

Bile Duct Resection

Yuji Nimura

Resection of tumors at the confluence of the left and right hepatic duct requires one of the most difficult operations. The surgical procedure requires not only a portal lymphadenectomy and bile duct resection, but also almost always a liver resection. This operation has three goals: 1) resection of the primary tumor, 2) resection of the lymphatic drainage of the liver, and 3) reestablishment of biliary continuity.

Indications and Contraindications

Indications

- Primary malignancies (e. g., intrahepatic cholangiocarcinoma involving the hepatic hilus, hilar cholangiocarcinoma, gallbladder carcinoma involving the hepatic hilus, diffuse carcinoma of the extrahepatic bile duct)
- Benign diseases (e. g., primary sclerosing cholangitis, inflammatory pseudotumor)
- Traumatic lesion at the hepatic hilus

Absolute Contraindications

- Biliary carcinoma with distant organ metastasis (liver, lung, bone, peritoneum)
- Uncontrollable severe cholangitis with or without sepsis
- Poor liver reserve with prolonged cholestasis
- Severe coagulopathy despite vitamin K administration

Relative Contraindications

- Cholangiocarcinoma with para-aortic lymph node metastasis

Preoperative Investigation and Preparation for the Procedure

Preoperative investigation

- *History:* Biliary surgery
- *Clinical evaluation:* Jaundice, cholangitis, nutritional status
- *Laboratory tests:* Bilirubin, alkaline phosphatase, ALT, AST, albumin, coagulation parameters (prothrombin time, platelets), indocyanin green test, tumor markers carbohydrate antigen 19–9 (CA 19–9) and carcinoembryonic antigen (CEA)
- *Radiology:* Ultrasonography, MRCP, MDCT cholangiography, PTC, ERCP, 3D angiography, CT volumetry
- *Endoscopy:* Peroral cholangioscopy, percutaneous transhepatic cholangioscopy.

The above procedures should be performed to make a differential diagnosis or to define the intraductal spread of cancer by taking a biopsy.

What not to do

- A metallic stent should not be used in resectable biliary carcinoma.

Preparation prior to surgery

- Antibiotics sensitive to bile culture
- Endoscopic nasobiliary drainage (ENBD) (endoscopic biliary drainage is not advisable)
- Percutaneous transhepatic biliary drainage
- Internal biliary drainage or bile replacement through a nasogastric tube for patients with external biliary drainage
- Portal vein embolization for major hepatectomy

Procedure

Access

Incision, division of round and falciform ligament (see Part I, ► Chaps. 2 “Positioning and Accesses” and 3 “Retractors and Principles of Exposure”).

Step 1

Exposure and exploration

The retractor is installed (see Part I, ► Chap. 3 “Retractors and Principles of Exposure”) and inspection is performed to look for possible peritoneal metastases.

Percutaneous transhepatic biliary drainage (PTBD) catheters are moved to the operative field to maintain intraoperative biliary drainage.

Ultrasound is used to evaluate the location of the tumor in relation to vascular structures (portal vein, hepatic artery, hepatic vein). Careful inspection of vascular variation is performed.

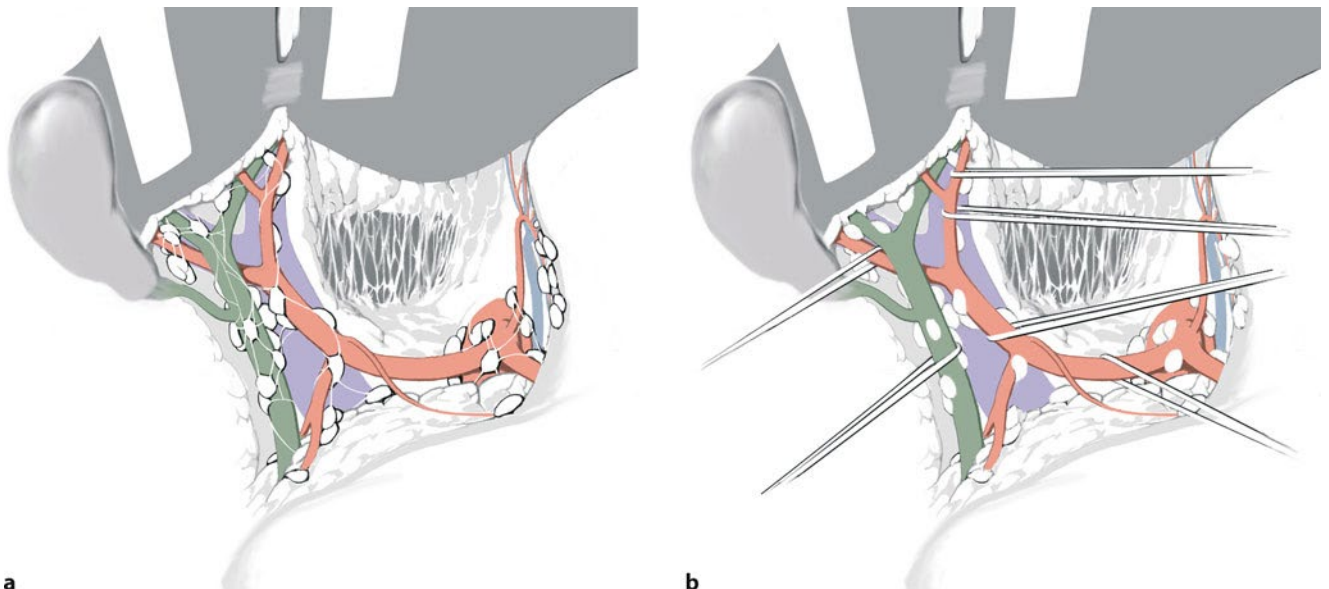
Step 2

Regional lymph node and connective tissue dissection

Lymph nodes in the hepatoduodenal ligament (No. 12), along the common hepatic (No. 8) and celiac arteries (No. 9) and retropancreatic nodes (No. 13), should be dissected (■ Fig. 70.1a) while placing a vessel loop around the common, proper, right, middle, and left hepatic arteries and common bile duct (■ Fig. 70.1b).

