterior and posterior segmentalbranches as soon as it enters the hepatic parenchyma. Each segmentalbranch further divides into inferior and superior subsegmental branches forits respective parenchymal subsegments.

Adifferent anatomic pattern is seen in the left portal vein. This Long Branchhas two parts, transverse and umbilical. It begins in the portahepatis as thetransverse part, which gives off a caudate branch, and travels to the left.At the level of the umbilical fissure, the umbilical part turns sharply. It coursesanteriorly in the direction of the round ligament and terminates in a cul-de-sacproximally to the inferior border of the liver. Here it is joinedanteriorly by the round ligament (ligamentum teres hepatis). Further on, the left portal vein divides into medial and lateral segmental branches, eachwith superior and inferior subsegmental branches. This anatomic patterndistinguishes the left portal vein from the left

hepatic artery and bile duct: theumbilical part provides the superior and inferior subsegmental veins for thelateral segment and also provides the medial segmental veins from its rightside.

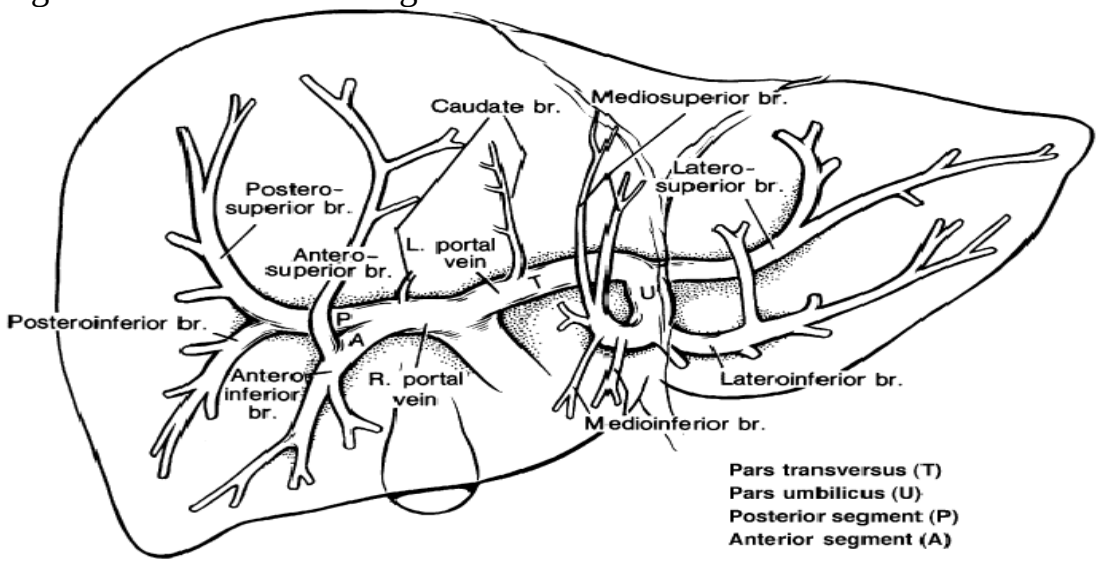

Fig. 3.Intrahepatic distribution of the hepatic portal vein.A, anterior segment; br, branch; P, posterior segment; T, pars transversus; U, pars umbilicus, the site of the embryonic ductusvenosus. (From Colborn GL, Skandalakis LJ, Gray SW, et al. Surgical anatomy of the liver and associated extrahepatic structures. Part 3 – surgical anatomy of the liver.ContempSurg 1987;31:25)

Hepatic veins(10)

The liver is drained by a series of dorsal hepatic veinsThree major and between 10 and 50 smaller veins open into the IVC .The right hepatic vein is the largest. It lies in the right fissure, draining theentire posterior segment (superior and inferior subsegments) and thesuperior subsegment of the anterior segment of the right lobe. It servessegments V, VI, VII, and part of VIII.

