

Renal Cell Carcinoma with Thrombus Extension into the Inferior Vena Cava and the Right Atrium: A Case Report



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INTRODUCTION

Renal cell carcinoma (RCC) extends into the renal vein and inferior vena cava (IVC) in about 10% of cases.¹ Further extension into the right atrium is detected in only 1% of all patients with RCC.² As such, a detailed description of RCC with right atrial extension can further understanding and potentially guide better management approaches. We report a case of RCC with thrombus extension into the IVC and right atrium, highlighting some of the aspects of management that are necessary to consider when evaluating such cases.

CASE PRESENTATION

A 60-year-old man presented to the outpatient clinic with shortness of breath with moderate exertion of 5 days' duration. He also described 20-lb weight loss, night sweats, subjective fevers, fatigue, and hip and back pain over the previous 9 months. The patient denied any chest pain, palpitations, or lower extremity swelling. Cardiac and pulmonary examinations were unremarkable. Abdominal examination revealed a 10- to 15-cm firm, irregular, and nontender mass in the right lower quadrant. There was no associated gastrointestinal bleeding or hematuria.

Initial blood workup was significant for a hemoglobin level of 9.7 g/dL. Chest radiography, electrocardiography, and two-dimensional transthoracic echocardiography were unremarkable. Computed tomography (CT) with intravenous contrast of the abdomen showed a large, heterogeneous enhancing mass in the mid to lower aspect of the right kidney, measuring approximately 11 × 10 × 13 cm, concerning for RCC. A filling defect extending from the renal hilum through the right renal vein and superiorly into the IVC was also noted. Images from CT failed to clearly identify whether the extending mass was an extension of the tumor or a bland thrombus (Figure 1, arrows). Evaluation for metastasis was carried out and was negative for intra-abdominal, adrenal, or lymph nodal metastasis.

Chest CT with intravenous contrast showed a large pulmonary embolism in the distal right main pulmonary artery (Figure 2, arrow). The patient was started on enoxaparin in preparation for surgery. Three weeks later, the patient presented to the emergency department

with symptoms of cough, shortness of breath, and increased fatigue. Chest CT showed no progression of the pulmonary emboli. Abdominal CT, however, showed propagation of the previously noted mass up to the right atrium (Figures 3 and 4, arrows). Transesophageal echocardiography (TEE) was done for further assessment of the new finding and showed the mass involving the IVC (Figure 5, arrows; Video 1) and prolapsing into the right atrium (Figure 6, arrows; Videos 2-4). The mass did not interfere with intracardiac structures; there was no significant obstruction of venous flow and no involvement or obstruction of the hepatic vein (Figure 7, Video 5). A difference in echogenicity was noted on TEE and implied the presence of two different masses, tumor and overlying bland thrombus (Figure 8, dashed circle; Video 6).

The patient underwent open radical nephrectomy and resection of the mass involving the IVC and the right atrium in a joint urologic and cardiothoracic effort. In the setting of cardiopulmonary bypass (CPB) and deep hypothermic circulatory arrest, the right atrium was accessed, and the most superior part of the mass was identified and pushed down into the IVC, which was then incised, and the mass was removed. Pathologic examination of the renal mass revealed clear RCC extending into the renal vein, while the mass involving the IVC and right atrium was shown to be a bland thrombus. The postoperative in-hospital stay was uneventful, and the patient was discharged shortly after the operation. Two months later, the patient developed new-onset headache and double vision, prompting brain magnetic resonance imaging (MRI) that revealed extensive brain metastasis. Unfortunately, the patient's status continued to deteriorate, and he expired few months later.