Nerve plexuses around the hepatic artery should be dissected.

Vascular variation is confirmed.

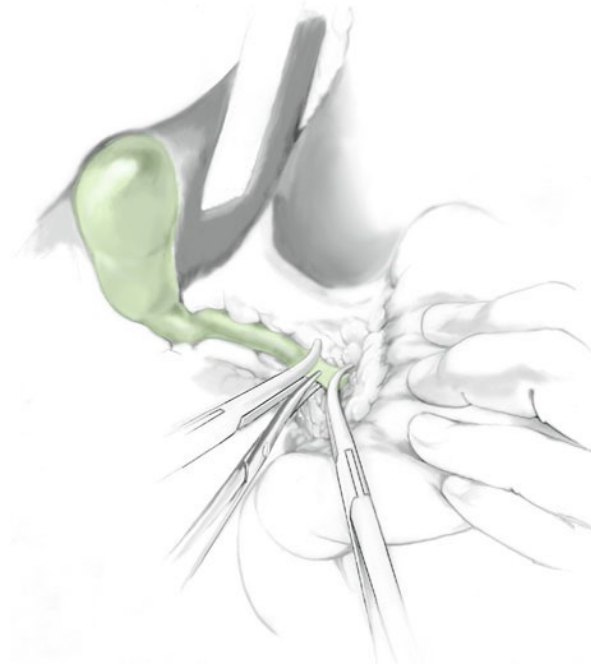


■ Fig. 70.1

Step 3**Distal bile duct resection**

The Kocher maneuver is performed to mobilize the duodenum and allow dissection of the distal bile duct. The distal bile duct is dissected down to the head of the pancreas and divided above the pancreas (■ Fig. 70.2). The resection margin must be examined by frozen section.

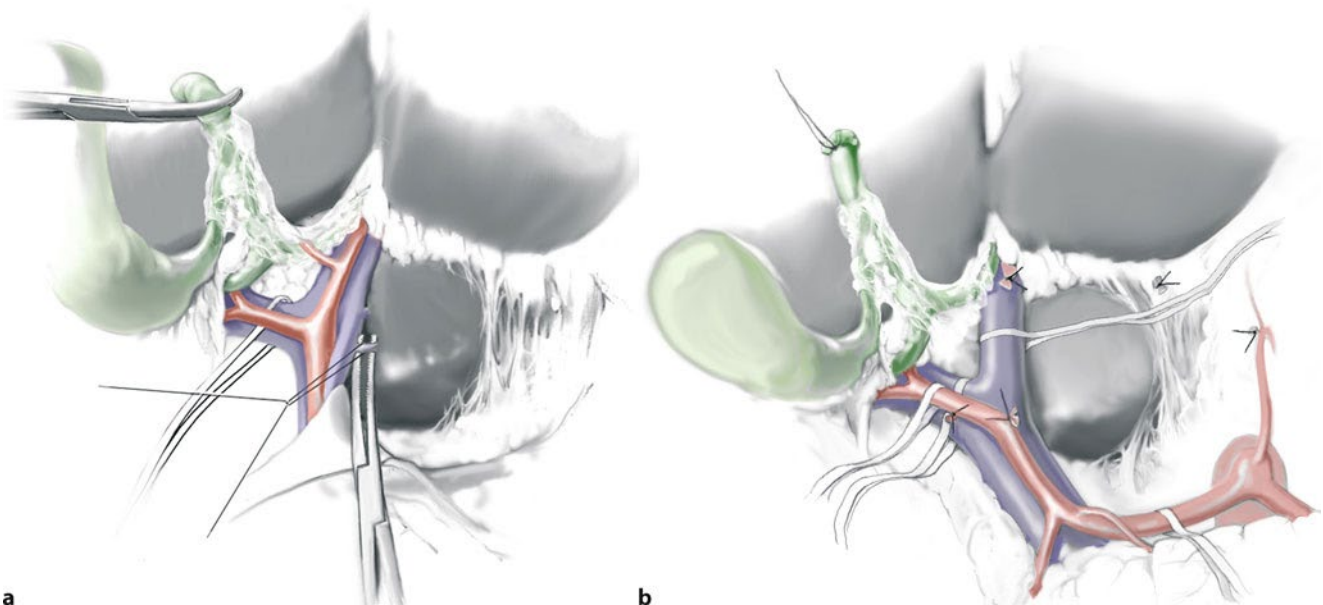
In some cases, this procedure should be advanced more distally to detach the bile duct from the pancreatic tissue and resect the duct in the pancreas with a free margin.



■ Fig. 70.2

Step 4**Skeletonization of the upper part of the hepatoduodenal ligament**

The transected distal bile duct is pulled up and the distal portion of the hepatic artery and portal bifurcation are exposed (■ Fig. 70.3a). After dividing the caudate lobe branches of the portal vein (■ Fig. 70.3a), the right and left portal veins are encircled by a vessel loop (■ Fig. 70.3b).



■ Fig. 70.3

Left Hepatic Resection

This procedure is indicated for a case of hilar cholangiocarcinoma predominantly involving the left intrahepatic bile ducts. Right hepatic resection is covered separately later.

