Laparoscopic Left Hepatectomy with Middle Hepatic Vein Resection for Hepatocellular Carcinoma with Extrahepatic Portal Vein Obstruction

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Data Collection B
Statistical Analysis C
Data Interpretation D
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Conflict of interest: None declared

Patient:	**Female, 70-year-old**
Final Diagnosis:	**Hepatocellular carcinoma with extrahepatic portal vein obstruction**
Symptoms:	**—**
Medication:	**—**
Clinical Procedure:	**Preoperative simulation and intraoperative navigation technique**
Specialty:	**Surgery**

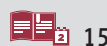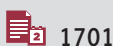**Objective:** **Unusual setting of medical care**

Background: Extrahepatic portal vein obstruction (EHPVO) is one of the most important diseases that causes pre-hepatic portal hypertension, and EHPVO sometimes develops cavernous transformation to maintain hepatopetal flow. In this report, we describe the first case of hepatocellular carcinoma (HCC) with EHPVO having underwent pure laparoscopic left hepatectomy with middle hepatic vein (MHV) resection.

Case Report: A 70-year-old woman with a diagnosis of mixed-type HCC or cholangiocarcinoma located in segment 4b was referred to our hospital, and computed tomography revealed EHPVO with cavernous transformation. We successfully performed pure laparoscopic left hepatectomy with MHV resection by using the individual hilar approach, frequent intraoperative sonography, and indocyanine green imaging. In this case, the routine Glissonian approach was impossible due to cavernous transformation growth and the absence of a portal vein. Therefore, frequent confirmation of intrahepatic flow was crucial to avoid intraoperative complications. The patient was discharged with no complications on postoperative day 7. A histopathological examination revealed that the moderately differentiated HCC formed a pseudoglandular pattern and cord-like structures, thereby defined as type II according to Edmondson's classification.

Conclusions: Currently, difficulty scoring systems for laparoscopic liver resection (LLR) usually contain the procedure and location of the hepatic tumor, but they do not contain the variety of anatomical abnormality due to its rarity. However, the false recognition of hilar vessels and biliary ducts in patients with an anatomical abnormality, including EHPVO, leads to severe injury; therefore, anatomical variety and abnormality are also important factors increasing the difficulty of LLR.

Keywords: **Anatomic Variation • Carcinoma, Hepatocellular • Hepatectomy • Laparoscopy • Portal Vein**

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Background

Extrahepatic portal vein obstruction (EHPVO) is one of the most important diseases that causes pre-hepatic portal hypertension [1]. Most cases of EHPVO are under 20 years old, and only 20% of EHPVO patients are diagnosed at ages over 20 years old. In adult patients with EHPVO, hepatopetal collateral pathways rapidly develop with reconstitution of flow into intrahepatic portal branches; therefore, in adult EHPVO, an apparent causal disease cannot be clinically identified, and liver function abnormalities are not always accompanied by portal hypertension symptoms [2].

Laparoscopic liver resection (LLR) has dramatically advanced in recent years because of technological developments, advances in preoperative assessments, and the publication of guidelines and consensus statements [3,4]. In addition, the Southampton consensus guidelines for laparoscopic liver surgery has concisely clarified LLR indications and implementation [5]. However, LLR demands complex hepatobiliary and pancreatic surgery experience and excellent surgical technique in the setting of anatomical variations or abnormalities in EHPVO. To date, there have been few reports of hepatocellular carcinoma (HCC) in patients with EHPVO since 1987 [6]; furthermore, laparoscopic major hepatectomy for patients with EHPVO has never been reported before. Here, we report the first case of hepatocellular carcinoma (HCC) with EHPVO in a patient who underwent laparoscopic left hepatectomy with middle hepatic vein (MHV) resection.

