

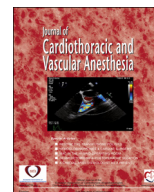
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Case Conference

Successful Team-Based Management of Renal Cell Carcinoma With Caval Extension of Tumor Thrombus Above the Diaphragm

Audrey Spelde, MD^{*}, Toby Steinberg, MD^{*}, Prakash A. Patel, MD^{*}, Harry Garcia, MD^{*}, Jeremy D. Kukafka, MD^{*}, Emily MacKay, DO^{*}, Jacob T. Gutsche, MD^{*}, Jonathan Frogel, MD^{*}, Michael Fabbro, DO[†], Jessie M. Raiten, MD[‡], John G.T. Augoustides, MD, FASE, FAHA^{*1}

^{*}Cardiovascular and Thoracic Section, Department of Anesthesiology and Critical Care, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA

[†]Cardiothoracic Anesthesiology, Department of Anesthesiology, Perioperative Medicine and Pain Management, Miller School of Medicine, University of Miami, Miami, FL

[‡]Department of Anesthesiology and Critical Care, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA

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RENAL CELL CARCINOMA (RCC) represents about 3% to 4% of all cancers, with about 5% to 10% of presentations including extension into the inferior vena cava (IVC) with tumor thrombus.^{1,2} Although surgical resection potentially is curative, the perioperative management is challenging due to life-threatening issues such as massive bleeding and tumor embolism.¹⁻³ This case conference highlights such a challenging case, with a discussion and expert commentaries that outline key perioperative aspects for successful patient outcome.

Case Report^{*}

A 49-year-old woman with a history of hypertension, obesity, diabetes mellitus, smoking, chronic hepatitis C infection, and chronic kidney disease was referred to the authors'

institution for evaluation of right-sided flank pain and hematuria.⁴ The patient's physical examination was notable for fever (temperature 38.3°C), obesity (body mass index 34 kg/m²), and a palpable mass in the right flank. There were no stigmata of cirrhosis. Laboratory studies were remarkable for a creatinine level of 2.2 mg/dL and a hemoglobin level of 11.3 g/dL. The liver function tests were within normal limits. The urinalysis was positive only for hematuria. The patient was culture negative. The electrocardiogram revealed normal sinus rhythm, left ventricular hypertrophy by voltage criteria, and no evidence of ischemia. The chest radiograph revealed a normal cardiac silhouette, features of chronic obstructive pulmonary disease, and no evidence of tumor metastasis.

Transthoracic echocardiography demonstrated normal biventricular systolic function, no significant valvular abnormalities, and mild diastolic dysfunction.⁵ Furthermore, careful echocardiographic evaluation of the right atrium demonstrated caval extension of tumor thrombus across the cavoatrial junction into the proximal right atrium with no further extension into the right heart. Additional detailed diagnostic

¹Address reprint requests to John G.T. Augoustides, MD, FASE, FAHA, Cardiovascular and Thoracic Section, Anesthesiology and Critical Care, Dulles 680, HUP, 3400 Spruce St., Philadelphia, PA.

E-mail address: yandoc@hotmail.com (J.G.T. Augoustides).

^{*}A. Spelde, T. Steinberg, P.A. Patel, H. Garcia, J.D. Kukafka, E. MacKay, J.T. Gutsche, J. Frogel

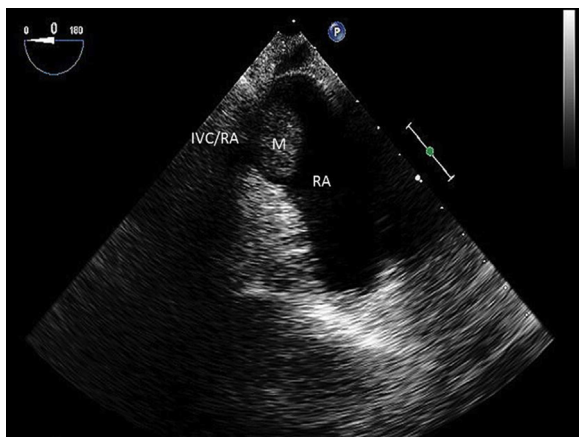


Fig 1. Tumor thrombus extension above the diaphragm. This is a modified midesophageal view demonstrating the IVC, its junction with the right atrium, and the body of the right atrium. The tumor thrombus is visualized extending from the IVC across its junction with the right atrium into the proximal right atrium. IVC/RA, junction of the inferior vena cava with the right atrium; M, tumor thrombus mass; RA, right atrium.

imaging with computed axial tomography and magnetic resonance imaging revealed a large right RCC with paraaortic lymph node involvement and cavoatrial extension, as outlined, with no further metastatic disease.^{1-3,5,6}

After thorough multidisciplinary evaluation, the patient was scheduled for surgical resection by a team that included urologists, vascular surgeons, cardiac surgeons, and cardiac anesthesiologists.^{6,7} The patient was admitted for preoperative heparinization and subsequent ethanol embolization of the right kidney. The renal postinfarction syndrome was mild in severity and responded to symptomatic management, including titrated analgesia and antiemetics (see Discussion). The patient was scheduled for surgical resection 48 hours later.

