

Implantation of a Partial Liver Graft from a Live Donor Surgical Technique of Living Donor Liver Transplantation

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Abstract : We have experienced six living donor liver transplantations (LDLT) so far. In this article, we discuss our procedure of LDLT focusing on the surgical techniques of implantation for a partial liver graft. Six LDLT operations performed from May 2005 to December 2007 were analyzed. Data were obtained from the operative record in the charts. A total hepatectomy was carried out for the preparation of LDLT. The inferior vena cava (IVC) was preserved, and the hepatic veins were divided at their orifices. Among our 6 cases, 5 were left liver grafts and one was right lateral sector graft. A single large hepatic vein anastomosis orifice was reconstructed. The portal vein anastomosis was made in an end-to-end fashion. From case number 4, microsurgery was applied for hepatic artery anastomosis. Duct-to-duct anastomosis was utilized for biliary reconstruction. There was no anastomosis-related postoperative complication in vascular anastomosis. Two out of our 6 cases developed delayed stricture at biliary anastomosis 6 month after surgery. The procedure of LDLT is meticulous. The further establishment of the surgical technique and the accumulation of patients for transplant team are thus mandatory.

Key words : Livingdonor liver transplantation (LDLT), Partial liver graft

Introduction

Since we experienced our first living donor liver transplantation (LDLT) at Fukuoka University Hospital on May 14th 2005, six LDLT had been performed by the end of 2007. The procedure of implantation of partial liver graft has been steadily improving and becoming more consistent. In this article, we discuss our procedure for LDLT focusing on the surgical techniques of a implantation of partial liver graft.

Subjects and Methods

Six LDLT operations performed from May 2005 to December 2007 were analyzed. Data were obtained from the operative record in the charts.

Surgical technique

Preparation

A total hepatectomy was carried out for the preparation of LDLT. The hepatic artery and the

LDLT : Living Donor Liver Transplantation MDCT : multidetector computed tomography IVC : Inferior Vena Cava
MHV : Middle Hepatic Vein LHV : Left Hepatic Vein PVT : Portal Vein Thrombosis HAT : Hepatic Artery Thrombosis
PTBD : Percutaneous Transhepatic Biliary Drainage

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portal vein were divided at the distal end of their first order branch. The biliary tree was dissected from the liver parenchyma including connective tissue and peribiliary vessels of the hilar plate. The bilateral hepatic ducts were also divided at the distal end of their first order branch. The liver was dissected from the inferior vena cava. The inferior vena cava (IVC) was preserved, and the hepatic veins were divided at their orifice.

Harvesting of the graft

The choice of a partial liver graft was determined by three dimensional volumetry based on multi-detector computed tomography (MDCT). A partial liver graft was chosen for LDLT when the calculated volume of the graft was greater than 35% of standard liver volume of the recipient. This is our policy that the volume of partial liver graft should be 35% or greater of the standard liver volume of the recipient to avoid the postoperative hepatic failure of the recipient. The remnant liver volume of the donor has to be 35% or greater to avoid the postoperative hepatic failure, too.

Harvesting the partial liver graft from the live donor was essentially the same as for an ordinary hepatectomy. However, the blood vessels such as hepatic artery, portal vein and hepatic vein had to be preserved until the hepatic transaction was completed. Following the dissection of the liver, the bile duct was divided. Next, the hepatic artery, the portal vein and the hepatic vein were clamped and divided.

Back table surgery

The partial liver graft was set on the back table immediately after the removal from the donor. The blood in the graft was flushed out with a lactate Ringer solution followed by replacement with the University of Wisconsin solution. Thereafter, the preparation of the blood vessels and the bile duct were attempted.

