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The Liver Transplant Operation

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The cadaveric donor operation, the live donor operation, and the recipient operation are described. In the cadaveric donor operation, the incision extends from the sternal notch to the symphysis pubis. A median sternotomy is performed. All hepatic ligaments are dissected toward the suprahepatic and infrahepatic vena cavae, and the right colon and small intestine are mobilized. The ligament of Trietz is taken down. The common bile duct (CBD) is dissected. The gallbladder is incised and emptied. The inferior vena cava (IVC) is transected in the chest and above the renal veins in the abdomen. The hepatic artery is dissected, and the supraceliac aorta is exposed on the left. The portal vein is exposed. Cutting across the right adrenal gland and dividing the hepato-pulmonary ligament completes the donor nephrectomy. In the live donor operation, the left lateral segment of a healthy adult is transplanted into a small child. The most common graft from a live donor for an adult recipient is a right lobe (segments V-VIII) with or without hepatic vein. In the recipient operation, a bilateral subcostal incision with a midline upper extension is made. The left triangular and gastrohepatic ligaments are taken down. In the porta hepatis, the CBD is exposed. Portal venous bypass is established. Hepatic ligaments are transected, and the liver is removed. The donor liver is put in place. The suprahepatic IVC anastomosis is performed followed by the portal vein anastomosis. The liver can be perfused. The hepatic artery and CBD anastomoses are completed.

Keywords: liver transplantation; controlled non-heart-beating donor; split liver grafts

IVC

Inferior vena cava

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Cadaveric Donors

Donor Selection

The cadaveric liver transplant begins with a donor offer from an Organ Procurement Organization (OPO) coordinator. The information in Table 1 should be obtained from the coordinator in each case.

The surgeon determines, based upon the donor and relevant recipient factors, the suitability of the donor for liver procurement. Donor suitability can sometimes only be determined intraoperatively or with a liver biopsy.

Pre-Op Donor Management

The patients' team carries out the preoperative management of a potential donor. Once a donor has been identified and consent obtained, a transplant coordinator is frequently on site to give advice about management. Brain dead patients may

undergo severe physiologic disturbances due to events such as Cushings' response and diabetes insipidus. These place the donor organs at risk and should be diagnosed early and treated aggressively. Table 3 shows some of the common syndromes encountered in donors, and their management until procurement can be arranged.

The Cadaveric Donor Operation

The patient is positioned supine on the table, muscle relaxation given, gastric tube placed, and prepped from neck to groins. An incision is made from sternal notch to symphysis pubis. The round ligament is divided and falciform ligament taken down toward suprahepatic inferior vena cava (IVC). A median sternotomy is performed and retractors are placed (see Fig. 1).

The falciform dissection is continued to the IVC, the left triangular ligament is taken down. The gas-

Table 1 | DONOR INFORMATION

ABO
Donor age and sex
Donor size (height and weight)
Cause of death
Time in hospital
Hospital course, including history of arrest, and stability of blood pressure and requirement of inotropes
Pulmonary status
Results of virus screening for hepatitis, HIV, etc.
Pertinent past medical history (tumors, infections, etc.)
Previous surgical history
Previous drug and alcohol history
Results of electrolytes and liver function studies
Results of relevant preoperative imaging

Table 2 | DONOR DEFINITIONS

Extended Criteria	Livers that are less than perfect due to previous donor history or current condition of donor
Brain Dead or Heart-Beating Donors	Heart still beating, brain death declared by clinical or investigational finding
Non-heart-beating donors	Fail brain death criteria, procurement occurs after cardiac death has been declared
Controlled	Support is withdrawn and death is declared
Non-Controlled	Cardiac arrest occurs despite continued support

Table 3 | PREOPERATIVE MANAGEMENT OF THE DONOR

PROBLEM	MANAGEMENT	Aim
Hypotension	Transfusion, dopamine, levo-thyroxine, epinephrine	Maintenance of good perfusion to donor organs
Hypertension	Beta blockers or other antihypertensives	Prevent acute hypertensive injury to donor organ
Hypoxia	Diuresis and oxygen delivery	Maintain adequate oxygenation of donor organs
Diabetes insipidus	Dextrose replacement	Avoid hypernatremia
Acidosis	Bicarbonate replacement	Avoid end organ acidosis
Severe instability	Urgent procurement	Minimize time of organ injury

CBD

Common bile duct

IMV

Inferior mesenteric vein

trohepatic ligament is incised; any accessory or replaced left hepatic artery is identified and preserved.

A full mobilization of the right colon and small intestine is performed beginning at the appendix, mobilizing the right colon and small bowel up and to the left, passing behind the second and third parts of the duodenum. The superior mesenteric artery limits this dissection.

The infrahepatic IVC is thus exposed and the upper border of the renal veins are defined as they enter it.

