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Case Report

Living Donor Liver Transplantation with Left Liver Graft

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Small-for-size syndrome in LDLT is associated with graft exposure to excessive portal perfusion. Prevention of graft overperfusion in LDLT can be achieved through intraoperative modulation of portal graft inflow. We report a successful LDLT utilising the left lobe with a GV/SLV of only 20%. A 43 year-old patient underwent to LDLT at our institution. During the anhepatic phase a porto-systemic shunt utilizing an interposition vein graft anastomosed between the right portal branch and the right hepatic vein was performed. After graft reperfusion splenectomy was also performed. Portal vein pressure, portal vein flow and hepatic artery flow were recorded. A decrease of portal vein pressure and flow was achieved, and the shunt was left in place. The recipient post-operative course was characterized by good graft function. Small-for-size syndrome by graft overperfusion can be successfully prevented by utilizing inflow modulation of the transplanted graft. This strategy can permit the use of left lobe in adult-to-adult living donor liver transplantation.

Key words: Liver cirrhosis, liver transplantation, living donor, portacaval shunt, portal hypertension

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Introduction

Liver transplantation using live donors is now widely employed at transplant centers throughout the world (1). It has been suggested that the major limitation of living donor liver transplantation (LDLT) for adult recipients is the size of the graft that can be harvested from a living donor (2). In recipients of liver grafts from living donors, early graft dysfunction characterized by protracted cholestasis, coagulopathy, renal dysfunction and possibly sepsis has been termed small-for-size syndrome (SSS) (3). While SSS can occur with grafts of any size, the incidence is far greater if the graft size is less than 40% of the graft volume/standard liver volume ratio (GV/SLV) (4), or an estimated graft weight: recipient body weight ratio (GWRBWR) $\geq$ 0.8% (5). Earlier reports have suggested that size alone does not determine the probability of developing SSS (6). Instead, this syndrome is a result of a combination of factors, including size, recipient performance status and portal inflow. It has been speculated that SSS is principally associated with graft exposure to excessive portal perfusion. Factors such as the presence of a hyperdynamic splanchnic state, severe portal hypertension, portocollateral circulation, or the effects of the loss of sympathetic hepatic innervation, could be responsible for the increased hepatic blood flow recorded in recipients undergoing liver transplantation (7–10). As reported elsewhere, prevention of graft overperfusion in liver transplantation can be achieved through intraoperative modulation of portal graft inflow such as splenic artery ligation or splenectomy (9,11). We report a successful LDLT utilizing the left lobe with a GV/SLV of only 20% in a recipient affected by HCV-related liver cirrhosis. Prevention of graft failure by portal overperfusion was achieved thanks to a porto-systemic shunt and spleen removal. The positive impact of this surgical procedure has been shown by portal pressure monitoring and both portal and hepatic artery flow echo-Doppler ultrasound during and after surgery.

Case Report

In January 2003, a 43-year-old female with a body weight of 68 kg was admitted to the Liver and Multivisceral Transplant Center at the University of Modena to undergo an LDLT. The indication for liver transplantation was HCV-related end-stage liver cirrhosis (MELD 16) worsened by hepatocellular carcinoma (HCC) in a patient with a B+ blood group. She was already accepted on the waiting list for cadaveric liver transplantation but her family raised the question of LDLT. After detailed explanation about the selection criteria, the operative procedure, the risks and benefits to the donor and recipient, her 38-year-old sister volunteered to be a living donor. Demographic and volumetric data of both recipient and donor are shown in Table 1. The donor's estimated liver weight calculated by performing a CT scan with volumetric assessment was 1146 g.

Donor surgical procedure

The donor surgical procedure was planned according to GV/SLV, dominance of the middle hepatic vein, and hepatic artery anatomy. The GV/SLV

Table 1: Demographic and volumetric data of the recipient and donor

	Recipient	Donor
Age (year)	43	38
Blood group	B+	B+
Body weight (kg)	68	63
Body height (cm)	165	162
SLV	1146	NA
GV/SLV	0.19	NA
GW (gm)	NA	220

SLV: standard liver volume; GV: graft volume; GW: graft weight.

represents the graft weight, as estimated on a CT scan of the donor's liver, divided by the standard liver weight of the recipient estimated by Urata's formula (4). Through a bilateral subcostal incision with median extension to the xyphoid an intra-operative evaluation of the biliary duct anatomy was performed. An intra-operative cholangiography showed multiple biliary ducts in the right half of the liver and the decision to use the left lobe was made. The donor procedure consisted of a left hepatectomy using a total intermittent inflow occlusion of the glissonian pedicle (12). After parenchymal transaction the liver graft was flushed with cold Celsior solution, and the weight was 220 g.

