Portal vein interposition in living donor liver transplantation for a pediatric hepatoblastoma patient with portal vein tumor thrombosis

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Liver transplantation is accepted as an effective therapeutic option for unresectable hepatoblastoma. We present a pediatric case of hepatoblastoma patient with portal vein tumor thrombosis (PVTT) that occluded the main portal vein completely despite neoadjuvant chemotherapy. The patient was a 36-month-old 17-kg girl suffering from hepatoblastoma with PVTT, which was partially regressed by neoadjuvant chemotherapy. Viable PVTT remained after left hepatectomy and repetition of systemic chemotherapy due to partial treatment response. To remove the tumor completely, we performed living donor liver transplantation using her mother's left lateral section graft. The blood flow from the native portal vein was greater than that from the pericholedochal collaterals, thus we used the native portal vein as the source of portal inflow. A cold-stored fresh external iliac vein homograft was anastomosed to the portal vein stump. Graft implantation was performed using standard procedures of pediatric liver transplantation. The patient recovered uneventfully. She has been undergoing scheduled adjuvant chemotherapy to date. Meticulous design for portal vein reconstruction using interposition vein graft with the remaining splanchnic vein stumps resulted in successful portal vein reconstruction with complete removal of PVTT.

Keywords: Interposition; Venoplasty; Pediatric transplantation; Portal vein tumor thrombosis; Neoadjuvant chemotherapy

INTRODUCTION

Hepatoblastoma is the most common malignant liver tumor in early childhood, accounting for 60%–85% of all pediatric hepatic tumors [1]. The primary treatment for hepatoblastoma is surgical resection. Advances in imaging

technology, neoadjuvant chemotherapy, and surgical resection have improved survival rates [2]. Patients with hepatoblastoma with resectable tumors have disease-free survival rates of 80%–90% [3]. The majority of patients have unresectable hepatoblastomas in initial imaging studies. Some tumors can regress with systemic chemotherapy, and

become resectable, thus surgical resection is indicated [2]. However, some other tumors remain unresectable despite chemotherapy, in which removal of the whole liver with liver transplantation (LT) is indicated because LT is accepted as an effective therapeutic option [4]. Hepatoblastoma that invades bilateral portal branches or the main portal trunk with tumor thrombosis is one of the most unresectable forms of tumors [5]. Although macrovascular invasion is regarded as a poor prognostic factor, the main purpose of LT is to achieve complete surgical resection for chemo-sensitive hepatoblastomas [5,6].

We herein present a pediatric case of hepatoblastoma patient with portal vein tumor thrombosis (PVTT) that occluded the main portal vein completely despite neoadjuvant chemotherapy. The patient was successfully treated with living donor liver transplantation (LDLT) combined with portal vein interposition graft.

CASE PRESENTATION

The patient was a 36-month-old 17-kg girl suffering from hepatoblastoma with PVTT. At 20 months after birth, abdominal distension was detected, and workup studies confirmed the diagnosis of hepatoblastoma with PRE-Treatment EXTent of tumor (PRETEXT) stage IV with PVTT (Fig.

1A) [7]. Initial serum alpha-fetoprotein protein (AFP) level was 2,390,000 $\mu\text{g/L}$. She underwent systemic chemotherapy four times at an outside hospital. The tumor size was gradually reduced and serum AFP level was decreased to 1,054 $\mu\text{g/L}$. Systemic chemotherapy with Children's Oncology Group AHEP 0731 was performed at our institution [8]. The tumor reduced further. However, viable tumor with PVTT remained due to partial response (Fig. 1B). Left hepatectomy was performed to remove the residual tumor at the left liver at the age of 24 months (Fig. 1C, D), for which a 1.5 cm-sized residual hepatoblastoma of epithelial type and mixed embryonal and fetal subtype was diagnosed. There were extensive necrosis and foam cell infiltration with portal vein invasion and microvascular invasion.

Follow-up computed tomography scan showed portal vein thrombosis with cavernous transformation (Fig. 2A), showing maintenance of normal liver function. The patient underwent scheduled chemotherapy. At 6 months after left hepatectomy, filling defects at the portal vein enlarged with elevation of AFP from 27 $\mu\text{g/L}$ to 178 $\mu\text{g/L}$, suggesting tumor recurrence (Fig. 2B). Chemotherapy with vincristine, irinotecan and docetaxel was performed. However, some parts of the tumor still remained, being partially responsive to systemic chemotherapy (Fig. 2C, D).

Thus, we decided to perform LDLT to remove the tumor

Fig. 1. Pretransplant computed tomography findings. (A) At 20 months of age, multiple tumors occupied the whole liver. (B) Tumors were reduced after neoadjuvant chemotherapy, but viable tumor with portal vein tumor thrombosis (arrow) remained. (C, D) Left hepatectomy was performed to remove viable tumors (arrows) at 1 year before liver transplantation.

completely. After we prepared a cold-stored fresh iliac homograft, which was recovered from a deceased organ donor, we performed an LDLT operation after living donor workup.

