Inferior vena cava stenting for middle hepatic vein deprivation-induced graft outflow vein obstruction in a patient who underwent living donor live transplantation: A case report with 22-year follow-up

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Inferior vena cava (IVC) stenting is known to be effective for treating IVC stenosis following liver transplantation (LT). We present the 22-year posttransplant course of a recipient of adult living donor LT (LDLT) who survived after IVC stenting. The patient was a 48-year-old male with hepatitis B virus-associated liver cirrhosis. The recipient underwent LDLT using a right liver graft without middle hepatic trunk or reconstruction. He was 170 cm in height and 65 kg in body weight. The model for end-stage liver disease score and graft-to-recipient ratio were 26 and 1.54%, respectively. Early computed tomography (CT) scan showed massive congestion of the right anterior section. Massive ascites was drained through abdominal drains and drainage volume was increased to 14 L/day at 30 days after LT. Simulative analysis of serial CT images revealed that excessive regeneration of the right posterior section compressed the IVC, which induced outflow occlusion of the inferior right hepatic vein. A self-made wall stent was inserted to relieve the IVC occlusion at 38 days after LT, which resulted in disappearance of pressure gradients within the retrohepatic IVC. Soon after stenting of this IVC, the amount of ascites was progressively decreased. The abdominal drain was successfully removed at 102 days after LT, and the patient was discharged at 106 days after LT. For 22 years after LDLT, the patient has been doing well without any noticeable complications. In conclusion, we believe that IVC stenting seems to be an effective treatment to cope with IVC stenosis due to various causes following LT.

Keywords: Middle hepatic vein; Right liver graft; Hepatic venous congestion; Stenosis; Living donor liver transplantation

INTRODUCTION

Although living donor liver transplantation (LDLT) had been originally developed as a solution to organ shortage in pediatric patients [1,2], it has been extended to adult patients in Asian countries where there was scarcity of deceased donors [3]. The major limitation of adult LDLT is graft-size matching. The majority of left liver grafts were considered to be small-for-size for large-sized adult recipients, thus a right liver graft (RLG) has been used to meet the metabolic demand of adult recipients. We have previously reported about the five cases of adult LDLT by using an RLG without middle hepatic vein (MHV) trunk or reconstruction in our institution, among the 46 cases of LDLT from December 1994 to February 1998 [4]. Among them, three patients survived after LDLT, but two patients suffered serious hepatic venous congestion (HVC) due to MHV outflow deprivation. One patient died due to graft failure and another patient survived after inferior vena cava (IVC) stenting. These early experiences of adult LDLT using an RLG contributed to the invention of a modified RLG. We present the 22-year posttransplant course of a recipient of adult LDLT who survived after IVC stenting.

CASE PRESENTATION

The patient was a 48-year-old male with hepatitis B virus-associated liver cirrhosis. He was 170 cm in height and 65 kg in body weight. The model for end-stage liver disease score was 26, with moderate amount of ascites. The living donor was his 33-year-old brother who was 166 cm in height and 69 kg in body weight. Preoperative computed tomography (CT) volumetry showed that the left and right liver volumes were 509 mL and 1,261 mL, respective-

ly. Considering the poor general condition of the patient, the left liver appeared to be too small to ensure success of LDLT. Thus, we decided to use an RLG. An RLG without MHV trunk was harvested. The weight of the RLG was 1,000 g, thus the graft-to-recipient ratio was 1.54%. The RLG graft had one 15 mm-sized right hepatic vein (RHV) orifice, one 20 mm-sized inferior right hepatic vein (IRHV) orifice, one 10 mm-sized segment V (V5) orifice, and one 8 mm-sized segment VIII (V8) orifice. The RHV and IRHV were reconstructed for graft implantation with sacrifice of V5 and V8 during parenchymal transection of the donor liver. Following graft hepatic vein anastomoses, reconstruction of one right portal vein, one right hepatic artery, and Roux-en-Y hepaticojejunostomy was performed.

During the early posttransplant days, liver enzyme levels decreased uneventfully, but serum total bilirubin sustained high levels (Fig. 1). The 1-week CT scan showed massive congestion of the right anterior section, which corresponded to the MHV-deprived area (Fig. 2). Massive ascitic fluid was drained through the abdominal drains, and the drainage volume was increased to 14 L/day at 30 days after liver transplantation (LT) (Fig. 3). Simulative analysis of CT images revealed that excessive regeneration of the right posterior section compressed the retrohepatic IVC (Fig. 4), which induced outflow occlusion of the IRHV. We presumed that the primary cause of massive ascites was occlusion of IRHV, V5 and V8. To restore the IRHV outflow, we performed IVC venogram at 38 days after LT. Because there was a significant pressure gradient between the suprahepatic and infra hepatic IVC portions, a self-made wall stent was inserted to relieve the IVC occlusion (Fig. 4). This procedure resulted in disappearance of pressure gradients within the retrohepatic IVC. Soon after stenting of this IVC, the amount of ascites was progressively decreased (Fig.

