Partial Cadaveric Liver Transplantation: Donor Procedure and Implantation

Massimo Del Gaudio, Xavier Rogiers, Daniel Azoulay

In 1989, Pichlmayr *et al.* were the first to report a case of splitting a cadaveric liver for two recipients, an adult and a child. In the same year, Bismuth *et al.* performed the first transplantation of a single liver into two adult recipients with fulminant hepatitis. Today, donor livers are split for an adult and a pediatric recipient or, less frequently, for two adults.

Indications and Contraindications

General donor criteria

- Age < 55 years
- Weight > 70 kg
- Hemodynamic stability
- Normal liver function tests
- No macroscopic aspect of liver steatosis
- Graft-to-recipient body weight ratio > 1 %

Donor Procedures

Ex situ versus in situ splitting

In general, the liver graft can be split either during the procurement procedure (i. e., in situ) or on the back table after a conventional donor procedure (ex situ).

For ex situ splitting of the liver, the whole organ is retrieved as described in ▶ Chap. 59, "Technique of Multi-Organ Procurement." Grafts are then prepared in the recipient transplant center. An alternative is the in situ splitting technique, which is closely related to the techniques established for procurement from living related donors.

The ex situ split is the most widely used method to obtain transplants for two patients with one liver, but the extended cold ischemic time and some rewarming due to the longer back-table procedure, as compared with conventional liver transplantation, increase the risk of graft dysfunction in the recipient. In situ splitting potentially eliminates this problem, but its application is limited by its more time-consuming and technically more demanding explantation procedure.

Back-table procedure for ex situ splitting

During back-table splitting, attention should be paid to keeping the liver cold. After standard procurement of the liver graft, the presence of a portal bifurcation is checked by inserting a blunt metallic probe into the portal trunk. The anatomy of the hepatic artery and the bile duct is identified by dissection, probing, or back-table X-ray with contrast medium. The ultimate dissection of the portal vein, the hepatic artery, the biliary tree, and the suprahepatic veins is performed on the back table.

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In situ split-liver donor procedure for an adult and a pediatric recipient

The goal of this procedure is to obtain the following grafts:
- Graft for adult recipient: Segments IV through VIII
- Graft for pediatric recipient: Segments II and III

Step 1

Mobilization and transection of the left lateral segments

Segments II and III are mobilized and prepared in an identical manner as for a living-donor procedure. The left hepatic artery and the left portal vein are isolated. Particular attention is paid to preserving the arterial branch to segment IV whenever possible. The left hepatic vein is identified and controlled by placing a vessel loop around it to allow vessel-loop guided parenchymal transection (Fig. 61.1a). (See ▶ Chap. 42, "Hanging Maneuver for Anatomic Hepatectomy.")

Optionally, a cholangiography can be performed, as shown in the chapters on living-donor procedures.

Parenchymal transection is performed along the falciform ligament (Fig. 61.1b, resection line 1). The hepatic veins are separated. The left hepatic vein remains with the left graft, whereas the right and the middle hepatic veins remain with the right graft in continuity with the inferior vena cava (IVC).

Once the division of the parenchyma reaches the hilar plate, it is cut straight with a scalpel slightly toward the left side, thus cutting the left hepatic duct blindly. This avoids unnecessary dissection of the bile duct, which would compromise the biliary arterial blood supply.

In case of a too-large right graft, or when the perfusion of segment IV is not optimal, segment IV can be resected after implantation (Fig. 61.1b, resection line 2). (Usually segment IV is somewhat discolored. This is normal and should not lead to resection of the segment.)

