Wedge-patch venoplasty for graft left portal vein in pediatric living donor liver transplantation

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Portal vein (PV)-size matching is important in preventing anastomotic stenosis in liver transplantation (LT) using a partial liver graft. Reconstruction of small graft PV with size-unmatched recipient PV is challenging, thus we present our surgical technique of wedge-patch venoplasty to enlarge the diameter of graft PV for size-matched reconstruction. On computational simulation, a longitudinal incision was made at the graft PV stump and then a small triangular homograft vein patch was attached. Our simulation showed that a 5-mm incision combined with patch venoplasty could make the diameter of graft PV 30%–50% larger than the native size. We applied this technique to two pediatric patients. The first case was a 4-year-old female patient who underwent second LT because of progressive deterioration of graft function. At the first LDLT operation for biliary atresia, an iliac vein conduit was interposed for PV reconstruction. At the second LT operation, the diameter of interposed PV was 10 mm, but the left liver graft PV was only 7 mm in diameter because of congenital waist. The second case was an 8-year-old female patient who underwent split LT because of intractable recurrent cholangitis following resection of choledochal cyst. The graft PV was small because of type III PV anomaly of the donor liver. We performed wedge venoplasty using an iliac vein homograft patch in these two cases, and no PV complication occurred. In conclusion, our wedge-patch venoplasty technique can be applied to small graft PV to cope with PV-size mismatching in LT using a partial liver graft.

Keywords: Portal vein stenosis; Venoplasty; Pediatric transplantation; Portal vein anomaly; Vein homograft

INTRODUCTION

Adequate size matching of the portal vein (PV) between the recipient and donor liver graft is essential in preventing anastomotic stenosis in living donor liver transplantation

(LDLT) [1]. In adult LDLT using a right liver graft, the size of the right liver graft PV does not matter because it is usually greater than 10 mm in diameter. However, the size of the left PV is variable depending on the anatomy of the left PV and the volume of the left liver. If the diameter of the graft

PV is smaller than 8 mm, it can induce anastomotic stenosis. We have experienced a few cases of PV anastomotic stenosis primarily caused by a small graft PV in more than 5,000 cases of LDLT. When the diameter of the graft PV appears small at the back table, its post-anastomosis diameter becomes smaller because application of a sufficient growth factor cannot prevent anastomosis-associated mechanical stenosis completely. Reconstruction of a small graft PV with the size-unmatched recipient PV is challenging, but enlargement of the graft PV by means of patch venoplasty has been rarely performed [2]. We present our surgical technique of wedge-patch venoplasty to enlarge the diameter of a graft left PV for size-matched reconstruction.

DESIGN OF SURGICAL RECONSTRUCTION AND COMPUTATIONAL SIMULATION

If a small graft PV is reconstructed with a normal-sized recipient PV stump, it will produce a significant anastomosis-associated mechanical stenosis. To resolve this problem, we made a longitudinal incision at the graft PV stump, which worked as a wedge to widen the PV orifice. We attached a small triangular homograft vein patch to fill the wedged wall defect. The orifice of the graft PV was widened to be as large as that of the recipient PV, which enabled to perform size-matched end-to-end anastomosis. An insertion of a vein patch offset the anastomosis-associated mechanical stenosis (Fig. 1). Our computational

Fig. 1. Illustration for surgical reconstruction of wedge-patch portal vein venoplasty. A yellow patch indicates a vein allograft. Dotted lines indicate the effective diameter of portal vein reconstruction.

simulation showed that a 5-mm incision combined with patch venoplasty could make the diameter of the graft PV 30%–50% larger than the native size.

CLINICAL APPLICATION

Case No. 1

A 4-year-old female patient weighing 14 kg underwent a second LDLT because of progressive deterioration of graft function for 3 years. The first LDLT operation was done because of biliary atresia at the age of 11 months and the donor was her mother. At the second LDLT, the donor was a 35-year-old sister of her mother and the graft was a 350 g-weighting whole left liver with the middle hepatic vein trunk. The diameter of the graft left PV was only 7 mm because of the presence of a waist at the first-order PV. In contrast, the diameter of the recipient PV was 12 mm because an iliac vein conduit had been interposed to cope with PV hypoplasia at the first LDLT operation.

To resolve the PV-size mismatching, we made a 5-mm-long longitudinal incision at the graft PV stump to release the waist. We inserted a small cold-preserved fresh iliac vein patch to widen the graft PV orifice, thus enlarging its diameter to 12 mm. The enlarged graft PV orifice was reconstructed with the recipient PV using a 6-0 polydioxanone continuous running suture (Fig. 2). The patient recovered uneventfully, and has been doing well for 3 years. The reconstructed PV showed a streamlined configuration without anastomotic stenosis.

Case No. 2

A 8-year-old female patient weighing 22 kg underwent split liver transplantation because of intractable recurrent cholangitis following resection of choledochal cyst and Roux-en-Y hepaticojejunostomy at 1 year of age. The deceased donor was a 29-year-old female and the split graft was a 330 g-weighting left lateral section. The donor liver had a type III PV anomaly, so we transected the graft left PV at the left end of the transverse portion close to the umbilical portion. We identified that the diameter of the graft left PV was 9 mm and its stump was retracted because it had a very short stump. The recipient had a normal portal vein, so we expected the size of PV with the branch patch to be 15 mm.

