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CASE REPORT

Successful treatment of pulmonary hypertension secondary to congenital extrahepatic portocaval shunts (Abernethy type 2) by living donor liver transplantation after surgical shunt ligation

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Summary

In this report, we describe a living donor liver transplantation (LDLT) in a patient (7-year-old boy) with Abernethy type 2 congenital extrahepatic portocaval shunts (CEPS). This patient underwent a surgical shunt ligation as the first treatment for pulmonary hypertension; pulmonary hypertension was improved and controlled successfully 4 years after the first operation. However, pulmonary hypertension recurred gradually because of multiple intrahepatic portosystemic shunts; therefore, LDLT was performed as a radical treatment of intrahepatic portosystemic shunts. His pulmonary arterial pressure was also controlled 22 months after LDLT, the postoperative continuous intravenous prostaglandin I_2 (PGI_2) treatment could be withdrawn successfully. We suggest that clinicians carefully follow up the recurrent portosystemic shunt and cardiopulmonary disorders secondary to Abernethy type 2 CEPS.

Introduction

Congenital extrahepatic portocaval shunts (CEPS), also known as Abernethy malformations, are characterized by congenital diversion of portal blood away from the liver – either an end-to-side or side-to-side shunt. This uncommon disease is frequently associated with other anomalies, and is classified into two types depending on the diversion [1]. One is congenital absence of the portal vein (side-to-end anastomosis, Abernethy type 1 shunt); the other is a shunt composed of a side-to-side anastomosis with hypoplastic portal blood flow into the hepatic parenchyma (Abernethy type 2 shunt) [1].

As Abernethy type 2 CEPS is very rare, the therapeutic selection is still controversial-either shunt ligation or liver transplantation [2]. We previously reported the successful surgical ligation of a large portosystemic shunt in a 3-year-old boy with Abernethy type 2 CEPS using an intrapulmonary shunt [3]. Four years after surgical ligation, the same patient showed gradual signs of relapse of multiple intrahepatic systemic shunts and pulmonary hypertension.

In this study, we describe the first case of living donor liver transplantation (LDLT) for Abernethy type 2 CEPS after surgical shunt ligation led to successful control of pulmonary hypertension.

Case report

This patient had been followed up because of his hypergalactosemia at a local hospital. When he was 3 years old, the patient was found to have mild lip cyanosis,

exertional dyspnea, clubbed fingers, and mild liver dysfunction with high transaminase- and ammonia levels. A cardiac catheterization and ^{99m}TcMAA scintigraphy demonstrated an intrapulmonary shunt without pulmonary hypertension. Abdominal ultrasonography and computed tomography showed a large communication between the portal vein and the inferior vena cava. Pre- and intraoperative portography revealed collapsed intrahepatic portal branches and a portocaval shunt. The patient was diagnosed with Abernethy type 2 CEPS with an intrapulmonary shunt. As intraoperative liver biopsy showed only mild fatty liver (macrovesicular steatosis: 15%) without fibrosis, surgical ligation of the portosystemic shunt was performed successfully on March 24, 2003, with intraoperative portal venous pressure monitoring. The patient was discharged on postoperative day (POD) 22 without any postoperative complications (including portal hypertension) [3].

The patient's pulse oximetry (SpO_2) in room air and exertional dyspnea improved postoperatively, and his intrapulmonary shunt rate decreased gradually. He returned to normal life without any symptoms.

However, 45 months after the operation (when the patient was 7 years old), the patient showed symptoms of dyspnea, lip cyanosis, and wet cough. On emergency admission, he was hypoxic with high baseline blood gases (PO_2 = 55 mmHg; CO_2 = 67 mmHg; percutaneous oxygen saturation = 80% with room air). Emergency cardiac ultrasonography demonstrated extreme dilatation of the right atrium and ventricle, collapse of left ventricle, and extreme pulmonary arterial dilatation. Systolic and mean pulmonary arterial pressure (PAP) was estimated at 68.1 mmHg, and 36.2 mmHg by cardiac ultrasonography. As the patient was diagnosed with pulmonary hypertensive crisis and right cardiac failure, we immediately initiated oxygen supply and the continuous intravenous administration of PGI_2 and dopamine.

After the first week of treatment initiation, the aforementioned symptoms improved. Estimated systolic (31.2 mmHg) and mean PAP (20.6 mmHg; using cardiac ultrasonography) were lower. A cardiac catheterization was performed, which showed that the actual PAP ranged from 42 to 20 mmHg (mean = 29 mmHg) using oxygen supply (FiO_2 = 0.2) and continuous PGI_2 infusion (9.6 ng/kg/min). The intrapulmonary shunt rate was 5.5% as measured using ^{99m}TcMAA scintigraphy.

