



Case Report

Anaesthetic challenges in a rare case of renal cell carcinoma with inferior vena cava tumor thrombus extension into right atrium under cardiopulmonary bypass with deep hypothermic circulatory arrest

Gokulakannan Murugesan¹, Neelesh Anand^{2*}, Revanth Muthukumar³, Sajal Sharma⁴

¹Kanchi Kamakoti CHILDS Trust Hospital, Chennai, Tamil Nadu, India

²Dept. of Anaesthesiology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

³Dept. of Anaesthesiology, Jawaharlal Institute of Post Graduate Medical Education and Research, Puducherry, India

⁴Dept. of Anaesthesiology, All India Institute of Medical Sciences, Bhopal, Madhya Pradesh, India



ARTICLE INFO

Article history:

Received 17-03-2024

Accepted 11-04-2024

Available online 03-06-2024

Keywords:

Renal cell carcinoma (RCC)

Tumor thrombus

Cardiopulmonary bypass (CPB)

Deep hypothermic circulatory arrest

(DHCA)

ABSTRACT

Renal cell carcinoma, an epithelial tumour of the kidney, is the ninth most common cancer worldwide. It is uniquely associated with tumour thrombi extending into the renal vein and inferior vena cava, while rarely extending till the right atrium. This poses challenges in intra-operative and post-operative hemodynamic management as well as perioperative cardio and neuroprotection making it a challenging case from anaesthetic point of view. We report a rare case of Right renal cell carcinoma with thrombus extension into right renal vein, inferior vena cava and right atrium. Right radical nephrectomy with en-bloc tumor-thrombus excision under cardiopulmonary bypass with deep hypothermic circulatory arrest was performed. The case was suspected to have a difficult intraoperative and postoperative course with major hemodynamic instability, neuroprotection, and cardioprotection in mind, and was managed appropriately.

This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

One of the most common forms of renal malignancy accounting for 3% of all tumors is Renal Cell Carcinoma (RCC).¹ It mostly presents in the 6th and 7th decade of life usually predominating in males, smokers, obese, hypertensive and in patients with acquired cystic kidney disease associated with end-stage renal disease.² A unique aspect of RCC includes venous migration and tumour thrombus formation. In 4% to 10% cases the tumor thrombus infrequently extends into the Inferior Vena Cava (IVC) and only in 1% cases the extension is into right atrium (RA).³ Precise extension of tumour thrombus must

be determined preoperatively. For large RCC with IVC tumor thrombi extension cardiopulmonary bypass (CPB) along with deep hypothermic circulatory arrest (DHCA) is the standard method for surgical removal of tumor.⁴ This approach requires integrated teamwork between cardiac anaesthetist, urologist and cardiothoracic surgeon. We report a rare case of a RCC patient with IVC tumor thrombi extending into RA undergoing en-bloc tumor excision under CPB with DHCA; describing the anaesthetic goals and management in this complicated surgery.

2. Case Report

A 55-year-old male with no history of diabetes mellitus, hypertension and any other comorbidity presented with right flank pain was detected to have a right lower

* Corresponding author.

E-mail address: neesh.anand.7@gmail.com (N. Anand).

pole renal mass on ultrasound abdomen. Investigations revealed hemoglobin 9.6 g/dL, TLC count 9,050/mm³, Platelet count 3,75,000/mm³, INR 1.2, serum urea 30 mg/dl, serum creatinine 0.9 mg/dl, serum sodium 136 mmol/L, serum potassium 4.3 mmol/L, serum chloride 102 mmol/L and normal ECG. CECT thorax and abdomen showed well differentiated heterogeneous diffuse mass in lower pole of right kidney, with right renal vein and IVC extension reaching up to the right atrium (level IV tumor as per Mayo classification). Transthoracic Echocardiography (TTE) revealed echogenic mass (thrombus) of 36 x 24 mm in right atrium, with ejection fraction of 68%, grade I diastolic dysfunction, mild tricuspid regurgitation. Patient was taken up for Right radical nephrectomy with IVC thrombectomy with en-bloc excision of tumor thrombus from RA under CPB with DHCA. On arrival in the operating room, a wide bore 18-gauge peripheral venous cannula was secured and monitors were attached as per the ASA standards. Right radial artery cannulation was done for invasive blood pressure monitoring and baseline arterial blood gas (ABG) as well as baseline activated clotting time (ACT) samples were withdrawn. Patient was premedicated with injection midazolam 2 mg, injection fentanyl 400 mcg and preoxygenated with 100% oxygen for 5 minutes. Induction of general anesthesia was done with injection etomidate 14 mg IV, injection vecuronium 7 mg IV and trachea was intubated with 8 mm cuffed oral endotracheal tube under direct laryngoscopy which was confirmed by auscultation of bilateral equal breath sounds as well as capnography. Patient was put on volume control mode with a tidal volume 6 ml/kg body weight, respiratory rate of 18/min, I:E of 1:2 and FiO₂ of 50%. Anaesthesia was maintained with sevoflurane (MAC 1.6) along with oxygen and air mixture at 50:50 concentration. Central venous cannulation of the right internal jugular vein was done. Using linear ultrasound probe, muscle plane between the internal intercostal and transversus thoracis muscle at 4th and 5th intercostal space was identified. A 22-gauge Quincke needle was inserted in-plane and transversus thoracis muscle plane block was given bilaterally using 15 mL of 0.25% levobupivacaine with dexamethasone 4mg as an adjuvant on each side. Using linear ultrasound probe, muscle plane between the internal oblique and transversus abdominis muscle was identified in the mid-axillary line between subcostal margin and iliac crest. A 22-gauge Quincke needle was inserted in-plane and transversus abdominis muscle plane block was given bilaterally using 15 mL of 0.375% ropivacaine with dexamethasone 4mg as an adjuvant on each side.