The ligament of Treitz is taken down, and the inferior mesenteric vein (IMV) is exposed and isolat-

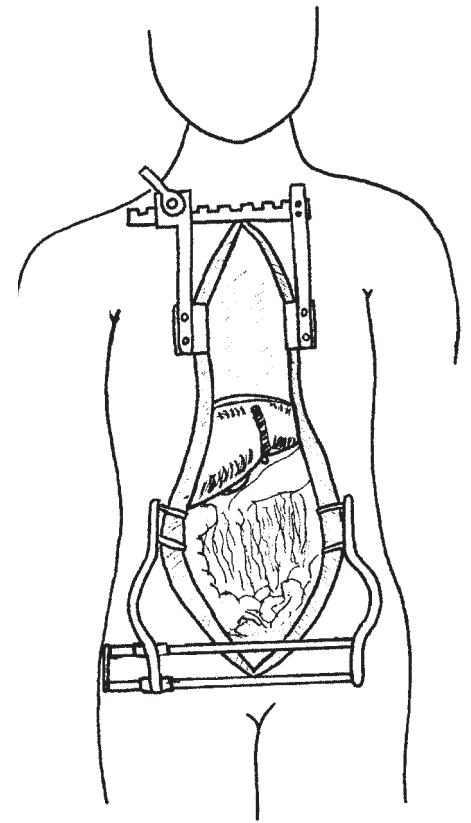


Figure 1. Donor setup.

ed. The aorta is then dissected just above its bifurcation, and umbilical tapes are placed around it for control later.

The bowel is returned, and the common bile duct (CBD) is dissected just above the duodenum in the hepatoduodenal ligament. It is ligated distally and incised above the tie. The gallbladder is incised and emptied, then flushed with normal saline until the effluent at the incised CBD is clear.

The supraceliac aorta is exposed by incising the right crus of the diaphragm.

Umbilical tape is placed around the aorta.

Heparin 30,000 units is given. The distal IMV is ligated, and the proximal IMV is cannulated, with the cannula passed into the portal vein. The distal aorta is ligated and the proximal aorta incised and cannulated with a large-bore infusion catheter.

The IVC is exposed within the pericardium. The right pleura is opened to allow blood to pool in the right chest.

In a coordinated fashion, the IVC (or right atrium) is cut, the supraceliac aorta is clamped, and the infusion of preservation solution into the IMV and aorta is begun. Ice is quickly placed over the liver and other intra-abdominal organs.

Suction catheters are placed in the chest to take the warm blood coming out of the IVC away from the liver. Infusion of preservation solution continues until the effluent from the IVC is clear (usually around 4-5 L total).

The IVC is completely transected in the chest, and the posterior pericardium is opened from side to side exposing the esophagus and thoracic aorta.

The diaphragm is divided sagittally in front of the esophagus well to the left of the suprahepatic IVC. The right diaphragm is then divided, well lateral to the right coronary ligament, and continued toward the infrahepatic IVC.

The IVC is transected above the renal veins, and a suction catheter is placed at this point.

The CBD is completely transected and the peritoneum above the duodenum is incised to allow the duodenum to peel downward. The right gastric artery is ligated and divided. The gastroduodenal artery (GDA) is exposed and followed to its origin from the hepatic artery. It is then ligated and divided away from the hepatic artery (see Fig. 2).

The hepatic artery is followed proximally on its left side, dividing the lymphatic and nervous tissue that overlies it here. The coronary vein will be seen and can be divided. It usually lies over the origin of the splenic artery, which can be dissected for a centimeter or two and then transected, once the celiac axis is clearly identified. The dissection is continued proximally along the left side of the celiac to the aorta.

The length of supraceliac aorta is exposed on its left side by division of the crus of the diaphragm. The supraceliac aorta is transected at the level of the clamp and the aorta just to the left of the celiac incised and continued superiorly to the point of transection.

The duodenum is now further mobilized away from the porta hepatis. And the tissue lateral to the portal vein is dissected toward the portal vein (PV) taking care to look for a replaced right hepatic artery. With the anterior surface of the vein exposed, the pancreas is split at the neck to expose the portal vein origin. The superior mesenteric and splenic

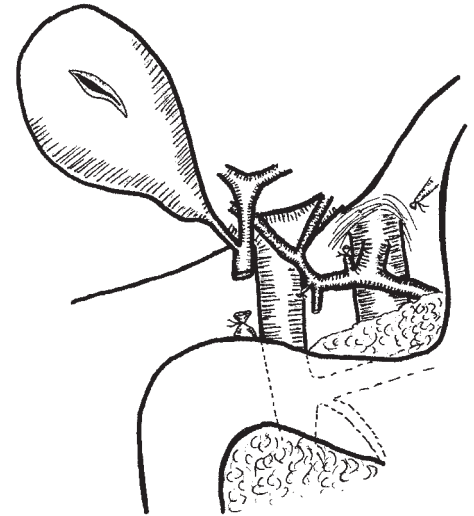


Figure 2. Donor porta hepatis.

veins are then transected. The portal vein segment is passed beneath the duodenum to lie with the other hepatic structures. If there is no replaced right hepatic artery, the nerves and lymphatic tissue lying behind the portal vein are divided all the way to the aorta between the celiac and SMA. If there is a replaced right hepatic artery, then it is preserved and the SMA is included in the aortic patch. The aortic patch is completed around the celiac origin and lifted up with the other portal structures.

