Living-Donor Liver Transplant Using the Right Hepatic Lobe Without the Right Hepatic Vein: Solving the Drainage Problem

Sami Akbulut,1 Mehmet Yılmaz,1 Cengiz Eris,1 Ramazan Kutlu,2 Sezai Yılmaz1

Abstract

Although rare, major congenital defects of the hepatic veins are detectable at autopsy, advanced, noninvasive imaging techniques such as Doppler ultrasonography and multislice computed tomography can accurately define these anomalies. One of these anomalies is congenital absence of the main right hepatic vein. We present a 21-year-old woman living-liver donor candidate with congenital absence of the right hepatic vein who underwent an extended right donor hepatectomy. She was tested for transplant compatibility with her 45-year-old brother, who had chronic liver failure secondary to hepatitis B. Multislice computed tomography revealed an absence of the right hepatic vein, and the right hepatic lobe was drained by 4 inferior hepatic veins with diameters ranging from 4 to 8.4 mm. An extended right-donor hepatectomy was performed. A common-large opening drainage reconstruction model that included all of the inferior hepatic veins and middle hepatic vein was created using the saphenous vein and an aortic homograft. There were no postoperative complications related to hepatic venous drainage thanks to the common-large opening model. We demonstrate that a right donor hepatectomy is feasible in congenital absence of the right hepatic vein solving the drainage problem using common-large opening reconstruction technique.

Key words: Liver transplant, Living donor, Congenital defect, Absence of the right hepatic vein

Introduction

Liver transplant is the main therapeutic option for patients with end-stage liver disease or acute liver failure. Because the number of patients on the waiting list for deceased-donor livers exceeds organ availability, living-donor liver transplant (LDLT) has become the main alternative therapeutic option to deceased-donor liver transplant.1, 2 Living-donor liver transplant allows healthy volunteers to donate part of their liver to compatible recipients. Therefore, preoperative knowledge of the vascular anatomy and its variation are crucial for the safety of the donor and the recipient.1, 3

The hepatic venous anatomy may be delineated using modern imaging techniques: Color Doppler ultrasonography, 3-dimensional multislice computed tomography, magnetic resonance imaging, and conventional angiography are particularly useful for observing the venous structures. Variations or congenital anomalies in hepatic venous anatomy in candidate living-liver donors can alter surgical management.1, 3, 4 One such hepatic venous anomaly is congenital absence of the right hepatic vein. To our knowledge, congenital absence of the right hepatic vein has not been described in the English literature.

Case Report

Recipient: A 45-year-old man (height, 1.73 m; weight, 63 kg; body mass index, 21 kg/m2; blood group, O Rh positive) under our care for chronic liver disease secondary to hepatitis B virus infection was admitted to our out-patient clinic with sudden-onset reduced consciousness, difficulty speaking, and weakness. A physical examination revealed disorientation...
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consistent with grade 2 to 3 hepatic encephalopathy and marked abdominal distension. Laboratory analyses revealed total bilirubin, albumin, international normalized ratio, and creatinine levels were 376.2 μmol/L, 13 μmol/L, 1.6 μmol/L, and 44.2 μmol/L. Based on these data, the calculated Mayo End-Stage Liver Disease and Child scores were 15 and 13 (Child C). The patient was given a diagnosis of acute, chronic liver failure. Because a deceased-donor organ was not available, he was selected for LDLT. After eliminating 10 of the 11 donor candidates who applied to our center for various reasons (4 with advanced fatty changes in the liver; 4 who were hepatitis B virus carriers, and 2 with multiple vascular abnormalities), only his 21-year-old sister qualified for further evaluation.