Recipient surgical procedure

Systemic hemodynamic parameters were measured continuously; intra-operative flowmetry was done with electromagnetic probes (Transonic System Inc., Ithaca, NY, USA) and expressed as total mL/min and as mL/min per 100 g graft. Portal vein pressure (PVP) was measured with a 20-gauge catheter introduced through the inferior mesenteric vein during the surgical procedure. Serial readings of the PVP, portal vein flow (PVF), portal vein flow per graft weight (PVF/GW) and hepatic artery flow per graft weight (HAF/GW) were obtained after reperfusion either with the shunt open or closed, and ultimately, after splenectomy.

Recipient total hepatectomy was made preserving the retrohepatic vena cava, during the anhepatic phase a porto-systemic shunt utilizing a saphenous vein interposition graft anastomosed between the right portal branch and the right hepatic vein was performed. After reconstructing the hepatic vein and portal vein, the hepatic artery was anastomosed and the biliary tract was reconstructed by hepaticojejunostomy using a Roux-en-Y loop (13). After graft reperfusion a splenectomy was also performed and the shunt was left in place (Figure 1).

Results

Before recipient hepatectomy, several measurements of PVP were taken with a mean of 24 mmHg, while mean PVP recorded after graft reperfusion with the portocaval shunt closed was 26 mmHg, as expected after portocaval shunt opening it fell to 14 mmHg. After the splenectomy PVP was even lower with a mean of 12 mmHg.

After portal and arterial reperfusion, mean PVF and PVF/GW with the shunt closed were 720 mL/min and 327 mL/100 g whereas they decreased to 420 mL/min and 190 mL/100 g, respectively, after opening the shunt. After the splenectomy, the two parameter averages were 360 mL/min and 145 mL/100 g. HAF/GW was 45 mL/100 g, respectively; however, after opening the portocaval shunt and performing the splenectomy, the mean value recorded was 61 mL/100 g. All the measurements recorded are summarized in Figure 2.

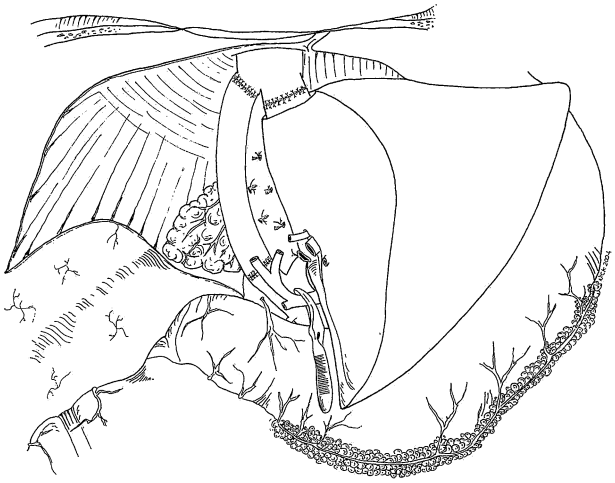

Figure 1: Living donor liver transplantation with left lobe. Schematic representation of the surgical field after graft reperfusion with portacaval shunt in place and open. (Figure drawn by author N.C.)

The recipient's post-operative course was characterized by immediate graft function, with steady normalization of serum total bilirubin and clotting profile. She was extubated on day 1 and transferred to the ward on day 3. Graft dysfunction, characterized by prolonged post-operative hyperbilirubinemia, ascites and renal failure did not occur but a biliary leakage, which occurred after 10 d, required a revision laparotomy.

The regeneration rate of the graft defined as the GV after surgery/harvested GV was used to assess post-operative graft regeneration (14). Computed tomography used for GV analysis at 15 and 30 d after transplantation did not show any regeneration impairment due to the portal flow modulation, and the portocaval shunt was left open.

Discussion

The success of pediatric LDLT led to the application of LDLT in adult recipients, for whom organ shortage has continued to worse. Some programs began to use left lobe grafts from large adult donors for small adult recipients (15), but this technique excluded normal-sized adult patients and small patients without large donors, and it therefore had limited applicability.

Three issues were implicated in these SSS cases: degree of illness in the recipient, graft outflow restriction, and overperfusion of the graft with portal blood (1,10,16). Any one of