DISCUSSION

We report a case of RCC with thrombus extension into the IVC and the right atrium in a patient who presented with pulmonary embolism. A thrombus extension into the right atrium can present as an incidental finding of a "thumblike" mass in the right atrium, detectable on routine transthoracic echocardiography.² However, heart failure can ensue because of IVC obstruction by the tumor mass.³

In patients with no evidence of local and distant metastasis, aggressive surgical resection of the tumor offers the best long-term outcomes.⁴ The Mayo Clinic describes five levels of RCC according to the presence or absence of renal vein, IVC, and right atrial involvement (Table 1).¹ Assessment of tumor extension is crucial for planning an appropriate management strategy.^{1,4}

Level 4 tumors require CPB to provide a bloodless environment for right atrial access and necessitate collaborative cardiothoracic and urologic intervention. Level 3 tumors may require CPB or venovenous bypass, because the suprahepatic IVC, which offers approximately two thirds of the venous return, needs to be clamped. However, the bypass can be waived in patients with chronic complete obstruction of the IVC, who are more likely to tolerate proximal IVC clamping

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VIDEO HIGHLIGHTS

Video 1: Transesophageal echocardiographic view of the IVC and hepatic vein demonstrating large mass extending superiorly into the IVC. The hepatic vein is clear.

Video 2: Transesophageal echocardiographic transgastric four-chamber view, focused on the right atrium, showing the mass prolapsing from the IVC into the right atrium.

Video 3: Three-dimensional transesophageal echocardiographic transgastric four-chamber view showing the tumor/thrombus mass prolapsing from the IVC into the right atrium.

Video 4: Three-dimensional transesophageal echocardiographic view showing the tumor/thrombus mass prolapsing through the orifice of the IVC into the right atrium.

Video 5: Transesophageal echocardiographic bicaval view with deeper insertion shows laminar, nonobstructed low-velocity flow in the hepatic vein and IVC.

Video 6: Transesophageal echocardiographic bicaval view with deeper insertion shows the hepatic vein clear of tumor thrombus. A distinction of echogenicity can be made between the more echogenic proximal end and the less echogenic distal (atrial) end of the mass, with the latter representing bland thrombus.

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because of the formation of extensive collateral vessels. On the other hand, partial obstruction of the IVC will most likely require venovenous bypass. For the same reasons, IVC interruption (filter placement, ligation, or resection) is more likely to complicate a partial obstruction than a complete obstruction. The degree of venous obstruction can be evident clinically in the form of lower extremity edema and dilated abdominal venous collateral vessels and on imaging by the presence of dilated lumbar or azygos veins on CT or MRI. Level 3 tumors often



Figure 1 Axial cut of a computed tomographic scan of the abdomen showing large heterogeneous mass (arrows) in the mid to lower aspect of the right kidney concerning for RCC. A filling defect extending from the renal hilum through the right renal vein and into the IVC (green arrow) is also noted.

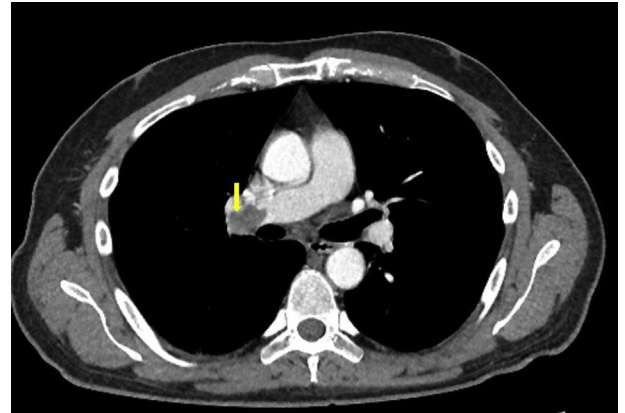


Figure 2 An axial cut of a computed tomographic scan of the chest showing large thrombus in the distal right main pulmonary artery (arrow).



Figure 3 Sagittal view of the abdomen showing propagation of the previously noted IVC tumor thrombus up to the right atrium (arrows).

require extensive mobilization of the liver and hence also require a hepatobiliary surgeon to be involved. Preoperative placement of an IVC filter is contraindicated in level 3 and 4 tumors because of the high risk for thrombus incorporation into the filter that will complicate future surgical resection.