Cutting across the right adrenal gland and dividing the hepato-pulmonary ligament completes the donor hepatectomy. The liver is surrounded by University of Wisconsin (UW) solution in a bag and then stored in ice for transportation.

The back table dissection is carried out with the liver sitting in UW solution surrounded by ice. The coronary ligaments are first taken down exposing the suprahepatic IVC. The diaphragm is carefully dissected off the IVC, ligating any phrenic veins. The infrahepatic cava is dissected free, after dividing the diaphragm between the aorta and IVC. The right adrenal vein and any other external branches are ligated and the adrenal gland removed.

The portal vein is dissected toward the liver with ligation of any small branches along its course until the bifurcation is seen. The PV is then cannulated with intravenous tubing, secured, and tested for leaks.

GDA

Gastroduodenal artery

Table 4 | EXTENDED CRITERIA DONORS

Age > 70 years
Prolonged premortal hospital stay
Hemodynamic instability or requirement for large doses of inotropes
Premortal cardiac arrest
Alcohol or drug dependency
Elevated liver function tests or serum sodium
Fatty liver
Hepatitis-infected liver
History of malignancy
Non-heart-beating donor

The artery is then dissected in segments from aorta toward splenic, and then splenic toward GDA. Small branches are ligated. The splenic is left open for "blowout" on reperfusion. It is leak tested, an aortic patch is created (1-2 mm brim), and the liver is covered by UW solution until required for implant.

Extended Criteria Donors

Extended criteria donors fall outside of the range of ideal or very suitable donors and include the factors outlined in Table 4. Extended criteria donors are used to expand the donor pool. They should be carefully matched with appropriate recipients.

The cold ischemic time for extended criteria donors should be kept to a minimum so that the risk of primary nonfunction in the recipient is reduced. Extended criteria donor recipients are also more likely to suffer with more severe reperfusion syndrome, and the graft should thus be washed out extensively prior to reperfusion.

Controlled Non-Heart-Beating Donors

This is a special group of extended criteria donors. These are donors for whom recovery is hopeless, and are on life support, but fail to fulfill the criteria of "brain death." The donor is brought to the operating room and prepped and draped. Perfusion lines are primed with UW solution. Heparin (300 unit/kg) and intravenous hydrocortisone 1000 mg are administered, and then life support is withdrawn. A physician from the donors' treating team pronounces the patient deceased according to clinical or electrical evidence. (If pronouncement does not occur within 1 hour after withdrawal of life support, then the procurement is abandoned and

the donor is returned to the intensive care unit.) Following the declaration of death, a mandatory wait period, determined by local policy (usually around 5 minutes), is allowed to elapse before the surgery begins.

The objective in this operation is for rapid perfusion of the organs with preservation solution and cooling. A midline laparotomy and sternotomy is performed, the aorta is cannulated just above the bifurcation, and cold perfusion is begun. The right atrium is opened for venting, and the thoracic aorta is clamped. The abdomen is filled with ice. The portal vein flush can be given either in situ or on the back table. After 3-5 liters of cold UW solution has been perfused, the liver (and other relevant organs) is expeditiously removed. The bile duct is flushed on the back table.

Critical judgment is required if the time between discontinuation of life support and death is prolonged, as these organs suffer from significant warm ischemia, which can be manifest as primary nonfunction, acute cellular rejection, or biliary stricture formation in the recipient.

Split Liver Grafts

The initial preparation is as for whole organ procurement.

Prior to cannulation and perfusion, attention is turned to the porta hepatis. The left hepatic artery is identified and dissected free near its origin and followed up to the umbilical fissure. The left portal vein is now dissected, and small caudate branches of the portal vein are ligated and divided.

The liver bridge between segments VI and III is divided (if present) where it crosses the umbilical fissure. This exposes the fissure with multiple small

CONTROLLED NON-HEART-BEATING DONOR

Donor for whom recovery is hopeless, who is on life support but does not fulfill the criteria of brain death

SPLIT LIVER GRAFTS

The division of a cadaveric organ between two recipients

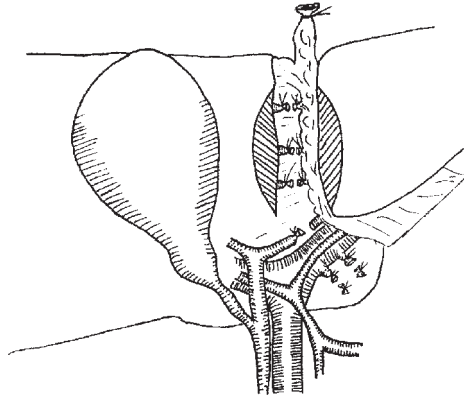


Figure 3. Split donor technique.

portal vein branches that cross between the umbilical vein and segment IV here. These are ligated and divided. After division of these branches, the left hepatic duct is identified lying above the artery and divided (see Fig. 3).

The left hepatic vein is dissected free of the middle hepatic vein over a short distance.

Parenchymal dissection can now begin just to the right of the falciform ligament. This is best done using electrocautery with ligation of any major structures crossing between the left lateral segment and segment IV.

This dissection is continued until the entire left segment is freed and the caudate lobe is exposed near the insertion of the gastrohepatic ligament.