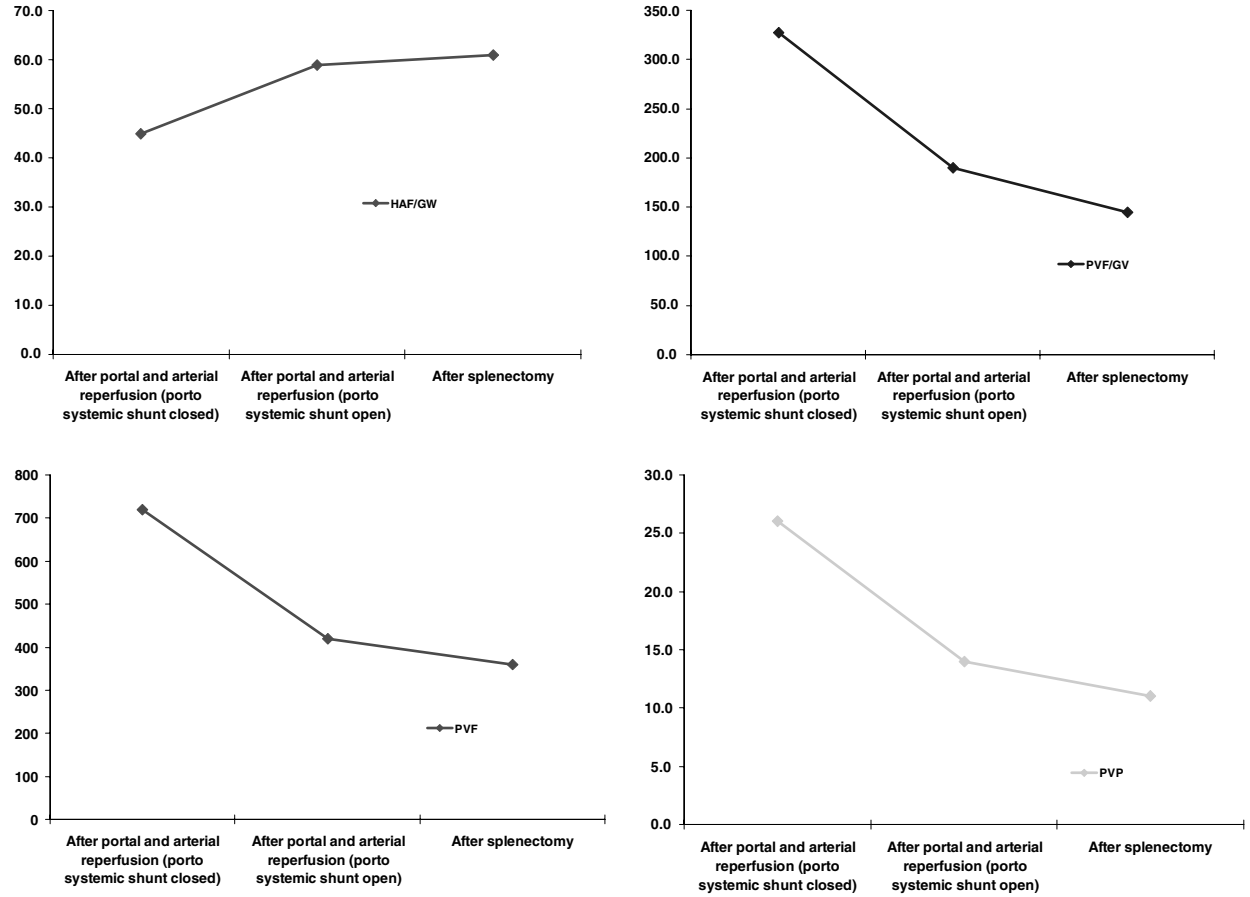

Figure 2: Hemodynamic features recorded during surgery.

these factors can, in a marginally sized graft, result in SSS. Therefore, it has become general practice to exclude the sickest patients from consideration for living donor transplants, and furthermore, in patients with severe portal hypertension, to choose donors who can supply grafts that provide 50–60% of the estimated liver volume. This allows for a volumetric margin of safety, in case graft inflow and outflow are not ideal. Decreasing portal flow by surgical or pharmacological means allows the use of a left lobe graft, maximizing safety for the donor.

In evaluating the adequacy of a liver graft relative to the need of the recipient, the GWRBWR is not the best indicator, because the liver volume of a normal subject is not directly proportional to body weight (2). The GV/SLV can give a more accurate prevision of the ideal graft weight. Nishizaki et al. showed that grafts smaller than 30% of the SLV could be used with careful intra-operative and post-operative management to gain time until regeneration of the graft is achieved (17). The greater extent of liver resection in the donor operation in cases of right hepatectomy with a perceived higher risk implies that this procedure should be considered only when the left lobe from the potential donor is too small for the need of the recipient's metabolic demand. In the case presented here, the presence of a biliary tree anatomic variation limited the resectable liver volume from the donor and made the surgeon choose a left lobectomy. In this case, the preoperative hemodynamic data which showed the absence of a hyperdynamic state and a relatively good pre-transplant condition were favourable for LDLT utilizing the left lobe.

In order to prevent graft failure due to portal overperfusion (18) a porto-systemic shunt between the right portal branch and the right hepatic vein (with a saphenous vein interposition graft) and a splenectomy were performed. The beneficial impact of this surgical procedure was shown by the decreased PVP, PVF and PVF/GW, in combination with the increased HAF/GW.

Careful evaluation of the recipient should include an assessment of the hemodynamic conditions, as the presence of a hyperdynamic state can be responsible for an excessive increase in portal vein flow after reperfusion. In these cases surgical modulation of graft inflow could prevent the SSS when small grafts are transplanted. The degree of inflow modification such as portocaval shunt and splenectomy, however, should be determined by intra-operative

hemodynamic measurements in order to assure acceptable and noninjurious parenchymal flow. These strategies can renew the enthusiasm for selective use of left lobes and thus maximize donor safety in adult-to-adult LDLT.

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