Pictorial Essay

Left-Lobe Hepatic Transplants: Spectrum of Normal Imaging Findings

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The limited availability of suitable size-matched donor whole organs has been a major cause of morbidity and mortality in infants and children requiring liver transplantation. Techniques for transplanting segments of the liver have successfully addressed this problem. The surgical anatomy of the left hepatic lobe transplant is unique in three primary respects: the cut edge, the presence of an enteric Roux loop for biliary drainage, and the alteration in the position and number of hepatic vessels. The spectrum of normal imaging findings in 17 left-lobe allografts is illustrated.

The successful use of orthotopic liver transplantation for treatment of both acute and chronic liver failure at a growing number of transplant centers has led to a relative scarcity of donor organs. Nowhere has this shortage been felt more acutely than in infants and children, among whom previously 20–50% of transplantation candidates died while waiting for a suitable donor [1]. Transplantation of segments of the liver (most commonly the left lobe) has been introduced to address this need. The technique is currently in use at a number of transplant centers, including our own, where deaths associated with a scarcity of donor organs have virtually been eliminated [2, 3].

Imaging (particularly sonography, and CT to a lesser degree) and clinical and biochemical tests play important roles in the assessment of graft function and complications after transplantation. The altered anatomy of the left-lobe hepatic allograft used is reflected on cross-sectional imaging.

This essay illustrates the unique imaging features of this allograft in children.

Materials and Methods

Initially, we retrospectively reviewed all posttransplantation sonograms and CT scans of 34 infants and children who had received 43

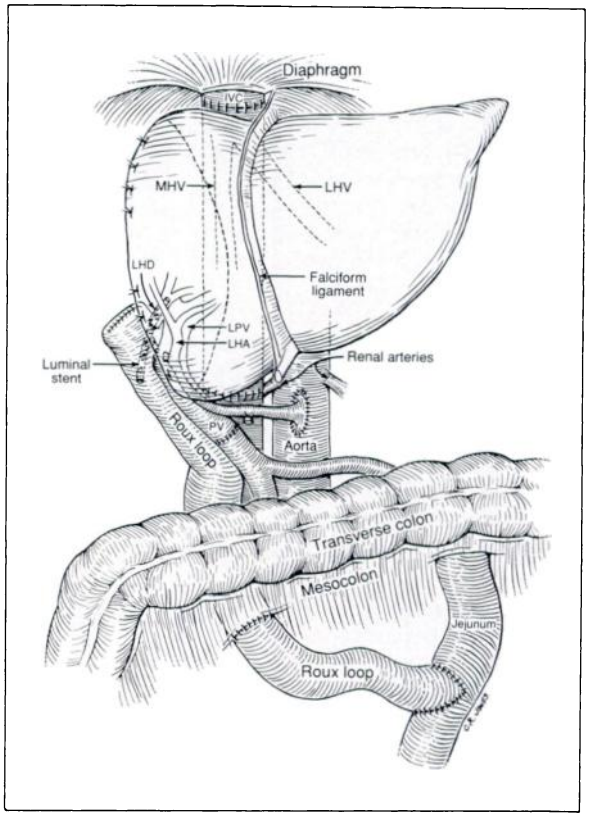

Fig. 1.—Diagram shows unique features of transplantation of left-lobe hepatic allograft: right lateral position of "porta hepatis," Roux-en-Y loop for biliary drainage, arterial end-to-side anastomosis of donor celiac artery to recipient infrarenal aorta, and presence of only two hepatic veins (see text for details). IVC = inferior vena cava, MHV = middle hepatic vein, LHV = left hepatic vein, LHD = left hepatic duct, LPV = left portal vein, LHA = left hepatic artery, PV = portal vein.

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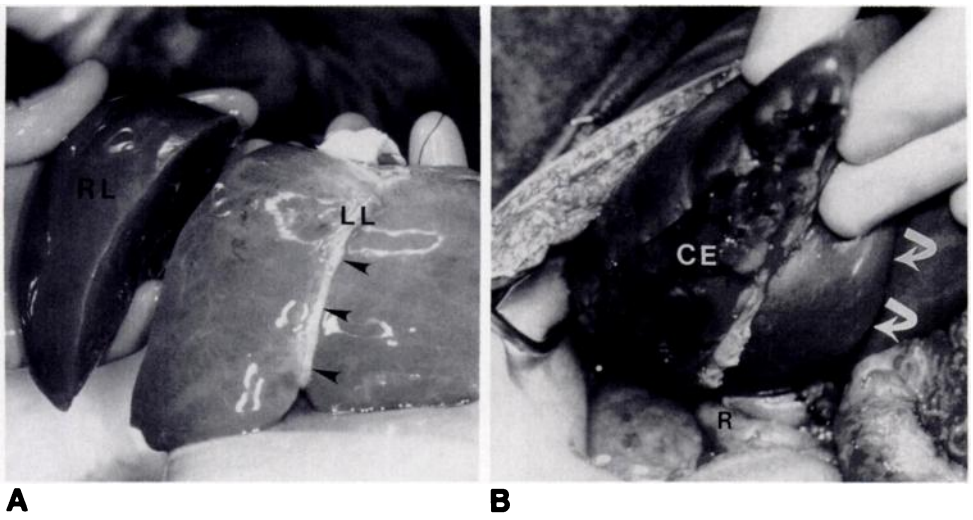

