Combined cavo-atrial thrombectomy and hepatectomy in hepatocellular carcinoma

To the Editor:

Hepatocellular carcinoma (HCC) remains one of the commonest cancers worldwide especially in hepatitis B endemic regions. Its aggressive behavior is characterised by the natural history of increasing size, a tendency for vascular invasion into the hepatic veins and portal veins. Further growth into the inferior vena cava (IVC) and right atrium (RA) is an infrequent finding but signifies a pre-terminal event with a dismal prognosis. The reported incidence is 3%-4%.[1] Patients are at high-risk of pulmonary embolism and systemic metastasis. Surgical resection with thrombectomy offers the only chance of tumor clearance and cure. The available evidence for surgery, however, is limited with only small case series and individual case reports published.[1-4] We describe a case of HCC with IVC and RA tumor thrombus successfully treated with combined cavo-atrial thrombectomy under cardiopulmonary bypass (CPB) and hepatectomy.

A 47-year-old Asian man presented with severe right upper quadrant pain. He was a known HBV carrier but otherwise had no significant medical history. Physical examination revealed hepatomegaly with an irregular margin and hard consistency. Liver function tests, platelet count and coagulation screens showed nothing abnormal. Alpha-fetoprotein (AFP) was raised at 3401 ng/mL. Initial computed tomography (CT) scan identified a large right lobar tumor with invasion into the IVC extending to the RA. A rim of hyperdense fluid was seen around the right lobe suggestive of rupture. He was referred to our tertiary center for further assessment and treatment. Formal triphasic CT scan of the abdomen and thorax confirmed a large arterial enhancing tumor with delayed contrast washout occupying most of the right lobe involving segments V-VIII (Fig. 1). The tumor showed central necrosis and measured 11.3×15.5×19.6 cm. There was a satellite tumor (1.7×1.6 cm) in segment V. The right hepatic vein (RHV) was displaced by the tumor, which invaded into the IVC. The tumor mass extended superiorly into the RA and measured 5.8×4.4×4.3 cm (Figs. 2 and 3). Ascites and right pleural effusion were also seen but no pulmonary or other intra-abdominal metastasis could be identified. Dual tracer positron emission tomography (PET) CT scan confirmed this right liver tumor with moderately increased fluorodeoxyglucose (^{18}FDG) uptake (SUV_{max} 4.2), highly suggestive of a moderately to poorly differentiated HCC. There was predominantly ^{11}C-acetate-avid foci (SUV_{max} 8.0) at the upper IVC and RA, consistent with active thrombi. The result of preoperative indocyanine green clearance (ICG) test was 13% at 15 minutes. Left lobe liver volume measured 972 mL. Echocardiogram demonstrated the RA tumor with structurally normal valves. The ejection fraction was 60% and the right ventricular systolic pressure was 30 mmHg.

An elective curative resection with thrombectomy was arranged for this patient. A bilateral subcostal incision with midline extension was used. On entry into the abdominal cavity, approximately 2 L of ascites was seen. The liver was congested due to IVC obstruction. A multifocal hard tumor of 15 cm was seen in the right lobe (Fig. 4). Intraoperative ultrasound confirmed extension of the tumor into the right portal vein, RHV, IVC and RA. The right hepatic artery was prominent. Following ligation of this, liver parenchymal transection by anterior approach was carried out using cavitron ultrasonic surgical aspirator (CUSA). Pringle maneuver (6 cycles at 10 minutes intervals, total 120 minutes) was applied as severe oozing was encountered from the engorged middle hepatic vein (MHV).

Continuing liver transection was hindered by the development of unstable hemodynamics as a result of right ventricular inflow obstruction secondary to ball-valve effect. A median sternotomy was made by the cardiac surgeons. Systemic heparin was then given. The patient was started on CPB via aorta and superior vena cava cannulation. A right atriotomy was made under beating heart. The atrial tumor was extending to the mid atrial septum abutting the tricuspid valve. After excision of the

Fig. 1. Contrast CT showing a large right lobe HCC with arterial enhancement (**A**), contrast washout in porto-venous (**B**) and delayed phase (**C**).

Fig. 2. Sagittal CT showing right lobe HCC with invasion into the IVC and RA.

Fig. 3. CT showing right atrial tumor thrombus.

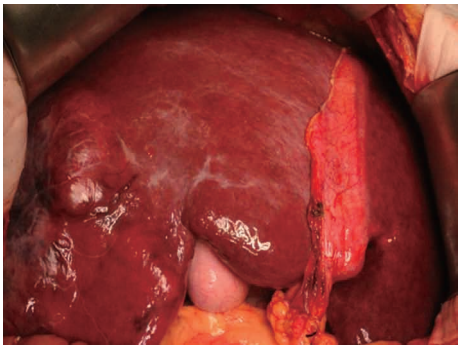

Fig. 4. Intraoperative photo showing right lobe HCC.

tumor, the atrial wall was closed with 4/0 prolene sutures. The total bypass time was 15 minutes. Heparinization was reversed with protamine following which liver transection resumed. Due to significant oozing, further 2 cycles of Pringle maneuver had to be applied before parenchymal transection was completed. Clamping of the supra and infrahepatic IVC was followed by an inverted T-shaped venotomy. The IVC tumor thrombus had a stalk, which was firmly adhered to the RHV and MHV junction. Caval thrombectomy and removal of tumor thrombus stalk was completed. Of particular importance to minimise tumor thrombus dislodgement, by using the anterior approach for right hepatectomy, mobilization of the right lobe was kept until the very end and to a minimum until after IVC thrombectomy and the tumor stalk was excised. Full mobilization of the right lobe for delivery of the specimen then followed. Gross tumor excision was achieved and confirmed by trans-oesophageal echocardiogram. Venotomy was closed with 5/0 prolene continuous sutures. The total blood loss was 30 L.

Postoperative recovery was uneventful and the patient was discharged on day 15. Pathological examination confirmed a moderately differentiated HCC with invasion into portal and hepatic veins. Atrial and IVC thrombi were also consistent with HCC. At 1 month postoperatively CT showed no recurrence of tumor and AFP had dropped to 94 ng/mL. He was started on adjuvant chemotherapy with cepacitabine and oxaloplatin. At 4 months post-surgery, the AFP level rebounded. Reassessment PET/CT identified bilateral pulmonary metastasis. The patient is alive and symptom-free at 7 months.

HCC with tumor thrombus in the IVC and RA poses a significant treatment challenge. Survival is extremely poor and has been quoted to be <4 months without any form of treatment.[5] Patients not only die from a