The cannulas are then placed and the organs perfused and dissected as per whole organ. The left lateral segment is removed by dividing the relevant vessels. The left hepatic artery can be taken at its origin, or the aortic patch and common hepatic artery can be kept with the left lateral segment by dividing the right hepatic artery at its origin.

The Recipient Operation

The patient is positioned supine on the operating table with arms extended to 90 degrees. A large-bore peripheral cannula, arterial line, and a Swan Ganz catheter are generally used for intraoperative management and fluid replacement. If percutaneous bypass is to be used, then the right internal jugular vein is cannulated with the large-bore cannula at this time.

A nasogastric tube and a Foley catheter are placed and a warming blanket or device is set up. The pa-

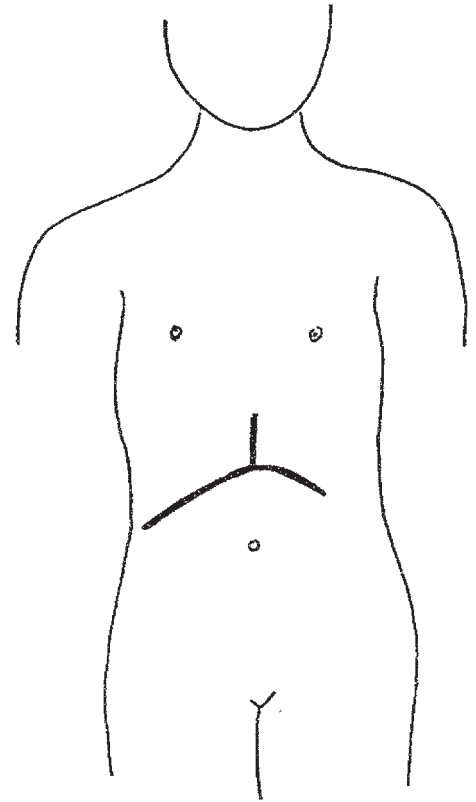


Figure 4. Incision.

tient is prepped and draped from neck to groin leaving particularly the left groin exposed for cannulation for bypass.

A bilateral subcostal incision with a midline upper extension is made, the round ligament is divided, and the falciform ligament is taken down toward the suprahepatic IVC.

Subcostal retractors are placed, and the dissection continues until the right and left hepatic veins are exposed. The left triangular ligament is taken down and the left lateral segment retracted medially. The gastrohepatic ligament is incised and continued cephalad, ligating any vessels crossing it.

Attention is turned to the porta hepatis, any adhesions are taken down and inferior retractors are placed. The peritoneum is scored level with the lower border of the caudate lobe. The cystic duct and artery are ligated and divided freeing the right edge of the hepatoduodenal ligament. The dissection is deepened stepwise until the hepatic arteries and CBD are exposed. These are ligated and divided.

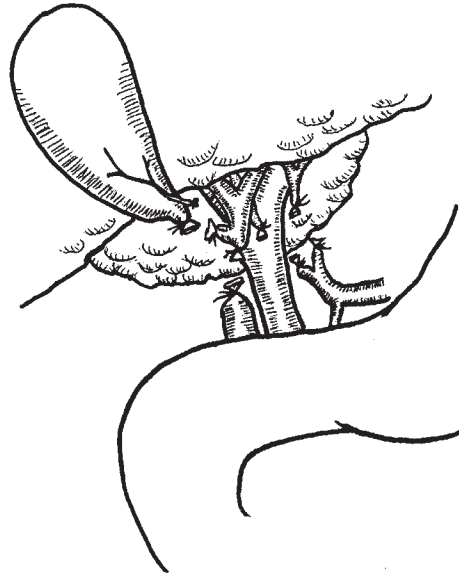


Figure 5. Recipient porta hepatis.

Dissection continues through the neural and lymphatic tissue until the portal vein is exposed. The portal vein is dissected carefully, ligating any small tributaries. Once sufficient length has been dissected on all sides, the remainder of the hepato-duodenal ligament tissue can be divided (see Fig. 5).

The left femoral vein is now cannulated using Seldinger technique and secured in place. Air in the lines is expelled, and the patient is placed on systemic venous bypass.

The portal vein is isolated with umbilical tape and a "snugger." The assistant controls the vessel with a large Debakey forceps. The distal portal vein is ligated near its bifurcation and incised just below this.

The bypass cannula is inserted to the level of the portal vein origin and secured with the umbilical tape snugger. The snugger is secured to the bypass tubing with further tape, and the portal vein transection is completed. The portal system is added to the circuit placing the patient on portal venous bypass (see Fig. 6). The dissection of the infrahepatic IVC is begun by scoring the overlying peritoneum and extending this line along the left side of the IVC up to the level of the phrenic vein, while retracting the liver and caudate lobe to the right so that the posterior aspect can be freed.

