

496

Rob & Smith's

Operative Surgery

Alimentary Tract and Abdominal Wall

2 Liver • Portal Hypertension • Spleen • Biliary Tract •
Pancreas

Fourth Edition

Edited by

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Liver transplantation

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Preoperative

Candidacy

Patients who have non-malignant end-stage liver diseases are candidates for liver transplantation. Such diseases include chronic aggressive hepatitis, alcoholic cirrhosis, primary biliary cirrhosis, sclerosing cholangitis, Budd-Chiari syndrome, congenital biliary atresia and inborn errors in metabolism (such as Wilson's disease and α_1 -antitrypsin deficiency). Massive hepatic necrosis due to hepatitis virus or anaesthesia could also be an indication but case selection is exceptionally difficult. Primary malignant liver neoplasms which are not resectable by conventional techniques of subtotal hepatectomy can be treated with total hepatectomy and liver replacement after exhaustive elimination of extrahepatic spread of the tumour, but subsequent metastases have been common after otherwise successful transplantation.

The preferable age ranges between 6 months and 50 years. The candidate should be free of infection and significant cardiopulmonary diseases.

Liver donors

Heart-beating and brain-dead cadavers without systemic infection or extracranial malignant tumours are potential donors of livers, kidneys and the heart. The size of the donor liver is important in selecting a recipient. The over-sized or excessively small donor liver can lead to many technical difficulties in transplantation.

Histocompatibility

The need for transplantation is so pressing in appropriate candidates that it is usually obligatory to proceed with the first available organ. Efforts to observe ABO blood group compatibility are made but even this criterion of matching is not absolute. The liver is unusually resistant to hyperacute rejection. Successful liver homografts have been achieved from the donors who are ABO blood group incompatible and from those with positive T-lymphocyte crossmatch.

It is unlikely that waiting for well matched (HLA) livers will be possible in the near future.

The operation

DONOR HEPATECTOMY AND LIVER PRESERVATION

1

The incision and exposure

Good exposure is provided with a long midline abdominal incision (A-A') with extensions laterally (B-B') or into one or both hemithoraces.

Identification of anatomical variant

As soon as adequate exposure is obtained, the portal triad is examined to find variant anatomy. The normal hepatic artery is located at the left anterior edge of the hepatoduodenal ligament and is the only arterial blood supply to the entire liver. However, anomalies are common. The right hepatic artery frequently arises from the superior mesenteric artery and runs posterior to the portal vein into the right lobe of the liver. The left hepatic artery sometimes originates from the left gastric artery or coeliac axis. In the latter variants the left hepatic artery often runs outside the hepatoduodenal ligament. Identification of these variant structures is essential for successful harvest of the liver.

Dissection of the portal triad, coeliac axis and aorta

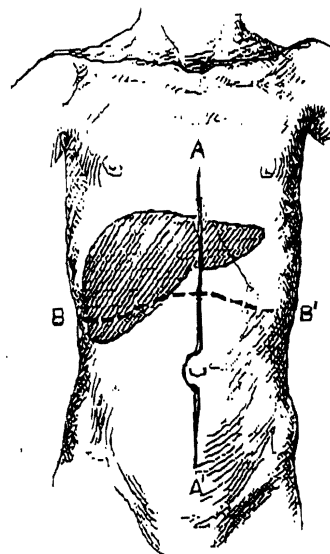
2

Continuous caudal traction is maintained on the duodenum. Dissection of the portal triad is kept as inferior as possible. The common bile duct is identified at the right anterior edge of the hepatoduodenal ligament. It is dissected to the superior margin of the pancreas and is transected there.

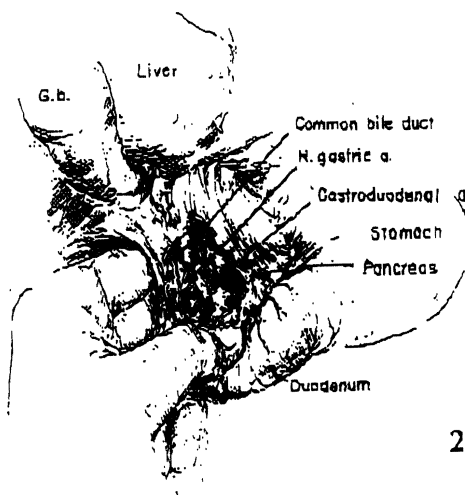
The right gastric and gastroduodenal branches of the common hepatic artery are next identified, doubly ligated and divided. The common hepatic artery is found to run almost directly left and at a right angle to the axis of the portal triad. The artery is dissected toward the coeliac axis by ligating and dividing the intervening tissues. Then, the splenic and left gastric arteries can be readily ligated and divided.