A trans-esophageal echocardiography (TEE) probe was inserted till the mid-oesophageal level and it showed a mass in the IVC extending into the right atrium (Figure 1). Laparotomy incision was made and right renal mass was exposed and IVC mobilisation was done. Sternotomy was performed, systemic heparinization done

with Unfractionated Heparin (UFH) 20,000 units IV, aortic cannulation was done 1st followed by Superior Vena Cava (SVC). Additional 5,000 units of UFH was used during priming of circuit. Cardiopulmonary bypass was initiated after reporting of ACT >400 seconds. Systemic cooling was done gradually over a duration of 90 minutes up to 20°C; CPB was stopped and the blood volume was stored into pump. Injection methylprednisolone (1 g) was given before hypothermia was initiated to protect the brain and vital organs while cross-clamping of ascending aorta was done. The RA was opened, IVC mobilized and the IVC tumor thrombus was removed. The CPB was reinitiated along with gradual rewarming up to a core temperature of 36 °C which was further maintained throughout during radical nephrectomy and in the postoperative period. During weaning off from bypass ionotropes and vasopressors were started as follows: Noradrenaline (0.07 mcg/kg/min), Adrenaline (0.04 mcg/kg/min), Dobutamine (4 mcg/kg/min) and Nitroglycerine (5 mcg/min). The infusions were titrated to maintain optimal hemodynamic status. Urine output was maintained > 1 mL/kg/hr throughout the duration of surgery. Insulin infusion was started and titrated to maintain blood glucose levels between 110 mg/dL to 180 mg/dL Protamine 250 mg was given for heparin reversal followed by termination of CPB when ACT value 120 was achieved. Injection tranexamic acid 2 gm IV, along with 3 Units of PRBC, 4 Units FFP and 4 Units RDP were given. Total time under DHCA was 32 minutes. A TEE in post-operative period showed no mass in the IVC and right atrium or any evidence of embolism into right ventricle or pulmonary artery. The left ventricular and right ventricular systolic function was found to be normal. (Figure 2) This patient had total blood loss around 1.3 L in the intraoperative period. Throughout the surgery patient was infused with 3 units of crystalloids. Total time under anaesthesia was 7 hours and patient was shifted to ICU for elective postoperative ventilation and was kept on overnight sedation with injection Midazolam and fentanyl. In the postoperative period, vitals were stable, ABG parameters was normal and the inotropes and vasopressors were tapered. Patient was extubated on postoperative day 1.

3. Discussion

Renal cell carcinoma (RCC) is the most common type of kidney cancer, constituting 5% of all malignancies. Metastasis is seen in 30-40% cases and in 5-10% of patients, IVC invasion is seen with tumour embolus extending up to right atrium in 1% of cases.⁵⁻⁷ Hematuria, flank pain, and a palpable mass in the flank is the classic triad of symptoms for diagnosis of RCC which is present only in 10% of cases.⁸ Our patient did not present with the classic triad but only with flank pain. diagnosis of RCC and extension of thrombosis from the IVC into the RA was detected on imaging. This was reported in only 1% of RCC