Case Report

A 70-year-old woman who was followed for nonalcoholic fatty liver disease or hepatic steatosis received abdominal ultrasonography, and a hepatic mass was detected in the left lobe. She was referred to our hospital for further investigation. Her body mass index was 24.6 kg/m^2, and she had no history of diabetes mellitus. A routine laboratory examination revealed only minor elevations in transaminases and tumor markers as follows: aspartate aminotransferase 31 U/L, alanine aminotransferase 31 U/L, platelet count 17.6×10^3/μL, carcinoembryonic antigen 1.5 ng/mL, carbohydrate antigen 19-9 8.0 U/mL, α-fetoprotein 9.5 ng/mL, and protein induced by vitamin K absence or antagonist II 58 mAU/mL, d-dimer 1.2 μg/mL, antithrombin-III 86%. She had no infection history of hepatitis virus or alcohol abuse; therefore, common etiologies of HCC were excluded except for nonalcoholic steatohepatitis. An abdominal ultrasonography examination revealed a hypoechoic mass with halos without intrahepatic bile duct dilatation. A dynamic enhanced computed tomography (CT) examination revealed a 5-cm, hypodense hepatic tumor in segment 4B that invaded the MHV (Figure 1A). This tumor did not stain in arterial phase as do typical HCCs; however, ring enhancement of the tumor was not observed. The portal phase of the CT examination also revealed cavernous transformation from the infrapancreatic superior mesenteric vein to the intrahepatic vessels; therefore, a complication of EHPVO was suspected (Figure 1B, 1C). No radiological signs of liver cirrhosis were observed on CT scan or abdominal ultrasound. Gadolinium-ethoxybenzyl-diethylenetriamine pentaacetic acid magnetic resonance imaging also revealed that the hepatic tumor seemed to be mixed-type HCC or cholangiocarcinoma from the contrast pattern (Figure 2A, 2B). The tumor showed low intensity in the hepatobiliary phase, without dilatation of intrahepatic bile ducts. The preoperative liver volumetry is shown in Figure 3. We could not find any signs of developing varices by esophagogastroduodenoscopy. We did not perform hemodynamic studies because she had no symptoms of portal hypertension. From this work-up, she was diagnosed with mixed-type HCC with EHPVO, and we performed laparoscopic left hepatectomy with MHV resection for this patient owing to the necessity of combined resection of the middle hepatic vein. During this operation, indocyanine green (ICG) imaging
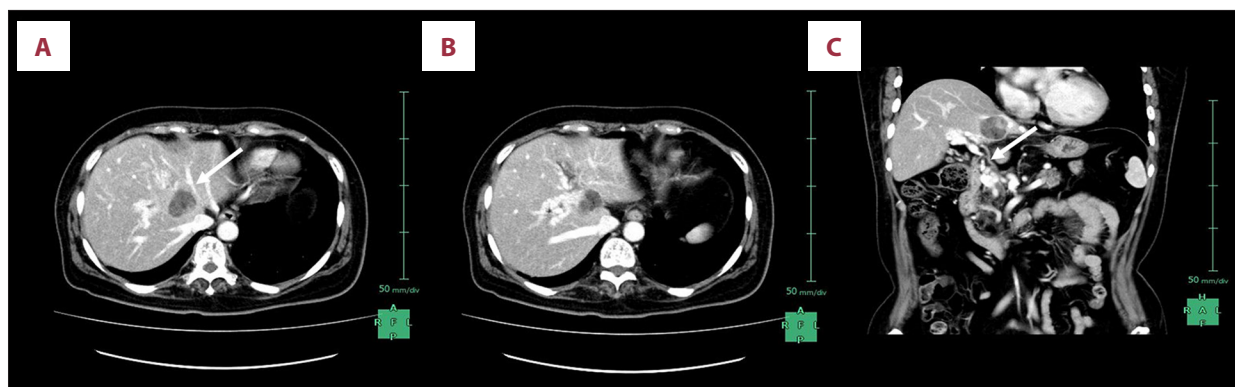