3

If not, the lesser omentum is widely opened and the stomach is retracted caudally. The coeliac axis is exposed by incising the crura of the diaphragm. The left gastric artery and splenic artery are dealt with using the extra exposure. The coeliac axis is dissected toward its origin.



1



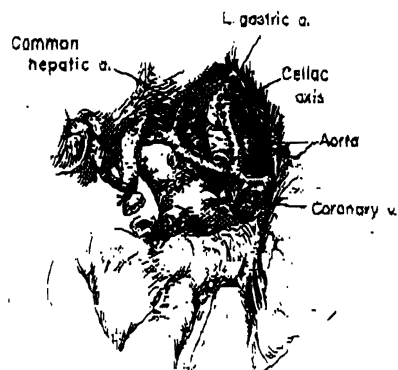
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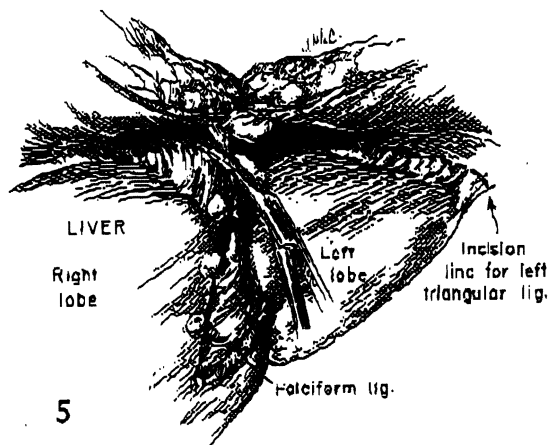
3

4

The portal vein is approached anteriorly just where it emerges from beneath the neck of the pancreas. With blunt dissection the lower part of the portal vein is separated from the pancreas, and the bifurcation of the superior mesenteric vein and the splenic vein is visualized. The left gastric (coronary) vein almost invariably enters on the left lateral aspect of the portal vein. This tributary is freed, doubly ligated, and divided in order to prevent its subsequent injury. One or two other variable branches often are encountered. The portal vein is encircled by ligating and dividing the tissue posterior to the vein. If a variant right hepatic artery arising from the superior mesenteric artery is present, it will usually be in this location and can be traced back to its origin.



4

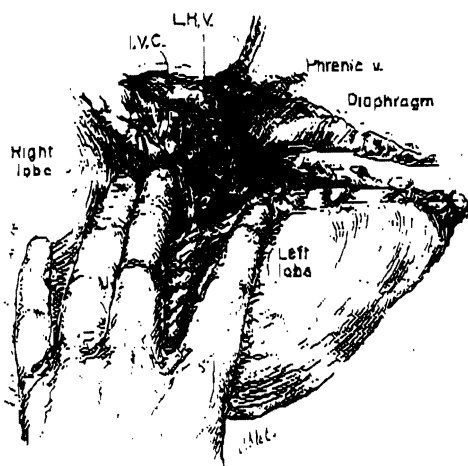


5

Dissection of vena cava

5

The falciform ligament is incised, beginning peripherally where the two component leaves are fused and continuing centrally to where the leaves separate.



6

6

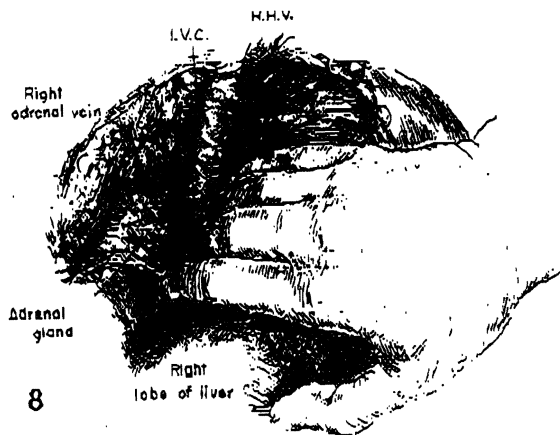
The left coronary ligament is cut.

7

The right triangular ligament is cut exposing a portion of the raw area of the liver.