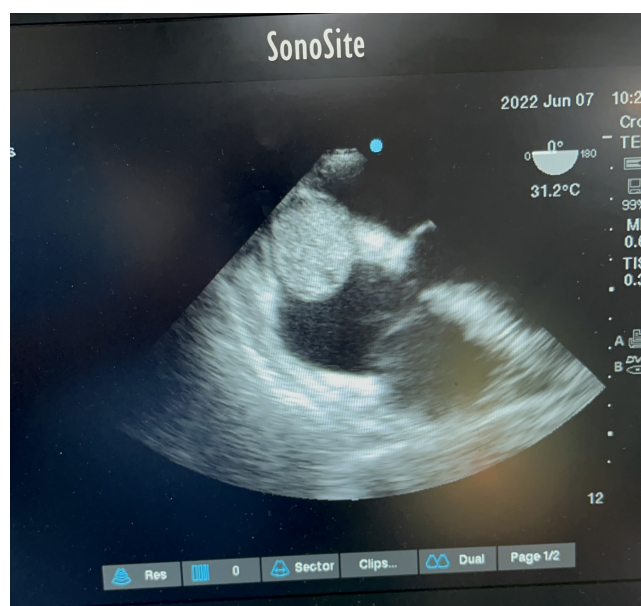


Figure 1: Preoperative TEE showing IVC tumour thrombus extending into RA



Figure 2: Intraoperative TEE after resection of tumour thrombus

cases. There is increased risk of mortality with a median survival of 5 months if RCC with tumor thrombus is left untreated.⁹ RCC is poorly responsive to radiotherapy and chemotherapy. Surgical resection by radical nephrectomy together with tumour-thrombectomy remains the gold standard technique. Tumour-thrombus extending into the right-side heart (Novick staging system type IV) requires Cardiopulmonary bypass for en-bloc tumour-thrombus excision and in certain cases, DHCA has to be implemented to ensure better surgical and patient outcome, even though

it is technically challenging.

Deep Hypothermic Circulatory Arrest (DHCA) is defined by induction of severe hypothermia ($\leq 20^{\circ}\text{C}$) during the complete arrest of circulation.¹⁰ The primary objectives include reduction in cerebral metabolic rate of oxygen consumption (CMRO₂) leading to neuroprotection and a bloodless surgical field. With reduction of body temperature by 1°C , CMRO₂ reduces by 6%. It was previously reported that there was no neurocognitive dysfunction associated with DHCA duration of up to 40 minutes at a body temperature of 12°C to 15°C ; any extension beyond this duration may lead to cerebral injury.¹¹ Cerebral hypoxia can occur as a result of rapid cooling. It occurs because cooling of brain is heterogenous as a result of non-uniform blood flow. Areas which haven't achieved adequate temperature are still prone for injury. Also, with reduced temperature oxygen affinity for hemoglobin is increased which further aggravates hypoxia in the non-homogeneously cooled areas. Therefore, to avoid detrimental effects of non-homogeneous cooling of the brain, ideal rate of cooling is 1°C every 3 – 5 minutes.¹⁰ Rewarming should also take place in a similar manner. After completion of rewarming temperature should be maintained between 35°C – 37°C and further hypothermia should be avoided. Coagulopathy is associated with DHCA due to the degree of hypothermia which is complicated by prolonged duration of CPB, exposure of surgical area and many suture lines in high pressure vessels. Transfusion of fresh whole blood or packed red cells, platelets, fresh frozen plasma/cryoprecipitate is essential. Use of antifibrinolytic agents to control bleeding, and steroids e.g., dexamethasone and methylprednisolone which are anti-inflammatory; may offer some protection.¹⁰ Hyperglycemia and hypoglycemia are both associated with poor outcome. Therefore, insulin infusion should be targeted to maintain serum glucose level between 110 mg/dL to 200 mg/dL.¹²

CPB without DHCA has certain drawbacks, including decreased visibility and exposure of IVC and RA during surgery accompanied with increased risk of renal and hepatic ischemia, increased risk of pulmonary embolism, and acute kidney injury.⁵

Also using CPB with DHCA has several advantages such as bloodless surgical field with optimal visualization of the IVC lumen and RA, minimal risk of hematogenous debris metastases, PE, massive hemorrhage, complete tumor excision from cardiac chambers, maintenance of adequate hemodynamics during long duration of surgery. It reduces risk of renal and liver ischemia intraoperatively during thrombus removal and provide protection to the contralateral kidney, thereby reducing the need of postoperative dialysis. Therefore, it is safe to assume that CPB accompanied with DHCA may be associated with lower mortality.^{13,14} The disadvantages associated with DHCA are prolonged surgery duration, increased risk of

platelet dysfunction, and neurological complications.⁵ As reported by previous studies DHCA at around 18°C is safe for up to 40 minutes regarding mortality and morbidities.¹¹

In this case, DHCA was implemented for about 32 minutes and gradual rewarming was done. Here a multidisciplinary approach between cardiothoracic surgeons, urologists, anesthetists and CPB perfusionists was present and surgery was successfully completed and patient were stable and discharged safely.

Utilizing Trans-Esophageal Echocardiography (TEE) during surgery enables us to locate tumours, calculate their size and extent, analyse their distribution along the long and short axes, evaluate preoperative and postoperative LV and RV dysfunction as a result of embolic events such pulmonary embolism or intracardiac air. Tran-thoracic echocardiography (TTE) in the per-operative period and TEE intraoperatively demonstrated extension of tumor-thrombus (33 mm x 40 mm) in the right atrium and IVC was full of the mass with same echogenicity. There was no adherence of the tumor-thrombus to wall of RA and IVC, and tricuspid valve. There was no evidence of post-operative LV or RV dysfunction, enlargement of cardiac chambers, resting wall motion abnormality and embolic events.