The right triangular and coronary ligaments are taken down with the liver retracted to the left, ex-

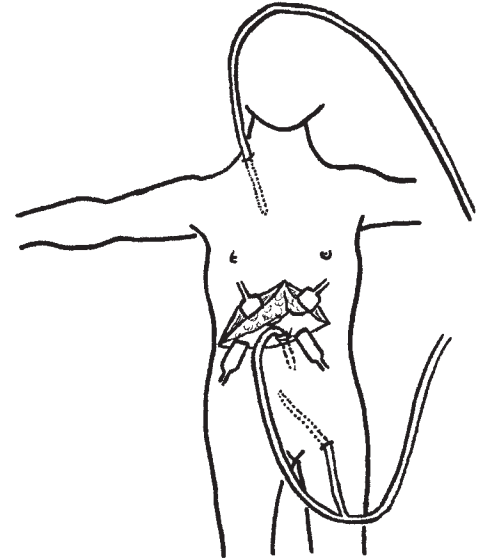


Figure 6. Recipient setup with bypass lines.

posing the right posterior aspect of the IVC. The right adrenal vein is ligated and divided. The infrahepatic IVC is clamped below the level of the right adrenal vein stump. The suprahepatic IVC is clamped in a manner to ensure that a good posterior length is available.

The liver is dissected off the IVC inferiorly ligating any caudate tributaries until a suitable length for anastomosis has been obtained. The infrahepatic IVC is transected. The hepatic veins are transected, and the suprahepatic IVC is transected below the hepatics.

The liver is removed and careful hemostasis is obtained. The diaphragmatic peritoneum corresponding to the bare area of the liver can be oversewn if desired for hemostasis.

The suprahepatic IVC is prepared for anastomosis by dividing the caval bridge between the middle and left hepatic veins and then dividing between this and the IVC. The bridge between the right hepatic vein and IVC is likewise divided. The IVC is then checked at both ends for holes or tributaries. There are usually one or two phrenic veins that require oversewing (knots tied on the outside).

The donor liver is delivered to the table and rechecked for IVC integrity. The posterior wall of the suprahepatic caval anastomosis is completed from the "inside" running from patients' left to right, us-

ing an everting or “lipping” technique. The same suture is continued along the front wall around half way from right to left, and then the remaining front wall is sutured from left to right and tied to the original suture (see Fig. 7).

The cannula in the donor portal vein is flushed with 700-1000 cc of cold Ringer’s lactate solution while surgical attention is turned to the infrahepatic IVC. This anastomosis is performed as described for the suprahepatic above.

The portal bypass line is clamped and the cannula removed from the recipient portal vein with a clamp placed.

The donor portal vein is measured up for length with the recipient vein. The anastomosis is performed in the manner described for the IVC except 5 or 6/0 prolens are used and the following suture is “placed” rather than pulled taut. Prior to tying, the vessel is temporarily opened to flush out any clot. A “growth factor” or air knot of 30%-50% the diameter of the portal vein is used for the final tie. This slack is taken up by expansion of the vein upon reperfusion.

The liver is now ready for reperfusion. The suprahepatic caval clamp is first removed, and the suprahepatic anastomosis and cava is checked for leaks. The infrahepatic clamp is released with warning given to the anesthesia team. When the anesthesia team are ready, the portal clamp is released and the liver reperfused. The femoral vein cannula can be clamped and removed once the patient is hemodynamically stable.

The recipient hepatic artery is dissected toward the celiac, beyond the level of the GDA where it is clamped. The GDA is ligated distally and divided well away from the hepatic artery. A branch patch is created using the distal hepatic artery and GDA. The lumen can be gently dilated using a mosquito forceps. The anastomosis is performed patch to patch using 6/0 prolene (see Fig. 8). The vessel is allowed to “blow out” any clot via the open donor splenic artery prior to opening up to the liver. The donor splenic artery is then ligated. The entire operative bed is checked in a systematic manner for hemostasis.

The donor gallbladder is dissected fundus down until it is suspended by the cystic duct. The cystic duct can be dissected all the way to the CBD. The

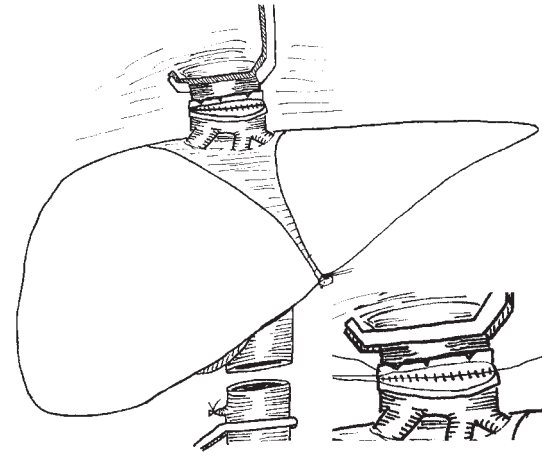


Figure 7. Caval anastomosis.

donor CBD is divided at the level of the cystic duct junction. The recipient bile duct and its blood supply are mobilized over a length of around 2 cm, and then divided just below the tie. The bile duct anastomosis is performed using 5/0 interrupted sutures (knots outside). A T-tube is optional.

A hemostatic check is made and the abdomen irrigated well. Three suction drains are placed: 1) along the right border of IVC to suprahepatic caval area, 2) abutting the porta hepatis and bile duct anastomotic area, and 3) along the left side of the IVC to the suprahepatic area. The wound is closed in a careful manner to prevent ascitic leak and hernias.