Step 5

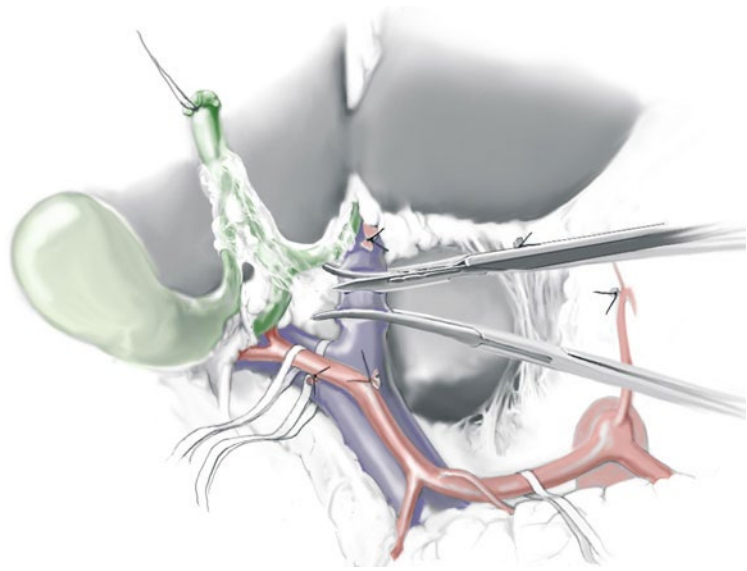
Dividing the hepatic artery

Once the arterial anatomy and possible arterial variation are clearly identified, the left and middle hepatic arteries (and cystic artery) are divided at the origin (see ■ Fig. 70.3b in STEP 4). The remaining right hepatic artery is skeletonized more distally to encircle the right anterior and posterior branches at the right extremity of the hilar plate.

Step 6

Transection of the left portal vein

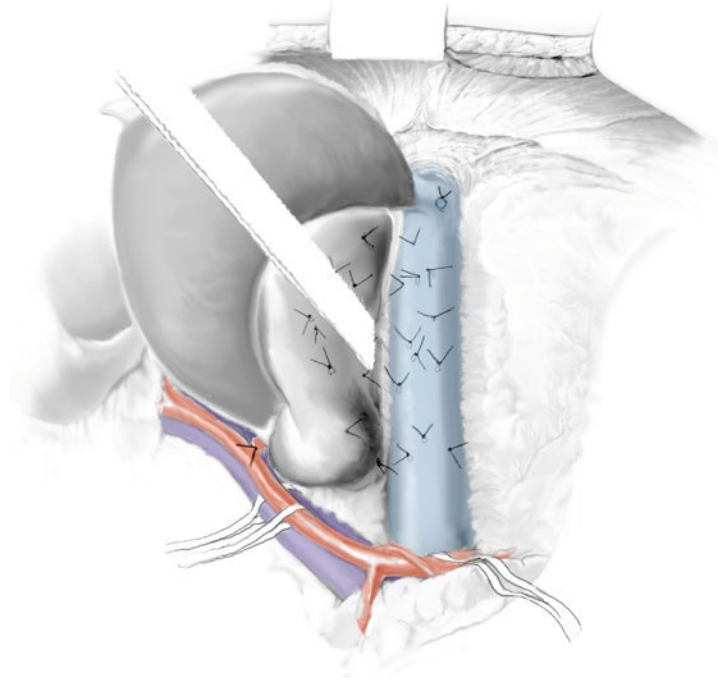
The left portal vein is ligated and divided distally to the bifurcation. An alternative is to use a vascular clamp on the proximal side and oversew the venous stump with a running suture of 5-0 Prolene (■ Fig. 70.4).



■ Fig. 70.4

Step 7**Mobilization of the caudate lobe with division of the short hepatic veins**

For a left-sided hepatectomy, the short hepatic veins are divided in the same manner from the left caudal side to the right cranial side. Finally, the distal end of the Arantius canal is ligated and divided at the confluence of the left hepatic vein or the vena cava (■ Fig. 70.5).



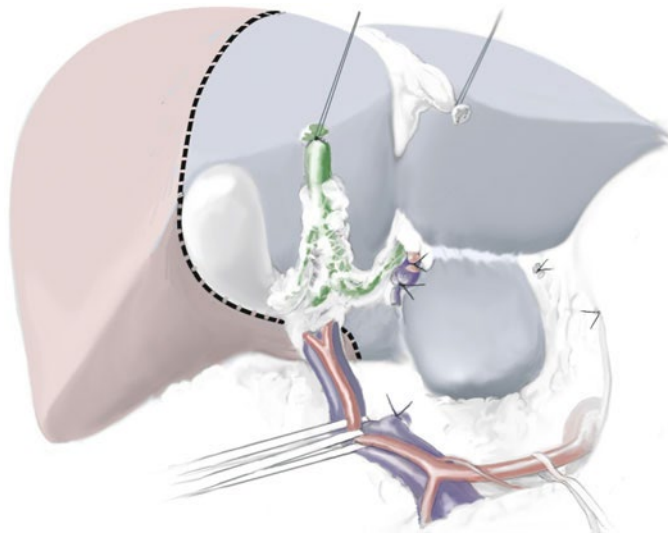
■ Fig. 70.5

Step 8**Exposure and transection of the left hepatic vein**

For a left hepatectomy, the left hepatic vein is not transected before liver dissection. A vessel loop is placed around the common trunk of the left and middle hepatic vein. For a left trisectionectomy, the common trunk of the left and middle hepatic veins is transected before liver dissection.

