Advanced renal cell carcinoma (RCC) resection has important anesthetic management implications, particularly when tumor extends, suprahepatic, into the right atrium. Use of transesophageal echocardiogram (TEE) is essential in identifying tumor extension and guiding resection. Latest surgical approach avoids venovenous and cardiopulmonary bypass yet requires special precautions and interventions on the anesthesiologist's part. We present a case of Level IV RCC resected without cardiopulmonary bypass and salvaged by TEE guidance and detection of residual intracardiac tumor.

Key words: Intracardiac thrombus; Renal cell carcinoma; Transesophageal echocardiogram

INTRODUCTION

At the time of diagnosis, renal cell carcinoma (RCC) is accompanied by tumor thrombus in the venous system in up to 10% of cases. Resection of RCC with inferior vena cava (IVC) tumor extension, Levels III and IV, poses a challenge with perioperative morbidity and mortality reaching 50%. Complete surgical removal remains the only potential hope for a cure. Incomplete resection results in 100% 5 years mortality. Surgical techniques adopted from liver transplant surgery allow for complete access to the IVC, and exploration of the right atrium (RA) when necessary, without venovenous or cardiopulmonary bypass. Whereas such techniques avoid the risks of cardiovascular bypass (i.e., coagulation system disturbances, longer operating times, systemic inflammatory response), the chance for hemodynamic compromise is increased during vena cava exploration and venous return interruption. Anesthesia monitoring with transesophageal echocardiogram (TEE) is essential for surgical resection and hemodynamic surveillance. In this case report, we describe the innovative surgical technique for the resection of advanced RCC without the use of venovenous or cardiopulmonary bypass. We also portray the vital role that continuous TEE monitoring played in detecting residual intra-atrial tumor and altering operative plan.

CASE REPORT

A 68-year-old female diagnosed with advanced RCC, Level IV, presented for right radical
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Surgery proceeded with a bilateral subcostal anterior incision with cardiothoracic surgical team and cardiopulmonary bypass team placed on standby. Using the methods adopted from liver transplantation surgery “piggyback technique,” the liver was mobilized, hepatic veins were exposed, and the IVC was isolated with subsequent vascular exclusion of the liver. After clamping the renal vein and IVC distal to the kidney, a clamp was applied at the cava-atrial junction under TEE surveillance; to ensure that the tumor was entirely isolated below the clamp. Hemodynamic stability was maintained during vena cava flow interruption using fluid boluses through the right internal jugular central line and vasopressors. The surgeon then performed cavotomy from the level of the diaphragm to the renal vein. Under continuous TEE monitoring, the tumor was pulled from the RA through the IVC. The procedure was deemed successful with the RA and PAs free of tumor thrombus by TEE exam. The cava was reconstructed, sutured, and the cava-atrial clamp was moved below the hepatic veins. The hepatic pedicle clamp, Pringle maneuver, was released restoring portal vein and hepatic artery blood flow through the liver and hepatic veins.

Further examination by TEE revealed what appeared to be a tumor remnant attached to the atrial wall [Figure 1b, Arrow]. The gross specimen was inspected and found to be missing a tissue fragment [Figure 2, Arrow]. Surgical exploration was deemed necessary. Via a transdiaphragmatic approach, a clamp was placed on the IVC superior to the hepatic veins. Next, the RA was clamped above the level of the tumor aided by TEE imaging. The pericardium and intrapericardial IVC were opened and the remaining tumor was removed, whereas fluid boluses and vasopressors maintained hemodynamic stability.

A final TEE exam revealed the RA, hepatic veins, and PAs to be free of thrombi. Patient was transferred intubated to the ICU for postoperative care after an estimated blood loss of 1200 ml and total fluid administration of 8000 ml.

DISCUSSION

Surgical resection remains treatment mainstay for RCC. Traditionally, venovenous bypass was employed to eliminate the hemodynamic disturbances caused by IVC clamping during advanced RCC resection. For tumors extending into the RA, cardiopulmonary bypass and total circulatory arrest were performed.\(^5\) However, novel surgical techniques borrowed from liver transplant surgery, piggyback technique, have allowed for exposure and isolation of the IVC during tumor resection thereby sparing the use of vascular bypass.\(^2,4\)

Figure 1: Transesophageal echocardiogram modified midesophageal bicaval view showing (a) tumor in right atrium prior to resection, (b) residual tumor post resection
RCC with tumor thrombus extending to the suprahepatic IVC can be resected while employing a series of clamps in succession on the IVC that allow for minimal venous return interruption. The extent of IVC tumor involvement dictates surgical approach. Intrahepatic Level III thrombi are removed via a transabdominal diaphragmatic incision and a suprahepatic IVC clamp placed above the level of the tumor guided by TEE. For Level IV thrombi, tumor extending into the RA, the heart is pulled toward the diaphragm and guided by TEE, the clamp is placed over a portion of the RA making sure not to entrap the tumor.

Once the IVC is opened, the thrombi are quickly milked or resected to a position in the IVC below the hepatic veins. After suturing the IVC, the clamp is then shifted to the infrahepatic IVC and liver inflow and outflow is restored. This partially mitigates the hemodynamic disturbance of impaired lower abdominal venous return.

Using these techniques, both hemodynamic and ischemic consequences are lessened but still require astute care from the anesthesiologist in the form of invasive monitors including arterial line, high volume central line, use of vasopressors, and TEE.

Intraoperative TEE is a low risk procedure that can have a major impact when used in the perioperative management of patients with tumors involving the IVC. TEE is essential for examination of tumor thrombus extension, continuous surveillance, hemodynamic monitoring, avoidance of intra-atrial thrombus shearing during central line insertion, monitoring for tumor embolization to the heart, and guidance of resection.

Real-time TEE visualization of the RA and IVC can help localize the tumor and guide the placement of clamps on the vena cava. In one report, TEE allowed the recognition of residual tumor fragments in the IVC after attempted surgical resection. Oikawa et al. described the intraoperative TEE use to position an intracaval balloon above tumor thrombus and resect without mobilizing the liver.

TEE use is important to identify the tumor migration, before and after resection, within the IVC, hepatic veins, the right heart and the main PA. This is accomplished using (1) the midesophageal four-chamber view, (2) midesophageal bicaval views, (3) the midesophageal right ventricle (RV) inflow-outflow view, (4) the midesophageal aortic valve (AV) short axis view, and (5) the upper esophageal aortic arch short-axis view. Furthermore, Doppler can be used for the assessment of hepatic veins and PA flows.

TEE examination begins from the midesophageal four-chamber view by maximizing display of the RA and IVC-RA junction. With the IVC in view, the probe is advanced in the esophagus to evaluate for tumor extension and occlusion of the vena cava. This modified transgastric view can also be used to verify that all tumor thrombi were resected completely and have not embolized into the hepatic veins. Likewise, the midesophageal bicaval view aids in visualization of the RA, the left atrium, the interatrial septum, the superior vena cava, and the IVC. TEE is indispensable in guiding advanced RCC tumor thrombi resection. As reported in this case, TEE utilization directed intraoperative surgical management, identified the existence of residual tumor in the heart, and altered surgical approach. Understanding this unique surgical procedure and coordinating with surgical team allowed for tumor excision without the use of venous or cardiopulmonary bypass. Vigilance, attention to detail, and communication with surgical team spared the patient from future morbidity due to residual tumor.

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Conflicts of interest
There are no conflicts of interest.
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