The surgical plan was right radical nephrectomy with caval thrombectomy. Given the significant suprahepatic extension of the RCC up the IVC into the right atrium, the multidisciplinary surgical team decided on both abdominal and mediastinal exposure to facilitate complete access above and below the liver, with application of cardiopulmonary bypass (CPB) to allow for complete tumor resection.^{6,7}

After placement of standard monitors, as defined by the American Society of Anesthesiologists, the induction of general anesthesia and endotracheal intubation were uneventful. Full invasive hemodynamic monitoring was instituted thereafter with a left radial arterial line, an oximetric pulmonary artery catheter via the right internal jugular vein, and transesophageal echocardiography (TEE).⁸ The pulmonary artery catheter was floated through the right heart with TEE guidance in real time to avoid tumor disruption in the right atrium and IVC. Comprehensive baseline TEE examination confirmed the preoperative echocardiographic findings, including the extension of tumor thrombus up the IVC across the cavoatrial junction (Fig 1). Thorough echocardiographic examination of the right heart at this time revealed no further tumor thrombus in the body of the right atrium, the right ventricle, and the proximal pulmonary artery.

The surgical plan was for initial dissection and mobilization of the right kidney and IVC. Given the risk of tumor thrombus embolization during this initial stage of the procedure, both laparotomy and median sternotomy were performed at the outset to allow for rapid access to the heart and great vessels for prompt institution of CPB as required.

The right kidney and tumor mass were dissected with ligation of the right renal hilum. After dissection of the IVC, the patient was heparinized systemically. Venous drainage cannulae subsequently were placed in the superior vena cava and right femoral vein. The arterial cannula was placed in the ascending aorta. After initiation of full CPB, the right atrium and IVC were opened. The tumor thrombus was mobilized from above and below the liver and subsequently removed en bloc with the renal mass. The right atrium then was closed and the IVC was reconstructed. The total surgical time was 427 minutes, with a total CPB time of 35 minutes.

Shortly after termination of CPB, the patient developed acute hemodynamic instability consistent with acute right heart failure. Comprehensive imaging with TEE at this time demonstrated a hyperdynamic and underfilled left ventricle coupled with a dilated right ventricle exhibiting severely decreased systolic function. Furthermore, mobile masses were observed both in the body of the right atrium and the intrahepatic IVC (Fig 2). Given this constellation of clinical and imaging findings, the diagnosis of pulmonary embolism by tumor thrombus was reached. Prompt hemodynamic recovery was achieved with titrated epinephrine and inhaled epoprostenol for selective pulmonary vasodilation. Gradual recovery of right ventricular systolic function occurred after the introduction of these pharmacologic interventions. The systemic vascular tone was maintained in the low-normal range with titrated infusions of phenylephrine and vasopressin.

The total blood loss during the entire case was estimated at about 3-to-4 L, which required aggressive intraoperative volume resuscitation, including transfusion with 12 U of packed red blood cells to maintain the hemoglobin in the 8-to-10 g/dL range.⁹ After reversal of systemic heparinization,

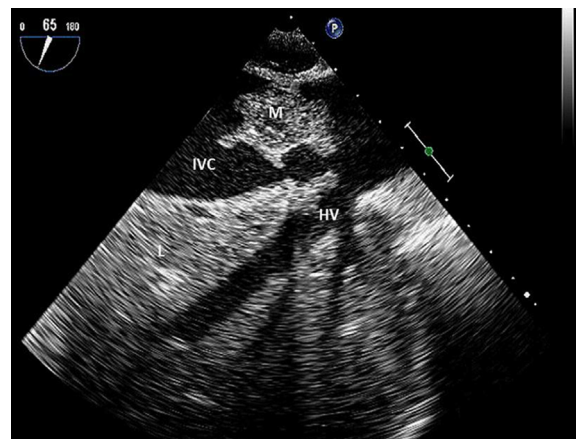


Fig 2. Residual tumor thrombus in the inferior vena cava. This is a modified transgastric view with the probe turned to the right and an omniplane angle of 65 degrees. The tumor mass is seen within the intrahepatic IVC. This mass also was mobile during real-time imaging. M, tumor mass; HV, hepatic vein.

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