Step 9**Demarcation and incision of the liver capsule**

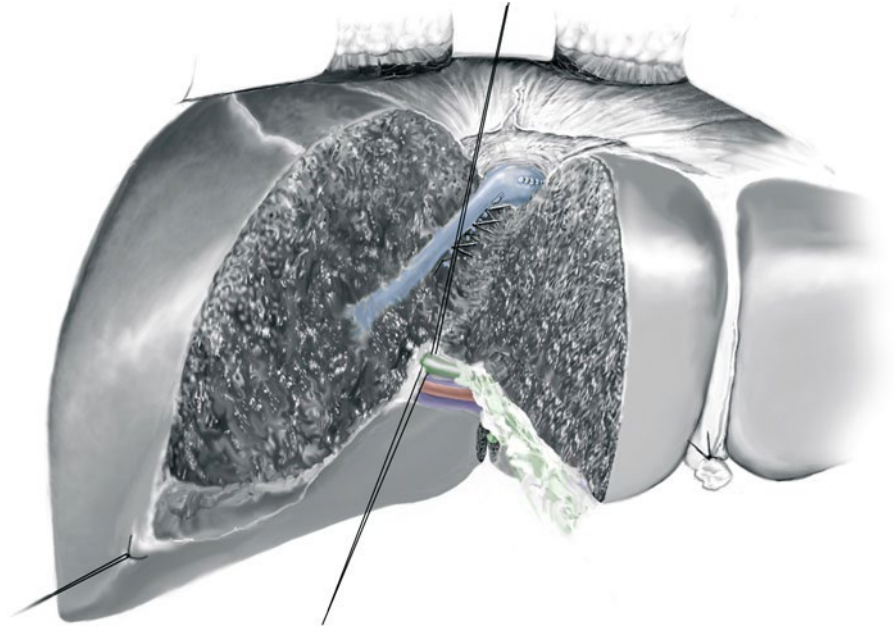
For a left hepatectomy with caudate lobe resection, dorsal demarcation appears between the caudate process and segment 7 after complete devascularization of the caudate lobe (■ Fig. 70.6).



■ Fig. 70.6

Step 10**Division of the draining veins of the paracaval segment**

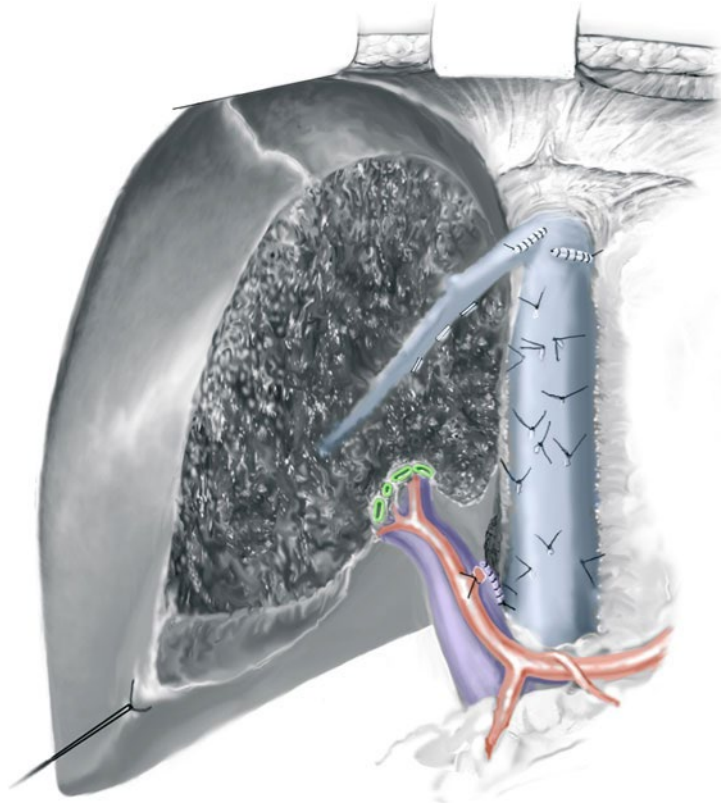
For a total caudate lobe resection, draining veins of the paracaval segment (segment 9) are identified behind the middle hepatic vein and carefully divided. Liver transection is continued until the left hepatic vein is reached, divided, and closed at its confluence of the middle hepatic vein. The right intrahepatic bile duct is identified behind the middle hepatic vein, and the posterior wall is carefully detached from the right anterior branch of the hepatic artery, which runs in the connective tissues between the bile duct and the portal vein. Two stay sutures are placed caudally and cranially, and the bile duct is incised from the caudal edge where the anterior branch or the bile duct of segment 5 is opened (■ Fig. 70.7).



■ Fig. 70.7

Step 11**Intrahepatic bile duct resection**

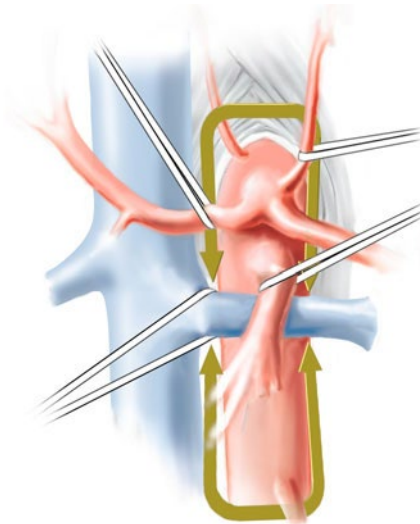
Further extension of the incision opens the segmental or subsegmental bile ducts of segment 8 (B8, B8a, B8bc) and the right posterior duct. The surgical field after removal of the left lobe and caudate lobe is shown (■ Fig. 70.8).



■ Fig. 70.8

Step 12**Extended lymph node dissection**

After removing the hemiliver and the caudate lobe, para-aortic node dissection is carried out from the level of the ligamentum crus to the origin of the inferior mesenteric artery. The lymph nodes behind the left renal vein are carefully dissected by taping the left renal vein and the right renal artery. Right celiac ganglionectomy is also performed during this procedure (■ Fig. 70.9).