7



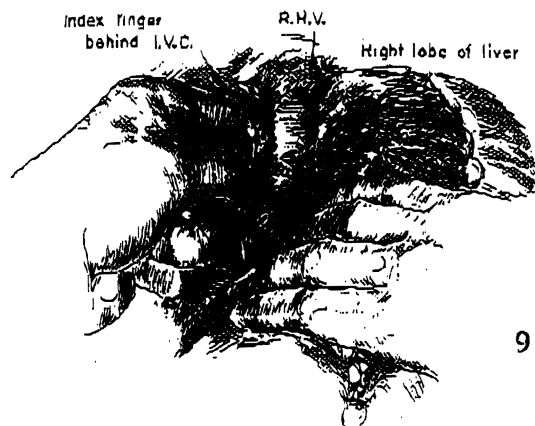
8

8

The liver is retracted up and toward the left. This plane should be developed with sharp dissection in order to avoid injury to the liver. With each cut of the scissors, the right lobe can be more completely elevated, until the right adrenal vein is seen. This is ligated and divided.

9

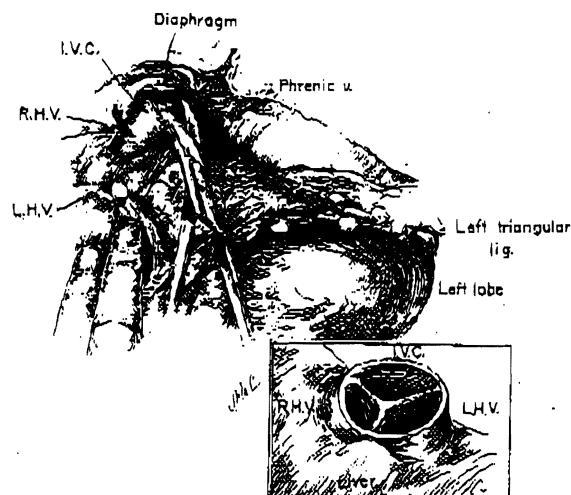
As the right adrenal vein is ordinarily the only tributary of the retrohepatic vena cava, it is usually possible after dividing it to pass freely a finger behind the retrohepatic vena cava all the way from the diaphragm to the level of the renal vein. If anomalous small venous branches to the vena cava are encountered with this manoeuvre, they are also ligated and divided.



9

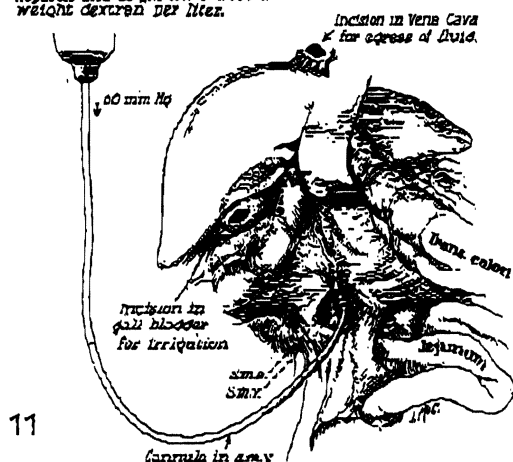
10

Attention is then returned to the suprahepatic inferior vena cava, between the dome of the liver and the diaphragm. This short segment of vessel is actually a confluence of the right and left (and often middle) hepatic veins with the vena cava. The anastomosis of the suprahepatic cava is made much easier with each millimetre of added length that is retained with the donor liver. Extra length can be obtained by dissection off the diaphragmatic reflection and by ligating and dividing phrenic veins.



10

2°C Balanced Electrolyte Solution
with 50 mg/ml procaine, 100 mg/ml
heparin and 25 gm/lwt molecular
weight dextran per liter.



11

Preservation

11

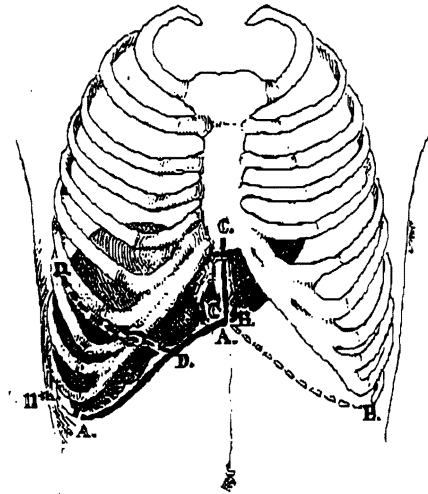
The aorta proximal to the coeliac axis is encircled but not clamped. The aorta and the inferior vena cava are clamped at their bifurcation. The patient is heparinized. Cannulas are introduced into the distal aorta and the vena cava and secured. A cannula is placed into the superior mesenteric vein, for infusion of the Collins' preservation solution. The gall bladder is now opened and irrigated until it is free of bile. When everything is ready, the proximal aorta is clamped and the vena cava cannula is opened to allow free venous drainage. The cannulas in the aorta and the mesenteric venous systems are opened and the Collins' solution is infused with gravity pressure (60–100 mmH₂O). When the liver is cool and blanched, the infusion is stopped and the coeliac axis is transected. It is usually desirable to remove part of the aorta with the coeliac axis. The suprahepatic vena cava is divided as high as possible and the infrahepatic vena cava as distally as possible in order to provide good length of caval cuffs. The liver is removed and placed into chilled Collins' solution for preservation. The liver can be preserved safely in this way for approximately 12 h.

