Techniques of reconstruction of hepatic veins in living-donor liver transplantation, especially for right hepatic vein and major short hepatic veins of right-lobe graft

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Abstract
Living-donor liver transplantation (LDLT) is now widely accepted as a therapeutic option for adult patients with acute and chronic end-stage liver disease. In the early period, the left lobe was the major liver graft used in adult LDLT to ensure donor safety, especially in Eastern countries. However, the frequent extremes of graft-size insufficiency in left-lobe LDLT represented a greater risk of small-for-size graft syndrome in the recipient, which has focused attention on transplantation of the right lobe from a living donor. The major concern of right-lobe LDLT has focused on its safety for the donor and the necessity for including the middle hepatic vein (MHV) in the graft to avoid congestion of the right anterior segment. The MHV carries out important venous drainage for the right anterior segment and is essential for perfect graft function. The decision of whether to take the MHV with the liver graft (extended right lobe graft) or whether to retain it in the donor, with reconstruction of the MHV tributaries in the liver graft (modified right lobe graft) has been extensively discussed in numerous studies. However, adequate right hepatic vein and major short hepatic vein (middle and inferior right hepatic vein [RHV]) drainage of the liver graft is perhaps equally important as MHV outflow drainage for the integrity of right-lobe graft function. Herein, the author describes various techniques of venoplasty of the right hepatic vein (RHV) and the major short hepatic veins to obviate venous outflow obstruction in these veins.

Key words Outflow obstruction · Middle hepatis vein · Hepatic veins of right lobe

Introduction

Living-donor liver transplantation (LDLT) is accepted as one of the therapeutic options to overcome graft shortage in adult patients waiting for liver transplanta-

tion. However, in adult patients, graft size is the major limitation for the wider application of this innovative procedure. A left-liver lobe graft, which is usually less than 40% of the total liver volume, may be insufficient if the donor and the recipient are equal in size, or if the donor is smaller than the recipient. Right-lobe LDLT is the major development in adult LDLT that has brought about a significant increase in graft supply, because a right lobe graft provides larger graft size and avoids small-for-size graft syndrome. However, right-lobe LDLT is more complex than whole-organ transplant and left-lobe LDLT for venous outflow reconstruction. Principles of whole-organ transplant and left-lobe LDLT do not necessarily apply to right-lobe LDLT, because right-lobe LDLT has unique functional anatomic characteristics of venous drainage that need to be considered to obtain optimal results. When a right-lobe graft is transplanted without reconstruction of the middle hepatic vein (MHV) or major short hepatic veins (SHVs), venous drainage patterns may change dramatically, with deterioration of drainage. The frequent observation that right-lobe grafts tend to appear more congested than full-size or left-lobe grafts immediately after reperfusion has led to modifications of the technical management of hepatic veins. Venous drainage of the liver graft is just as important as hepatic inflow for the integrity of graft function (Fig. 1). Unsatisfactory venous outflow leads to suboptimal liver graft function and finally to graft failure.

Inclusion and/or reconstruction of the middle hepatic vein (MHV) in right-lobe graft

The major controversy with right-lobe LDLT lies in the
necessity for including the MHV in the graft and in concerns for the safety of the donor. The MHV was not included in right-lobe grafts in several series because of the surgeons’ conviction that one single large right hepatic vein (RHV) anastomosis was sufficient and that intrahepatic venous collaterals were present between the MHV and the RHV. The MHV carries out important venous drainage for the right anterior segment and is essential for perfect graft function in nearly 85% of right-lobe LDLTs. The intrahepatic collaterals are often small and do not open up fully until posttransplant day 9. Before the collaterals appear to function, graft function may be suboptimal and the graft may have a sustained injury already. It is still controversial whether such collaterals exist in all normal persons. Contrary to the common belief, the MHV is larger than or of the same size as the RHV in about 58% of individuals. In 13% of right liver lobes, the MHV partially or totally drains the area of segment 6. In the absence of the MHV, the venous drainage of a right-lobe graft is, therefore, precarious and the right anterior segment of the liver graft may suffer from congestion and damage. If the venous drainage of the right anterior segment is totally occluded, all portal blood flows into the right posterior segment, which sustains diffuse mechanical injury, as the liver graft now becomes effectively small-for-size. With the inclusion or the reconstruction of the MHV, early graft function is satisfactory, even in the presence of very high portal venous blood flow in patients with portal hypertension. Concerning the MHV controversy, the inclusion of the MHV in the graft might impair the venous drainage of segment 4 in the donor and, hence, the remnant liver function of the donor may be compromised. The inclusion of the MHV or not in the donor’s right lobectomy should be based on sound criteria to provide adequate functional liver mass for the recipient, while keeping the risk to the donor to a minimum.

Refinement of venous reconstruction of right hepatic vein (RHV) and major short hepatic veins (SHVs), including the middle RHV (MRHV) and inferior RHV (IRHV)

In right-lobe LDLT, reconstruction of venous outflow drainage is trickier and more challenging than that of left-lobe LDLT, because multiple SHVs (IRHV, MRHV, superficial RHV) often exist (Fig. 2), and their individual anastomoses not infrequently result in the early occlusion of one or even all hepatic veins. Short and direct anastomosis is most commonly performed for RHV reconstruction. The right-lobe graft is always smaller than the standard liver size of the adult recipient and consequently regenerates in all directions after LDLT in the limited right subphrenic space (Fig. 3). The regenerating enlarged graft may push on the vena cava and RHV anastomosis. The resulting outflow obstruction could congest the liver graft, leading to a vicious cycle of further graft distension and dysfunction in the recipient (Fig. 3).

A 25-year-old woman suffering from fulminant hepatic failure with Wilson’s disease underwent right-lobe LDLT urgently in December 2000. Her liver graft had a 3-cm-caliber RHV with one small MHV tributary and an IRHV, and all of them were reconstructed. A direct and short RHV anastomosis revealed good patency on posttransplant Doppler ultrasonography (USG). On posttransplant day 26, her liver function was normal, but ascites production had increased and computed