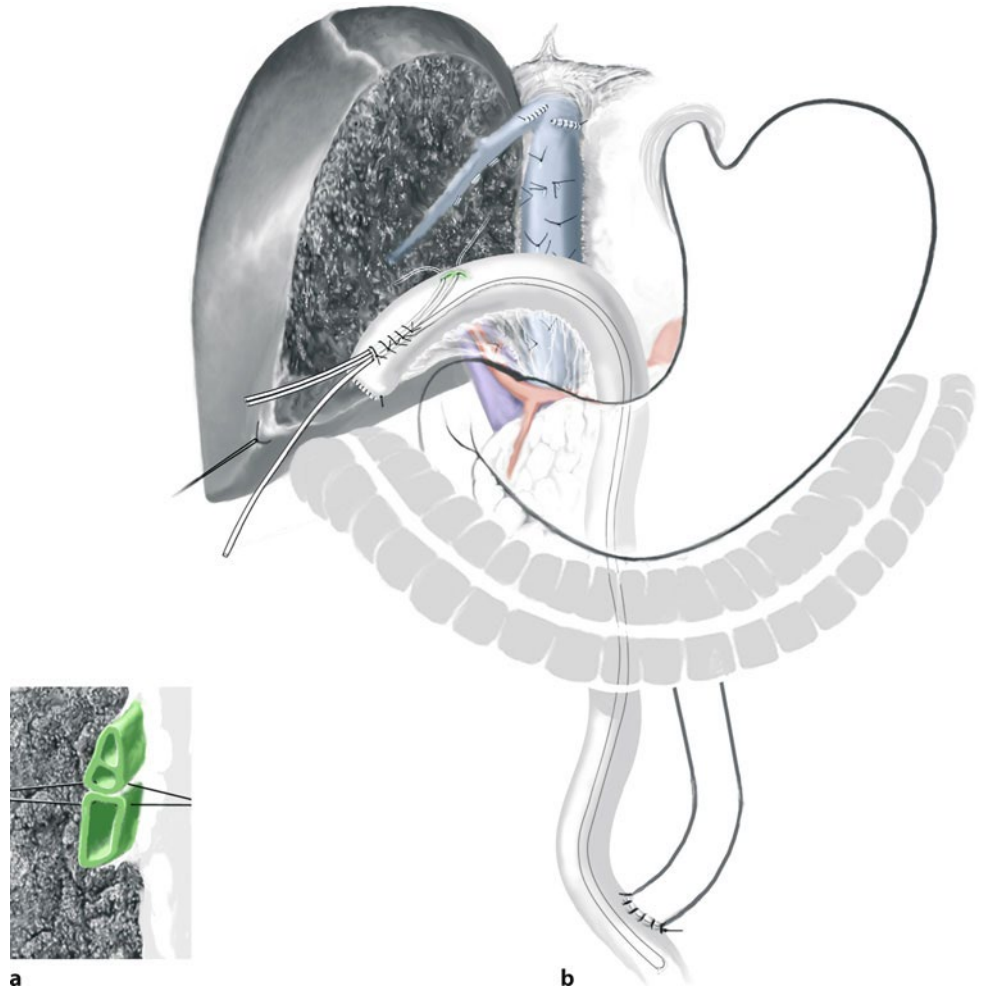
■ Fig. 70.9

Step 13**Biliary reconstructions**

Before bilioenteric anastomosis, hepaticoplasty should be performed with 5-0 PDS sutures to minimize the number of anastomoses (■ Fig. 70.10a).

A Roux-en-Y jejunal loop is lifted through the shortest route: the retrocolic and retrogastric route. A jejunostomy tube is also introduced from the proximal edge of the jejunal limb before hepaticojejunostomy (■ Fig. 70.10b).

The posterior wall is first anastomosed with 4-0 PDS sutures and a biliary drainage tube is placed in each anastomosis. Finally, the anterior wall is anastomosed. See ► Chap. 73 on biliary anastomosis.



■ Fig. 70.10

Step 14**Drainage after reconstruction**

After completing hemostasis in the surgical field, closed drains are placed in the foramen of Winslow, in the paracaval space along the aorta, and along the cut surface of the liver. Biliary drainage catheters and a jejunostomy tube are fixed on the skin, and the abdomen is closed. Although some groups do not use biliary stents, externally drained bile is mixed with elemental diet and ingested through the jejunostomy tube from the second postoperative day.

Right Hepatic Resection

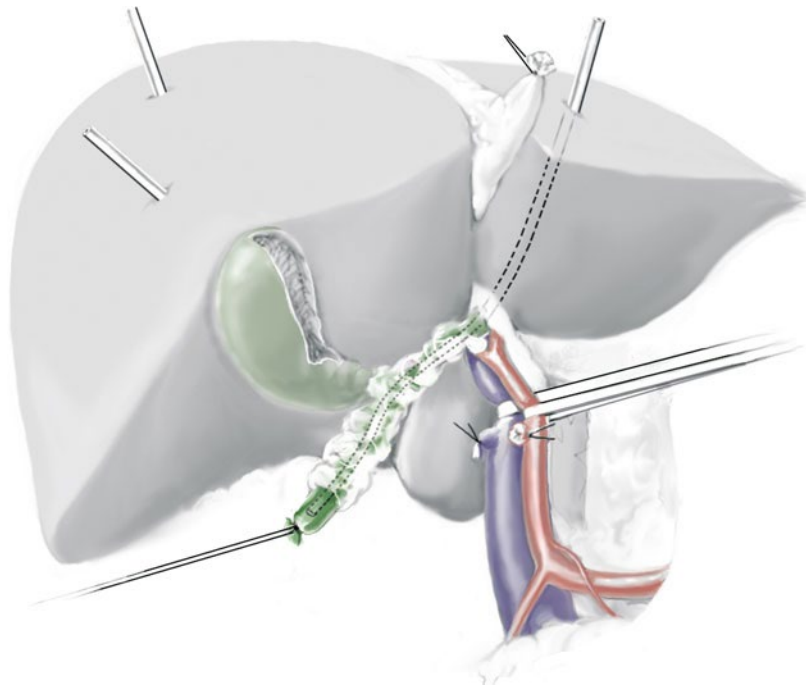
Contrary to left hepatic resection which is covered in the previous pages, this procedure is indicated for a case of hilar cholangiocarcinoma predominantly involving the right intrahepatic bile ducts.

Step 5

Dividing the hepatic artery and portal vein

Once the arterial anatomy and possible arterial variations are clearly identified, the right hepatic artery is divided at its origin. The remaining left and middle hepatic arteries are skeletonized more distally at the left extremity of the hilar plate or the middle and left hepatic artery at the Rex recess.