RECIPIENT HEPATECTOMY

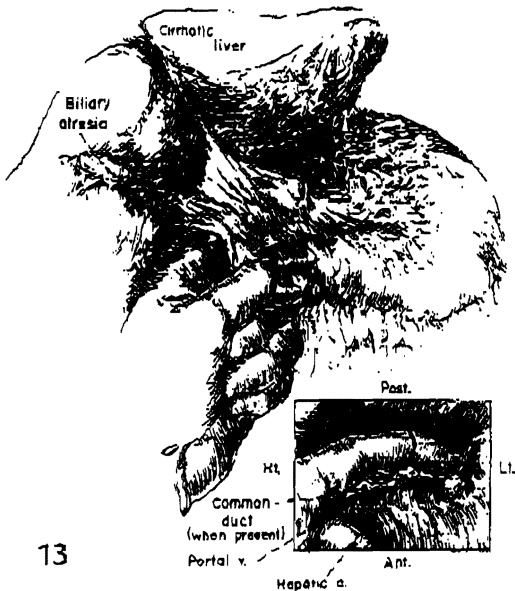
12

The incision

A bilateral subcostal incision with an upper midline extension, removing the xiphoid process, usually gives an excellent exposure. If this is not adequate, an additional incision is made in the right eighth intercostal space and the diaphragm is incised.



12



13

Dissection of the portal triad

13

The exposure, identification and dissection of the portal triad are the same as those in donor hepatectomy, except that the longest possible length of the portal structures is preserved in the recipient. A combination of previous operative scars and venous collaterals in portal hypertension makes for a particularly difficult and dangerous portal dissection.

Once the portal triad has been encircled, its three constituent structures can be freed with relative safety, providing their triangular spatial relationship is appreciated as shown in the inset.

14 & 15

Segments of the vessels and bile duct long enough to permit subsequent anastomoses are developed. This may require ligation and division of the right gastric and gastroduodenal branches of the hepatic artery. Sacrifice of these vessels has another advantage; as soon as they are divided, it is much easier to visualize and dissect the portal vein where it emerges from the neck of the pancreas. Branches of the portal vein also have to be ligated and divided; of these the left gastric (coronary) vein, which enters on the left side and posterolaterally a few millimetres above the pancreas, is the most constant.

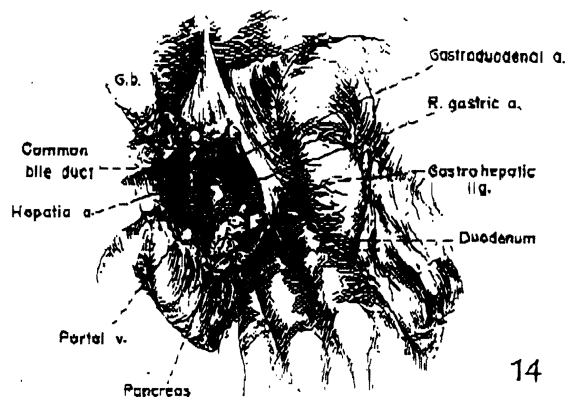
The distal common duct and its surrounding adventitia and vessels are left long for later choledochocholedochostomy. In order to prevent haemorrhage and later lymph leaks, intervening bits of tissues must be tied meticulously.

