Cavoatrial Thrombectomy in Hepatocellular Carcinoma with Tumor Thrombus in the Vena Cava and Atrium Without the Use of Cardiopulmonary Bypass

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Background: Hepatocellular carcinoma (HCC) with tumor thrombus (TT) in hepatic vein, inferior vena cava (IVC), and right atrium (RA) portends a poor prognosis because of intravascular extension leading to rapid distal metastases. En bloc resection of cavoatrial TT without the use of cardiopulmonary bypass (CPB) is challenging. We describe a new method of vascular occlusion for thrombus entering into the RA without the need for CPB as shown in echocardiography.

Methods and Results: Retrospective analysis was carried out in 1 HCC patient, who had undergone hepatectomy with TT extension into IVC and RA. The infrahepatic IVC was occluded with vascular tape and the right atrial appendage was controlled with a Satinsky clamp proximal to the TT. The IVC wall was incised under direct vision from the infrahepatic IVC cranially. The tumor and thrombus were then removed en bloc under direct vision. Thus, cavoatrial thrombectomy was performed under total hepatic vascular exclusion without the use of CPB. He survived for 6 months and died of tumor recurrence.

Conclusions: Using this technique, advanced HCC with cavoatrial TT can be resected safely without CPB and thereby avoid dislodgement of TT and air embolism.

Hepatocellular carcinoma (HCC) with inferior vena cava (IVC) tumor thrombus (TT) is classified into 3 types[1] according to its anatomic location relative to the heart: type I: posterior hepatic type, where the TT is in the retrohepatic IVC and below the diaphragm; type II: superior hepatic type, where the TT is in the suprahepatic IVC but outside the atrium; and type III: intracardiac type, where the TT extends into the right atrium (RA). These 3 types of IVC TT require different methods of vascular control and resection.[1] Techniques for the resection of type III TT have been described using cardiopulmonary bypass (CPB) in conjunction with cardiovascular surgeons.[1–7] Here, we introduce a simple and novel technique for the resection of a liver with a TT without the need for CPB.

CASE REPORT

A 66-year-old man with relatively asymptomatic HCC because of hepatitis B infection was admitted to our clinic. He denied syncope, palpitations, chest discomfort, shortness of breath, and leg swelling. He denied high blood pressure, heart disease, or diabetes. Physical examination was normal. Electrocardiogram and chest X-ray were all normal. Serologic examination result was as follows: white blood cell count 4.60 × 109/L, hemoglobin 130 g/L, platelet

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count 204 × 109/L, total bilirubin (TBil) 7.1 μmol/L, albumin (Alb) 35.8 g/L, alanine aminotransferase (ALT) 44.0 U/L, and aspartate aminotransferase (AST) 38 U/L. Hepatitis B antigen and hepatitis C antibody were negative. Alpha-fetoprotein, carotid endarterectomy, and carbohydrate antigen 19-9 were all within normal range. Abdominal computed tomography and magnetic resonance imaging examinations revealed a 12-cm mass in the right liver with a TT in the IVC, extending from the right hepatic vein to the RA (Fig. 1A). Echocardiography showed intracardiac extension slightly into the RA (Fig. 1B, top). Ultrasound showed the thrombus entering into the IVC (Fig. 1B, bottom). Because the patient had well-preserved liver function without distant metastasis, a resection was performed.

Surgery was performed through a bilateral subcostal incision extended superiorly in the midline, the liver was mobilized and intraoperative ultrasonography was performed to assess the TT in the hepatic vein and IVC. The infrahepatic and suprahepatic IVC were exposed, but only the infrahepatic IVC was encircled with an umbilical method for later total hepatic vascular exclusion (THVE). The suprahepatic IVC was not encircled. Hepatic parenchymal transection using the clamp-crushing technique was performed with inflow occlusion (Pringle's maneuver). The portal veins, bile ducts, and hepatic venous branches were ligated until the IVC was reached, enabling delineation of the relationship of the right hepatic vein containing the TT in connection with the IVC and tumor. The diaphragm was transected via a 5- to 8-cm vertical incision exposing the right atrial appendage. The infrahepatic IVC was occluded with vascular tape and the right atrial appendage was controlled with a Satinsky clamp proximal to the TT. The IVC wall was incised under direct vision from the infrahepatic IVC cranially. The tumor and thrombus were then removed en bloc under direct vision. Thus, cavoatrial thrombectomy was performed under THVE without the use of CPB. The IVC was sewn longitudinally. Subsequently, the Satinsky clamp was released, followed by the infrahepatic IVC occlusion, and finally, the Pringle's maneuver. THVE was maintained for 15 min for the fluid stage of the en bloc resection. During THVE, the patient's hemodynamic condition was carefully monitored and treated by the anesthesiology team. There was no significant change in pulse, blood pressure, and central venous pressure during the THVE. This technique ensures that the TT does not break off and systemically embolize. The diaphragm muscles were sewn and the cut surfaces of the liver were covered by greater omentum. The resected tumor is shown in Figure 2. The total operative time was 3 hr with an estimated blood loss of 800 mL, with 4 U of red blood cell and 4 U of fresh plasma transfused. Continuous abdominal double cannula lavage with low negative pressure drainage was used for 4 days postoperatively. The liver function tests rose to their highest level on the first day after operation, TBil 39.5 μmol/L, Alb 31.6 g/L, ALT 680.1 U/L, AST 474.2 U/L, and then gradually declined. Liver function tests after 3 days revealed the following: TBil 24.7 μmol/L, Alb 33.5 g/L, ALT 301.2 U/L, and AST 165.3 U/L. Liver function tests after 7 days revealed the