Donor: A 21-year-old woman (height, 1.57 m; weight, 68 kg; body mass index, 27.5 kg/m²; blood group, O Rh positive) was admitted as a possible donor for her older brother. Multislice computed tomography revealed an absence of the right hepatic vein, and the right hepatic lobe was drained by 4 inferior hepatic veins with diameters ranging from 4 to 8.4 mm (Figure 1A). From volumetric computed tomography measurements, the total liver, right lobe, and left lobe volumes were 1006 mL, 601 mL, and 405 mL, with 40% remnant volume. The total bloodless liver, right lobe, and left lobe volumes were 791 mL, 484 mL, and 307 mL, with 39% remnant volume. The liver could not be biopsied owing to the patient’s high body mass index and ultrasonographic detection of hepatosteatosis. Because the fat content of the liver was < 1% on examination, the donor candidate underwent an extended right hepatectomy including the middle hepatic vein because the graft-weight-to-body-weight ratio was < 1%. The parenchyma was transected using bipolar cautery and a Cavitron Ultrasonic Surgical Aspirator (CUSA; ValleyLab, Boulder, CO, USA). The postoperative period was uneventful, and the donor patient went home 6 days after surgery.

Back table reconstruction

Direct measurement on the back table revealed a bloodless graft volume of 548 g and a graft-weight-to-body-weight ratio of 0.86%. Therefore, we reconstructed a common-large opening drainage model encompassing all of the inferior hepatic veins and the middle hepatic vein (Figure 1B). First, a saphenous vein homograft patch was placed between 2 inferior hepatic veins with the same diameter, and a common-large opening system was created using an aortic homograft for all of the inferior hepatic veins and middle hepatic vein (Figure 1C). The liver graft, with reconstructed venous drainage, was implanted.

Figure 1. View of the Preoperative Multislice Computed Tomography Image and Intraoperative Venous Reconstruction Models

(A) Oblique coronal 3-dimensional multislice CT angiography showing venous drainage of the right hepatic lobe by multiple right inferior hepatic veins with no main right hepatic vein. (B) View of the right donor hemipatectomy specimen at the back-table stage. Right hepatic venous drainage through multiple right inferior hepatic veins without a right hepatic vein is obvious. (C) A common hepatic vein drainage model is created using an aortic graft and a saphenous vein patch. (D) Photographs taken during the implantation process show the anastomosis created between the aortic graft and recipient vena cava inferior.
in the recipient (Figure 1D). There were no postoperative complications related to the venous drainage (Figure 2). Consequently, the recipient patient was discharged 25 days after surgery with no complications related to transplant.

**Figure 2.** Postoperative Multislice Computed Tomography Images Show That the Common Drainage Model Functions Properly

Absence of congestion in liver supports the proper drainage.

Discussion

Living-donor liver transplant is rapidly becoming the main alternative to deceased-donor liver transplant for acute and chronic end-stage liver disease. Although most liver transplants undertaken in Western countries are supplied by deceased donor pools, live donors constitute a large part of the donor pool in Asian countries including Turkey.5,6 In our clinic, LDLT constitutes 76.3% of all liver transplants performed.

The first step in evaluating living donor candidates includes biochemical tests and viral markers. The second step is radiologic examinations and liver biopsy, if indicated.7 Multislice computed tomography facilitates determining hepatic volumes, dimensions, and the hepatic anatomy including possible vascular anomalies.

One important difference between deceased-donor liver transplant and LDLT is the hepatic venous drainage. The presence of hepatic venous anomalies or variations in the deceased donor is not an obstacle to anastomosis or drainage, because drainage can be reconstructed easily using a piggyback or standard technique. Conversely, as vascular anomalies and variations of living donor candidates may cause difficulties implanting the graft liver to the recipient, these vascular anomalies and variations must be documented clearly by multidetector computed tomography before surgery. In our case, the congenital absence of the right hepatic vein and presence of the inferior hepatic veins were identified easily on preoperative multislice computed tomography, which allowed us to plan the surgery.

Some LDLT centers do not accept donor candidates with radiologically detected major hepatic vascular variations unless it is necessary because both hepatectomy and implantation procedures may be complicated in such cases. Most studies on patients undergoing LDLT are about the difficulties in hepatic venous drainage and newly developed technical modifications. The middle hepatic vein (MHV) draining the central region of the liver and the related segment 4b, segment V5, and segment V8 veins are the most important factors affecting venous drainage of the remnant and graft liver. It is known that the MHV is crucial for right lobe anterior segment drainage and severe congestion ensues in grafts where all or part of the MHV is not included.5 Whether short hepatic veins (which at times have an important role in draining the right lobe of liver) should be included in draining the right lobe is as important as the MHVs.