Abdominal computerized tomography revealed that the right branch of the portal vein was absent; the left branch of the portal vein fed the right lobe of the liver via a large intrahepatic systemic shunt (Fig. 1). We, therefore, diagnosed pulmonary hypertension secondary to the intrahepatic systemic shunt. We decided to perform liver transplantation, as (i) the surgical ligation or interventional embolization were considered very difficult because of the large intrahepatic systemic shunts; (ii) the hypoplastic portal venous system remained even after local treatment; and (iii) the patient's pulmonary hypertension deteriorated.

On May 18, 2007, the patient underwent living donor liver transplantation, receiving the left lobe graft from his father (blood type = compatible; graft volume = 340 g; graft-recipient weight ratio = 1.62%). Intraoperative finding showed neither chronic hepatitis nor liver cirrhosis. However, slight atrophy of the right hepatic lobe was observed. The previously ligated extrahepatic portosystemic shunt seemed to be a cord-like structure without patency.

Macroscopic findings of the resected specimen demonstrated that the right Glisson's sheath was hypoplastic (Fig. 2a), and there were intrahepatic shunts in the atrophic right lobe (Fig. 2b). Postoperative histologic findings of the explanted liver specimen revealed that the portal venules were extremely dilated, and arterial dilatation was observed predominantly in the right lobe. The intrahepatic shunts corresponded to the dilatations of the portal venules. In the right Glisson's sheath, the native right branches of the portal vein were hypoplastic. The native liver showed mild steatosis (about 5%), no inflammatory change, and no fibrosis.

The patient showed no postoperative surgical complications or progression of pulmonary hypertension. He was

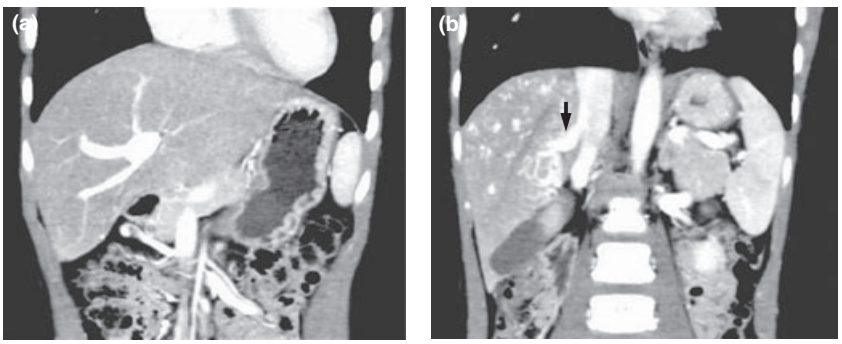

Figure 1 (a) An abdominal computed tomography (CT) scan revealed that the right branch of the portal vein was absent and the left branch of the portal vein was connected to the right lobe of the liver. (b) The large intrahepatic systemic shunt (black arrow) appeared between the intrahepatic portal venous branches and inferior vena cava.