Hepatic vein plasty was important to prevent venous outflow block that caused postoperative insufficient graft function.¹⁾ Making a single large orifice of the hepatic vein of the graft is essential in LDLT. We perform venous patch plasty for hepatic vein reconstruction. The venous patch graft obtained from the right or left portal vein, hepatic

vein, the greater saphenous vein of the recipient was utilized. In our first case the cryopreserved graft obtained from the cadaver donor was available.²⁾ In the left liver graft, a vertical cut was made on the spur between the left and the middle hepatic vein and reconstructed to the single orifice with a non-absorbable monofilament suture. When the orifice of the left and the middle hepatic vein were separated, their medial walls are then sutured to make a single orifice. Then venous patch grafts were attached to the anterior and the posterior wall of the reconstructed hepatic vein (Fig. 1-a). In case number 4, a hepatic vein tributary was present on the distal side of the cut surface of the right posterior segment (right lateral sector) graft. In that case, a side-to-end anastomosis between the distal hepatic vein tributary of the graft and the right hepatic vein graft obtained from the recipient was done. Then the proximal side of this right hepatic vein graft was sutured to the right hepatic vein of the graft and the single big orifice was reconstructed. The same technique was applied for the anastomosis of the short hepatic vein of the left caudate lobe (Spiegel portion) in case number 5 (Fig. 1-b).

The portal vein of the graft did not need reconstruction on the back table in all cases, because they were properly dissected during a hepatectomy in the donor. In one of our 6 cases, the hepatic artery reconstruction was needed using free arterial graft obtained from the right gastroepiploic artery of the recipient.

There was one case that needed bile duct reconstruction on the back table. In that case, the bile duct of the graft as separated two orifices. They were reconstructed into one orifice by suturing their medial wall.

Implantation of the partial liver graft

The implantation of the partial liver graft was completed starting with hepatic vein anastomosis followed by portal vein and hepatic artery anastomosis. The biliary anastomosis was done after the blood perfusion of the graft had been restored.

Hepatic vein anastomosis

The hepatic vein of the graft was reconstructed

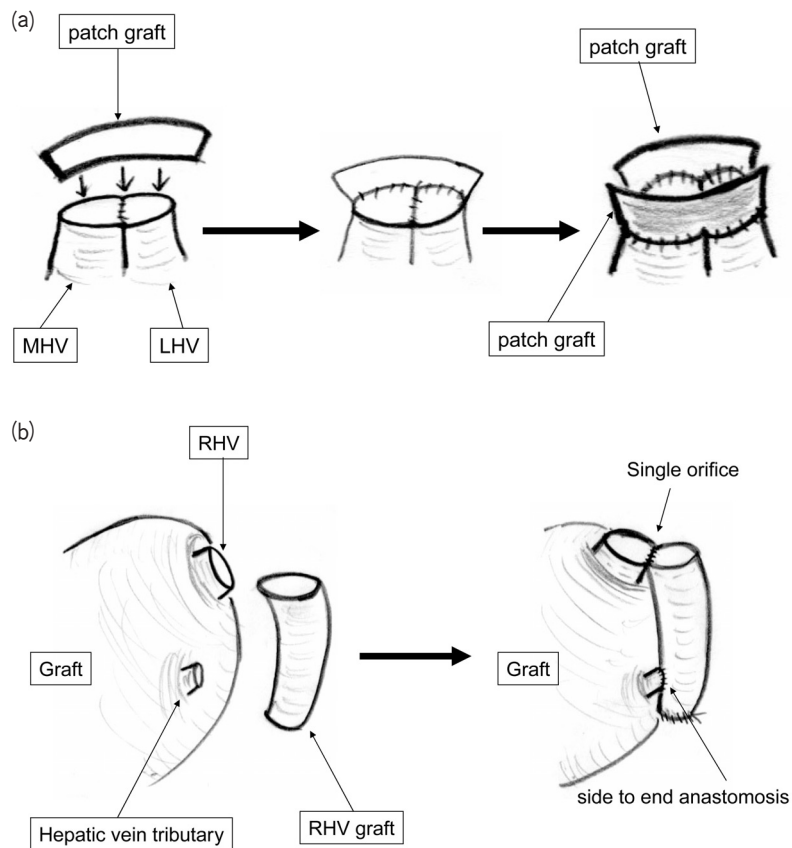


Fig. 1. Venoplasty of the hepatic vein orifice in the partial liver graft. (a) In case of left liver graft. The venous patch grafts are attached to the anterior and the posterior wall of the reconstructed middle (MHV) and left hepatic vein (LHV). (b) The technique in case number 4 and 5. A hepatic vein tributary is anastomosed to the right hepatic vein graft from the recipient. Then single large hepatic vein orifice is reconstructed in the proximal side of the graft.