Figure 1. (**A**) An enhanced CT examination revealed that the middle hepatic vein was encased by a low-density mass (white arrow). (**B, C**) The portal phase of the CT examination also revealed cavernous transformation from the infrapancreatic superior mesenteric vein to the intrahepatic vessels (white arrow).
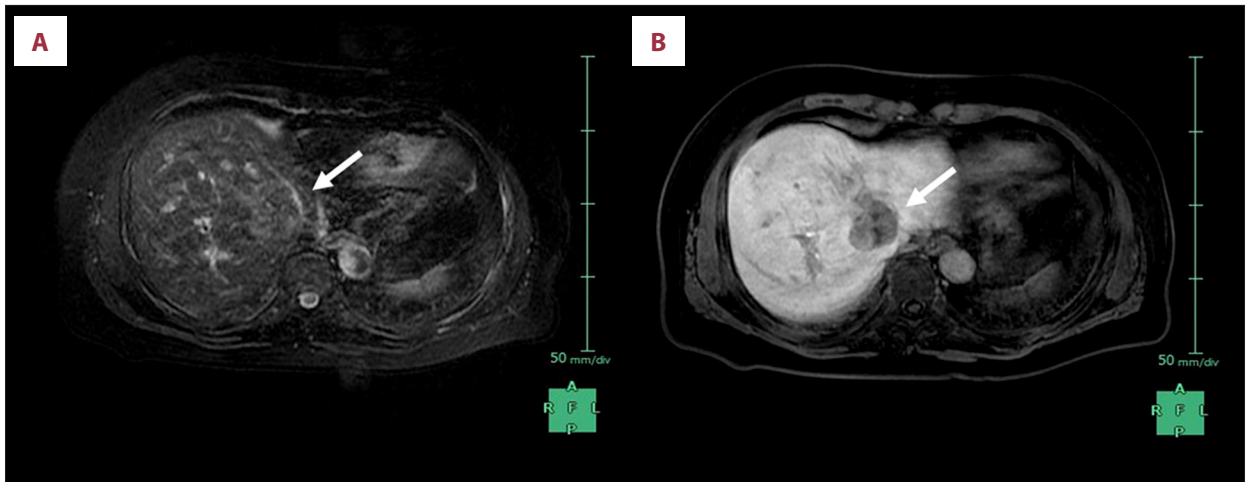
Figure 2. The findings of gadolinium-ethoxybenzyl-diethylenetriamine pentaacetic acid magnetic resonance imaging are shown. (**A**) T2-weighted image revealed that an iso-intensity mass was located in segment 4 (white arrow). (**B**) The tumor showed low intensity in the hepatobiliary phase (white arrow).
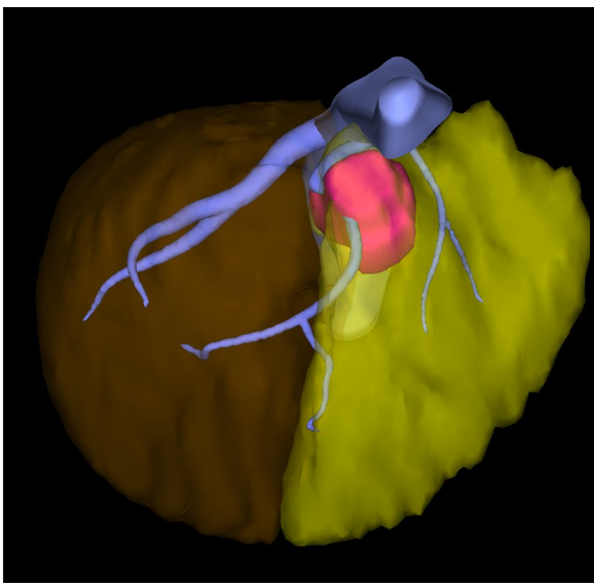

Figure 3. Preoperative volumetry is shown. The middle hepatic vein was encased by the tumor; therefore, we planned to divide the root of the middle and left hepatic veins. The volume of the resected liver, remnant liver, and the tumor were estimated as 248 mL (yellow), 701 mL (brown), and 19 mL (pink), respectively.

Figure 4. Trocar placements are shown.

(PINPOINT; NOVADAQ Technologies, Canada) was used to visualize the demarcation line and branches of hepatic ducts.