Special Operative Problems

Previous Operation(s)

The re-operative abdomen presents special operative challenges to the liver transplant surgeon. Adhesions, formed after previous surgery, are generally dense and have large venous collaterals running through them.

The incision remains the same with special care when entering the abdomen, so as not to damage bowel stuck to previous incisions. The incision is gradually deepened and continued into the peritoneal space using careful electrocautery dissection to separate the abdominal contents from the wound. The round ligament is divided.

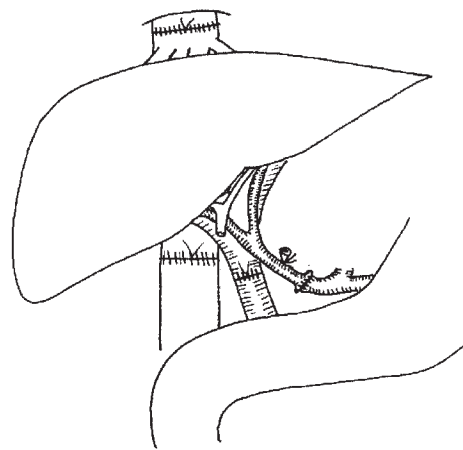


Figure 8. Vascular anastomosis.

The liver surface is sought and abdominal contents are dissected down and off the anterior surface of the liver. Once the incision edges and anterior surface of the liver are clear, subcostal retractors are placed. The left lobe of the liver should be mobilized in the normal fashion and the gastrohepatic ligament divided. This helps define the left edge of the porta hepatis.

The key to this surgery is to start the dissection toward the porta hepatis from the sides, taking down adhesions from the inferior surface of the liver until the "normal" anatomy is clear. This is done by staying in the plane right next to the liver, and if in doubt, venturing a little into the liver rather than away from it. An argon beam coagulator is invaluable in this surgery for drying up the bleeding liver surface. Coming across the gallbladder fossa following prior cholecystectomy is usually difficult because the duodenum may be firmly adhered in this region. When dissecting from the right, the plane of dissection continues across the gallbladder fossa and then should leave the liver surface and continue between the porta hepatis and the falciform ligament.

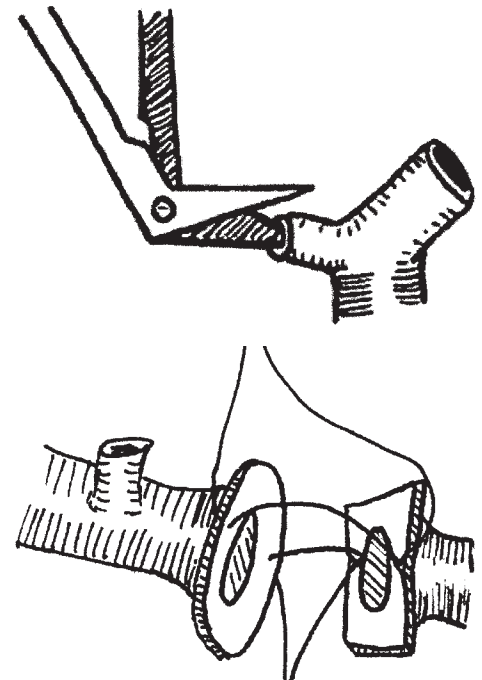


Figure 9. Bile duct.

The duodenum and other adhesive elements are gently dissected down off the porta hepatis. From either side, the epiploic foramen can be gently probed digitally and reconstituted.

The remainder of the operation is as for the naive abdomen except that care is taken to ensure hemostasis of all the previously adhered abdominal contents.

Retransplantation

The retransplant of the liver begins as described above for previous surgery. The operation is essentially as for the primary graft except for the following potential deviations.

In the dissection of the porta hepatis; the hepatic artery from the previous transplant is likely to be folded and redundant and is found to lie more superficial than expected. Great care is taken when dissecting the portal vein to avoid close dissection of the previous anastomosis, lest it be inadvertently disrupted until proximal control is gained.

The native suprahepatic IVC may be significantly shortened and weakened by the previous anastomosis here, and if an attempt were made to replace the cava, as described above, there can be significant risk for loss of integrity of the suprahepatic anastomosis. Therefore, many surgeons elect to sew in the new liver with a "piggy back" (end to side) technique. This of course preserves the first graft IVC.

The arterial anastomosis should be made more proximally than the original and may necessitate using a splenic artery branch patch. The portal venous anastomosis is rarely a concern, since the original anastomosis can be preserved if needed for extra length. The bile duct reconstruction frequently requires a Roux-en-Y hepatico-jejunostomy.

Portal Vein Thrombosis

Portal vein thrombosis leads to larger and higher pressure collateral vessels, and extra care is required during the initial dissection. Most portal vein thromboses are partial and can either be ignored or removed.