Level 1 and 2 tumors do not need CPB or venovenous bypass. Level 2 tumors require clamping of the IVC above and below the tumor, in addition to the contralateral renal and lumbar veins, and thus may benefit from the collaboration of a vascular surgeon. The use of preoperative IVC filters in level 1 and 2 tumors is still controversial.

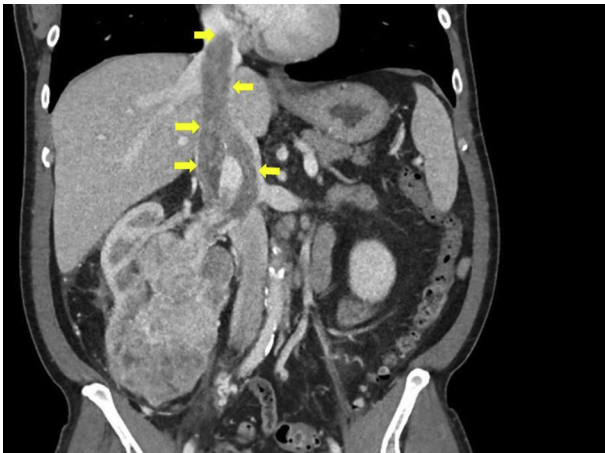


Figure 4 Coronal view of the abdomen showing propagation of the previously noted IVC tumor thrombus up to the right atrium (arrows).

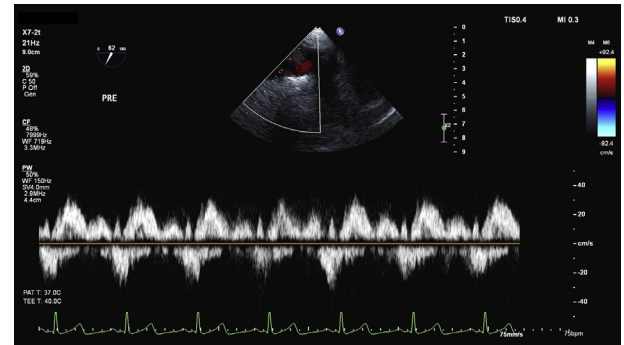


Figure 7 Pulsed-wave Doppler of the hepatic vein showing normal Doppler flow.

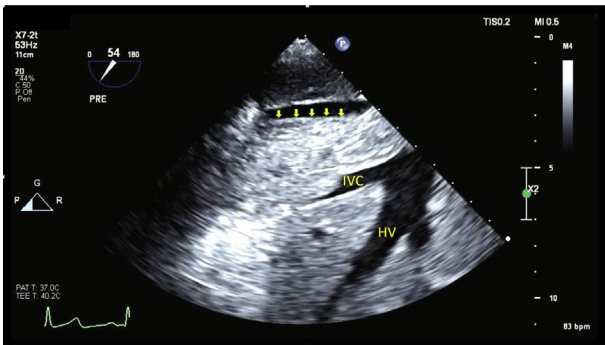


Figure 5 Transesophageal echocardiographic view of the IVC and hepatic vein (HV) shows tumor/thrombus (arrows) involvement of the IVC.

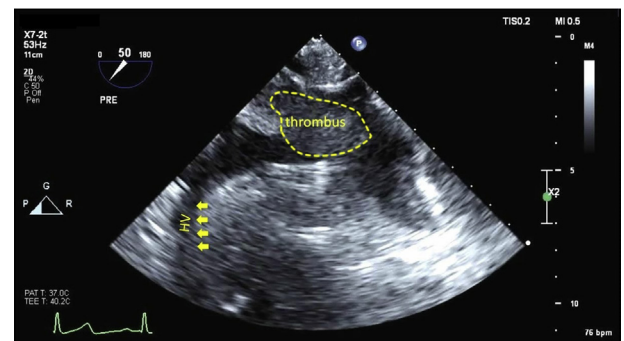


Figure 8 Transesophageal echocardiographic bicaval view with deeper insertion shows the hepatic vein (HV) clear of tumor thrombus. A distinction of echogenicity can be made between the more echogenic proximal end and the less echogenic distal (atrial) end of the mass, with the latter representing bland thrombus (encircled).