Mobilization and vena cava dissection

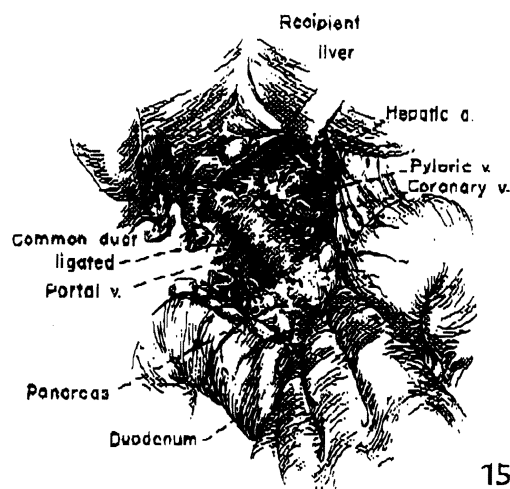
The steps in mobilization and vena cava dissection are almost identical to those already described for donor hepatectomy, except for the most careful haemostasis of the diaphragm and the retroperitoneum behind the liver. Right adrenalectomy sometimes becomes necessary to obtain the satisfactory haemostasis. A finger is passed around the vena cava below and above the liver, and the retrohepatic vena cava is freed from the posterior body wall. It is essential that the suprahepatic vena cava is freed from the diaphragm and the phrenic veins are divided in order to avoid crushing injury to the right phrenic nerve by the vascular clamp. Particular care must be taken in obtaining the maximum length of the suprahepatic vena cava.

16

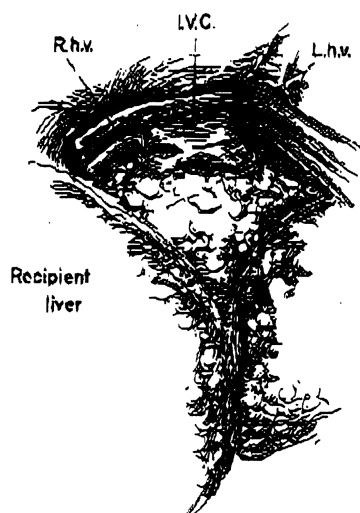
In all of our first cases, the following technique was used. The vascular clamp was placed as superiorly as is feasible without drawing a piece of contiguous diaphragm into the bit. The liver parenchyma is crushed or incised to expose enough length of right and left hepatic vein. A venotomy is then made in either the main right or left hepatic vein. With one blade of the scissors in the lumen and the other outside, the clasp formed by the confluence of the vena cava and hepatic veins is incised close to the liver around the entire 360 degrees. After the infrahepatic vena cava, the portal vein and the hepatic artery have been cut, the specimen is removed.



14



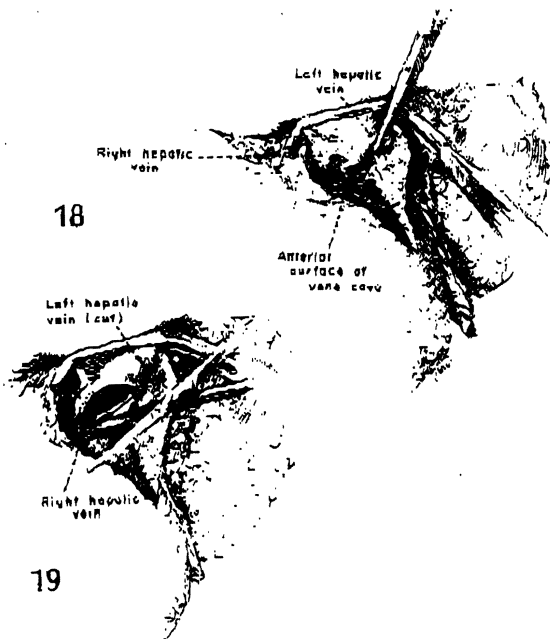
15



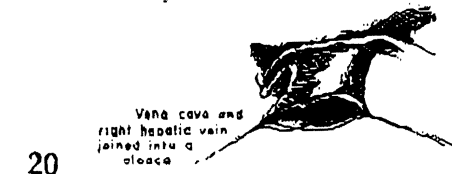
16

17

It is often impossible to get enough length of the suprahepatic vena cava. The following technique has been found to be helpful. The liver is devascularized and the infrahepatic vena cava is clamped. The suprahepatic cava is crossclamped but not transected. Instead the liver is split vertically with a knife down to the cava which is scraped clean.



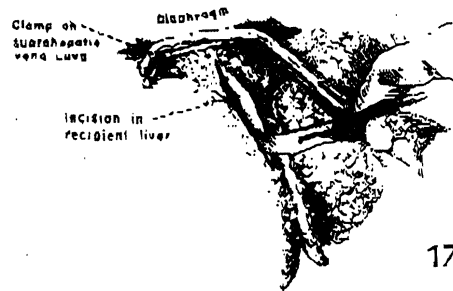
19



21

After the vessels entering and leaving the liver have been skeletonized, they are individually occluded with non-crushing vascular clamps and divided, leaving them as long as possible.