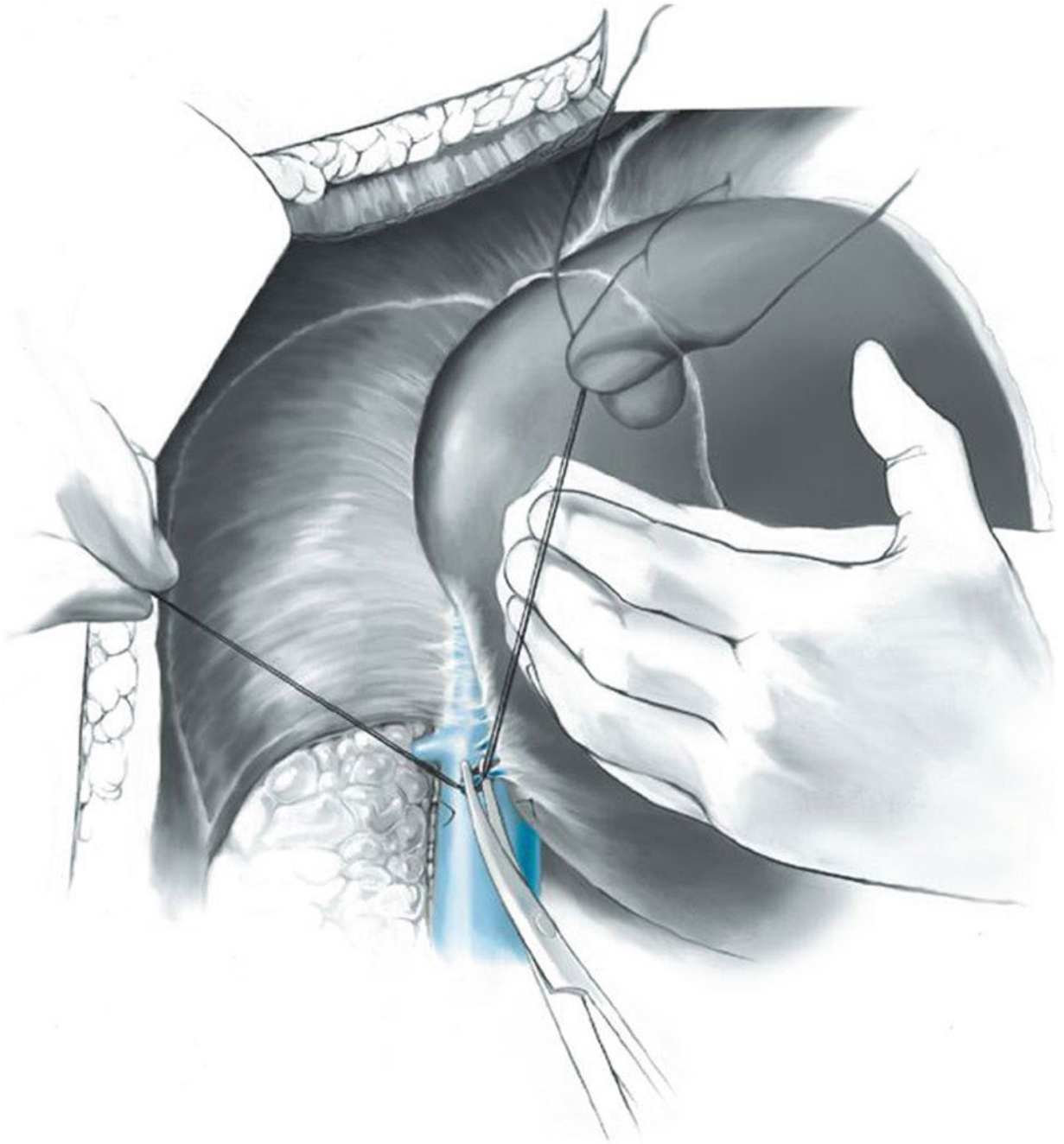
■ Figure 70.11 demonstrates a right predominant lesion and ligation of the right portal vein. Also illustrated is the ligated right hepatic artery.



■ Fig. 70.11

Step 6**Mobilization of the right hepatic lobe and caudate lobe with division of the short hepatic veins**

The right liver is mobilized and the entire short hepatic veins are divided between ties on the caval side and clips on the liver side from the right caudal side to the left cranial side (■ Fig. 70.12).



■ Fig. 70.12

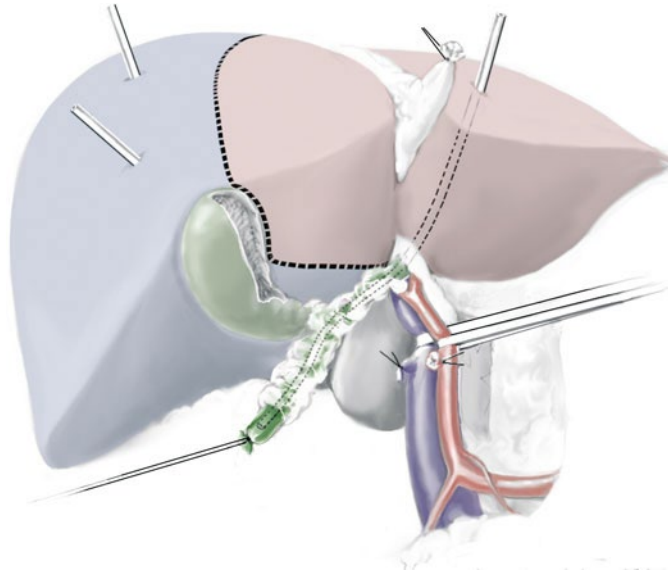
Step 7**Exposure and transection of the right hepatic vein**

A vessel loop is placed around the right hepatic vein, and vascular clamps are placed on the caval side and the liver side. The transection can be performed between the clamps. The caval side is secured by a running 4-0 Prolene suture and the other side with a 3-0 silk suture. An alternative technique is to transect the right hepatic vein with a vascular stapler (see ► Chap. 46 “Right Hemihepatectomy”).