Fig. 2.—*A*, Plane of cut margin of resected donor liver viewed anteriorly. RL = right lobe, LL = left lobe, *arrowheads* = falciform ligament.

B, Transplanted left lobe in vivo as viewed from below after vessels are unclamped. Note cut edge (CE) posteriorly on patient's right. Roux loop (R) is adjacent to cut edge. *Arrows* show rightward position of falciform ligament.

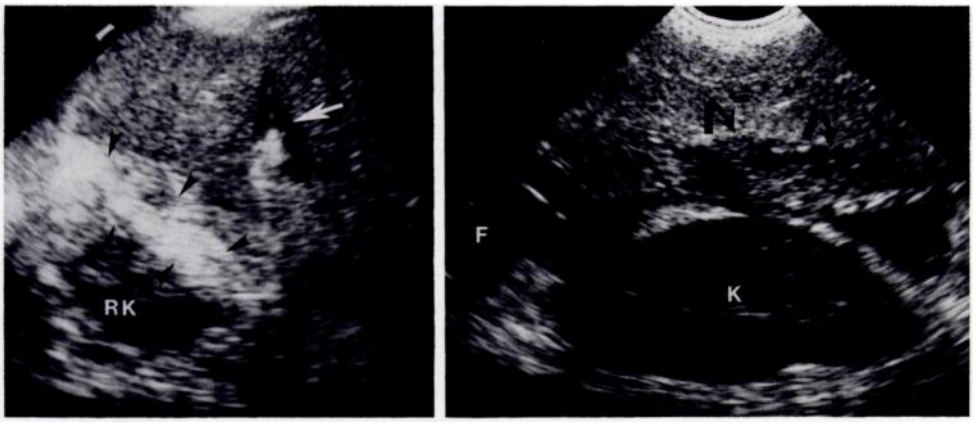

Fig. 3.—Transverse sonogram of patient with transplanted left-lobe allograft shows a rind of echogenic material (*arrowheads*) along cut edge. Note fluid along falciform ligament (*arrow*). RK = right kidney.

Fig. 4.—Longitudinal sonogram of right upper quadrant of patient with transplanted left-lobe allograft shows heterogeneous echogenicity (*arrows*) of cut surface. Note fluid collection (F) above right kidney (K).

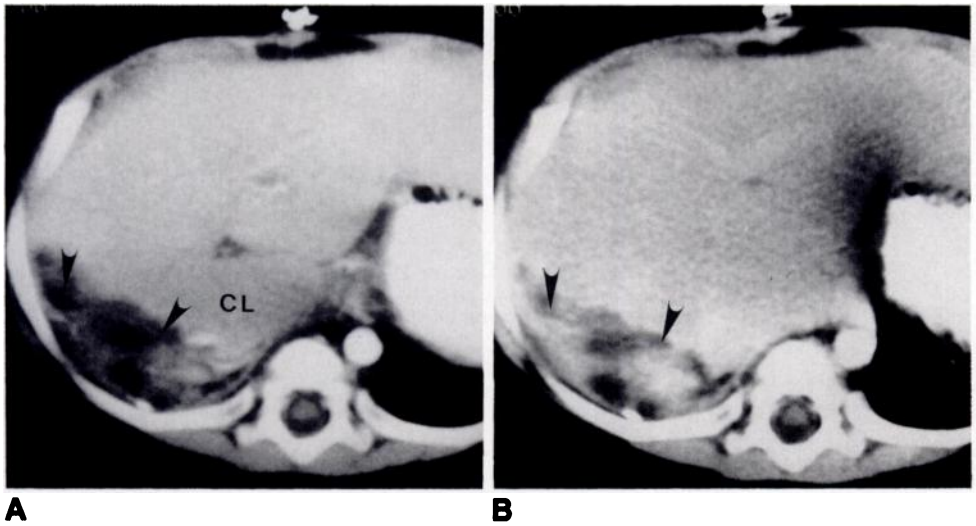

Fig. 5.—*A* and *B*, CT scans of transplanted left-lobe allograft obtained immediately (*A*) and 9 min after (*B*) injection of contrast material show delayed enhancement of portions of cut surface (*arrowheads*). CL = caudate lobe.

liver transplants at our institution between July 1986 and November 1989. Twenty-four whole-liver grafts were given to 20 patients (12 girls and eight boys). The remaining 14 patients (seven girls and seven boys) received 17 left-lobe grafts. Two of the left-lobe recipients were given emergent transplants within 1 week after failure of an initial whole graft. Since July 1988, when segmental grafting techniques were started at our institution, 59 transplantations have been performed, and all but 18 of these involved segmental transplants.