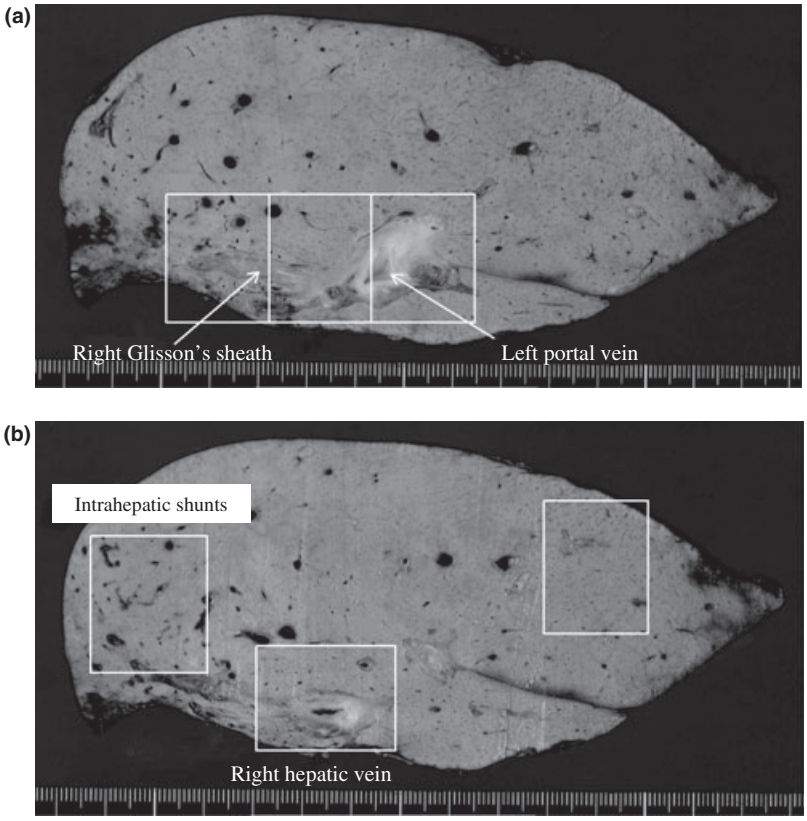

Figure 2 (a) Macroscopic examination of the resected specimen demonstrated that the right Glisson's sheath was hypoplastic. (b) The presence of intrahepatic shunts in the atrophic right lobe. The image shows no evidence of inflammatory change or fibrosis.

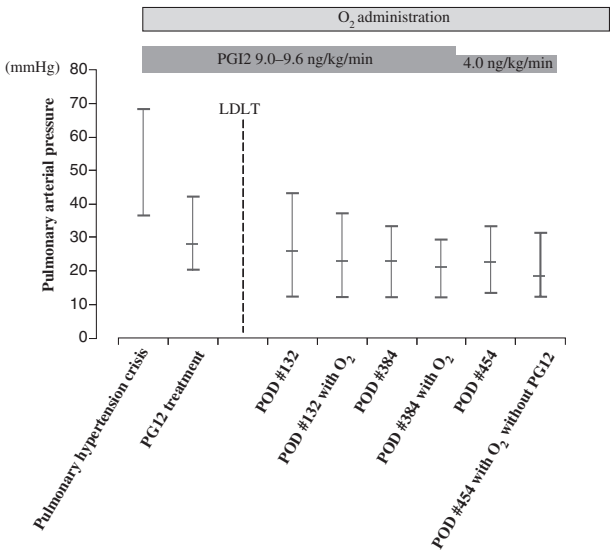

Figure 3 Serial changes of pulmonary arterial pressure. Pulmonary hypertension gradually improved, and the dose of PGI_2 was incrementally decreased. The patient's pulmonary artery pressure normalized and the discontinuation of continuous PGI_2 treatment was achieved on POD#454 after living donor liver transplantation.

discharged from the hospital on POD#58 with a nasal O_2 supply and continuous PGI_2 infusion.

His pulmonary hypertension was followed up by pediatric cardiologists. His pulmonary pressure was evaluated by cardiac ultrasound and cardiac catheterization. His pulmonary hypertension gradually improved, and the dose of PGI_2 was lowered incrementally (Fig. 3). Finally, his mean pulmonary artery pressure normalized and the discontinuation of continuous PGI_2 treatment was achieved on POD#454 after LDLT. The discontinuation of nasal O_2 supply was scheduled after the confirmation of improved results at the next cardiac catheterization.

Discussion

With regard to therapeutic strategy in CEPS, liver transplantation may be required to provide a patent portal system, to treat the metabolic abnormalities, and to treat the underlying liver diseases in patients with Abernethy type 1 CEPS [4].

Most pediatric patients with Abernethy type 2 CEPS have a liver dysfunction such as jaundice [1,5], respiratory symptoms such as cyanosis, dyspnea caused by

hepatopulmonary syndrome [2,6], and pulmonary hypertension; middle-aged or elderly patients may have encephalopathy [7,8]. Table 1 shows the previously recorded profiles of pediatric patients with Abernethy type 2 CEPS.

In Abernethy type 2 shunts, the portal vein is generally intact, but the portal blood is diverted into the vena cava through a side-to-side extrahepatic communication. Most patients with Abernethy type 2 shunts can be treated by ligating or banding the shunt vessels while monitoring portal pressures so as to not induce portal hypertension [1,2,5,6].

Postoperative portal hypertension can occur after shunt ligation in some cases (5, 8). Because of this, intestinal engorgement, refractory ascites, and portal vein thrombosis may develop. Furthermore, Kanamori *et al.* reported the formation of a new portosystemic shunt through the collateral vessels 4 months after shunt ligation [5]. The pathogenesis of portal hypertension after shunt ligation may be caused by hypoplasia of the portal vessel bed in the liver [5].

In this case, although the surgical ligation of CEPS was initially performed successfully (with no postoperative portal hypertension) [3], the patient developed a large intrahepatic systemic shunt and pulmonary hypertension 4 years after the initial operation.

