

Role of Transesophageal Echocardiography in “Off-pump” Inferior Vena Cava Thrombectomy Associated with Renal Cell Carcinoma: A Case Report

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Received on: 08 October 2023; Accepted on: 13 December 2023; Published on: 20 February 2024

ABSTRACT

The treatment for renal cell carcinoma (RCC), with tumor thrombus extending into the supradiaphragmatic inferior vena cava (IVC) and right atrium (RA), is IVC thrombectomy with radical nephrectomy. Intraoperative transesophageal echocardiography (TEE) plays a vital role in such cases and is essential for accurate surgical planning. TEE aids in defining tumor mobility, adherence, and fragility, assessing adequacy of tumor removal, placement of central venous catheter (CVC), and continuous hemodynamic monitoring. We present a case of RCC with supradiaphragmatic extension of IVC thrombus where real-time TEE imaging was pivotal in changing the operative approach to the tumor thrombus and averting cardiopulmonary bypass (CPB) and its antecedent complications.

Keywords: Cardiopulmonary bypass, Case report, Renal cell carcinoma, Transesophageal echocardiography, Tumor thrombus.

Journal of Perioperative Echocardiography (2021): 10.5005/jp-journals-10034-1134

BACKGROUND

Renal cell carcinoma (RCC) is the seventh most common neoplasm in the developed world and is notoriously known for its vascular invasion leading to tumor thrombus in the venous system.¹ According to the Mayo Clinic classification, extension of tumor thrombus above the diaphragm or into the right atrium (RA) represents level IV disease.² The surgical approach for accessing the tumor thrombus frequently requires institution of cardiopulmonary bypass (CPB) with or without deep hypothermic circulatory arrest (DHCA). However, CPB and DHCA come with their share of complications including pulmonary, neurological, and renal injury which leads to significant perioperative morbidity and mortality.³ In this case report, we highlight how real-time transesophageal echocardiography (TEE) evaluation in an advanced RCC helped change the surgical approach and avoided the use of CPB.

CASE DESCRIPTION

A 55 kg, 60-year-old male presented with a history of increased frequency of micturition associated with dysuria for 8 months along with an episode of hematuria 7 months back. General physical examination was unremarkable, but on abdominal examination, a large mass was palpable in the right hypochondrium and flank. His hemoglobin level was 8.1 gm/dL and the renal function tests were deranged with a blood urea of 79 mg/dL and serum creatinine of 1.9 mg/dL. Abdominal ultrasonography revealed a right renal mass 15 × 13 cm which on further evaluation with contrast-enhanced computed tomography (CECT) demonstrated an associated inferior vena cava (IVC) thrombus involving the supradiaphragmatic IVC extending into the RA (level IV thrombus-Mayo Clinic classification) (Fig. 1). A preoperative transthoracic echocardiography (TTE) confirmed the tumor thrombus in the IVC extending into the RA. He had right ventricular (RV) dysfunction with moderate tricuspid regurgitation. His RA and RV were dilated, and systolic pulmonary artery pressure was 40 mm Hg. The IVC was also dilated—2.8 cm

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How to cite this article: Mital T, Francis J, Hasija S, et al. Role of Transesophageal Echocardiography in “Off-pump” Inferior Vena Cava Thrombectomy Associated with Renal Cell Carcinoma: A Case Report. *J Perioper Echocardiogr* 2021;9(2):41–44.

Source of support: Nil

Conflict of interest: None

Patient consent statement: The author(s) have obtained written informed consent from the patient for publication of the case report details and related images.

with a <50% collapsibility. The left ventricle (LV) function was normal and ejection fraction was 55%.

The preanesthetic checkup demonstrated a blood pressure of 148/80 mm Hg and heart rate of 88/minute. He was posted for a right radical nephrectomy with IVC thrombectomy on CPB. The patient was induced with fentanyl and propofol and intubated after giving rocuronium. A large bore intravenous line and radial arterial line were placed in the left upper limb, TEE probe was

- Level 0-extending to renal vein
- Level I-extending into IVC ≤2cm above renal vein
- Level II-extending into IVC >2cm above renal vein, but not to hepatic veins
- Level III-extending into IVC above hepatic vein but below diaphragm
- Level IV-extending into supradiaphragmatic IVC or right atrium.