Of the children in the study group who received left-lobe grafts, 64% (9/14) were less than 3 years old and 71% (10/14) weighed 15 kg or less. In contrast, only 35% (7/20) of those who received whole-liver transplants were less than 3 years old and only 30% (6/20) weighed 15 kg or less. The numbers underscore the applicability of this technique to smaller patients, who are a high-risk population.

The major indication for transplantation in both groups was biliary atresia.

Surgical Technique

The surgical techniques of transplanting left-lobe hepatic allografts have been described (Fig. 1). Discussion of their differences compared with standard whole-liver allografts is

Fig. 6.—Transverse sonogram of right upper quadrant in patient with transplanted left-lobe hepatic allograft shows fluid-filled Roux loop (*arrows*) along posterolateral aspect of allograft (LA).

Fig. 7.—Transverse sonogram of patient with transplanted left-lobe hepatic allograft shows Roux loop (*black arrows*), which appears to be collapsed and echogenic with surrounding fluid (F). Stent (*white arrow*), a visible echogenic structure directed into loop, has posterior acoustical shadowing. RK = right kidney.

Fig. 8.—Contrast-enhanced CT scan of transplanted left-lobe hepatic allograft shows position of Roux loop because enteric contrast material (*arrowheads*) has refluxed.

Fig. 9.—Contrast-enhanced CT scan of transplanted left-lobe hepatic allograft shows right posterolateral location of porta hepatis and angled course of portal vein (*white arrowheads*). Note radiopaque biliary stent (*black arrow*) and hypodense cut surface (*black arrowheads*) of graft. A radiopaque surgical drain (*white arrow*) is present adjacent to cut edge.

Fig. 10.—Oblique sonogram parallel to portal vein in patient with transplanted left-lobe hepatic allograft shows typical change in diameter and luminal narrowing of portal venous anastomosis (*arrows*), which may be confused with a thrombus. RK = right kidney.

Fig. 11.—Longitudinal sonogram parallel to inferior vena cava in patient with transplanted left-lobe hepatic allograft shows normal location of suprahepatic inferior vena cava anastomosis with typical luminal narrowing (*arrows*).

warranted. Figure 1 is a diagram of the anatomy of a left-lobe transplant.

During the initial development of the procedure, the left lobe of the liver was resected ex vivo (Fig. 2A) by using sharp dissection, and major vessels and biliary radicles along the raw cut surface were individually ligated. Mattress sutures were placed along the cut margin to provide additional hemostasis. This technique, however, has been revised because of concerns about devitalizing the margin of the allograft. Blunt parenchymal fracture by means of a hemostat and then individual ligature of vessels and bile ducts are now performed sequentially to resect the left lobe. Several coats of fibrin glue are then applied to seal the cut surface after hemostasis is achieved in the transplanted allograft. The anterior portion of the caudate lobe is usually resected, leaving the caval portion in place.

In order to achieve biliary drainage, a Roux-en-Y choledochojejunostomy is performed, with a multifenestrated internal radiopaque stent bridging the anastomosis. The stent is secured with dissolving suture material and usually is passed in the gastrointestinal tract approximately 1 month after placement. The Roux loop (35 cm long) is placed through the mesocolon and posteriorly adjacent to the cut edge (Fig. 2B).

Two hepatic veins (left and middle) are present in the left-lobe allograft. The donor inferior vena cava is secured via end-to-end anastomosis to both the infra- and suprahepatic recipient inferior vena cava. The right portal vein orifice is oversewn during graft preparation, and an end-to-end anastomosis is performed between the donor and recipient main portal veins. The arterial anastomosis is end-to-side between the donor celiac axis and the recipient infrarenal aorta. The intervening arterial branches of the donor celiac trunk up to the left hepatic artery (splenic, left gastric, gastroduodenal, and right hepatic arteries) are ligated during harvesting of the graft.

Imaging Findings

The unique imaging features of left-lobe allograft as compared with standard whole-liver allografts relate primarily to three aspects: the cut edge of the graft, the position of the Roux-en-Y loop, and the altered vascular anatomy.