The patient was placed in the supine position, and we used a five-trocar technique for usual left-sided laparoscopic hepatectomy (**Figure 4**). During hepatic parenchymal transection, the upper limit of pneumoperitoneum pressure was set to 10-12 mmHg. The falciform and left triangular ligaments were transected and cholecystectomy was performed as usual.
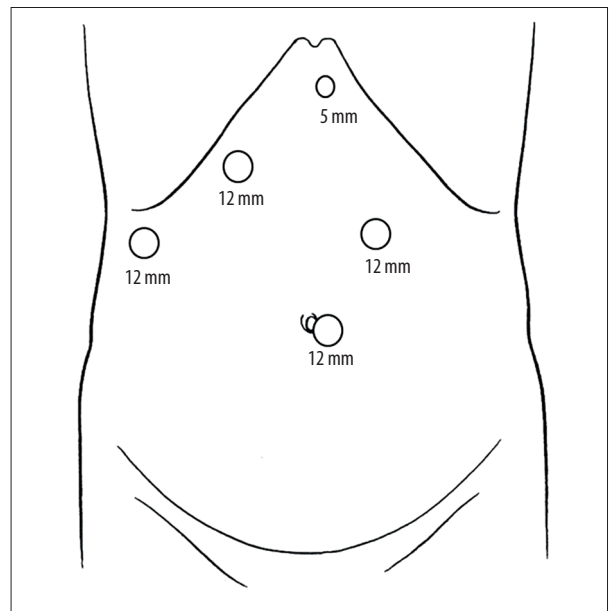
Then, we confirmed the root of the middle and left hepatic veins (**Figure 5A**), and the ductus venosus was clipped and divided (**Figure 5B**). Our usual laparoscopic hilar approach is the Glissonian approach; however, EHPVO with cavernous transformation prevented us from dissecting the left Glissonian pedicle. Therefore, we used an individual approach in this case. We first identified the left hepatic artery, and it was then clipped and divided (**Figure 5C**). A magnified view revealed that cavernous transformation consisted of some small vessels that delivered a hepatopetal flow; therefore, we carefully transected them one by one, using intraoperative sonography to confirm the intrahepatic blood flow in the right lobe (**Figure 5D**). After transecting these small vessels, the demarcation line
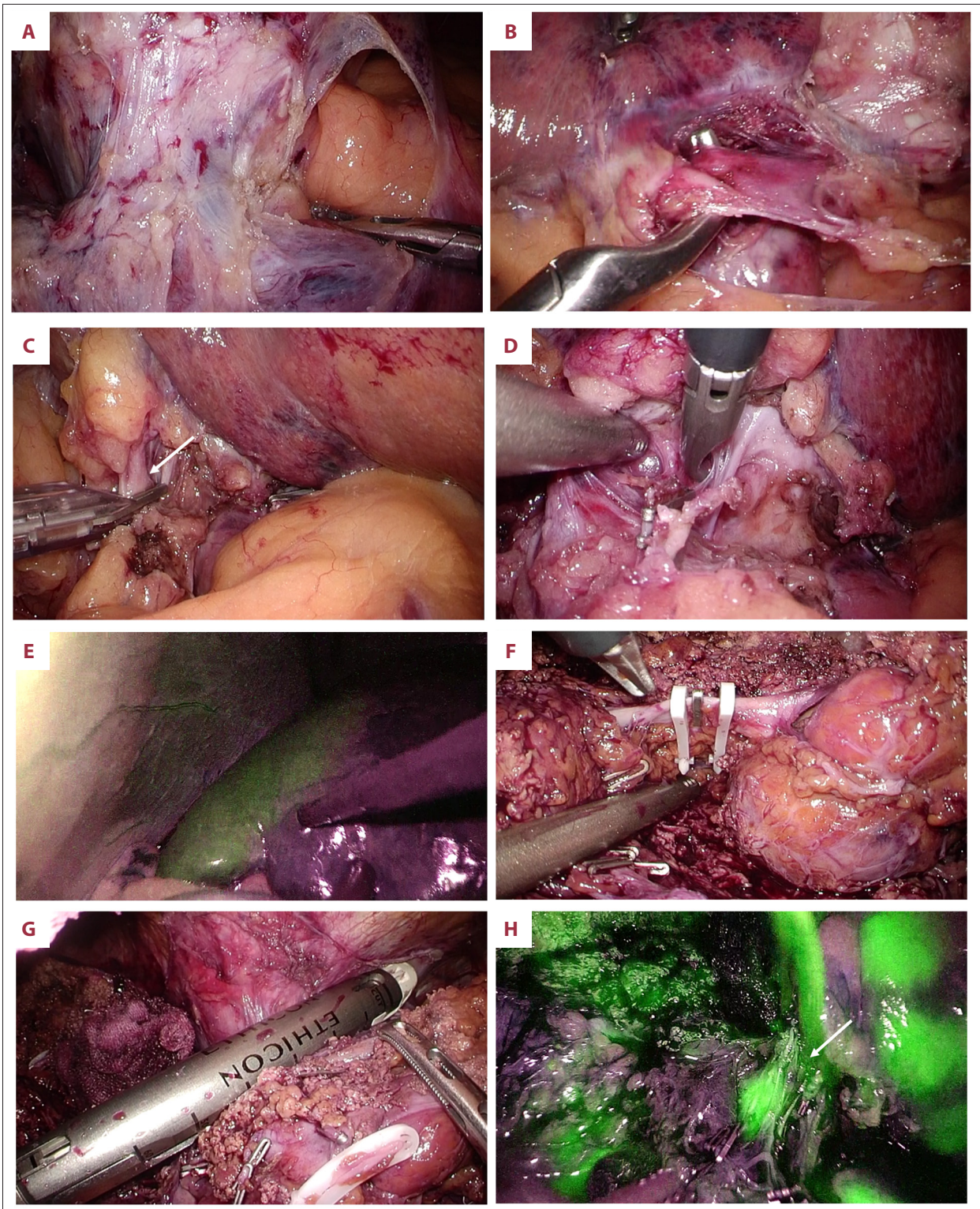
Figure 5. Surgical procedure is shown. (**A**) The root of the left and middle hepatic vein was visualized. (**B**) The ductus venosus was visualized and transected. (**C**) The left hepatic artery was identified and clipped (white arrow). (**D**) Small vessels from cavernous transformation were individually clipped and divided. (**E**) Demarcation line was clarified by ICG imaging. (**F**) The middle hepatic vein was exposed and divided at the tumor invasion. (**G**) The roots of the left and middle hepatic veins were transected by a linear stapler. (**H**) The left hepatic duct was visualized by ICG imaging (white arrow).
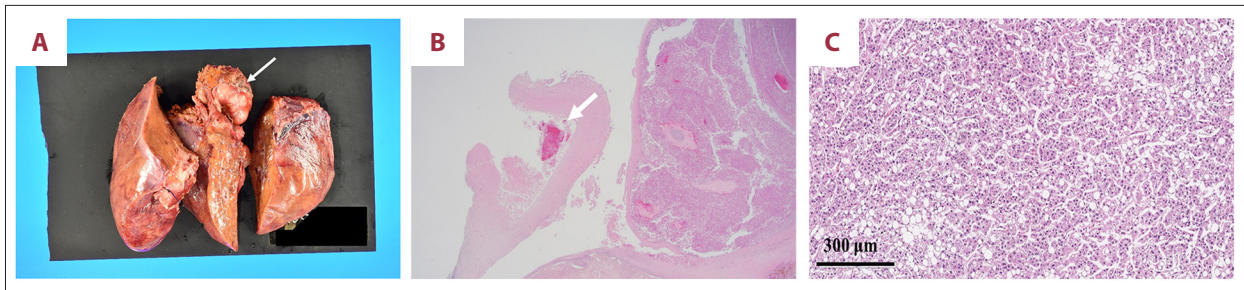
Figure 6. (**A**) Macroscopic findings showed that a capsulized tumor of 38×26 mm in size was located at segment 4 (white arrow). (**B**) The middle hepatic vein was also observed beside this tumor, and intraluminal coagulative necrosis seemed a part of a tumor thrombosis (white arrow). (**C**) A magnified view (×100) also revealed that the moderately differentiated HCC formed a pseudoglandular pattern and cord-like structures.