Fig. 1: According to Mayo Clinic classification for IVC tumor thrombus in RCC, thrombus is classified as mentioned above

inserted, and central venous cannulation was performed in the right internal jugular vein under TEE guidance. The catheter was fixed at 12 cm corresponding to the level of SVC-RA junction. Anesthesia was maintained with fentanyl, cisatracurium, and isoflurane in oxygen-air mixture. A focused TEE examination of right side of the heart, IVC, hepatic veins, and pulmonary artery was performed. TEE revealed the tumor thrombus in the IVC at the level of hepatic veins extending up to the supradiaphragmatic IVC and protruding into the RA (Fig. 2). It was not attached to the RA wall. The thrombus was not adherent to the IVC wall along the extent visible with TEE. Since the tumor thrombus in the IVC was free-floating and oscillating into and out of the RA (Fig. 3), it was decided to remove it en bloc without CPB. Hence, the intraoperative TEE examination aided in the modification of the surgical plan in the operating room (OR) by preventing the use of CPB for tumor thrombectomy.

A midline thoracoabdominal incision was made, and the right kidney was mobilized. Meanwhile, sternotomy was done, and venous cannula was secured in the RA under TEE monitoring to avoid displacement of RA thrombus. The renal artery and vein were ligated, and the nephrectomy was performed. The patient was

administered heparin (100 units/kg) so as to achieve an activated clotting time (ACT) between 200 and 250 seconds. A venovenous bypass was then initiated between RA and infrarenal IVC to avoid the hemodynamic compromise of preload interruption. Thereafter, proximal and distal clamps were applied at suprahepatic and infrarenal parts of IVC (Fig. 4A). Under real-time TEE guidance focusing on IVC and RA, IVC was opened at the level of renal vein and thrombus was delivered en bloc by milking it down below the level of diaphragm (Fig. 4B). No evidence of residual thrombus or embolus was present in TEE (Fig. 5). The clamp time was 15 minutes and hemodynamic stability was maintained throughout the procedure. The total blood loss was around 400 mL and intraoperative cell salvage was performed. Further, intraoperative and postoperative course was uneventful. The patient was extubated on postoperative day 1 and discharged after 5 days.

DISCUSSION

About 4–10% of patients with RCC present with tumor thrombus extending into the IVC.⁴ About 50% of the cases with level III or IV thrombus are associated with perioperative morbidity and

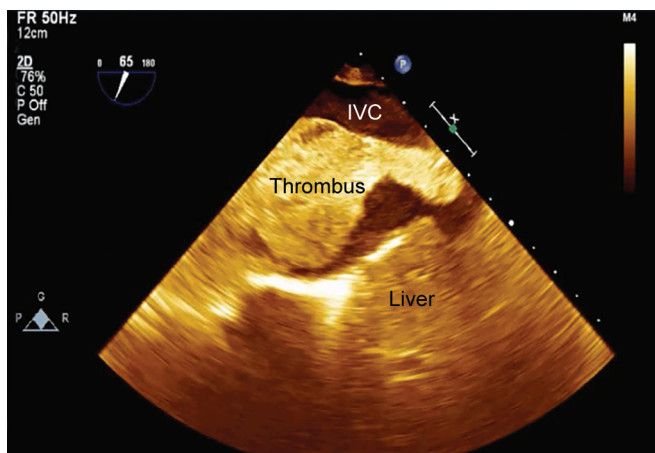


Fig. 2: Transgastric modified hepatic vein TEE view focused on the intrahepatic IVC in the long axis (65°) showing the presence of a hyperechoic structure almost completely occupying the lumen of the IVC. IVC, inferior vena cava; RA, right atrium; TEE, transesophageal echocardiography