to make a single large orifice using a vein patch *ex-situ*. In case of left liver graft, a big orifice was previously reconstructed with the left and the middle hepatic vein of the recipient (Fig. 2-a.). When the right lateral sector graft was implanted (case number 4), the right hepatic vein of the recipient was used for hepatic vein anastomosis. The anterior wall of the right hepatic vein was cut longitudinally and a rectangular shaped vein patch was attached to enlarge the orifice (Fig. 2-b.). Hepatic vein anastomosis was done in an end-to-end manner.

Portal vein anastomosis

The portal vein anastomosis was made between the first order branch of the recipient portal vein and the portal vein of the partial liver graft. The portal vein anastomosis was completed in an end-

to-end continuous suture with 6-0 non-absorbable monofilament suture.

Hepatic artery anastomosis

End-to-end hepatic artery anastomosis was done between the left or right hepatic artery of the recipient and the hepatic artery of the partial liver graft with 8-0 non-absorbable monofilament suture. Either end-to-end anastomosis or branch patch reconstruction was chosen for each case. Microsurgery was applied for hepatic artery anastomosis in last three cases (cases 4 to 6).

Biliary anastomosis

The biliary reconstruction was the final phase of partial liver graft implantation. Among our cases, we apply duct-to-duct anastomosis between the left or right hepatic duct of the recipient and the

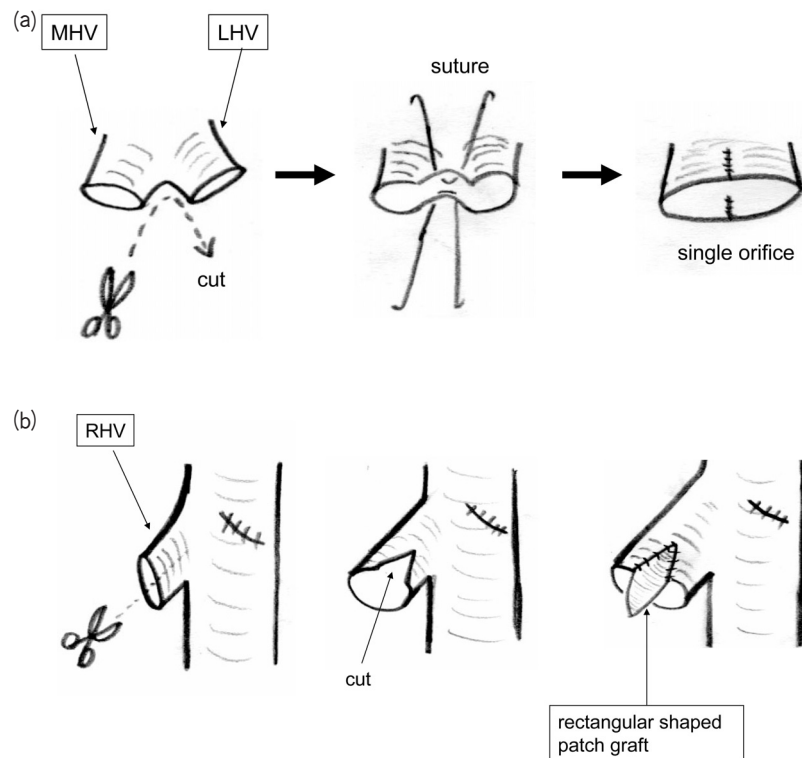


Fig. 2. Venoplasty of the recipient's hepatic vein. (a) The confluence of the middle (MHV) and the left hepatic vein (LHV) is cut and reconstructed to the single large orifice. (b) The anterior wall of the right hepatic vein is cut longitudinally. A rectangular shaped patch graft is attached and the orifice is enlarged.

