CLINICAL STUDY

Long-Term Outcome of Percutaneous Transhepatic Balloon Angioplasty for Portal Vein Stenosis after Pediatric Living Donor Liver Transplantation: A Single Institute's Experience

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ABSTRACT

Purpose: To evaluate retrospectively the long-term outcomes of percutaneous transhepatic balloon angioplasty performed for portal vein stenosis (PVS) after pediatric living donor liver transplantation (LDLT).

Materials and Methods: Between October 1997 and December 2013, of 527 pediatric patients (age < 18 y) who underwent LDLT in a single institution, 43 patients (19 boys, 24 girls; mean age, 4.1 y ± 4.1) were confirmed to have PVS at direct portography with or without manometry and underwent percutaneous interventions, including balloon angioplasty with or without stent placement. Technical success, clinical success, laboratory findings, manometry findings, patency rates, and major complications were evaluated. Follow-up periods after initial balloon angioplasty ranged from 5–169 months (mean, 119 mo).

Results: Technical success was achieved in 65 of 66 sessions (98.5%) and in 42 of 43 patients (97.7%), and clinical success was achieved in 37 of 43 patients (86.0%). Platelet counts improved significantly. Of 32 patients undergoing manometry, 19 showed significant improvement of pressure gradient across the stenosis after percutaneous transhepatic balloon angioplasty. At 1, 3, 5, and 10 years after balloon angioplasty, the rates of primary patency were 83%, 78%, 76%, and 70%, and the rates of primary-assisted patency were 100%, 100%, 100%, and 96%. Two major complications subsequent to balloon angioplasty were noted: severe asthma attack and portal vein thrombosis.

Conclusions: Percutaneous transhepatic balloon angioplasty is a safe and effective treatment with long-term patency for PVS after pediatric LDLT.

ABBREVIATIONS

LDLT = living donor liver transplantation, PVS = portal vein stenosis, PVT = portal vein thrombosis

Liver transplantation is an established treatment for end-stage liver disease (1). Although deceased donor liver transplantation is considered a standard procedure, living donor liver transplantation (LDLT) has been widely performed owing to the shortage of donors (2,3). LDLT and split liver transplantation are technically demanding because of the use of short vascular pedicles, which are more likely to cause postoperative vascular complications. The rate of portal vein complications after deceased donor liver transplantation has been reported to be < 3% (4–7). However, in patients with reduced-size liver transplantation or LDLT, the rate of portal vein complications can be higher (9%–14%) than in patients with conventional deceased donor liver transplantation (8–11). Portal vein complications are divided mainly into anastomotic portal vein stenosis (PVS) and portal vein thrombosis (PVT) (12). Anastomotic PVS can lead to graft failure if not properly treated. Treatment options for PVS after liver transplantation are surgical treatment and percutaneous interventions, including percutaneous transhepatic

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balloon angioplasty and stent placement (13). However, surgical treatment of these complications has been limited owing to technical difficulties or invasiveness. At the present time, the surgical treatment of PVS has been replaced by percutaneous balloon angioplasty and stent placement because they are less invasive and more effective (7,14–19). The purpose of our study was to evaluate retrospectively the long-term outcomes of percutaneous transhepatic balloon angioplasty for anastomotic PVS in pediatric patients after LDLT.

MATERIALS AND METHODS

The Human Subjects Research Review Board at our institution approved our protocol and retrospective study and did not require informed consent. Informed consent for portography and interventional procedures was obtained from patients or parents of patients.

Patients

Between October 1997 and December 2013, 527 pediatric patients (age < 18 y) underwent LDLT in our department of surgery. PVS was clinically suspected with the following findings: (*i*) clinical symptoms of portal hypertension, such as ascites, splenomegaly, gastrointestinal tract bleeding from varices, and thrombocytopenia, and (*ii*) ultrasound (US) findings, including > 50% stenosis (diameter of stenosis/diameter of a main portal vein on the mesenteric side), no flow in the portal vein, or the presence of an acceleration of flow at the stenosis or a poststenotic jet flow or minimal flow in the intrahepatic portal vein on Doppler US. Complications of the biliary tract and hepatic vein and artery were excluded on the basis of findings on computed tomography, US, and Doppler US. Additionally, rejections, recurrence or progression of primary disease, and hepatic vein complications were excluded on the basis of liver biopsy findings.

Using direct portography with or without manometry, 44 patients were confirmed to have PVS. Our inclusion criteria for PVS were (*i*) > 50% stenosis (diameter of the stenosis/diameter of a portal vein on the distal side) or (*ii*) > 5 mm Hg pressure gradient across the stenosis between the proximal and distal portal vein. One patient, who died of infection 8 days after direct portography and successful percutaneous balloon angioplasty, was excluded from the study because of the short follow-up. The characteristics of the remaining 43 patients are shown in the **Table**. There were 15 patients who overlapped with our previous study (18). All 43 patients underwent percutaneous interventions, including balloon angioplasty with or without stent placement. The age of the patients ranged from 7 months to 19 years (mean ± SD, 4.1 y ± 4.1) at the first intervention. The interval between liver transplantation and the first percutaneous intervention was 2–118 months (mean ± SD, 21.9 mo ± 25.1). The intervention was performed in 2 patients in the subacute period, 1–3 months after LDLT; in the other 41 patients, the intervention was performed 4–118 months after LDLT.

Table. Patient Characteristics

Characteristic	Data
Sex	
Boy	19
Girl	24
Age at initial percutaneous intervention	
Range	7 mo–19 y
Mean	4.1 y
Mode of transplantation	
Lateral segment	38
Left lobe	5
Original disease	
Biliary atresia	36
Wilson disease	3
Alagille syndrome	2
Hemangioendothelioma	1
Hypergalactosemia	1

Procedures

Four authors (M.Y., Tos.S., Toy.S. and K.S.) with 5, 29, 17, and 5 years of experience in interventional radiology performed the procedures. Percutaneous interventions were performed with general anesthesia in all patients. The approach to the intrahepatic portal vein was transhepatic in all patients at the first session. The portal vein was punctured using an 18-gauge needle (Hanako Medical Co, Ltd, Saitama, Japan) under US and fluoroscopic guidance. The needle was exchanged for a 7.0-F sheath (Brite Tip; Cordis, Roden, The Netherlands) over a 0.035-inch guide wire (Cook, Inc, Bloomington, Indiana). A 0.032-inch angled hydrophilic guide wire (Terumo, Tokyo, Japan) and a 5.0-F catheter with a hockeystick-shaped tip (Cook, Inc) were used to traverse the stenotic lesion. After a 5.0-F catheter was placed at the superior mesenteric vein, direct portography with or without manometry was performed. When PVS was very severe, manometry was not performed to avoid passing through PVS again with the guide wire after manometry. Balloon angioplasty was performed with a 7.0-F percutaneous transluminal angioplasty catheter (Powerflex Plus; Cordis Corporation, Warren, New Jersey) with a balloon diameter of 6–12 mm and a length of 40 mm. The balloon diameter was matched to the size of the mesenteric vessel leading to the stenosis. The balloon was inflated three times for 60 seconds with an atmospheric pressure of 10 atm. Portography with or without manometry was repeated to evaluate the effectiveness of the balloon angioplasty. For hemostasis, the sheath was pulled back to the portal vein puncture site,