between the right and left lobes was revealed by ICG imaging (**Figure 5E**). Intraoperatively, 2.5 mg of ICG was injected into the vein to examine the perfusion area of the cystic vein. The demarcation of stained areas within the hepatic parenchyma was marked by electrocautery to determine the transecting line. Then, parenchymal transection was routinely performed along the demarcation line and the MHV, using Pringle's maneuver. We used intestinal clips for Pringle's maneuver because they do not obstruct the operating field, unlike a tourniquet. The superficial parenchyma was transected by vessel sealer, and deep parenchyma was transected by clamp-crush technique. We used high-density monopolar saline-cooled radiofrequency device for hemostasis. The middle hepatic vein was exposed toward the inferior vena cava and divided at the site of tumor invasion (**Figure 5F**). The root of the middle and left hepatic veins was transected using a linear stapler (**Figure 5G**). Finally, the left hepatic duct was visualized by ICG imaging (**Figure 5H**) and transected using a linear stapler. The resected specimen was obtained from an intraumbilical incision. Frequency and total time of Pringle's maneuver were 6 times and 103 minutes and 54 seconds, respectively. The operating time was 285 minutes, and blood loss was 71 mL. A suction drain remained in place for 3 days, and on postoperative day 7, the patient was discharged without any complications. There were no postoperative complications as of 90-day follow-up.