Liver transplantation 515



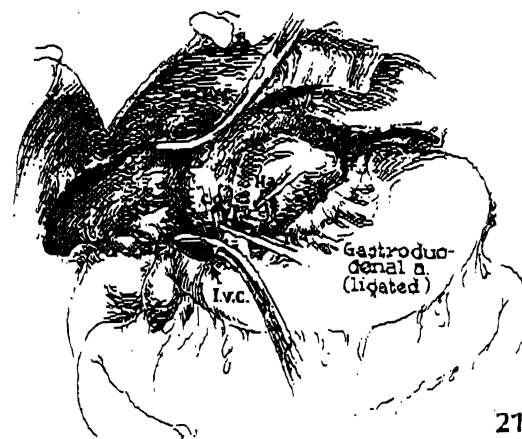
17

18 & 19

The left hepatic vein is isolated, divided and closed with a double-layer vascular suture.

20

The vena cava and the right hepatic veins are joined into a cloaca, thus forming the cuff necessary for the transplantation. The cuff is finally inspected for defects from small hepatic veins which may have been transected. All defects must be carefully taken care of.



21

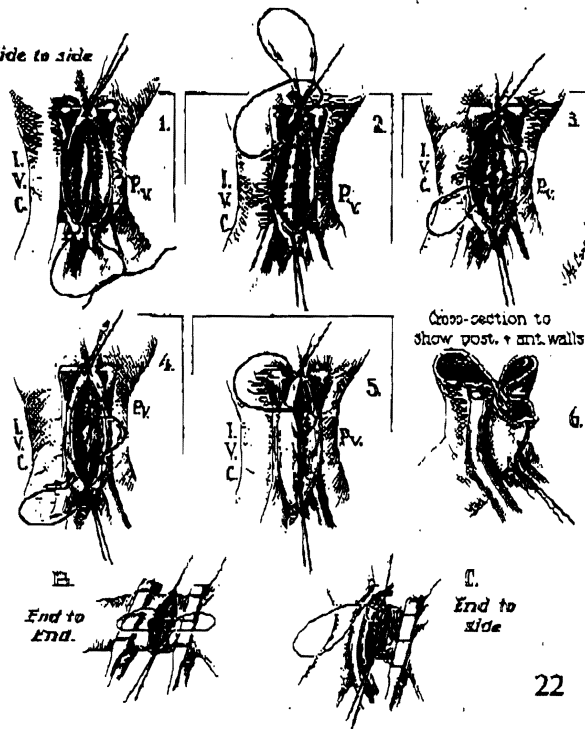
ORTHOTOPIC LIVER TRANSPLANTATION

22

Suprahepatic vena cava

This is the most difficult and dangerous of the vascular anastomoses. First, the lengths of host and homograft vessel that are available for sewing are very short; second, the presence of the new liver makes it difficult to improve exposure by retraction or other manipulations; and finally, the fact that the suture line, particularly its posterior portion, cannot easily be re-exposed later for control of haemorrhage makes it mandatory that a perfect result be obtained at once. This must be achieved by fashioning the posterior portion of the anastomosis from within the lumen. The principle of the method, as demonstrated in the illustration for a side-to-side anastomosis, is the immediate formation of intraluminal shoulders in both vessels to be joined. First, sutures are placed in the extremities of the anastomosis. The needle is passed into the posterior part of the lumen of one of the vessels 1 or 2 mm from the line of incision. A firm bite of the other vessel is then taken, making sure that the entry and exit sites of the needle pass through the intima at some distance from the cut edge. The full thickness of the wall is included. If the thread is pulled tight, a mound of protruding tissue presents, which makes the similar placement of subsequent sutures easy. When the opposite end of the posterior anastomotic line is reached, the needle is passed outside and the anterior row is completed with an everting over-and-over suture. The steps are almost exactly the same for an end-to-end or end-to-side anastomosis. A perfect intimal coaptation can thus be assured all around the vessel.