After laparotomy, the hepatic hilum was meticulously dissected (Fig. 3) and the portal vein collaterals developed along the common bile duct was isolated because such pericholedochal varices could be an inflow source of portal flow (Fig. 4A) [9].

A 320-g left lateral section liver graft was harvested from her 32-year-old mother and unification venoplasty was performed to the graft outflow vein. The graft-to-recipient weight ratio was 1.88%.

For recipient hepatectomy, the pericholedochal varices were transected. However, weak flow was identified from these collateral veins (Fig. 4B–D). The thrombosed native portal vein was extensively dissected to the confluence level of the superior mesenteric vein and the splenic vein. It was transected at this level (Fig. 5A, B). An intraoperative frozen-section biopsy showed absence of tumor involvement at the portal vein resection margin. The blood flow from the native portal vein was greater than that from the pericholedochal collaterals, thus we decided to use the native portal vein as the source of portal inflow. A cold-stored

fresh external iliac vein homograft was anastomosed to the portal vein stump (Fig. 5C, D).

For graft implantation, hepatic vein reconstruction was

Fig. 3. Intraoperative photograph of the recipient liver after mobilization. The blue and yellow vessel loop each encircled the thrombosed native portal vein and the pericholedochal collateral, respectively.

Fig. 2. Pretransplant computed tomography (CT) findings. (A) Portal vein thrombosis with cavernous transformation was visible at 2 months after left hepatectomy. (B) At 6 months after left hepatectomy, filling defects were detected at the portal vein enlarged (arrow). (C, D) CT scan just before transplantation showed the pericholedochal collaterals (yellow arrow) and the occluded confluence portion of the superior mesenteric vein and the splenic vein (red arrow).

Fig. 4. Intraoperative photographs showing transection of the pericholedochal varices. (A) The longitudinal axis of the pericholedochal varices is marked. (B) The common bile duct opening (arrow) is exposed. (C) Weak blood flow (arrow) is identified from the collateral veins. (D) The pericholedochal varices are temporarily clamped.

Fig. 5. Intraoperative photographs showing preparation of the native portal vein. (A, B) The thrombosed native portal vein is extensively dissected to the confluence level of the superior mesenteric vein and the splenic vein, and transected at this level. (C, D) A cold-stored fresh external iliac vein homograft is anastomosed to the portal vein stump.

Fig. 6. Intraoperative photographs of the graft implantation. (A-C) Hepatic vein reconstruction is performed. (D-G) Portal vein reconstruction is performed after careful length adjustment of the interposed vein conduit. (H) The pericholedochal collaterals including the common bile duct are securely ligated after graft reperfusion.

performed (Fig. 6A–C), followed by portal vein reconstruction with careful length adjustment of the interposed vein conduit (Fig. 6D–G). Pericholedochal collaterals including the common bile duct were securely ligated after graft

reperfusion (Fig. 6H). One graft left hepatic artery was reconstructed, and Roux-en-Y hepaticojejunostomy was performed. Since the liver graft was not large for the size of the recipient abdomen, the abdominal wall was repaired primarily.

The resected liver specimen showed a 1-cm-sized residual hepatoblastoma in the portal vein (epithelial type, and mixed embryonal and fetal subtype) without involvement of the portal vein resection margin (Fig. 7). The hepatic parenchyma showed mild fatty change without no fibrosis.

No vascular complication developed after the LDLT operation (Fig. 8). This patient recovered uneventfully. She has been doing well with maintenance of normal AFP level for three months to date. She has been undergoing scheduled adjuvant chemotherapy.

DISCUSSION

The indication for LT for unresectable hepatoblastoma includes tumor having characteristics of multifocal PRETEXT IV without extrahepatic lesion, unifocal centrally located PRETEXT II and III involving the three main hilar structures, or all three of the main hepatic veins and POST-Treatment EXTent of tumor (POST-TEXT) III with

Fig. 7. Gross photograph of the explanted liver. Arrow indicates the portal vein tumor thrombus.

Fig. 8. Post-transplant computed tomography finding taken at 10 days after transplantation. (A) A left lateral section graft is well regenerated. (B) Collateral veins (arrow) are visible around the pancreas. (C, D) The portal vein conduit is anastomosed at the confluence portion of the superior mesenteric vein and the splenic vein (arrows).

macroscopic vascular invasion [1-4,6]. In the present case, the tumor invaded bilateral portal branches with tumor thrombosis in the main portal vein trunk. While neoadjuvant chemotherapy induced marked regression of the tumors and shrinkage of PVTT, PVTT persisted or recurred at the main portal vein with complete portal vein occlusion and development of pericholedochal collaterals. Because viable tumor cells were present at pretransplant imaging studies, we prudently decided to perform LDLT because of intraoperative hematogenous tumor spread and incomplete removal of PVTT due to extensive portal vein tumor involvement.