To resolve the PV-size mismatching, we made a 5-mm-long longitudinal incision and inserted a small iliac vein patch obtained from the same donor to widen the graft PV orifice, thus enlarging its diameter to 13 mm. The enlarged

graft PV orifice was reconstructed with the recipient PV using a 6-0 polydioxanone continuous running suture (Fig. 3). We placed a tissue expander to prevent detrimental dextro-rotation of the liver graft because the graft-to-recipient weight ratio was only 1.50. Water filling the tissue expander was gradually extracted along graft regeneration, and the expander was removed at two weeks after transplantation. The patient recovered uneventfully and has been doing well for 2 months. The reconstructed PV also showed a streamlined configuration without anastomotic stenosis.

DISCUSSION

In pediatric LT, PV stenosis is one of the most common and most critical complications. Most PV-associated complications resulted from inadequacy of the recipient PV, such as hypoplastic PV in patients with biliary atresia [3,4]. Thus, recipient PV venoplasty has been a matter of concern [5,6].

In contrast, unusually small graft portal veins have rarely been encountered in LDLT. When a right liver graft is used, the size of the graft PV does not matter because it is usually greater than 10 mm in diameter. We have rarely encountered an unusually small left PV, such as in our cases [2]. Previously, we had thought that the graft PV is a no-touch area, because the donors had no problems before donation in their lives. However, we must admit that there is a technical limitation in venous vascular reconstruction, which can induce anastomosis-associated mechanical stenosis. Considering that the diameter loss caused by such technical factors is approximately 15%, the actual cross-sectional area of the PV reconstruction would be reduced 28%. If the native graft PV is smaller than usual, the PV cross-sectional area loss would be exaggerated, and the PV insufficiency can happen.

The underlying causes of small graft PVs were different in our two cases. The donor of the first case had a congen-

Fig. 2. Portal vein reconstruction in Case no. 1. (A) Computed tomography of the donor shows a waist at the left portal vein (arrow). (B–D) Wedged-patch venoplasty is performed to the graft portal vein using an iliac vein homograft patch. (E) After portal vein reconstruction, the patch is intervened between the recipient and donor portal veins (arrow). (F) Computed tomography taken at two weeks after transplantation shows a streamlined portal vein without noticeable stenosis.

Fig. 3. Portal vein reconstruction in Case no. 2. (A–C) Wedge-patch venoplasty is performed to the graft portal vein using an iliac vein homograft patch. (D) End-to-end portal vein reconstruction is performed with adequate size matching. (E) After portal vein reconstruction, the patch is intervened between the recipient and donor portal veins (arrow). (F) Computed tomography taken at one week after transplantation shows a streamlined portal vein without noticeable stenosis. A tissue expander is placed to prevent dextro-rotation of the small liver graft.

ital waist at the first-order branch of the donor PV. Such a finding is not clinically significant except for left liver graft donation. The donor of the second case had a type III portal vein anomaly [7], so the PV transection plane had to be moved excessively toward the PV umbilication portion to protect the right anterior PV branch. Regardless of the graft PV size, we had previously considered a single graft PV to be a no-touch area because manipulation of the single PV is usually unnecessary. Meanwhile, unification of two graft PV orifices at the back table has been accepted as a standard procedure [1,8-11]. In thinking out of the box, we devised wedge-patch venoplasty for a small graft PV. The surgical technique for wedge-patch venoplasty is intuitive and simple because we accumulated similar experience on graft hepatic vein venoplasty [12]. We here present the cases of left PV venoplasty, which also have been applied to LDLT using a right liver graft with a single PV orifice. Regardless of the shape and size of the graft PV, our surgical technique with wedge-patch venoplasty could effectively offset the anastomosis-associated mechanical stenosis

because it converted the graft PV into a standard shape. Thus, it can be included as a part of graft standardization in LDLT.

The availability of a vein patch is essential for patch venoplasty. A vein homograft from deceased or tissue donors is the most suitable material, but it is usually limited in short supply in many LDLT centers. As an alternative, any small vein segment that can be recovered from the living donor's abdomen, such as an ovarian, gonadal or inferior mesenteric vein, can be a useful small vein patch [13]. Currently, cryopreserved femoral vein and artery, and greater saphenous vein homografts are available through the Korea Public Tissue Bank and institutional tissue banks [14]. All human tissues were donated and stored at the tissue bank after informed consent was obtained from donors' family members. All procedures for vascular tissue procurement and processing were complied with Korean legislation and conformed to the ethical and safety concerns for therapeutic use.

In conclusion, we believe that our wedge-patch

venoplasty technique can be applied to small graft PV to cope with PV-size mismatching in LT using a partial liver graft.

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CONFLICT OF INTEREST

All authors have no conflicts of interest to declare.

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AUTHORS' CONTRIBUTIONS

Conceptualization: SH. Data curation: JMN, KMK, SHO. Methodology: TYH, HK. Visualization: SH. Writing - original draft: SH, JMN. Writing - review & editing: All.

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