4. Conclusion

Renal carcinoma with tumor extension into the IVC and RA is a major surgical challenge. In this case, several aspects need to be considered. The diagnosis of RCC and extension of tumor thrombi into the IVC and RA. Cardiopulmonary bypass with Deep Hypothermic Cardiac arrest is necessary carry out Radical nephrectomy with en-bloc excision of the Cavo-atrial tumor-thrombus. It significantly reduces severe intraoperative complications as well as mortality. The anaesthetic concerns regarding DHCA were managed well. This suggests CPB with DHCA has enhanced safety and the efficacy of the surgery with a good patient outcome.

5. Patient Consent

Patient's consent has been obtained for publication of case report.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Jemal A, Siegel R, Xu J, Ward E. Cancer statistics. *CA Cancer J Clin.* 2010;60(5):277–300.


2. Chow WH, Gridley G, Fraumeni JF, Jarvholm B. Obesity, hypertension, and the risk of kidney cancer in men. *N Engl J Med.* 2000;343(18):1305–11.
3. Chiappini B, Savini C, Marinelli G, Suarez SM, Eusanio MD, Fiorani V, et al. Cavo atrial tumor thrombus: single-stage surgical approach with profound hypothermia and circulatory arrest, including a review of the literature. *J Thorac Cardiovasc Surg.* 2002;124:684–8.
4. Pouliot F, Shuch B, Larochelle JC, Pantuck A, Belldegrun A, Fiorani V, et al. Contemporary management of renal tumors with venous tumor thrombus. *J Urol.* 2010;184:833–41.
5. Dedeilias P, Koletsis E, Rousakis AG, Kouerinis I, Zaragkas S, Grigorakis A, et al. Deep hypothermia and circulatory arrest in the surgical management of renal tumors with cavo atrial extension. *J Card Surg.* 2009;24(6):617–23.
6. Ljungberg B, Stenling R, Osterdahl B, Farrelly E, Aberg T, Roos G, et al. Vein invasion in renal cell carcinoma: Impact on metastatic behaviour and survival. *J Urol.* 1995;154(5):1681–4.
7. Schimmer C, Hillig F, Riedmiller H, Elert O. Surgical treatment of renal cell carcinoma with intravascular extension. *Interact Cardiovasc Thorac Surg.* 2004;3(2):395–7.
8. Doshi D, Saab M, Singh N. Atypical presentation of renal cell carcinoma: A case report. *J Med Case Reports.* 2007;1:26.
9. Psutka SP, Leibovich BC. Management of inferior vena cava tumor thrombus in locally advanced renal cell carcinoma. *Ther Adv Urol.* 2015;7(4):216–29.
10. Ullah H. Deep hypothermic circulatory arrest – anesthetic considerations. *Anaesth Pain Intensive Care.* 2016;20(1):115–8.
11. Gega A, Rizzo JA, Johnson MH, Tranquilli M, Farkas EA, Elefteriades EA. Straight deep hypothermic arrest: experience in 394 patients supports its effectiveness as a sole means of brain preservation. *Ann Thorac Surg.* 2007;84(3):759–66.
12. Shine TS, Uchikado M, Crawford CC, Murray MJ. Importance of perioperative blood glucose management in cardiac surgical patients. *Asian Cardiovasc Thorac Ann.* 2007;15(6):534–8.
13. Zhu P, Du S, Chen S, Zheng S, Hu Y, Liu L, et al. The role of deep hypothermic circulatory arrest in surgery for renal or adrenal tumor with vena cava thrombus: a single-institution experience. *J Cardiothorac Surg.* 2018;13(1):85.
14. Morita Y, Ayabe K, Nurok M, Young J. Perioperative anesthetic management for renal cell carcinoma with vena caval thrombus extending into the right atrium: Case series. *J Clin Anesth.* 2017;36:39–46.

Author biography

Gokulakannan Murugesan, Senior Resident

Neelesh Anand, Senior Resident  <https://orcid.org/0000-0003-1477-3517>

Revanth Muthukumar, Senior Resident

Sajal Sharma, Senior Resident  <https://orcid.org/0009-0002-0134-8239>

Cite this article: Murugesan G, Anand N, Muthukumar R, Sharma S. Anaesthetic challenges in a rare case of renal cell carcinoma with inferior vena cava tumor thrombus extension into right atrium under cardiopulmonary bypass with deep hypothermic circulatory arrest. *Indian J Clin Anaesth* 2024;11(2):247–250.