Step 8**Demarcation and marking of the liver capsule**

A stay suture is placed at the inferior margin of the ischemic side of the liver, and the liver capsule is incised with monopolar diathermy or bipolar scissors along the demarcation. At this point, central venous pressure (CVP) should be maintained below 3 cm H₂O.

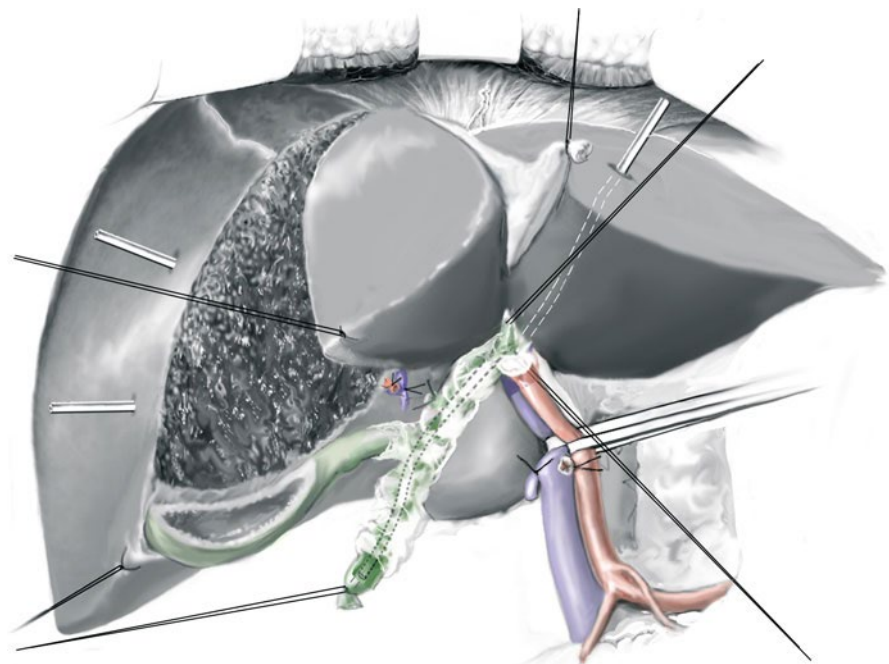
For a right hepatectomy with caudate lobectomy, a transection line on the visceral surface of the liver is turned transversely from the Cantlie line about 1 cm above the hilar plate to maintain a surgical margin and reach to the right edge of the Rex recess (■ Fig. 70.13).



■ Fig. 70.13

Step 9**Transection of the liver**

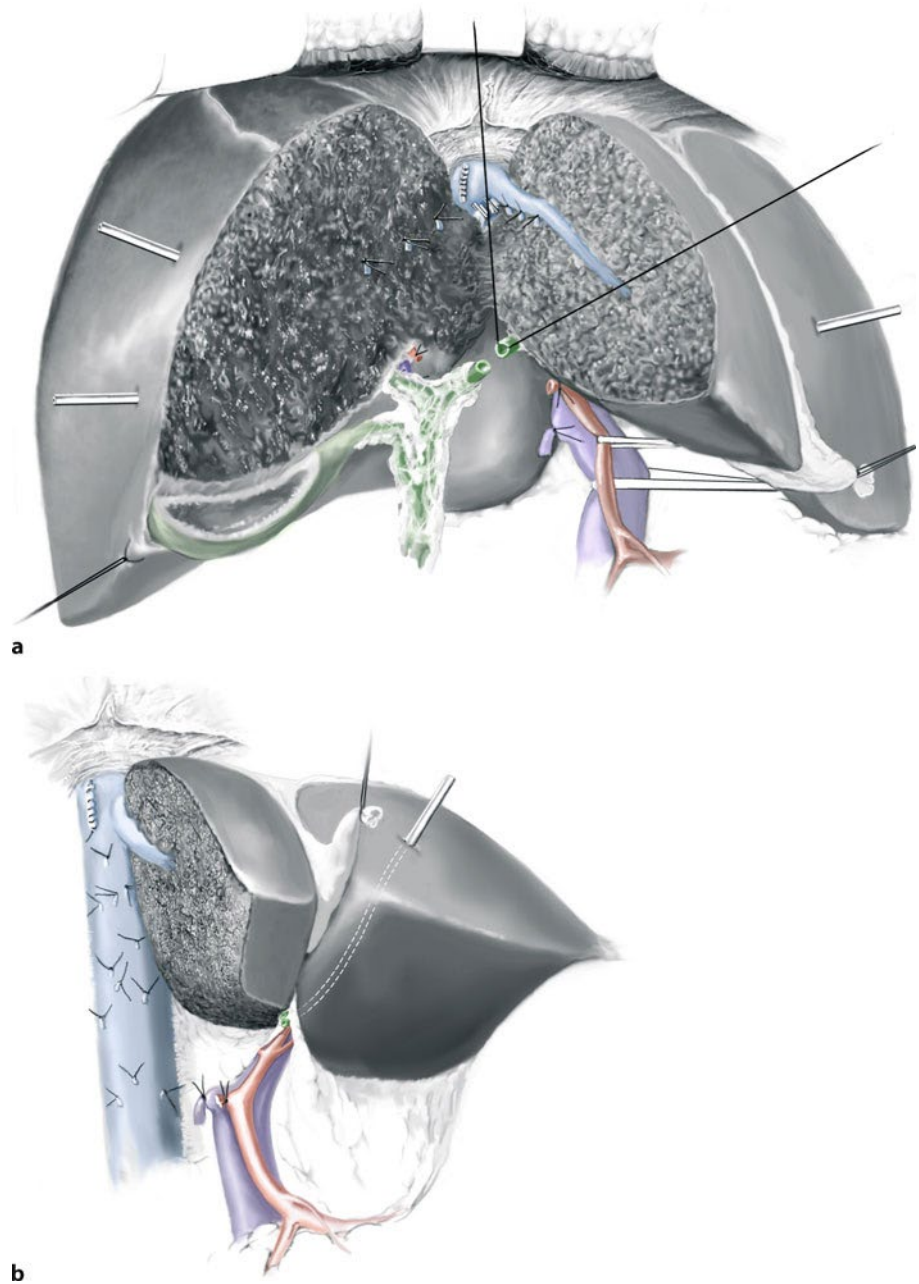
The liver dissection is started from the inferior margin under intermittent occlusion of the hepatic artery and the portal vein. The dissection is continued cranially and posteriorly, exposing the middle hepatic vein on the raw surface of the liver (■ Fig. 70.14).