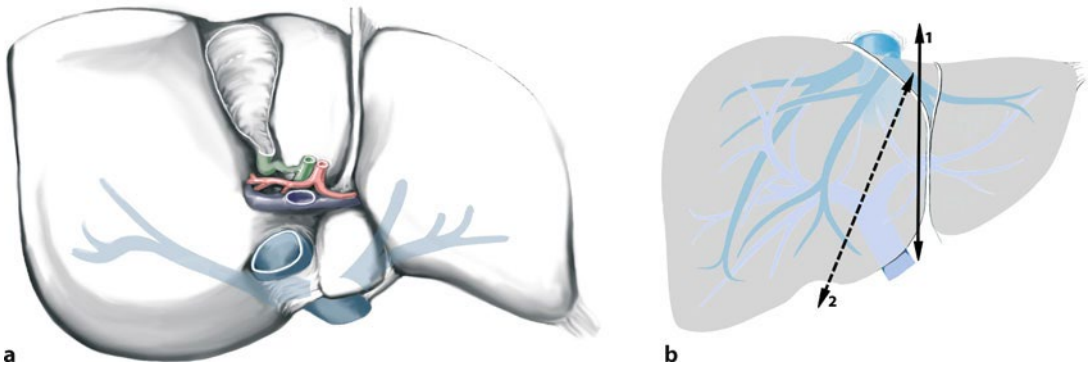

Fig. 61.1

Step 2

Procurement of the grafts

Now the graft is prepared for procurement. Flushing of the organs is performed as in a standard multiorgan procurement. The left or right portal vein is cut at its origin and the orifice is closed with a 7-0 monofilament running suture. If the portal vein is to be cut at the origin of the left branch, the branches from the first centimeters of the left branch of the portal vein to segment I are secured between ligatures and divided in order to gain length and to allow for coaxial anastomosis to the recipient's portal vein.

In a standard situation, the artery is divided at the origin of the right hepatic artery, leaving the celiac trunk with the left graft. The left hepatic vein is divided and the left graft is removed and stored. Then the right graft is removed (Fig. 61.2).

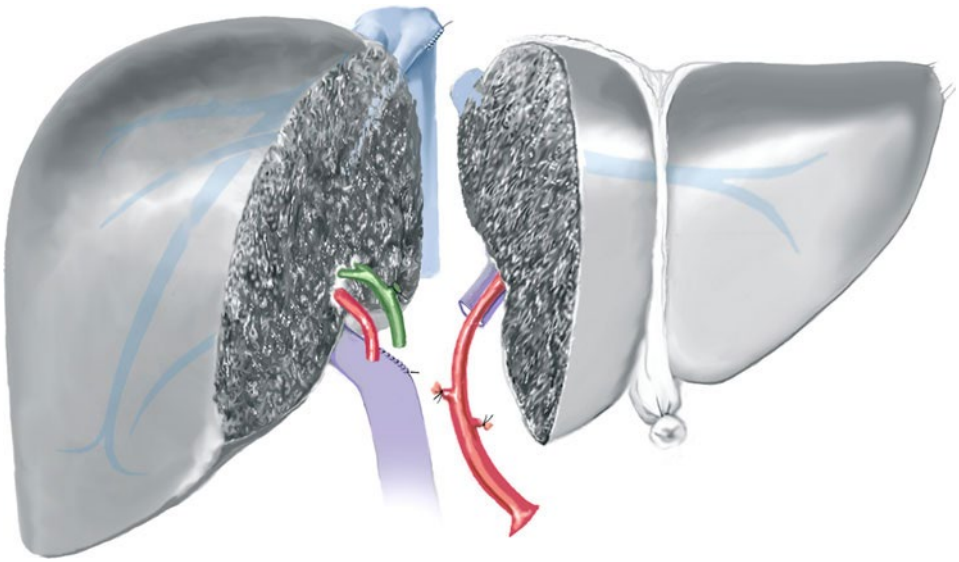

Fig. 61.2

In situ splitting for two adult recipients

The goal of this procedure is to obtain the following grafts:
- Right graft: Segments 5 through 8
- Left graft: Segments 2 through 4

The hepatic dissection starts with complete mobilization of the right liver, including isolation of the right hepatic vein, which is prepared for vessel loop–guided parenchymal transection. Short accessory hepatic veins draining the right liver are preserved if they are larger than 5 mm, as they need to be anastomosed during implantation of the right graft.

The portal vein and the hepatic artery are prepared as described in the section on adult and pediatric split-liver procedure. In a standard situation, the celiac axis remains with the left graft. Regarding portal bifurcation, the portal vein trunk is kept in continuity with the left graft. In case of portal trifurcation, the portal trunk is kept with the right graft. The plane of transection is to the right of the middle hepatic vein, so the whole of segment 4 is included in the left graft. This procedure yields two grafts as shown in Fig. 61.3. In contrast to the split-liver procedure for an adult and a pediatric recipient, in this situation the cava remains with the left graft.