A. Side to side



22

Infrahepatic vena cava

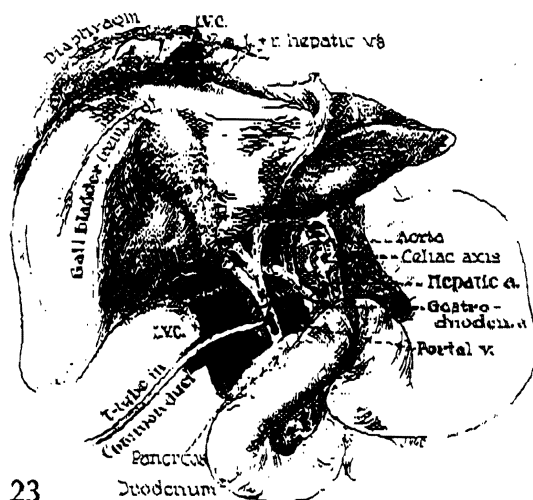
The technique of anastomosis is identical to that described above, including intraluminal suture of the posterior wall.

23

Portal vein and hepatic artery

Excess lengths of both host and graft portal vein are usually present. Both vessels must ordinarily be shortened so that there is approximation without kinking or tension. Because of this requirement of perfect length, there is not enough room to turn the vessels for external suturing of the posterior wall. The continuous intraluminal technique described earlier is applied, using 6/0 vascular silk. The use of Prolene suture here tends to purse-string the anastomosis of the thin-walled portal vein.

The usual technique of rearterialization is by anastomosis of the graft common hepatic artery or coeliac axis to the recipient common or proper hepatic artery. The anastomosis is easy in adults with a standard continuous arterial suture technique, using 6/0 Prolene. In contrast, the hepatic arteries in paediatric donors are both small and fragile. In such cases the use of graft coeliac axis is usually advisable. This can be connected without difficulty to the recipient common hepatic artery, which is usually larger than normal in patients with cirrhosis.

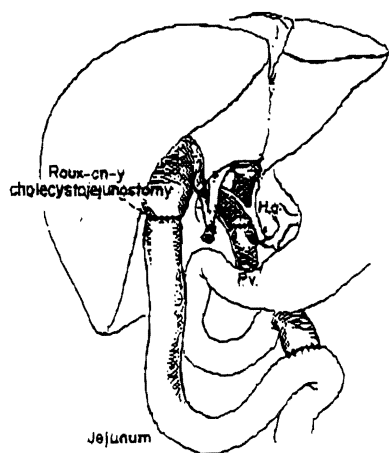


23

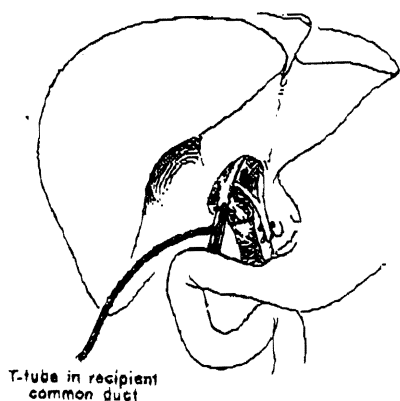
24 & 25

Variants of homograft vasculatures

Some of the most serious technical problems with orthotopic liver transplantation are caused by variants of hepatic artery. When the right hepatic artery arises from the superior mesenteric artery as shown, the graft coeliac axis is anastomosed to the recipient common hepatic artery, and the graft right hepatic artery is anastomosed to the recipient splenic artery. When a small left hepatic artery arises from the left gastric artery, the graft coeliac axis is used for anastomosis. If this left hepatic artery is not recognized and is inadvertently ligated and divided, this has to be reanastomosed to the original branch or small other available arterial branch.