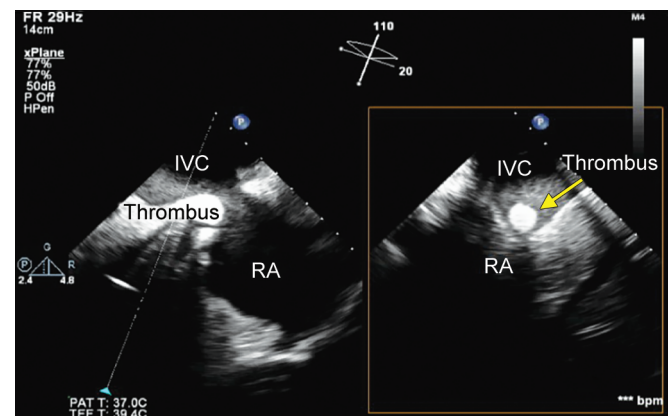
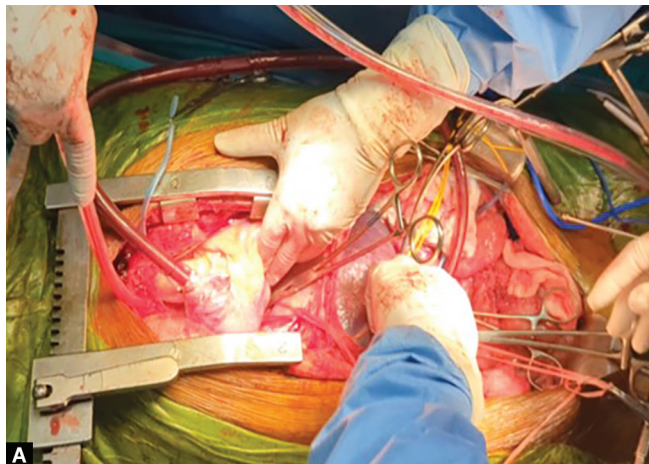
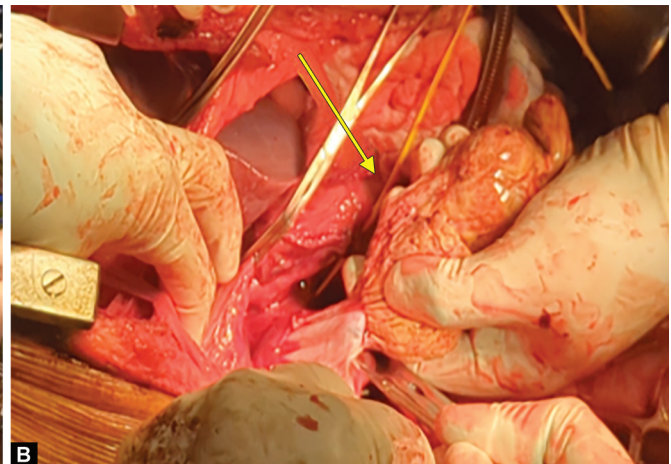


Fig. 3: Lower esophageal hepatic TEE view with biplane mode focused on the thrombus in the IVC showing the thrombus head oscillating within the RA and the RA wall is free from thrombus attachment. The thrombus was visualized in the long axis at 110° and in the short axis at 20°. IVC, inferior vena cava; RA, right atrium; TEE, transesophageal echocardiography



Figs 4A and B: (A) Intraoperative image showing thoracoabdominal incision with venovenous bypass and a clamp in suprahepatic IVC in the pericardial cavity; (B) Intraoperative image showing the tumor thrombus being removed from the IVC en bloc (arrow); IVC: inferior vena cava

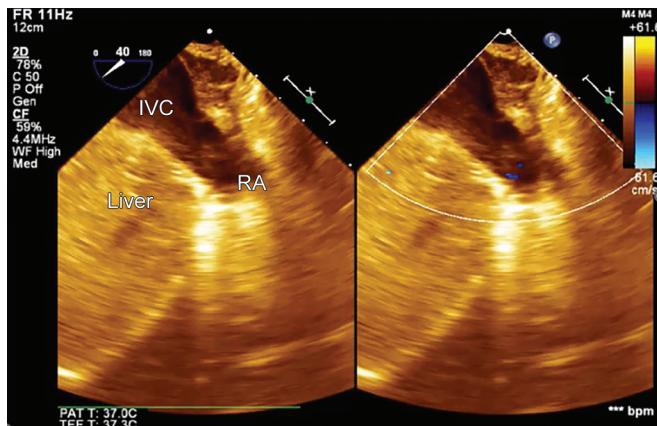


Fig. 5: Lower esophageal hepatic TEE view with color compare taken post-thrombectomy focused at the IVC-RA junction showing the adequacy of thrombus removal from the IVC and RA; IVC, inferior vena cava; RA, right atrium; TEE, transesophageal echocardiography