■ Fig. 70.14

Step 10**Intrahepatic bile duct resection**

The left intrahepatic bile duct is identified at the right edge of the Rex recess. Two stay sutures are placed ventrally and dorsally (■ Fig. 70.15a), the left hepatic duct is transected perpendicularly, and the right liver, caudate lobe, and extrahepatic bile duct are removed (■ Fig. 70.15b). At the ventral edge of the resected margin of the left hepatic duct, the bile duct of segment 4 is opened, followed by segments 3 and 2 dorsally.



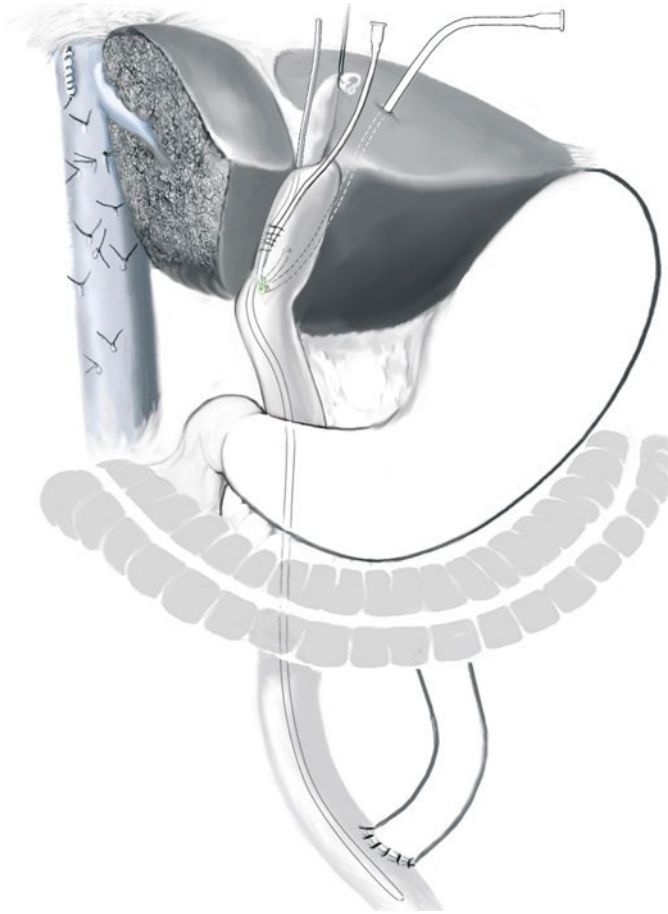
■ Fig. 70.15

Step 11**Extended lymph node dissection**

Extended lymph node dissection is performed as above.

Step 12**Biliary reconstructions**

A Roux-en-Y jejunal loop is lifted through the shortest route: the retrocolic and retrogastric route. A jejunostomy tube is also introduced from the proximal edge of the jejunal limb before hepaticojejunostomy (■ Fig. 70.16).



■ Fig. 70.16

Postoperative Tests

- Postoperative surveillance in an intensive or intermediate care unit
- Liver function tests (bilirubin, ALT, AST, albumin), coagulation parameters, hemoglobin, red blood cell (RBC), white blood cell (WBC), CRP
- Color Doppler ultrasound to estimate the blood flow of the portal vein and hepatic artery

Local Postoperative Complications

- **Short-term**
 - (Pleural effusion)
 - Wound infection
 - Bile leak from hepaticojejunostomy or raw surface of the liver
 - Subphrenic or subhepatic abscess
 - Intra-abdominal bleeding
 - Liver failure
 - Portal vein thrombosis

- **Long-term:**
- Cholangitis
- Anastomotic stricture
- Chronic liver failure

Tricks of the Senior Surgeon

- Check the intraoperative external biliary drainage to prevent unexpected biliary congestion from which septic complications may develop.
- Overview Stop
- Suture the large short hepatic veins or caudate lobe veins in detaching the caudate lobe from the vena cava.
- Check the CVP in the monitor before liver transection. If the CVP is higher than 3 cm H₂O, do not start to transect the liver.
- The hepatic vein on the liver side should be closed by a running suture to prevent bleeding during the handling of the liver.
- Stay sutures should be placed before dividing the intrahepatic bile duct; otherwise the small segmental duct will slip away and be hidden by the liver parenchyma.
- The lymphatic vessels should be tied in a para-aortic lymph node dissection to prevent post-operative massive lymphorrhea, although the indication of para-aortic node dissection has been controversial.

Editor's Comments

- Tissue diagnosis is not a prerequisite for surgical resection of suspected cholangiocarcinoma; clinical presentation and radiographic appearance are enough.
- ERCP and peroral cholangioscopy are avoided for high bile duct obstruction, as these are unlikely to define the problems or palliate obstruction, and they can lead to cholangitis.
- Percutaneous drainage is not always necessary prior to surgery. The patients who will benefit from preoperative drainage are those who 1) have cholangitis, 2) have renal dysfunction, 3) have possible vascular invasion on the side that will be the remnant liver after resection, or 4) should undergo portal vein embolization.