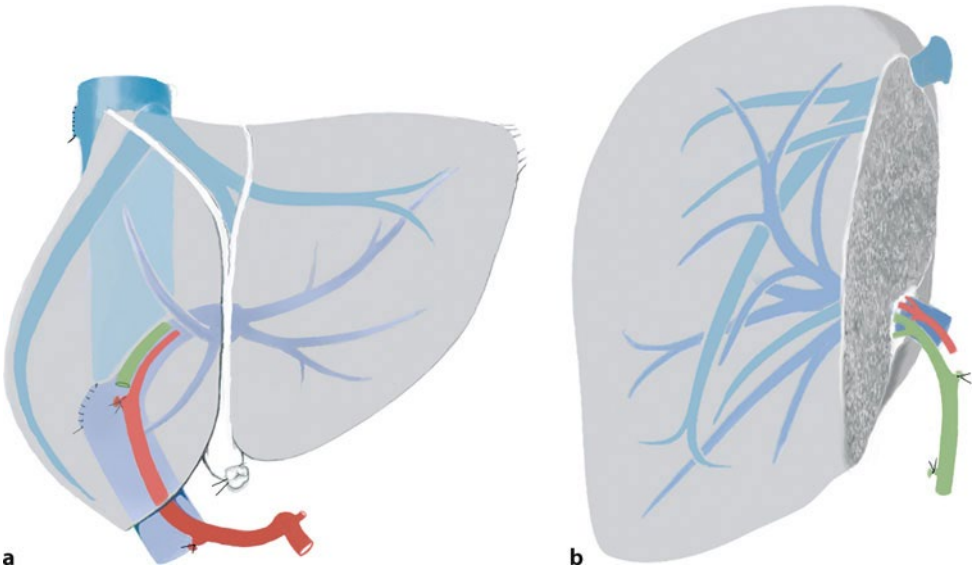

Fig. 61.3

Implantation Procedures

Implantation of the right graft when the liver is split for an adult and a pediatric recipient

Step 1

Preparation of the graft

The cava remains with the right graft, so a side-to-side cavocavostomy is possible and yields optimal allograft outflow. The preparation of the graft consists of resection of the upper and lower IVC cuffs at a level beneath the first major hepatic veins draining the residual part of Sg1. A 6-cm cavotomy at the right posterior side of the IVC encompasses the orifices of the major hepatic veins (Fig. 61.4).

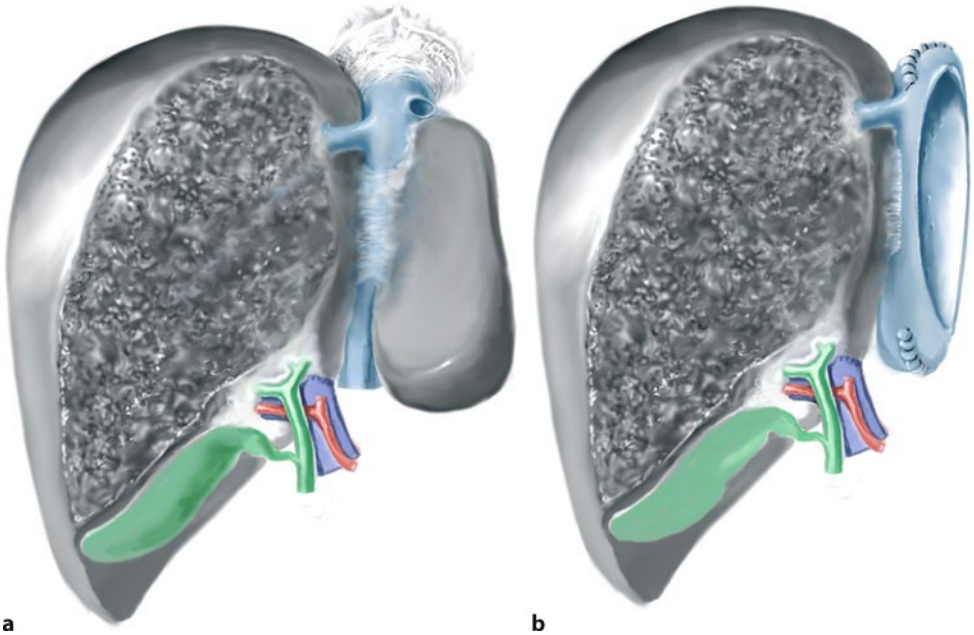

Fig. 61.4

Step 2

Side-to-side cavocavostomy

A side-to-side cavocavostomy using partial clamping of the recipient IVC is performed. (See also ▶ Chap. 60) Optional: resection of the retrocaval and left part of Sg1 during the back-table procedure improves exposure and thereby easy anastomosis between the two caval veins. The same technique can be applied for the left graft in a procedure for two adult recipients, as the cava remains with the left liver in that situation (Fig. 61.5).