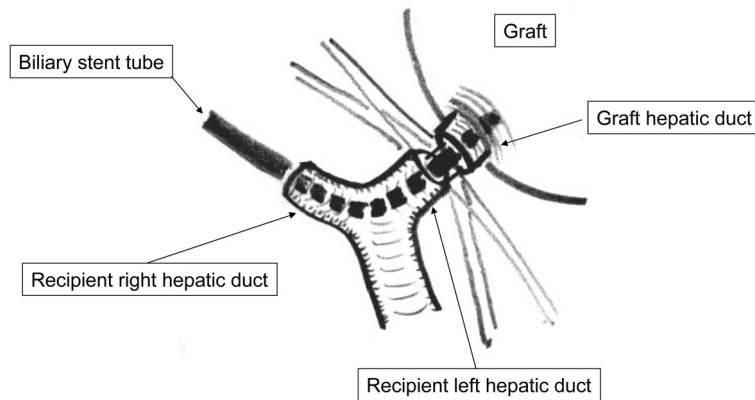


Fig. 3. Biliary reconstruction. A duct to duct anastomosis between the left hepatic duct of the recipient and the hepatic duct of the partial liver graft. A single layer interrupted suture is applied using 4-0 or 5-0 absorbable suture. The biliary drainage tube is placed into the hepatic duct of the partial liver graft through the orifice of the right hepatic duct of the recipient.

hepatic duct of the partial liver graft. A single layer, interrupted suture was carried out using 4-0 or 5-0 absorbable suture for bile duct anastomosis. The biliary drainage tube was placed into the hepatic duct of the partial live graft through the tributary of the hepatic duct on the other side of

the recipient (Fig. 3.).

Results

A total of 6 LDLTs were performed. The patient's age ranged 30 to 60. Four were male and

Table 1. Characters of LDLT cases

Case #	Age	Sex	Diagnosis	Graft	Hepatic Vein Reconstruction	Portal Vein Anastomosis	Hepatic Artery Anastomosis	Bile Duct Anastomosis	Outcome, /cause of death
1	60	Male	C-LC, HCC	Left Liver	Cryopreserved Graft	End-to-End	End-to-end	Duct-to-Duct	Survive 31months
2	30	Female	Fulminant hepatic failure	Left Liver	Venous Patch	End-to-End	End-to-end	Duct-to-Duct	Survive 21 months
3	59	Male	C-LC, HCC	Left Liver	Venous Patch	End-to-End	Branch patch	Duct-to-Duct	Survive 19 months
4	41	Male	Alcoholic cirrhosis	Right Lateral Sector	Right Hepatic Vein Graft	End-to-End	End-to-end, Microsurgery	Duct-to-Duct, Bile Duct Plasty	Died 4 months after LDLT/Biliary and Pulmonary infection (aspergillosis)
5	36	Female	Wilson's Disease	Left Liver	Right Hepatic Vein Graft	End-to-End	End-to-end, Microsurgery	Duct-to-Duct	Survive 2 months
6	53	Male	Alcoholic cirrhosis	Left Liver	Venous Patch	End-to-End	End-to-end, Microsurgery	Duct-to-Duct	Died 3 days after LDLT/Hepatic failure

C-LC : type C hepatitis related cirrhosis, HCC : hepatocellular carcinoma

2 were female. The diagnosis was 2 hepatitis C related cirrhosis with hepatocellular carcinoma, 2 alcoholic cirrhosis, 1 fulminant liver failure and 1 Wilson's disease.

Among our 6 cases, 5 were left liver grafts and one was a right lateral sector graft (case 4). Usually, the left liver graft was accompanied by the left caudate lobe (Spiegel portion). In our case 4, the right lateral sector graft was selected because the volume of the left liver of the donor was less than 35% of the standard liver volume of the recipient, and the volume of the right lateral sector of the donor was greater than 40% of the standard liver volume of the recipient. The clinical characteristics of partial liver grafts are shown in [Table 1](#). There were 2 mortality cases in our series. One was a left liver graft case who died due to postoperative hepatic failure. The other patient used a right lateral sector graft, and who died due to biliary and pulmonary infection.

