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Rescue of outflow block of the remnant left liver after extended right hemihepatectomy for resection of a tumor in the caudate lobe

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Abstract: Outflow block of the liver is a life-threatening event after living donor liver transplantation. Herein, we rescued a patient suffering from the outflow block of the remnant left hemiliver caused by bending of the left hepatic vein (LHV) after right hemihepatectomy plus caudate lobectomy combined with resection of the middle hepatic vein (MHV). A metastatic tumor sized 6 cm in the caudate lobe of the liver involving the root of the MHV was found in a 50's year old patient after resection of a right breast cancer eight years ago. Right hemihepatectomy and caudate lobectomy combined with resection of the MHV was performed using a two-stage hepatectomy (partial TIPE ALPPS). On day 1, the total bilirubin value increased to 4.5 mg/dL, and a dynamic computed tomography (CT) scan showed the bent LHV. On the diagnosis of outflow block of the left liver, a self-expandable metallic stent was placed in the LHV using an interventional approach, and the pressure in the LHV decreased from 27 cmH_2O to 12 cmH_2O. The bilirubin value decreased to 1.2 mg/dL on day 3. Outflow block of the LHV can happen after extended right hemihepatectomy with resection of the MHV. Early diagnosis and interventional stenting treatment can rescue the patient from congestive liver failure.

***Keywords*:** ALPPS, interventional stenting, left hepatic vein, liver failure, outflow block

Introduction

It is technically demanding to resect a metastatic tumor involving the major hepatic veins located in the caudate lobe of the liver. Extended hepatectomy with/without venous reconstruction using venous grafts has been performed occasionally (*1,2*), however there has been no report on the treatment for outflow block of the remnant liver caused by bending of the remnant major hepatic vein after major hepatectomy.

Outflow block of the liver is a serious problem unique to living donor liver transplantation (LDLT) seldomly found in orthotopic liver transplantation, which can be found in 6.5–7.1% after LDLT using left liver graft (*3-5*). Venous congestion of the transplanted graft can result in congestive liver failure. Thus, it is mandatory to make enough orifice of the major hepatic veins using venous grafts during outflow reconstruction of the right/left hemiliver graft (*6,7*).

Herein, we report on the interventional treatment in a patient suffering from outflow block of the left hepatic vein (LHV) after right hemihepatectomy plus caudate lobectomy combined with resection of the middle hepatic vein (MHV).

Patient & Surgical technique

The patient was a 60's year-old woman who underwent partial mastectomy and radiotherapy for a Stage I right breast cancer nine years ago. A metastatic hepatic tumor in the caudate lobe of the liver and thoracic nodal metastases were found four years after surgery. She received local radiotherapy and chemotherapy for three years. The response was stable disease for nodal metastases, however the hepatic tumor increased in size. Contrast-enhanced computed tomography (CT) showed a 60 × 50 mm low attenuation tumor in the caudate lobe of the liver. The tumors involved the three major hepatic veins, inferior vena cava (IVC) and the hepatic hilum (Figure 1A). Suppose that extended right hemihepatectomy was conducted, the future liver remnant volume (FLRV) was estimated as 27%. Indocyanine green retention (ICG) rate was 4.4%, and ICG-Krem was 0.056, which suggested marginal safety of upfront extended right hemihepatectomy. Thus, preoperative right portal vein embolization (PVE) to increase the remnant left hemiliver was necessary. However, the left portal vein appeared stenotic and compressed by the tumor (Figure 1B) and there was

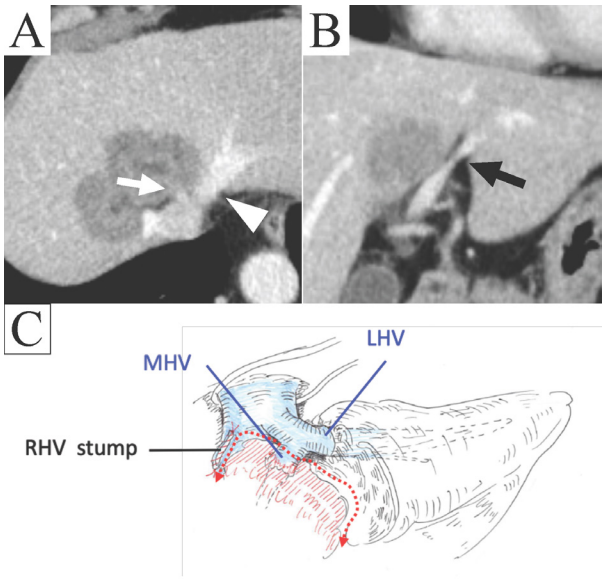

Figure 1. (A) Dynamic CT scan images of the liver tumor in the caudate lobe before surgery. The tumor involved roots of the three major hepatic veins. Middle hepatic vein (white arrow), left hepatic vein (white arrow head). **(B) The left portal vein appeared stenotic compressed by the tumor (black arrow). (C) The MHV was divided while preserving the LHV circumferentially.** CT, computed tomography; LHV, left hepatic vein; MHV, middle hepatic vein.