Fig. 1. Laboratory findings during the early posttransplant period. ALT, alanine transaminase.

Fig. 2. Posttransplant computed tomography scan showing progressive resolution of hepatic venous congestion at the right anterior section. IVC, inferior vena cava.

Fig. 3. Changes in the amount of drained ascitic fluid during the first three months after transplantation. IVC, inferior vena cava.

Fig. 4. Illustration presenting the mechanism of IVC compression by excessive regeneration of the right posterior section and its expansion by IVC stenting. IVC, inferior vena cava; RHV, right hepatic vein; IRHV, inferior right hepatic vein.

Fig. 5. Serial posttransplant computed tomography scans showing the venous drainage status at the right hepatic vein (RHV) and inferior right hepatic vein (IRHV) levels.

Fig. 6. Posttransplant computed tomography images with 3-dimensional reconstruction taken at 18 years after transplantation showing good patency of the inferior vena cava stent.

3). The abdominal drain was successfully removed at 102 days after LT, and the patient was discharged at 106 days after LT. For 22 years after LT, the patient has been doing well without any noticeable complications (Fig. 5, 6).

DISCUSSION

The present case showed a unique phenomenon of the retrohepatic IVC occlusion induced by compensatory hypertrophy of the right posterior section, which was initiated by MHV occlusion-induced HVC at the right anterior section [4]. Because the IRHV was a dominant outflow vein, its occlusion induced significant impairment of the venous outflow. Such hemodynamic impairment was similar to that in Budd–Chiari syndrome. IVC stenting induced restoration of the IRHV outflow because it relieved the extrinsic compression induced by the hypertrophied right posterior section. The present case was the first case of IVC stenting in our experience of more than 6,000 cases of LDLT. These clinical sequences provided valuable information on the association between hepatic hemodynamic changes and disproportionate liver regeneration, which greatly contributed to the invention of a modified RLG in our institution [5].

IVC stenting is proven to be an effective procedure for resolving IVC stenosis. Its main indication is IVC occlusion induced by extrinsic compression. We have previously presented a case of IVC stenting to relieve stenosis from side-to-side cavo-caval anastomosis in an adult patient who underwent deceased whole LT [6]. During recipient hepatectomy, the abdomen was heavily adhered because of the previous four hepatectomies and one bowel surgery. The suprahepatic IVC was heavily adhered to the diaphragm, hence extensive dissection for clamping of the IVC at the level of the diaphragm was not possible. Inevitably, graft outflow vein reconstruction using a double IVC reconstruction technique was performed after dissection of the retrohepatic IVC. Early follow-up CT showed extrinsic compression-associated stenosis of the reconstructed IVC, so IVC wall stenting was performed to resolve the graft outflow vein obstruction.

IVC stenting has been sporadically reported following LT or hepatectomy. Huber et al. [7] evaluated the technical efficacy and safety of stent angioplasty of IVC in 16 patients who underwent LT or hepatic resection. IVC stent placement was technically successful in 100% of cases and clinical success was achieved in 81.3% of cases, including two patients with early restenosis and one patient who suffered from thrombosis distal to the stent. During a

mean follow-up of 372 days, primary patency and primary assisted patency rates were 75.0% and 93.8%, respectively.

Donaldson et al. [8] presented a case series analysis and meta-analysis to assess the efficacy of stenting of post-transplant IVC stenosis. LT recipients treated for symptomatic IVC stenosis at a major medical center from 1996 to 2017 were assessed. The case series included 40 patients (31 treated with stents; nine treated without stents). Meta-analysis of 5,277 records identified 17 eligible studies involving 73 patients. Stenting was effective in resolving the gradient in 100% of patients and in relieving symptoms in 85% of patients. Primary stent patency with a median follow-up period of 556 days was seen in 96% of patients. Stenting for IVC stenosis after LT was clinically effective and durable, with 96% of stents showing long-term patency and 85% of patients experiencing symptom relief.

We also reported the efficacy of stent placement for treating IVC stenosis and the patency of hepatic veins following IVC stent placement [9]. Fourteen LT recipients underwent stent placement for treating IVC stenosis. The median interval between LT and stent placement was 32 days. Stents varied from 20 to 36 mm in diameter and 60 to 120 mm in length. Stent placement was successful in all patients. Clinical success was achieved in 12 patients. Four patients underwent hepatic vein balloon angioplasty or stent placement through IVC stent meshes either immediately (n=1) or 12 to 110 days after (n=3) IVC stent placement.

The IVC is a low-velocity high-flow vein, which obviates the need for anticoagulation. We did not apply anticoagulation therapy even in recipients who underwent LDLT with IVC replacement using a synthetic vascular graft [10].

In conclusion, we believe that IVC stenting seems to be an effective treatment to cope with IVC stenosis due to various causes following LT.

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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: TYH, CSA, DBM.
 Methodology: GWS, DHJ, GCP, SGL. Visualization: SH. Writing - original draft: SH, TYH. Writing - review & editing: All.

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