There has not been any problem, such as venous outflow block or postoperative bleeding in hepatic venous anastomosis.

There has also not been any problem regarding portal vein anastomosis. However, we have experienced a case of partial portal vein thrombosis that developed portal vein thrombus in the peripheral portal branch of segment 7 due to inflammation of the adjacent bile duct (case 4). Anticoagulation therapy was not effective in this case because the

cholangitis of the adjacent bile duct could not be resolved.

We have not experienced any anastomosis-related complication in the hepatic artery among our 6 cases so far.

The two out of our 6 cases developed delayed stricture at the biliary anastomosis 6 month after surgery. One had a tube stent, and the other one has been undergoing percutaneous transhepatic biliary drainage (PTBD).

Discussion

A graft size mismatch is a problem that sometimes arises in adult-to-adult LDLT. Because only a part of the liver is implanted in LDLT, the graft mass is not enough for the metabolic demand of the recipient. To prevent this problem, the number of right liver graft implantations which are usually larger than the left liver graft has thus been increasing. According to the annual report of the liver transplantation society of Japan, 60.3% of adult to adult LDLT used right liver graft.³⁾ However, the major complications of the donor occur more often in right liver graft harvesting than left liver graft. Hwang et al. reported that the incidence of major donor complication was 1.4% for left liver graft cases, whereas it was 4.9% for right liver graft cases.⁴⁾ Moreover, the mortality cases of right liver donor have been reported in

western country and Japan.⁵⁾ From the point of donor safety, we use the left liver graft when the graft volume is 35% or greater of the standard liver volume of the recipient that is considered to meet the recipient's metabolic demand. The right lateral sector graft is chosen when the volume of the left liver of the donor was less than 35% of the standard liver volume of the recipient, and the volume of the right lateral sector of the donor was greater than 35% of the standard liver volume of the recipient. In our series, the use of these two kind of grafts did not show any difference in the outcome. There was one mortality case each for both types of graft, and the causes of death were hepatic failure and infection.

Venous outflow block which causes the congestion of the liver and the liver dysfunction is one of the major concerns in LDLT. Because venous outflow block is caused by a kink or flexion of the hepatic vein anastomosis that related to regeneration and enlargement of the partial liver graft. Making a large anastomosis orifice of the hepatic vein is thus essential to prevent the kink of hepatic vein anastomosis. For this purpose various venous reconstruction have been contrived using venous graft either autograft or cryopreserved graft.¹⁾²⁾³⁾⁸⁾ In our series, 1 case out of 6 cases used cryopreserved venous graft, others used autograft.

The portal vein thrombosis (PVT) and the hepatic artery thrombosis (HAT) are common postoperative complications in liver transplantation. It is said that the incidence of postoperative PVT is 1–3%, while HAT is 3.7%. In our series, there was 1 case of partial portal vein thrombosis, whereas no HAT was experienced. That portal vein thrombosis was developed in the peripheral portal branch of segment 7 due to cholangitis of the adjacent bile duct. The application of microsurgery in hepatic artery anastomosis lowers the risk for HAT.⁹⁾¹⁰⁾ In our last three cases (cases 4 to 6), microsurgery has been applied for hepatic artery anastomosis.

Biliary complications remain another serious problem in liver transplantation. The bibliographical incidence of biliary complications is 4.7% for bile leakage, and 26.6% for biliary stricture in duct-to-duct anastomosis.¹¹⁾ The treatment are biliary decompression, drainage or balloon dilation.¹¹⁾¹²⁾ We performed duct-to-duct anastomosis all of our

6 cases, and experienced 2 cases of biliary stricture.

In conclusion, we have had success in performing LDLT at Fukuoka University Hospital so far. However, the procedure of LDLT is meticulous. Further establishment of surgical technique and the accumulation of appropriately indicated patients for transplant team are mandatory.

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