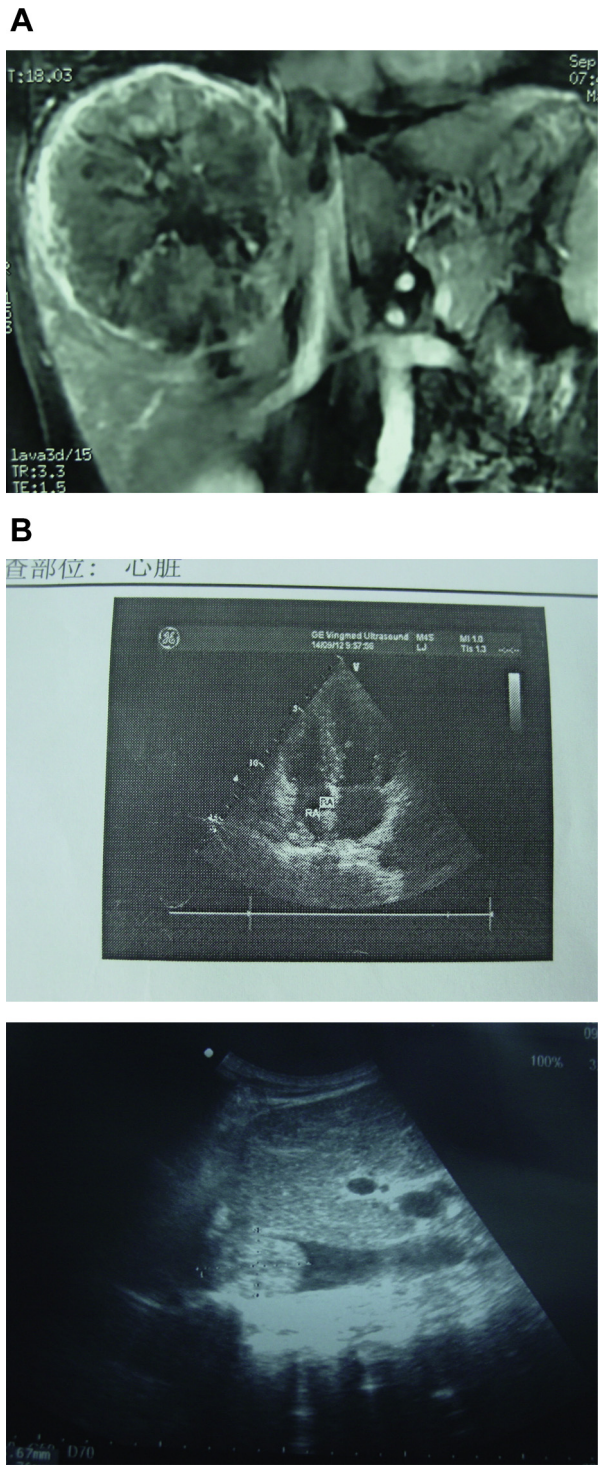

Fig. 1. (**A**) Imaging of HCC with IVC tumor thrombus. Magnetic resonance imaging revealed a 12-cm HCC in the right lobe of the liver with a tumor thrombus advancing into IVC and the RA. (**B**) Echocardiography scans revealing the tumor thrombus extension into the RA (*top*) and ultrasound scan revealing the tumor thrombus in the IVC (*bottom*).