As surgical ligation or complete embolization were considered problematic (because of the size of the shunt), we decided to perform liver transplantation. Kamata *et al.* described successful secondary shunt ligation after the intrahepatic portal branches were increased by the banding of the shunt [9]. However, even though the intrahepatic portal branches seem to grow after ligation (presumably because of increased intrahepatic blood flow), our case demonstrated: (i) communications between the portal vein and hepatic vein, and (ii) that the hypoplasia of the portal vein may remain harmful in the long term.

Moreover, native livers in CEPS have potentials to develop liver tumors including focal nodular hyperplasia, hepatoblastoma, hepatocellular carcinoma and hepatocellular adenoma (5). Therefore, considering the recurrent of portal hypertension and portosystemic shunt and the potential for occurrence of liver tumor, total hepatectomy of native liver and liver transplantation would be necessary for CEPS in the long term; just hepatectomy including the hyperplasia of portal vein and intrahepatic systemic shunt is an inadequate treatment.

To-date, no research has reported the long-term postoperative course (more than 4 years) of Abernethy type 2 CEPS patients after ligation. This case report demonstrated that careful follow up after ligation should be essential in the long term, as liver transplantation may be required.

The association between CEPS and pulmonary hypertension is not known, nor is the association between CEPS and hepatopulmonary syndromes such as intrapulmonary shunts. Alvarez *et al.* speculated that Abernethy malformation should be included as one of the etiologies of hepatopulmonary syndrome, because nonmetabolized substances (bypassing the liver) can be responsible for the imbalance between vasodilatation and vasoconstriction of pulmonary circulation [10]. Several reports have demonstrated that intrapulmonary shunts can be treated successfully by the ligation of CEPS [2,3,9] or liver transplantation [4].

Despite recent advancements, severe pulmonary hypertension (over 35 mmHg) is a severe contraindication in liver transplantation. Although the clinical significance of liver transplantation in pulmonary hypertension is still unclear, we expect that liver transplantation has some potential for the treatment of pulmonary hypertension.

In the therapeutic strategy for Abernethy type 2 CEPS, shunt ligations may be suitable therapy for patients

Table 1. Type 2 congenital extrahepatic portocaval shunts in pediatric patients.

Case	Reference	Age/gender	Symptom	Treatment	Complication	Prognosis
1	Howard & Davenport [1]	5 days/M	Pulmonary insufficiency	(–)	BA, polysplenia	18 days died
2	Howard & Davenport [1]	6 weeks/M	Jaundice	Ligation	(–)	3 years alive
3	Howard & Davenport [1]	9 weeks/M	Jaundice	Ligation	(–)	2 years alive
4	Howard & Davenport [1]	7 weeks/M	Jaundice	(–)	PVA	Unknown
5	Kamata *et al.* [9]	6 years/M	Hypoxia, liver dysfunction	Banding, ligation	Intrapulmonary shunt	2 years 4 months alive
6	Kanamori *et al.* [5]	4 years/F	Liver dysfunction, liver mass	Ligation	Brain atrophy	1 year alive
7	Yoshimoto *et al.* [6]	10 years/F	Cyanosis, dyspnea	Ligation	HPS	6 months alive
8	Tercier *et al.* [2]	5 years/M	Cyanosis, dyspnea	Ligation	HPS	4 years alive
9	Current case	7 years/M	Cyanosis, dyspnea	Ligation–> LDLT	Pulmonary hypertension	4 years alive* 22 months alive†

*After shunt ligation.

†After LDLT.

BA, biliary atresia; PVA, percutaneous vascular access; HPS, hepatopulmonary syndrome; LDLT, living donor liver transplantation.

without portal hypertension. However, we should also consider the potential recurrent portosystemic shunt, intrapulmonary shunts, and cardiopulmonary disorders such as pulmonary hypertension.

Conclusion

We have reported the first successful case of LDLT for Abernethy type 2 CEPS, 4 years after shunt ligation. Pulmonary hypertension (secondary to Abernethy type 2 CEPS) was also controlled 22 months after LDLT. Clinicians should follow up the recurrent portosystemic shunt and cardiopulmonary disorders in Abernethy type 2 CEPS.

Authorship

TI: wrote the paper, collected data, designed the paper and performed operation, postoperative management. YO: performed operation, collected data and designed the paper. HD: managed and follow up on pulmonary hypertension. SY: collected data, operation and postoperative management. HK: collected data, operation and postoperative management. HI: collected data, operation and postoperative management. SS: operation and postoperative management. SO: operation and postoperative management. SU: performed operation and designed the paper.

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