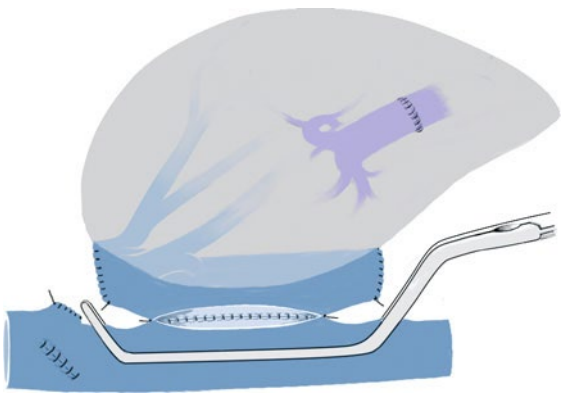

Fig. 61.5

Step 3

Portal vein, hepatic artery, and bile duct anastomoses

An end-to-end portal vein anastomosis is performed between the right branch of the portal vein of the graft and the common trunk of the portal vein of the recipient. If long enough, the right hepatic artery is anastomosed to the hepatic artery of the recipient at the level of the bifurcation with the gastroduodenal artery. Otherwise, it is anastomosed to the right or common hepatic artery. Finally, the right hepatic duct is connected to the common bile duct of the recipient, applying the same technique as in orthotopic liver transplantation (Fig. 61.6).

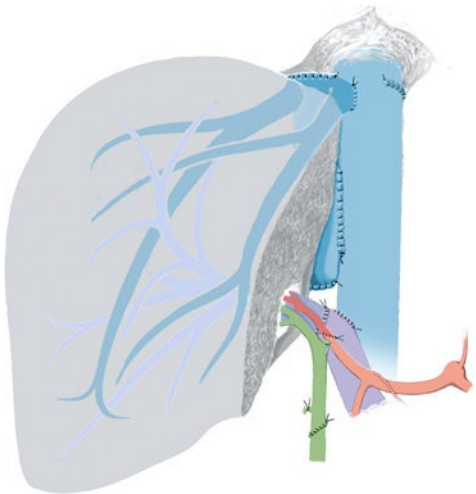

Fig. 61.6

Implantation of the right graft after splitting for two adult grafts or after right living-donor procurement

Implantation of the left graft when the liver is split for two adult recipients is described in ▶ Chap. 63.

In the situation of living-donor procurement, the cava remains in the donor, and in a split-liver procedure for two adult recipients, the cava remains with the left graft. Therefore, the venous outflow is reconstructed by anastomosing the donor's hepatic veins to the recipient's vena cava. The hepatectomy in the recipient is performed as for orthotopic liver transplantation with preservation of the IVC. The orifices of the middle and left hepatic veins are oversewn or stapled; the right hepatic vein is directly anastomosed to the stump of the right hepatic vein or to a wider orifice in the recipient's vena cava. Any inferior hepatic veins more than 5 mm in diameter are also anastomosed directly to the IVC. A significant hepatic vein from segment 5 or 8 must be drained. This can be achieved by constructing a jump graft by means of a saphenous vein or, depending on the anatomic situation, by creating a common orifice with the right hepatic vein.

Anastomoses of the portal vein and the hepatic artery are performed as for the split graft for adult and pediatric recipients. Biliary continuity can be restored by bilidigestive anastomosis, as shown in the figure, or by a direct connection between the right hepatic duct of the right graft and the common bile duct of the recipient (Fig. 61.7).

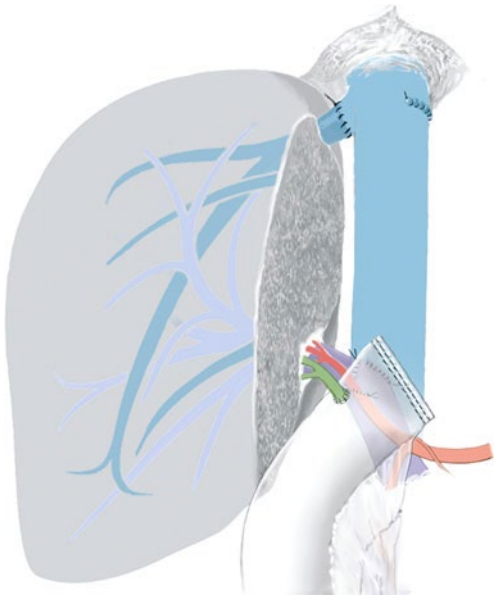

Fig. 61.7

Implantation of the left graft in a pediatric recipient (segments 2 and 3)

As in this situation the cava stays with the right graft, the left hepatic vein is anastomosed directly on the IVC of the recipient. It is fundamental to keep the hepatic vein short, as too long a vein can lead to kinking of the caval anastomosis. End-to-end anastomosis of the portal vein between the donor's left portal vein and the recipient's common trunk is performed. Finally, the celiac axis of the left graft is anastomosed to the hepatic artery of the recipient at the level of the gastroduodenal artery, and biliary continuity is reconstituted by a Roux-en-Y bilidigestive anastomosis (Fig. 61.8).

