Pretransplantation Imaging Workup of the Liver Donor and Recipient

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KEYWORDS

• Liver transplantation • Preliving donor liver transplant imaging • Hepatic artery anatomy and variants • Portal vein anatomy and variants • Hepatic vein anatomy and variants • Biliary anatomy and variants

KEY POINTS

- Preoperative evaluation of the hepatic vasculature, parenchyma, and biliary system with computed tomography (CT) and MR imaging/magnetic resonance cholangiopancreatography (MRCP) allows for improved candidate selection and a reduction in transplant operative complication rates.
- Use of low-dose CT protocols, contrast-enhanced MRCP, and image postprocessing (3-dimensional, maximal intensity projection [MIP], and volume rendering) maximizes preoperative planning while minimizing the risk of imaging to the donor.
- The purpose of preoperative recipient imaging is to define vascular inflow and outflow, and to determine the extent of tumor burden in Hepatocellular Carcinoma (HCC) patients awaiting transplant.
- Preoperative living donor liver transplantation donor imaging involves assessment of the vascular and biliary anatomy; evaluation of the hepatic parenchyma for steatosis, iron, and focal lesions; and calculation of liver volumes.
- Surgically relevant vascular and biliary anatomic variants are common, but most remain eligible for donation because of prospective identification with imaging and advances in microvascular surgical technique.

INTRODUCTION

Liver transplantation has become the accepted treatment for patients with end stage liver disease, with 15,294 candidates currently on the waiting list.[1] In 2013 alone, 5921 liver transplants were performed. Unfortunately, the availability of organs remains inadequate to keep up with demands; by the end of 2013, 12,407 candidates remained on the transplant list, with 1767 patients dying while on the waiting list, and 1223 being removed as they became too sick to qualify for transplant.[2]

Because of the shortage of cadaveric liver grafts, transplantation of partial grafts from both living and deceased donors has developed as a method for expansion of the potential donor pool. Although these operations pose a substantial technical challenge, they do allow a portion of the waitlisted candidate population to achieve transplantation, often in an expedited fashion.[3] Concomitant with the technical refinements in partial liver transplantation has been the increased use of imaging techniques to allow for a precise

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understanding of donor and recipient anatomy prior to surgery. This has allowed for improved candidate selection and a reduction in operative complication rates.

TRANSPLANT OPERATION

Cadaveric Liver Transplant

There are 3 types of liver transplants performed today: whole-liver cadaveric transplant, split-liver cadaveric transplant, and living donor liver transplant. The most common type is a complete cadaveric liver transplant, wherein the entire donor liver is transplanted into the recipient. This has the advantage of being the most technically straightforward operation, although organ availability is limited.[4]

Split-Liver Cadaveric Transplant

Least common is a split-liver cadaveric transplant, which accounted for only 1.2% of transplants in 2013.[2] Cadaveric split liver can be performed in situ (in the donor prior to organ retrieval), or ex vivo (on the back table following liver retrieval) (**Fig. 1**).[5,6] The most common cadaveric splitting technique involves a transection plane to the right of the falciform ligament, resulting in a right trisegment graft (segments I and IV–VIII) for an adult recipient, and a left lateral graft (segments II–III) for a pediatric recipient. More rarely, a true right–left split technique can be utilized for 2 adult recipients, and involves a transection plane to the right of the middle hepatic vein (MHV) to create a right hemi-liver graft (segments V-VIII +/− I) and a left hemi-liver graft (segments II-IV +/− I).[7–9] Split-liver transplantation helps mitigate the shortage of donor livers available, but is a technically demanding operation and poses an increased risk of complications for the graft recipient.[10–12]

Living Donor Liver Transplant

Living donor liver transplant accounted for 4.0% of the liver transplants performed in the last 10 years (**Fig. 2**).[13] The decision of which lobe is transplanted is based on donor anatomic considerations and the anticipated residual liver and graft sizes. The residual donor liver must be greater than 30% of the total donor hepatic volume to ensure adequate postoperative liver function, and the graft-to-recipient body weight ratio must be greater than 0.8 to minimize the risk of small-for-size syndrome in the recipient.[4]

A left lateral segmentectomy technique is typically used for a pediatric recipient. In this operation, the transection plane runs just to the right of the falciform ligament (**Fig. 3**A). If a larger-volume graft is required, then a full left hepatic lobectomy with inclusion of the MHV can be performed, with or without the caudate lobe.

For an adult recipient, either a full-right or full-left hepatic graft can be used. Historically, the right lateral hepatectomy technique has been most commonly performed. In this operation, the liver is split approximately 1 cm to the right of the MHV, close to Cantlie line that connects the inferior vena cava (IVC) to the gallbladder fossa (**Fig. 3**B). Variations in anatomy of the MHV are critically important to the success of this

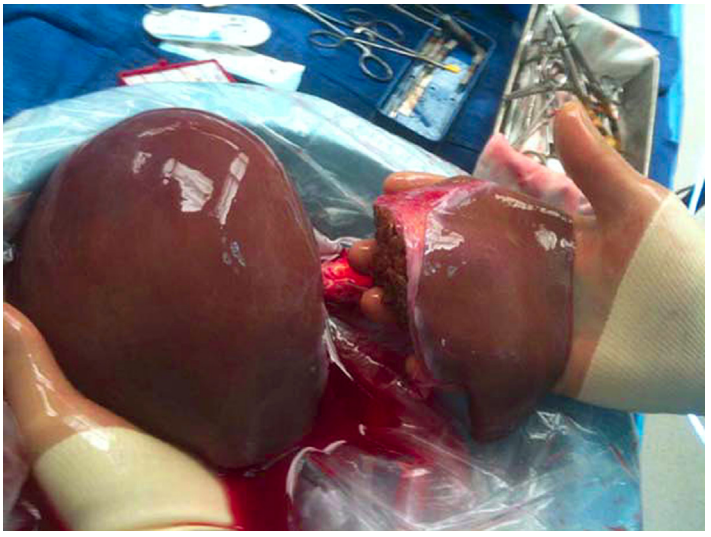

Fig. 1. Ex vivo split-liver cadaveric transplant—the right tri-segment graft was transplanted into an adult recipient with HCC, while the left lateral segment graft went to an infant with fulminant hepatic failure.