The cut surface of the graft typically has a rind of tissue that may be uniformly echogenic on sonograms (Fig. 3). More frequently it is heterogeneously echogenic (Fig. 4). Seepage of blood, bile, lymph, and serous fluid may contribute to the altered appearance of the cut edge. On CT with bolus IV contrast infusion, this rind typically has low attenuation relative to normal liver parenchyma. On delayed CT scans, the area may partially fill in with contrast material (Fig. 5), suggesting relative ischemia as a partial cause of the changes in echogenicity and density.

Fluid collections adjacent to the cut surface occur frequently and were present in 12 (71%) of 17 left-lobe allografts as shown by sonography. Distinguishing a sterile seroma from an abscess collection on the basis of imaging findings often is not possible. Percutaneous aspiration and Gram's staining and culture of the fluid is usually necessary in recipients of left-lobe allografts who have any clinical indication of infection. The prevalence of fluid collections adjacent to the cut surface has decreased noticeably now that sharp dissection of the allograft has been abandoned and fibrin glue is applied to the cut surface.

The Roux-en-Y loop is positioned posterolaterally adjacent to the cut edge and if fluid-filled may simulate an abnormal fluid collection (Fig. 6). The loop may appear collapsed and

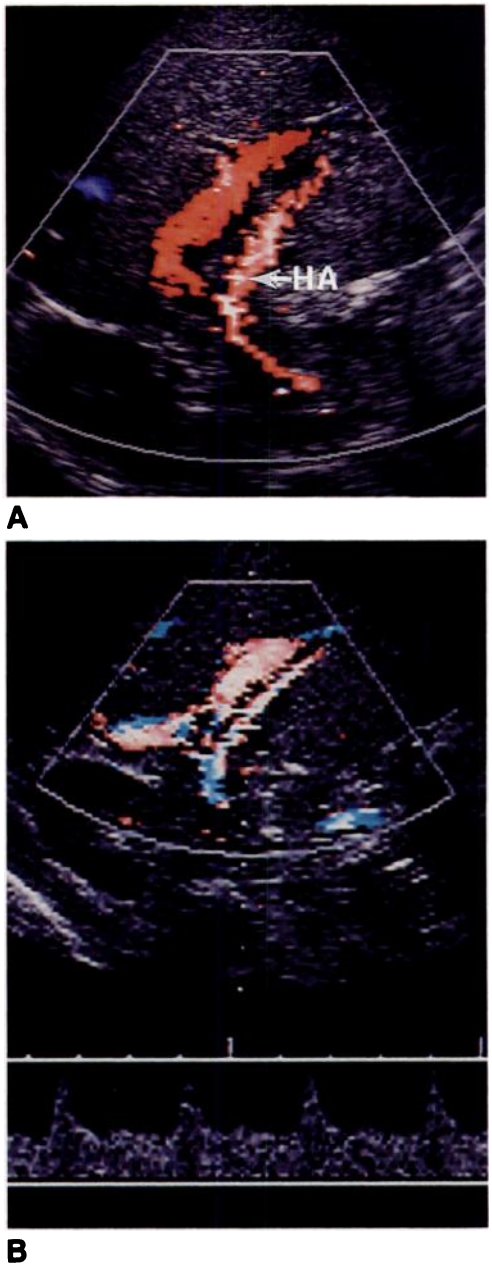

Fig. 12.—*A* and *B*, Transverse color Doppler images alone (*A*) and in conjunction with duplex analysis (*B*) in patient with transplanted left-lobe hepatic allograft show hepatic artery (HA) running parallel to portal vein in porta hepatis.

echogenic, sometimes with surrounding fluid (Fig. 7). Detection of an inner echogenic margin (corresponding to the mucosa/submucosa of the bowel loop), the tubular nature of the loop, and the echogenic (radiopaque) stent help in distinguishing the Roux loop from an abnormal fluid collection. Reflux of enteric contrast material into the loop is helpful for detection of the loop on CT scans (Fig. 8). Once the stent has passed into the gastrointestinal tract and if no enteric contrast material is refluxed, a fluid-filled loop may be difficult to distinguish from an abnormal fluid collection on imaging studies.

The left-lobe allograft typically fills the anatomic space previously occupied by the diseased native liver. The porta hepatis is located eccentrically along the right inferolateral aspect of the allograft close to the cut surface. This is evident in the axial plane, where the portal vein has a moderately angled course and extends more laterally to the right than in the whole liver (Fig. 9). The hepatic artery parallels this course, but it is more difficult to trace because of its smaller size. The normal sites and sonographic appearance of the portal venous and inferior vena cava anastomoses must be recognized. Typically, mild to moderate luminal narrowing occurs that may mimic nonobstructive clot (Figs. 10 and 11). Duplex and color flow Doppler sonographic examination of these vessels is an integral part of postoperative follow-up in these patients to confirm vascular patency (Fig. 12).

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