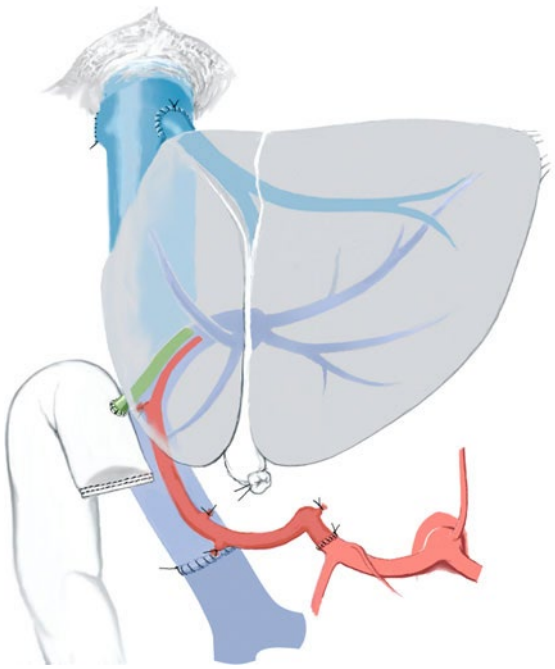

Fig. 61.8

Alternative management of the hepatic venous outflow in split-liver transplantation for two adults

In split-liver transplantation for two adults, the maintenance of an optimal venous outflow is of great importance for maximal parenchymal integrity. In principle, the same venous reconstructions and anastomoses are made as in right liver donation, including reanastomosis of segment 6 veins and reconstruction of larger segment 5 or 8 veins, as shown. Two additional techniques that are not usable in living donation can be applied to make the implantation easier while maintaining optimal venous outflow:

- *Splitting of the inferior vena cava:* This technique can be used in both the in situ and ex situ technique. The front wall and back wall of the vena cava are cut longitudinally, thus obtaining a caval patch on both grafts containing the respective hepatic veins as well as a possible segment 6 vein on the right side and segment 1 veins on the left side. At implantation, the caval patches are sewn into the front wall of the preserved recipient vena cava (Fig. 61.9).

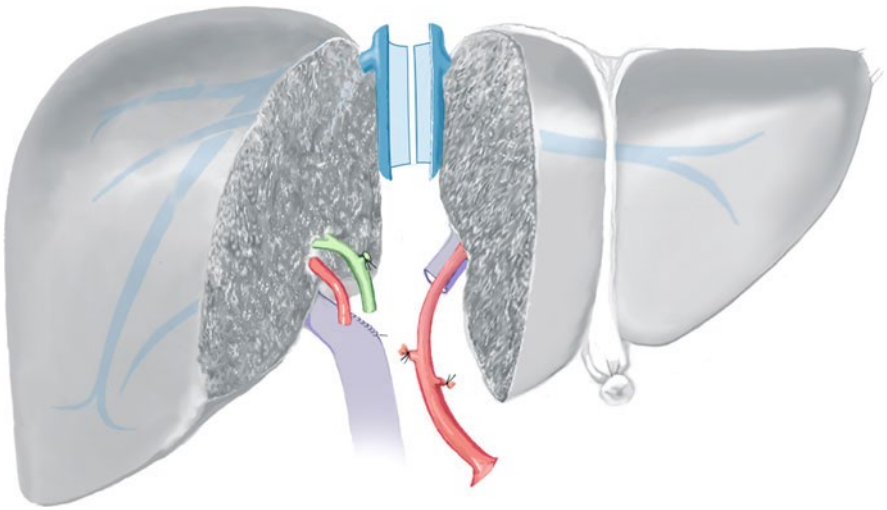

Fig. 61.9

- *Splitting of the middle hepatic vein:* This technique can be performed only in ex situ splitting. During parenchymal transection, the middle hepatic vein is cut through the middle, in continuity with its orifice in the vena cava (Fig. 61.10a). On both sides, it is reconstructed using donor iliac vein patches. In this way, larger segment 5 or 8 veins are drained without the need for any further reconstructions or anastomoses (Fig. 61.10b,c).