Woodruff *et al.*⁵ recommended using IVC filters for only 48 hours before surgery and in patients who cannot be anticoagulated, while Ayyathurai *et al.*⁶ did not limit the preoperative use of IVC filters to a certain time period.^{1,4-7}

Whether the extending mass is an extension of the tumor or a bland thrombus can be differentiated by the enhancement seen with a tumor mass on contrast CT or MRI, reflecting tumor vascularity.¹

Although CT showed mass enhancement throughout the IVC and up to the right atrium, this did not align with the findings on renal biopsy, which confined the tumor to the renal vein. However, TEE showed two masses with different echogenicity, with the cranial mass representing a bland thrombus (Figure 8, dashed circle; Video 6). MRI has been shown to be more accurate than CT in differentiating tumor thrombus from bland thrombus.⁸ The presence of bland



Figure 6 Transesophageal echocardiographic transgastric four-chamber view, focused on the right atrium (RA), showing mass prolapsing (arrows) from the IVC into the RA.

Table 1 Mayo Clinic RCC tumor thrombus level classification system and potential surgical approach

Level	Description	Surgical approach
0	Limited to renal vein or its tributaries	Renal vein ligation
1	Extends into IVC but <2 cm above renal vein orifice	Milking of IVC tumor thrombus into renal vein followed by renal vein ligation
2	Extends into IVC, >2 cm above renal vein orifice but below hepatic veins	Some mobilization of liver (ligation of accessory hepatic veins draining caudate lobe), clamping of intrahepatic IVC, clamping of intrahepatic IVC and contralateral renal vein
3	Extends above hepatic veins but below diaphragm	Extensive mobilization of liver, including ligation of diaphragmatic attachments, clamping of suprahepatic IVC with adjunctive venovenous or CPB
4	Extends above diaphragm	Involvement of cardiothoracic surgery, potential thoracotomy and open heart surgery

thrombus predicts more complex surgical management that might involve IVC interruption. Preoperative anticoagulation is generally recommended, with high emphasis on patients who experienced embolic complications and patients with bland thrombus.^{1,5,6}

Intraoperative TEE is valuable to confirm the atrial extent of the tumor, as tumor level may change after ligation of the renal artery, thereby requiring a different surgical approach. TEE also helps identify the adherence of the tumor to cardiac structures, which bears upon the decision to incise the heart. Intraoperative TEE can also detect tumor dislodgement during surgery and verify the absence of any residual mass after resection.^{1,4} The critical role of intraoperative TEE in such cases was demonstrated in a similar case report. TEE was continuously used to monitor the mass during radical nephrectomy and tumor resection. When the right kidney was mobilized, the intracaval thrombus detached and migrated to the patient's right atrium, causing severe hemodynamic instability. After emergent sternotomy and during the initiation of CPB, the mass was no longer detectable in the heart and had to be removed in its entirety from the left pulmonary artery.⁹

In the current case, CT with intravenous contrast identified the tumor as a level 4 RCC. Of note, anticoagulation did not stop thrombus progression in our patient, which continued to extend until it reached the right atrium. However, the patient did not encounter more embolic events, either intraoperatively or perioperatively. Intraoperative TEE confirmed the level of the tumor as level 4 and confirmed the complete resection of the mass from both the IVC and right atrium.

CONCLUSION

Management of RCC with venous tumor thrombus extension requires an accurate assessment of the level of tumor, the degree of IVC obstruction, and the presence of bland thrombus on top of the tumor. Standard MRI or CT can be used reliably to determine tumor features and extent. TEE is a valuable intraoperative asset and might help distinguish a tumor from an overlying bland thrombus.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.case.2020.05.004>.

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