The middle hepatic vein lies in the median fissure and drains the inferior Subsegment of the anterior segment of the right lobe and the inferior area ofthe medial subsegment of the left lobe. The middle hepatic vein also drainsthe right anterior superior subsegment (5). This vein mainly serves the leftliver, together with the left hepatic vein (5). The middle hepatic vein servesmainly segments IV, V, and VIII.

The left hepatic vein lies in the upper part of the left fissure. It drains thesuperior area of the medial subsegment (segment IV) and the left anterior superior and inferior subsegments (segments II and III). In about 60% of individuals, the left and middle veins unite to enter the IVC as a single vein(8)..

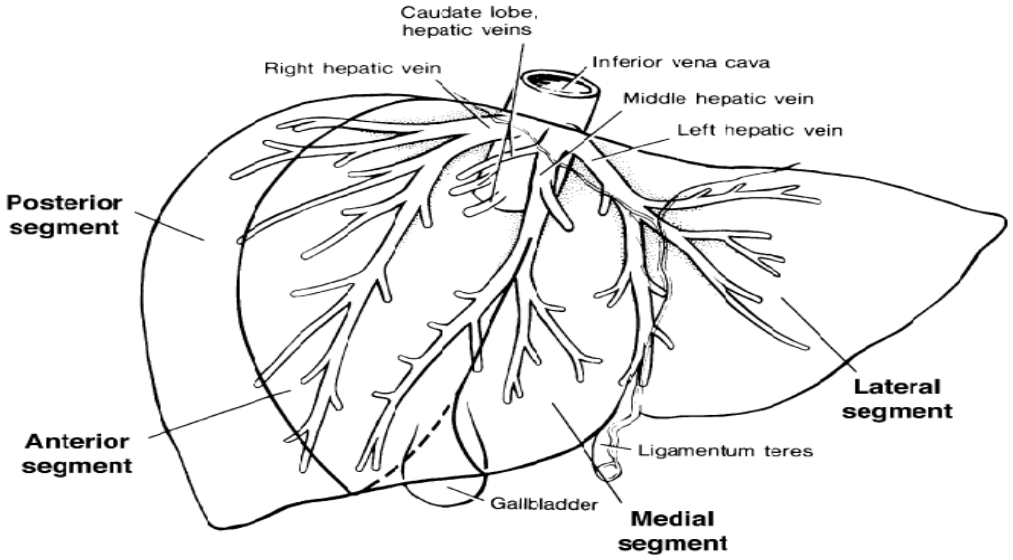

Fig. 4.Diagram of the intrahepatic distribution of the hepatic veins. The hepatic veins are located between lobes and segments rather than in them. (From Colborn GL, Skandalakis LJ, Gray SW, et al. Surgical anatomy of the liver and associated extrahepatic structures. Part 3 – surgical anatomy of the liver.ContempSurg 1987;31:25)

Intrahepatic biliary tract

Bile canaliculi are formed by parts of the membrane of adjacent parenchymal cells, and they are isolated from the peri-sinusoidal space by junctions. Bile flows from the canaliculi through ductules (canals of Hering)into the interlobular bile ducts found in portal pedicles. In the segmental andsubsegmental pedicles surrounded by the Glissonian sheath, bile ducts arefound above and veins and arteries beneath. Biliary segmentation isidentical to portal vein segmentation. In contrast to portal vein branches, which may communicate, no communication is observed in biliary branches (10).

The right hepatic duct

The right hepatic duct has an average length of 0.9 cm and is formed by the union of the anterior and posterior branches at the portahepatis. Each branch is further bifurcated into superior and inferior branches to drain thefour subsegments of the right lobe: V (right anterior inferior subsegment),VI (right anterior superior subsegment), VII (right posterior inferiorsubsegment), and VIII (right posterior superior subsegment). This is theusual pattern, present in 72% of specimens examined by Healey and Schroy[11]. In the remainder, the posterior branch or, rarely, the anterior branchcrosses the segmental fissure to empty into the left hepatic duct or one of itstributaries. In these cases the right hepatic duct is absent.