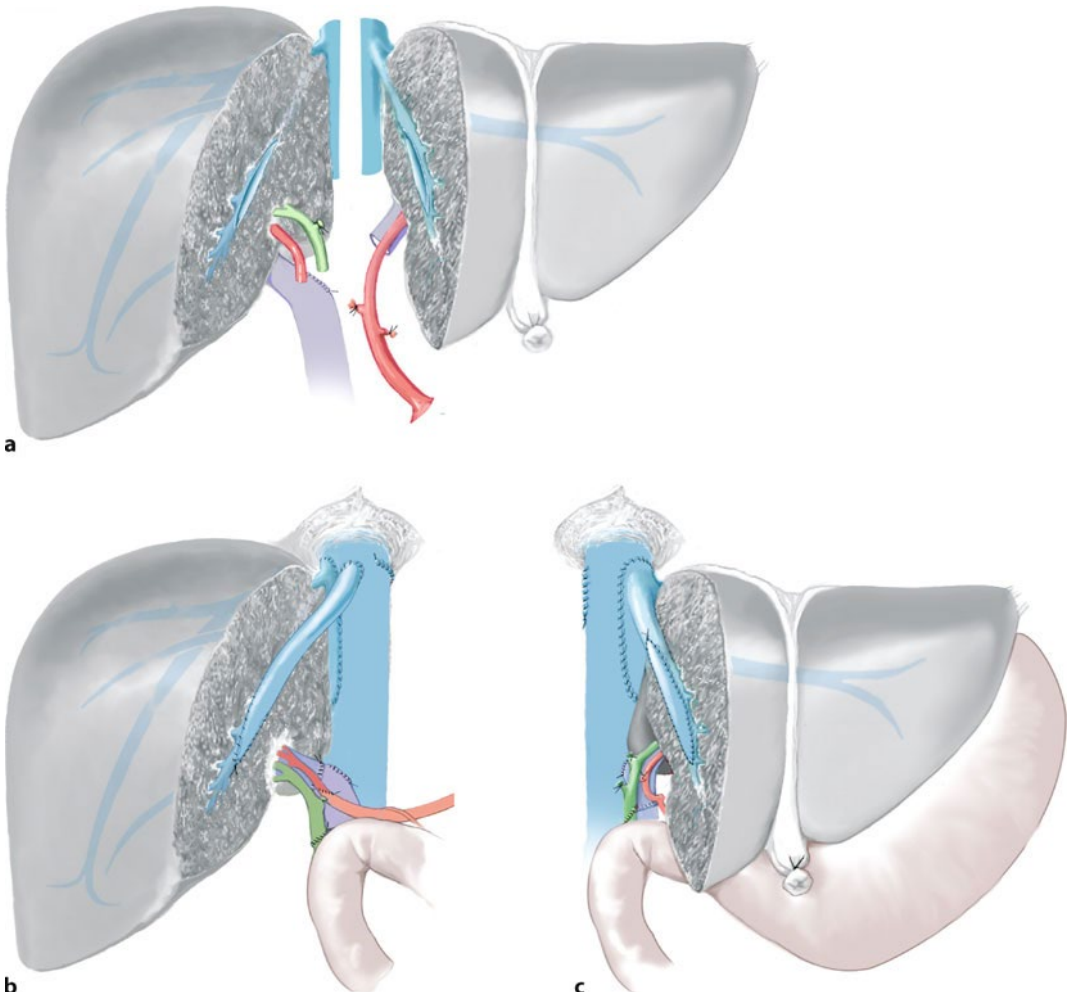

Fig. 61.10

Routine Postoperative Tests

- Doppler ultrasound examination daily in the intensive care unit, then weekly until discharge
- Laboratory parameters as for orthotopic liver transplantation

Postoperative Complications

- Biliary leaks from the raw surface, which usually resolve with percutaneous drainage.
- Other complications are the same as for orthotopic liver transplantation or living-donor transplantations and should be treated accordingly.

Tricks of the Senior Surgeon

- Sharp transection of the parenchyma is preferred, as it leaves a flat surface allowing for most efficient hemostasis.
- Clips have a propensity to drop off during the implantation procedure. Therefore, every individual vessel seen on the cut surface is closed with stitches. During this step, care is taken to avoid liver rewarming by applying cold towels, leaving only the cut surface exposed.