mortality, including pulmonary embolism, hemorrhage, acute renal failure, and wound infection.⁵ Therefore, accurate assessment of characteristics, attachment, and extent of tumor thrombus is paramount for surgical planning. Intraoperative TEE monitoring is imperative for IVC tumor thrombectomy associated with RCC, especially for level III and IV IVC thrombus.⁶

The TEE findings that helped avoid CPB in our patient were that the IVC thrombus was:

- Nonbulky
- Nonfriable
- Freely mobile
- Easily reducible below diaphragm
- Not associated with pulmonary embolism.

In RCC associated with level IV thrombus, resection was routinely performed under CPB with or without DHCA. However, with the advent of specialized surgical techniques, CPB can be entirely avoided by relying on TEE in some cases.⁷ This can be beneficial in preventing systemic complications, perioperative coagulopathy from full heparinization, neurological sequelae of DHCA, and pulmonary and renal insult associated with CPB.^{8,9} Up to 45% of cases of RCC with level IV tumor thrombus required CPB to facilitate sufficient exposure and bloodless field for resection. DHCA was necessary in 55.2% of these cases for complete tumor resection.¹⁰

In our patient, preoperative CECT or TTE could not precisely reflect the extent of the thrombus which ultimately impacted the surgical approach. The surgical plan to go on CPB and approach the thrombus *via* both RA and IVC was modified after TEE identified the true nature of the tumor thrombus. The proximal and distal IVC clamps were placed under TEE guidance to prevent any thrombus disruption. Since the IVC wall was free, once clamps were applied and preload was reduced in the RA, the tumor thrombus got retracted from the RA allowing its safe removal. No residual tumor was observed in the RA or IVC.

In addition, TEE guidance assists in the placement of the central line in cases where thrombus is entering the RA.⁵ Real-time TEE imaging helps identify the occurrence of intraoperative pulmonary embolism by identifying the presence of thrombus in pulmonary artery, sudden disappearance of tumor head from the IVC or RA, and evolution of right heart dysfunction.

The recognition of residual thrombus is an additional advantage of TEE.¹¹ Furthermore, a continuous evaluation of ventricular function and fluid responsiveness guided by TEE can help prevent adverse cardiac events.¹²

CONCLUSION

A sound knowledge of the anesthetic implications of RCC is essential to manage its perioperative course successfully. TEE forms a crucial component of the intraoperative management of RCC with IVC thrombus. It not only allows for a real-time assessment of the extent of tumor thrombus but also helps in making intraoperative decisions based on completeness of thrombus removal, reestablishment of IVC blood flow, detection of pulmonary embolism, and evaluation of cardiac function. We further emphasize that the use of CPB is not necessary in all cases of RCC with level IV tumor thrombus and its use needs to be individualized on a case-to-case basis.

SUPPLEMENTARY MATERIAL

The supplementary Videos 1-2 are available online on the website of www.jpccardio.com

Video 1: Transgastric modified hepatic vein TEE view focused on the intrahepatic IVC in the long axis (65°) showing the presence of a hyperechogenic structure almost completely occupying the lumen of the IVC. TEE: Transesophageal echocardiography; IVC: Inferior Vena Cava; RA: Right Atrium.

Video 2: Lower esophageal hepatic TEE view with biplane mode focused on the thrombus in the IVC showing the thrombus head oscillating within the RA and the RA wall is free from thrombus attachment. The thrombus was visualized in the long axis at 110° and in the short axis at 20°. TEE: Transesophageal Echocardiography; IVC: Inferior Vena Cava; RA: Right Atrium.

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