The technique for thrombectomy is as follows: The portal vein is controlled proximally by the assistant with a large forceps and ligated near the bifurcation. A longitudinal incision is made in the anterior wall. 5/0 prolene stay sutures are placed on either side. A plane is developed between the vein wall and the thrombus using a carotid dissector. The distal end of the thrombus is grasped and delivered out of the vein. Gentle upward traction is placed on the thrombus while the portal vein wall is peeled off it proximally (see Fig. 10). The controlling forceps will need to be released briefly to deliver the proximal thrombus (which usually ex-

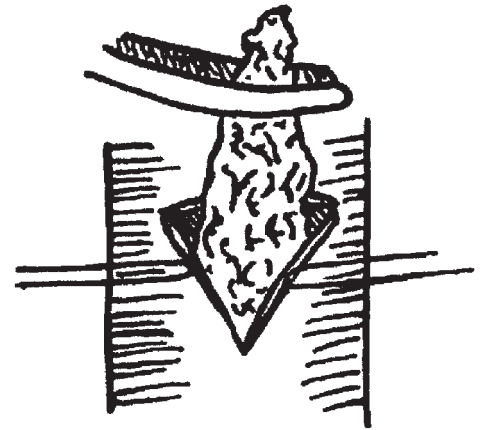


Figure 10. Portal thrombectomy.

tends at least to the portal vein origin). Now a large Fogarty balloon catheter is passed proximally to sweep the portal vein of any further, loosely adherent thrombus. The portal vein is opened and flushed to determine flow and bypass proceeds in the usual manner.

In the unusual circumstance that the portal vein is completely thrombosed and cannot be cleared using the method above or if the flow is poor, a jump graft using donor iliac vein to superior mesenteric vein may be required.

Previous TIPS Procedure

A perfectly placed TIPS (Transjugular intrahepatic porto-systemic shunt) is intrahepatic in its course and does not present any particular problem. However, the TIPS can extend into the extrahepatic portal vein or back up into the right atrium.

For extension into the portal vein, the vein is transected short on the recipient below the shunt. If this cannot be done, then a jump graft to the SMV may be required.

The TIPS extending into the IVC or the right atrium is a more dangerous problem. It is essential that the suprahepatic clamp be placed above the end of the shunt. This is achieved by more aggressive dissection of the diaphragm off the cava here and by pinching off the right atrium with the suprahepatic clamp. A useful technique is to place a smaller clamp on as high as possible and then placing a larger clamp outside and thereby above the first clamp.

TIPS

Transjugular intrahepatic porto-systemic shunt

Table 5 | SELECTION CRITERIA FOR RIGHT LOBE DONORS

	TEST	IDEAL	EXCLUDE
Phase 1 Over the phone and local doctor	Age	Young adult	< 18, > 50 years old
	History	No significant illnesses or previous abdominal surgery	Significant morbidities, previous cholecystectomy is a relative contraindication
	Blood group	ABO identical	ABO incompatible
	Liver function tests	Normal	Abnormal
	BUN Creatinine	Normal	Significantly abnormal renal function
Meet with transplant surgeon and briefing of procedures, risks, and benefits			
Phase 2 Transplant center	Imaging (Volumetric MRI or CT scan)	No pathology identified Suitable volume for donation (donated segment > 1% of weight of recipient) No steatosis	Pathology identified in liver, steatosis, donor segment < 0.8% of body weight of recipient, remnant < 0.7% of donor weight
	Further labs	HIV, Hepatitis virology negative	Positive HIV or hepatitis serology
	Psychosocial evaluation	Stable with good social supports psychiatric history	Drug or alcohol dependency, no social support. Marginal if significant
Phase 3 Transplant center	Liver biopsy (center variability on its use)	Normal liver	Fibrosis, hepatitis, significant steatosis > 10%
	Celiac and Superior mesenteric angiography and portal venography	Normal anatomy, or replaced left hepatic artery completely replaced right hepatic artery	Accessory right hepatic from SMA in the present of normal right
	ERC or MRC (center variability on their use)	Normal biliary anatomy	Large segment four duct draining to right hepatic duct well above the bifurcation

Live Liver Donors

Living donation for liver transplantation has been practiced in children since 1989. This has predominantly been the transplant of the left lateral segment of a healthy adult into a small child or infant. The donor procedure for left lateral segment (similar to the split liver described above) is safe and relatively straightforward, and the results for recipients have been excellent when compared to cadaveric grafts. Since 1995, live donors have been used for liver transplants in adults, and in the past few years, this practice has increased greatly. The most common graft from a live donor for an adult recipient is a right lobe (segments V-VIII) with or without the middle hepatic vein. Healthy

donors are selected according to criteria included in Table 5.

The Right Lobe Living Donor Operation

With the patient positioned supine and a nasogastric tube and Foley catheter in place, a subcostal incision, with vertical upper extension, is made. The falciform ligament is taken down, and the suprahepatic IVC is exposed with dissection of the right hepatic vein insertion.

Any adhesions around the gallbladder or porta hepatis are taken down, and a fundus down cholecystectomy is performed. After a limited exploratory dissection of the porta hepatis, a cholangiogram is performed via the cystic duct. It is helpful to have

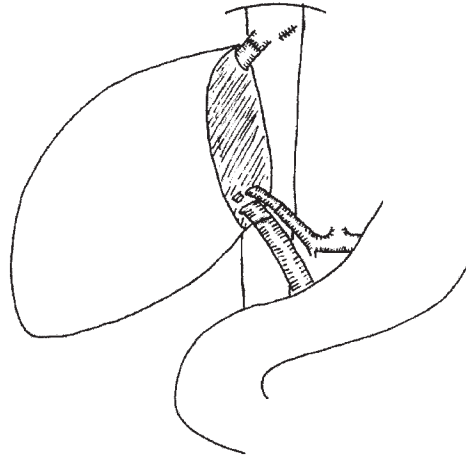


Figure 11. Right lobe vascular anastomosis.