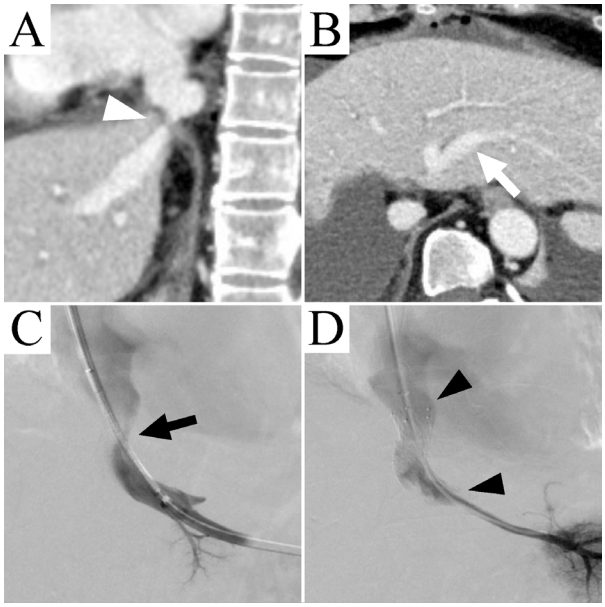

Figure 2. (A) Contrast-enhanced CT the day after 2nd stage hepatectomy. The bending of remnant LHV (white arrow head). **(B) The LHV trunk is patent (white arrow). (C) Interventional treatment of the stenosis of the remnant left hepatic vein through the right jugular vein.** The black arrow shows the stenotic point on the root of the left hepatic vein. **(D) A self-expandable stent was bridged between the left hepatic vein and the IVC.** The black arrow heads indicate the both ends of the stent. CT, computed tomography; LHV, left hepatic vein; MHV, middle hepatic vein.

a considerable possibility that right PVE remarkably increases the portal pressure.

Therefore, we introduced two-stage hepatectomy named partial TIPE ALPPS (*8,9*), that is, associating liver partial partition associated with trans-ileocecal portal vein embolization for staged hepatectomy. Briefly, at the 1st stage, exploration of the resectability of the tumor focusing on the left hilar plate, partial partition of the liver along the Rex-Cantlie's line preserving the MHV, and trans-ileocecal right PVE using digital subtraction image were performed. We confirmed that the tumor could be dissected from the hepatic hilum and IVC or major hepatic veins safely. The portal pressure increased from 10 cmH_2O to 15 cmH_2O before and after PVE suggestingenough patency of the left portal vein. Three weeks after the 1st stage, the FLRV was 36.2% (576 mL) and ICG-Krem was 0.057. Right hemihepatectomy plus total caudate lobectomy combined with resection of the MHV was performed. Fortunately, the tumor was dissected from the hepatic hilum and IVC completely. The confluent of LHV and MHV was strongly compressed by the tumor and the LHV was stretched longitudinally. The MHV was divided while preserving the LHV circumferentially (Figure 1C). Immediately after hepatectomy, the remnant left hemiliver transiently palpated elastic hard suggesting mild congestion. Adequate antegrade venous flow of the LHV was repeatedly confirmed using Doppler ultrasonography before closure of the abdomen. The falciform ligament was shrunk after two stage hepatectomies, and thus was not fixed on the midline incision.

On day 1, the total bilirubin value increased to 4.5 mg/dL. Dynamic CT scan showed the bending of the remnant LHV (Figure 2A) and the enlarged remnant left hemiliver (800 mL) deviated to the right side (Figure 2B). On the diagnosis of outflow block of the remnant left liver, an emergent interventional stenting was performed *via* the right jugular vein (Figure 2C). A self-expandable stent (Epic, Boston Scientific, Marlborough, MA, USA) with a size of 12 mm diameter and 6 cm length was deployed between the LHV and IVC (Figure 2D). The venous pressure in the LHV decreased from 27 cmH_2O to 12 cmH_2O. The bilirubin value decreased to 1.2 mg/dL on day 3 and the patient was discharged on day 15.

Cause of outflow block of the left hepatic vein and it's solution after right hemihepatectomy

Venous outflow block of the remnant liver happened after right hemihepatectomy plus total caudate lobectomy with resection of the MHV. The caudate large tumor stretched the confluent of the LHV and MHV, in other words, the stretched LHV was supported by the tumor with the MHV. Thus, the LHV lost support by the tumor and MHV after surgical resection and was bent. This rapidly caused the congestion of the remnant

left liver leading to congestive liver failure. Emergent placement of the metallic stent in the LHV decreased the venous pressure by 15 mmH_2O, and thereby prevented irreversible liver failure.

Hepatic venous outflow block is one of the serious complications leading to graft dysfunction after LDLT. The size, length and angle of the hepatic venous anastomosis and the graft position in the abdomen will affect the occurrence of outflow block (*4,5*). Outflow block can be found more often in the left liver graft rather than right liver graft, because the smaller left graft regenerates toward the right and dorsal side, and the topological position of the LHV and/or MHV will be changed rapidly.

In the present case, the size of the LHV was enough, but the stretched LHV losing support by the tumor and MHV was bent, and mild transient congestion of the remnant liver was found intraoperatively. We did not fix the falciform ligament to the midline incision before closure of the abdomen. This may cause bending of the LHV, but simultaneously this may let the remarkable enlargement of the remnant left liver dislodged to the right side, avoiding occlusion of the LHV.

A modified two-stage hepatectomy, named partial TIPE ALPPS was used to obtain enough FLRV before hepatectomy. In the present case, two stage hepatectomy was used *i*) to increase the FRLV effectively, and *ii*) to explore the resectability of the hepatic tumor against the left hepatic duct and IVC or major hepatic veins. Originally ALPPS was introduced in Europe and South America to obtain rapid growth of the FLRV for resection of advanced liver cancers, but was associated with high morbidity and mortality rates up to 9% even in patients with liver metastasis (*10*). Among several modified ALPPS procedures, partial ALPPS will be associated with better hypertrophy of the FLR and with low mortality rates (*11*). In our experience, we have no severe morbidity caused by partial TIPE ALPPS (*8,9*).

In conclusion, we experienced outflow block of the remnant left hemiliver caused by bending of the sole left hepatic vein after extended right hemihepatectomy. It is important to suspect venous outflow block when hyperbilirubinemia and congestion of the remnant liver were found after extensive hemihepatectomy. Prompt interventional stenting will be very effective to restore venous blood flow.

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