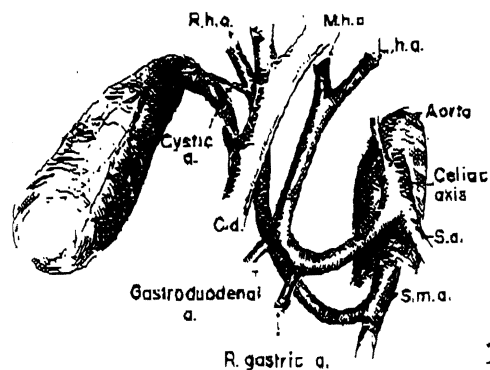


26a

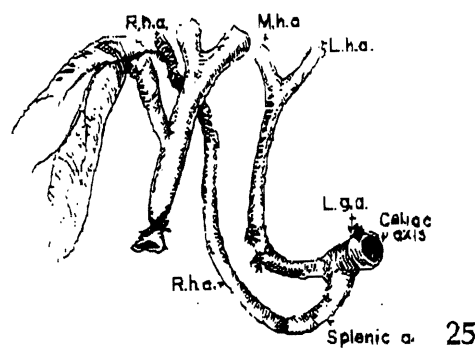


26b

DONOR LIVER



24



25

Biliary drainage

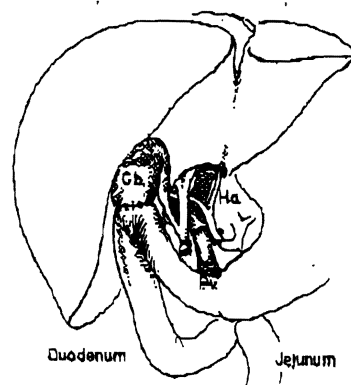
26a & b

Until 1976, we commonly performed cholecystoduodenostomy (a). Although this is the simplest biliary reconstruction, obstruction at the cystic duct was common. Furthermore, homografts are subjected to repeated bacterial contamination with resulting cholangitis and consequent systemic infection. Thus, this anastomosis is now abandoned.

We now believe that the ideal biliary reconstruction is choledochocholedochostomy with a T-tube stent (b), using 5/0 or 6/0 chromic catgut interrupted sutures. After operation, the T-tube is left in place as briefly as one month to as long as 2 years. A T-tube cholangiogram is of great value as part of the postoperative evaluation of jaundice and fever. After the T-tube is removed, periodic endoscopic retrograde cholangiography via the duodenum can be done.

27a & b

Choledochocholedochostomy is often not feasible, as, for example, in children with biliary atresia. As an alternative, we perform cholecystojejunostomy (a) or choledochojejunostomy (b) to a Roux limb of jejunum. The advantages of cholecystojejunostomy are that a large calibre anastomosis is possible, even in a child's liver, and that no stenting or drainage is necessary. The disadvantage is that obstruction of the cystic duct often necessitates reoperation and conversion to choledochojejunostomy.



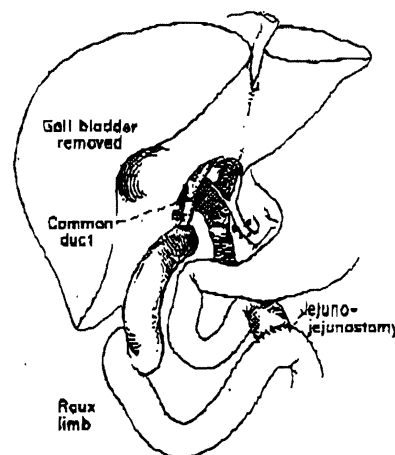
27a

Splenectomy

Splenectomy is not done if there is enough space for graft liver. We now use cyclosporin A exclusively for liver transplantation which does not cause bone marrow suppression. With conventional immunosuppression using azathioprine and prednisone, splenectomies were often done to raise the white cell count thereby making treatment with larger doses of azathioprine possible.

Closure

Primary closure of the wound is desirable, providing complete haemostasis and satisfactory biliary reconstruction have been achieved. Otherwise 5-7 cm of the wound are left open and Penrose drains inserted to allow adequate drainage. The drains are removed as early as possible and irrigation of the cavity is done daily until the wound is completely healed.



27b

Postoperative care

The immunosuppression used until 1980 was azathioprine and prednisone which was given with or without anti-lymphocyte globulin. We now use cyclosporin A and a low dose of prednisone.

Fluid and electrolyte management

A significant derangement of fluid and electrolytes may occur during the immediate post-transplant period. Massive accumulation of fluid in the third space may occur during the initial 24 h, which necessitates a large amount of crystalloid and colloid infusion. Serum potassium concentration often drops below 3.0 mEq/l. As the potassium changes are unpredictable, very careful monitoring and adjustment are mandatory. Serum glucose is kept above normal with 5 per cent glucose solution. If the serum glucose falls below the normal level with maintenance

infusions of 5 per cent glucose solution, significant damage of the graft liver is suspected.

Coagulation factors, such as platelets, prothrombin and fibrinogen, decrease immediately after liver transplantation, partly because of massive transfusion during operation. If the graft functions well, the coagulation abnormalities are corrected to near normal within 24-48 h.

Complications

Successful liver transplantation is only achieved by controlling various complications. The best policy is of course prevention. The causes of complication are multiple and closely interrelated. The most common aetiologies are: (1) poor liver graft function; (2) technical accidents or errors; (3) side-effects of immunosuppression (essentially infections); and (4) rejection. Careful and constant monitoring of the patient is essential.

Results

Orthotopic liver transplantation using conventional immunosuppression has at best yielded a 50 per cent one year patient survival¹. In a recent series of patients treated with cyclosporin A and low doses of prednisone, a 79 per cent one year patient survival was achieved².

Acknowledgements

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Further reading

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