Macroscopic findings of the resected specimens showed that a capsulized tumor 38×26 mm in size was located at segment 4 (**Figure 6A**). The MHV was also observed grossly adjacent to the tumor, and tumor thrombosis was noted, with intraluminal coagulative necrosis (**Figure 6B**). A magnified view also revealed that the moderately differentiated HCC formed a pseudoglandular pattern and cord-like structures (**Figure 6C**); therefore, this HCC was defined as type II according to Edmondson's classification, and was defined as T4N0M0, stage IIIB according to the American Joint Committee on Cancer classification. The minimum surgical margin from the tumor was about 2mm, but there was no exposure of tumor cells. In Japan, no adjuvant chemotherapy is recommended after curative resection of HCC; therefore, the patient receives intensive follow-up with periotic CT examinations. Three months after the operation, the patient showed no signs of recurrence.

Discussion

EHPVO is usually recognized as one of the common causes of noncirrhotic portal hypertension [1,2]. In adults, EHPVO is often diagnosed while evaluating another disease, because some patients with EHPVO have no symptoms of portal hypertension owing to the prompt development of cavernous transformation. There are various speculated etiologies of EHPVO in adults, including trauma, sepsis due to cholangitis and infected pancreatic necrosis caused by severe pancreatitis, umbilical vein catheterization, dehydration, myeloproliferative disorder, coagulation defects, congenital anomalies of the portal vein, malignancy, and cirrhosis [7]; however, there was no clear history of any cause of EHPVO in this case.

The specific phenomenon of EHPVO is cavernous transformation, which distributes to reduce portal pressure and supply hepatopetal flow. However, the precise role of cavernous transformation is still unclear because there are some cases developing severe duodenal varices that bypass from the superior mesenteric vein to the inferior vena cava. In addition, EHPVO sometimes causes ectopic varices in the biliary tract; therefore, cavernous transformation does not always work to reduce portal pressure [8]. Fortunately, there was no history of gastrointestinal bleeding in this case. It is crucial to confirm these histories and findings because potential portal hypertension should be evaluated and treated preoperatively to reduce postoperative complications. With regards to postoperative management in EHPVO patients, frequent abdominal sonography examinations are performed to evaluate hepatopetal flow to the remnant liver, and we checked enhanced CT examination on postoperative day 7 to confirm the absence of any portal vein thrombi.

There is no clear evidence of tumorigenesis of EHPVO; therefore, there have been few reports of hepatectomy in cases with EHPVO. To the best of our knowledge, our report is the first case of HCC with EHPVO having undergone laparoscopic left hepatectomy with MHV resection. LLR has rapidly developed worldwide, and hemihepatectomies in LLR are also routinely performed at high-volume centers [9, 10]. Some difficulty scoring systems have revealed that the procedure and tumor location are important factors for LLR [11,12]. Our previous analyses also revealed that body mass index and platelet count are also factors influencing LLR difficulty, in addition to the above 2 factors [12]. However, anatomical variations and abnormalities are not considered influencing factors due to their rarity and surgical risk because critical anatomical abnormalities and anomalies are very rare. For example, the most notable anomaly of the portal vein is right umbilical portion; the umbilical portion exists between the right anterior and left medial section in this anomaly [13]. Therefore, the usual Glissonian approach consequently leads to complete portal vein clamping. To avoid incorrect transection of the hilar vessels, we used not the Glissonian approach but the individual approach for hilar

dissection, and ICG imaging was also a mandatory technique for such an unusual case [14,15]. In the near future, advances in real-time navigation systems will make LLR a more sophisticated procedure.

Conclusions

We herein report the first case of HCC with EHPVO having undergone laparoscopic left hepatectomy with MHV resection. Currently, LLR with an anatomical abnormality, including EHPVO, is not routinely recommended because these cases have the potential risk of severe intraoperative complications. Only experienced LLR teams can employ various surgical techniques and tactful strategies for difficult LLRs. The individual approach for hilar dissection with intraoperative sonography and ICG imaging was crucial to transect the vessels of cavernous transformation, and LLRs have some advantages of magnified view, close dissection, and controlling intraoperative bleeding by pneumoperitoneum. We have demonstrated that LLR is feasible and safe in patients with EHPVO.

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