To summarize briefly, then, the MHV should be left in donor’s side in cases without a segment 4b vein. In cases having a segment 4b vein, the decision to include the MHV to the graft is made with respect to the remnant liver volume. If the remnant liver volume is ≤ 30%, the MHV should be kept in the donor’s side. If the remnant liver volume is > 30%, the decision is made with respect to the diameters of veins draining segment 5 and 8. The MHV is left in the graft side if the diameters of segmental (V5, V8) veins are less than 5 mm. The operation is determined respecting the graft volume/recipient body weight ratio if their diameters are equal to or greater than 5 mm.4,8 Almost none of the anatomic variations of the hepatic artery constitutes an absolute contraindication for donor hepatectomy. However, a hepatic artery diameter of < 2 mm and presence of multiple hepatic arteries constitute a relative contraindication, as they complicate surgery.9 Nakamura type D and type E portal venous
variations form contraindications for right lobe donation. Conversely, a short transverse part of left portal vein may complicate the left lateral segment donation.\textsuperscript{3,10}

Controversy surrounds the short hepatic vein group formed mostly by inferior right hepatic veins into the graft’s drainage system. Furthermore, it is controversial whether the diameter of the SVH and location should be integrated into drainage, and whether the veins to be integrated should be anastomosed to the inferior vena cava as a common drainage model or individually. As known, the implanted graft liver postoperatively undergoes a regeneration process. It is widely accepted that the liver growing by regeneration compresses short and narrow venous anastomoses; thus, graft congestion and dysfunction ensues. Wide ostium drainage models have been developed to accept the graft’s compression.\textsuperscript{2,11}

Hwang and associates,\textsuperscript{12-14} who advocated that SVHs should be greater than 5 mm to be integrated into the drainage system, reported in their latest study that they integrated SVHs ≥ 4 mm into the drainage system. Most the integration models aimed at developing a wide ostium anastomosis tolerating compression are made of allogenic grafts or artificial graft materials. The most commonly used techniques are unification venoplasty with the right hepatic vein are a separate anastomosis with funneling venoplasty, unification venoplasty with funneling, or quilt venoplasty and large clustered venoplasty with the right hepatic vein.\textsuperscript{2,11,13} Figure 3 shows several hepatic venous reconstruction models used in our clinic.

Various graft materials are needed to create hepatic venous reconstruction models in patients undergoing LDLT. The most common graft materials are homologous, autologous, and artificial vascular grafts. The most common materials used as a homologous vessel graft are the saphenous vein, the inferior vena cava, the iliac vein, the iliac artery, and aortic homografts obtained from deceased donors. At some centers, homologous vascular grafts are obtained from varicotomy operations by cardiovascular surgery. Homologous grafts should be preserved by cryopreservation, and no proliferation in cultures should form from the graft material before using the graft.\textsuperscript{1,6,12} The recipient left portal vein, the paraumbilical vein, and the vena saphena magna may be used as an autologous vessel

\textit{Figure 3. View of Several Hepatic Venous Drainage Models From Our Transplantation Clinic}
The increased number of LDLTs has made artificial graft use in hepatic venous reconstruction. Hwang and associates have demonstrated that the results of MHV reconstruction with polytetrafluoroethylene are quite good, and the polytetrafluoroethylene graft may be used safely in the absence of homologous graft. Yi and associates have reported successful use of the polytetrafluoroethylene to include V5 and V8 in the drainage. The saphenous vein used in our case was obtained from another patient’s varicotomy operation while the aortic graft was obtained from deceased cases.

To cope with the drainage problem, we designed a common large opening reconstruction model on the back table using different vascular homograft materials. Venous drainage was achieved easily, and the anastomosis in the recipient was completed quickly. There was a high probability of hepatic venous obstruction if we made individual anastomoses for each inferior hepatic vein with the inferior vena cava. In addition, it would have been a difficult, prolonged process to determine suitable sites for the anastomoses.

We demonstrated that the right lobe belonging to a donor with congenital absence of right hepatic vein can be used as a graft, thanks to the common large opening technique that allows integration of both SVHs and the MHV into the drainage model. Second, all venous structures with a diameter ≥ 4 cm should be integrated into the drainage system to prevent congestion, which may affect functioning of the liver graft implanted to the recipient.

References