Relation to the Portal Vein

The typical anatomic location of the left lateral segment ducts is supraportal (i.e., running on the cranial side of the umbilical portion of the portal vein) and this occurs in 97% of individuals. In the other 3% the left lateral segmental ducts run caudal to the umbilical portion of the portal vein (12).

Surgical Anatomy

In cases in which the rarely seen variation of infraportal left lateral segmental duct is not recognized preoperatively, this configuration may be inadvertently injured during left lateral segmentectomy.

In the variation with B4 and B3 forming a common trunk, injury to B4 may occur in the residual liver during a left lateral segmentectomy while dissecting on the hilar side of the umbilical portion of the portal vein (14).

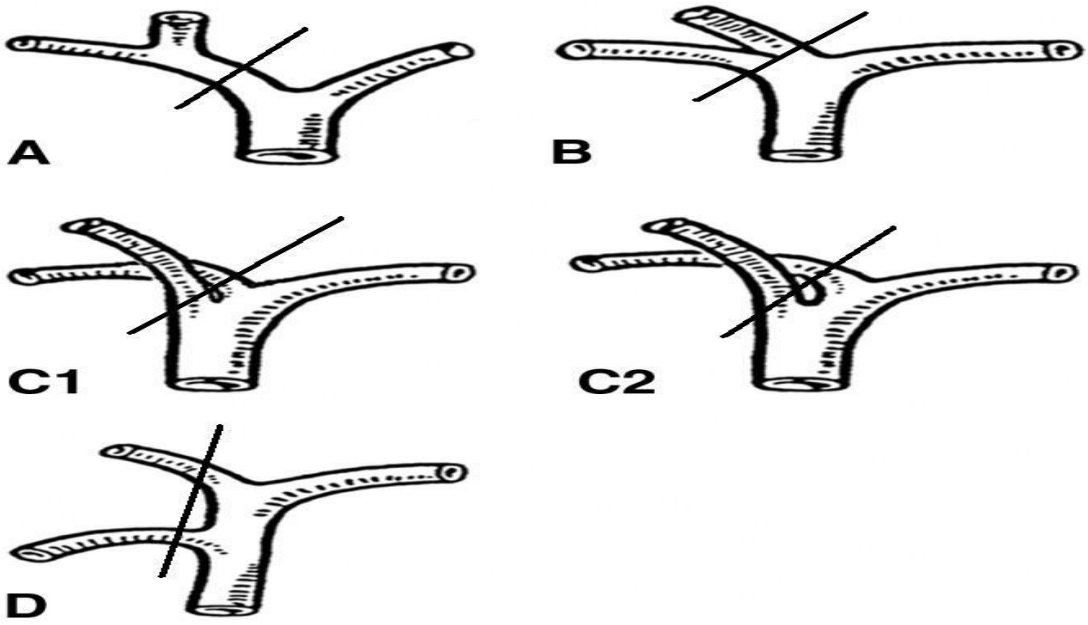

fig. 5.
Impact of right biliary anatomy on the number of donor ducts(Hwang 2006)

The left hepatic duct (10)

Medial and lateral branches converge to form the left hepatic duct, whichhas as average length of 1.7 cm. Each branch is formed by superior andinferior branches of the respective subsegments. The left hepatic duct drainsthe three segments of the left lobe: II (left lateral superior subsegment), III(left lateral inferior subsegment), and IV (left medial subsegment). SegmentIV is drained by medio-superior and medio-inferior branches. This typicalpattern was met in 67% of Healey and Schroy's specimens. The medialand lateral branches unite in the left fissure (50%), to the right of the fissure(42%), or to the left of the fissure (8%).

Relation to the Portal Vein

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Surgical Anatomy

In cases in which the rarely seen variation of infraportal left lateral segmental duct is notrecognized preoperatively, this configuration may be inadvertently injured during left lateral segmentectomy (11, 15).