The main concern during planning LDLT in the present case was how to obtain sufficient portal inflow. We planned two tracks. The first was using the pericholedochal varices for portal inflow with closure of the common bile duct opening [9]. The second was using the native portal vein stump with vein interposition [10,11]. We chose the latter because the amount of blood outflow from the native portal vein was greater than that from the pericholedochal varices. Post-transplant three-dimensional reconstruction images of the portal vein reconstruction showed that portal flow was well drained from the smooth streamlined confluence of the native superior mesenteric vein, the splenic vein and other collateral veins.

During deceased organ donor surgery, sizable vessel homografts were retrieved after obtaining a written consent for tissue donation, which were registered in the tissue bank at our institution. To use a vessel homograft in a fresh state, it can be stored in a 4°C histidine-tryptophan-ketoglutarate solution within seven days in principle instead of cryopreservation [12].

In conclusion, our patient underwent LDLT for hepatoblastoma with PVTT that occluded the main portal vein completely. Meticulous design for portal vein reconstruction using interposition vein graft with the remaining splanchnic vein stumps resulted in successful portal vein reconstruction with complete removal of PVTT.

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CONFLICT OF INTEREST

All authors have no conflicts of interest to declare.

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

REFERENCES

1. Parkin DM, Stiller CA, Draper GJ, Bieber CA. The international incidence of childhood cancer. *Int J Cancer* 1988;42:511-520.
2. Perilongo G, Maibach R, Shafford E, Brugieres L, Brock P, Morland B, et al. Cisplatin versus cisplatin plus doxorubicin for standard-risk hepatoblastoma. *N Engl J Med* 2009;361:1662-1670.
3. Trobaugh-Lotrario AD, Katzenstein HM. Chemotherapeutic approaches for newly diagnosed hepatoblastoma: past, present, and future strategies. *Pediatr Blood Cancer* 2012;59:809-812.
4. Kasahara M, Ueda M, Haga H, Hiramatsu H, Kobayashi M, Adachi S, et al. Living-donor liver transplantation for hepatoblastoma. *Am J Transplant* 2005;5:2229-2235.
5. Kanazawa H, Sakamoto S, Matsunami M, Sasaki K, Uchida H, Shigeta T, et al. Technical refinement in living-donor liver transplantation for hepatoblastoma with main portal vein tumor thrombosis - a pullout technique. *Pediatr Transplant* 2014;18:E266-E269.
6. Otte JB, de Ville de Goyet J, Reding R. Liver transplantation for hepatoblastoma: indications and contraindications in the modern era. *Pediatr Transplant* 2005;9:557-565.
7. Roebuck DJ, Aronson D, Clapuyt P, Czauderna P, de Ville de Goyet J, Gauthier F, et al.; International Childhood Liver Tumor Strategy Group. 2005 PRETEXT: a revised staging system for primary malignant liver tumours of childhood developed by the SIOPEL group. *Pediatr Radiol* 2007;37:123-132; quiz 249-250.
8. Katzenstein HM, Langham MR, Malogolowkin MH, Krailo MD,

- Towbin AJ, McCarville MB, et al. Minimal adjuvant chemotherapy for children with hepatoblastoma resected at diagnosis (AHEP0731): a Children's Oncology Group, multicentre, phase 3 trial. *Lancet Oncol* 2019;20:719-727.
9. Moon DB, Lee SG, Ahn CS, Hwang S, Kim KH, Ha TY, et al. Restoration of portal flow using a pericholedochal varix in adult living donor liver transplantation for patients with total portosplenomesenteric thrombosis. *Liver Transpl* 2014;20:612-615.
 10. Hwang S, Kim DY, Ahn CS, Moon DB, Kim KM, Park GC, et al. Computational simulation-based vessel interposition reconstruction technique for portal vein hypoplasia in pediatric liver transplantation. *Transplant Proc* 2013;45:255-258.
 11. Namgoong JM, Hwang S, Oh SH, Kim KM, Park GC, Ahn CS, et al. Living donor liver transplantation with total pancreatectomy and portal vein homograft replacement in a pediatric patient with advanced pancreatoblastoma. *Ann Hepatobiliary Pancreat Surg* 2020;24:78-84.
 12. Hwang S, Bae JH, Kim IO, Hong JJ. Current vascular allograft procurement, cryopreservation and transplantation techniques in the Asan Medical Center Tissue Bank. *Ann Liver Transplant* 2021;1:79-85.