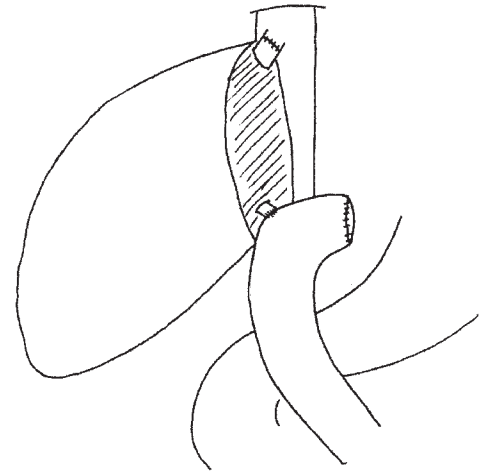


Figure 12. Hepatico-jejunostomy.

dissected some way up into the porta hepatis, taking down the hilar plate to expose the confluence of the hepatic ducts, which is marked with a forceps for confirmation on the cholangiogram. If a segment IV duct is joining the right hepatic duct, then an assessment needs to be made whether to proceed, as this portion of the right hepatic duct will need to remain with the donor.

All of the porta hepatis dissection should be limited to the right side of the common bile duct. Attention is turned to the right hepatic artery, which is identified as it passes beneath the common hepatic duct. It is dissected well up into the liver to facilitate the dissection of the hepatic duct and portal vein. The right hepatic duct is dissected and transected several millimeters from the confluence, and the donor side is suture ligated. It is more common than not to have two hepatic ducts on the donor side, and these are marked with prolene sutures to aid identification later. Retracting the common bile duct and the hepatic artery to the patient's left exposes the right portal vein. Dissection of the right portal vein continues up toward the right lobe of the liver working on both sides of the hepatic artery until the bifurcation of the portal vein is clearly seen. Now the posterior portal vein is dissected and caudate branches of the vein are ligated and divided. Approximately 2 cm of right portal vein should be freed on all sides in this manner until a right-angle forceps can be safely passed around the right portal vein.

The right triangular and coronary ligaments are taken down exposing the right posterolateral aspect of the IVC. The liver is returned to its anatomical position, and the peritoneum overlying the anterior surface of the infrahepatic IVC is dissected and freed. Dissection is continued up toward the liver. The caudate lobe is elevated off the cava and small tributaries from the caudate lobe are ligated and divided. Small tributaries from the right lobe are likewise ligated and divided. Larger tributaries (>5 mm) are preserved for re-implantation. In such a manner, the entire anterior and right lateral surfaces of the cava are exposed up to the level of the right hepatic vein, which is now dissected working both from above and below until it can be isolated with a vessel loop.

The caudate process between the right portal vein and the IVC is scored. The line of resection is marked on the surface of the liver. This line runs from between the middle and right hepatic veins to the left side of the gallbladder fossa, and then down the inferior surface of the liver to the IVC.

Parenchymal dissection is undertaken using the technique preferred by the operating team. During this dissection, it is usual to encounter two significant middle hepatic vein tributaries, one from segment V and one from segment VIII. When these are large, some centers re-implant one or other of these into the recipient cava using a venous conduit.

Once completed, the two parts of the liver with their respective blood supplies should be left until

the recipient hepatectomy is completed. A completion cholangiogram can be performed to exclude stricture or leak at the sight of the oversewn right hepatic stump. The liver segment is removed by clamping vessels (inflow before outflow) on the remnant side and dividing the vessels. The graft is immediately placed on ice and flushed via the portal vein and hepatic artery with preservation solution.

The donor ends of the vessels are oversewn, and the wound is closed with drains to the cut surface of the liver.

The Live Donor Right Lobe Recipient Operation

The hepatectomy is undertaken as for the whole organ recipient except that the bile duct and the vessels are left especially long and the IVC is left in place by ligating caudate lobe tributaries. The left and middle hepatic veins are oversewn. The right hepatic vein opening can be extended into the IVC inferiorly for a wide-open anastomosis.

The segment is sewn in beginning with the right hepatic vein, which lies best if sewn up-to-down instead of left-to-right (this is not tied down until after flushing the liver). The hepatic arterial anastomosis is completed, usually using the hepatic artery bifurcation as a patch. The liver is flushed through the portal vein, and the hepatic vein is tied down. The portal venous anastomosis is carried out as usual, and the liver is reperfused with portal and arterial blood. The type of bile duct anastomosis is determined by the donor anatomy. A duct-to-duct anastomosis is usually possible, although a Roux-en-Y hepatico-jejunostomy may be required for biliary reconstruction.

Hemostasis is obtained, drains are placed, and the abdomen is closed as usual.