Caudate lobe drainage

The biliary drainage of the caudate lobe (segment I) enters both the right and the left hepatic duct systems in 80% of individuals . In 15% of casesthe caudate lobe drains only into the left hepatic duct system, and in 5% itdrains only in the right system. The caudate process is drained by bothright and left hepatic ducts (10).

Surgical Anatomy

The caudate lobe is generally not included when performing a donor hepatectomy.

Transplantation of a thick left-sided caudate lobe in addition to the left hepaticlobe has been described (16).

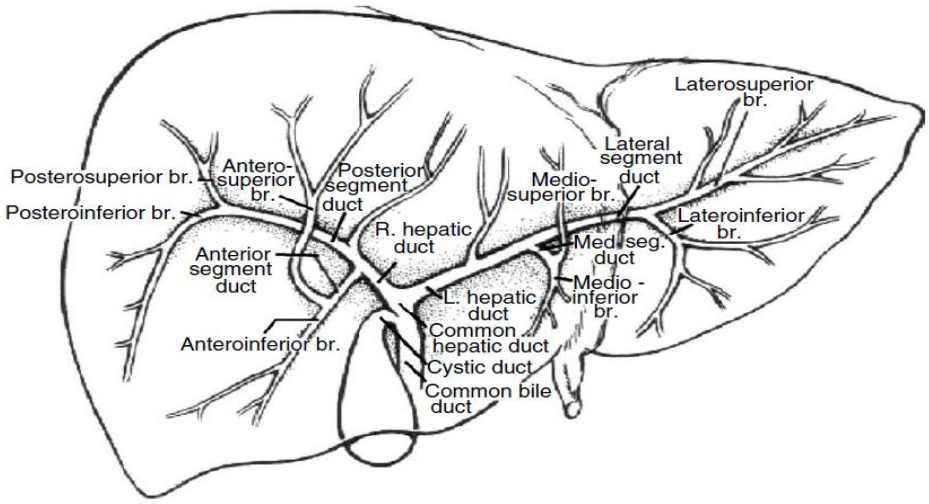

Fig. 6.Intrahepatic distribution of the bile ducts.Br, branch. (From Colborn GL, SkandalakisLJ, Gray SW, et al. Surgical anatomy of the liver and associated extrahepaticstructures.Part 3 – surgical anatomy of the liver. ContempSurg 1987;31:25;)

Common Hepatic Duct

The hepatic bile duct confluence, which lies cephalic and ventral to the portal veinbifurcation, gives rise to the common hepatic duct, the duct between the confluence and the cystic duct takeoff. The common hepatic duct is 1 to 4 cm in length and has adiameter of approximately 4 mm. It lies in front of the portal vein and to the right of the hepatic artery. The common hepatic duct is joined at an acute angle by the cystic duct to form the common bile duct (14).

Surgical Anatomy

During harvesting a hepatic lobe it is important not to divide the correspondinghepatic duct too close to the confluence, as this will invariably lead to donorbiliary stricturing. It is tempting for the surgeon to try and obtain the greatesthepatic duct length to facilitate the biliary reconstruction(17).

Common Bile Duct

The common bile duct extends from the cystic duct to the ampulla of Vater. A normalcommon bile duct is about 7 to 11 cm in length and 5 to 10 mm in diameter(18).

Upper Third

The upper third (supraduodenal portion) passes downward in the free edge of thehepato-duodenal ligament, to the right of the hepatic artery and anterior to the portal vein.

Middle Third

The middle third (retro duodenal portion) of the common bile duct curves behind the firstportion of the duodenum and diverges laterally from the portal vein and the hepaticarteries.

Surgical Anatomy

In OLT during the cadaveric liver procurement the common bile duct is typicallycut just behind the duodenum after partial kocherization of the duodenum.

Lower Third

The lower third (pancreatic portion) curves behind the head of the pancreas in a groove, or traverses through it and enters the second part of the duodenum through the muscular sphincter of Oddi at the duodenal papilla (19).

Surgical Anatomy