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*Case Report / Olgu Sunumu*

# Anesthetic management of renal cavoatrial tumor thrombus during partial cardiopulmonary bypass

*Kısmi kardiyopulmoner baypas sırasında renal kavoatriyal tümör trombozunun anestezi yönetimi*

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***ABSTRACT***

A 58-year-old male patient was scheduled for the surgical removal of a cavoatrial thrombus and renal tumors during cardiopulmonary bypass without circulatory arrest. Throughout the operation, continuous monitoring for pulmonary embolism was carried out by transesophageal echocardiography. A multidisciplinary team including anesthetists, urologists, and cardiovascular and gastrointestinal surgeons performed the operation successfully. This case report highlights the importance of anesthetic management in renal-cell carcinoma patients with a cavoatrial thrombus.

***Keywords:*** Anesthetic management; cavoatrial thrombus; transesophageal echocardiography.

***ÖZ***

Elli sekiz yaşında erkek hastada kardiyopulmoner baypas sırasında dolaşım arresti olmaksızın kavoatriyal trombus ve renal tümörlerin cerrahi olarak çıkarılması planlandı. Ameliyat süresince transözofageal ekokardiyografi ile pulmoner emboli açısından sürekli takip yapıldı. Ameliyat anesteziyoloji uzmanları, üroloji uzmanları ve kalp damar ve gastrointestinal cerrahlarından oluşan multidisipliner bir ekip tarafından başarıyla gerçekleştirildi. Bu olgu, kavoatriyal trombüslü renal hücreli karsinom hastalarında anestezi yönetiminin önemini göstermektedir.

***Anahtar sözcükler:*** Anestezi yönetimi; kavoatriyal trombus; transözofageal ekokardiyografi.

It has been reported that cavoatrial thrombi occur in approximately 6% of patients with a renal-cell carcinoma (RCC).[1] Although cavoatrial thrombi may occur in renal tumors, the absence of distant metastases still allows radical surgery techniques to be employed. In the surgical treatment of patients with renal tumors and caval thrombi at multiple levels, cardiopulmonary bypass (CPB) with or without hypothermic circulatory arrest is used.[2-4]

In RCC with cavoatrial thrombi, a multidisciplinary approach is needed during pre-, intra-, and postoperative care.[5] Using the multidisciplinary approach, managing the anesthesia has an important role, as the findings from transesophageal echocardiography (TEE) may alter the vascular bypass options and surgical technique. A preoperative discussion regarding end-of-life care is important, considering the high morbidity and mortality for these patients. Patients should be informed about the risk of multisystem organ failure and clearly report their desired treatment plans, if these circumstances occur.[6]

In patients with a thrombus, a potential complication for the anesthesiologist is pulmonary embolism caused by fragmentation.[7] As RCCs have vigorous prothrombotic properties, breakage, enlargement, or migration of a tumor thrombus may occur as soon as a few days after identifying its location. Therefore, it is of utmost importance to confirm the preoperative status using intraoperative TEE, if available. Preoperative magnetic resonance imaging (MRI) and computed tomography (CT) are also extremely useful and highly sensitive for the detection of intra-cardiac masses or tumor thrombi in patients with RCC. Nonetheless, separated fragments

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**Table 1. Classification of inferior vena cava thrombus based on anatomic landmarks[8]**

| Level/description |
|---|
| 1. Thrombus is limited to renal vein |
| 2. Superior extent of thrombus is below the level of the intrahepatic IVC |
| 3. a) Intrahepatic thrombus extending into the retrohepatic IVC, but below the major hepatic veins<br>b) Hepatic thrombus extending into the retrohepatic IVC reaching the ostia of the major hepatic veins<br>c) Thrombus extending into supra- and infradiaphragmatic IVC<br>d) Suprahepatic, supradiaphragmatic, infra-atrial thrombus |
| 4. Thrombus extending into right atrium |

IVC: Inferior vena cava.

of the thrombus always pose a risk for pulmonary embolism.[7]

Staging is made based on the relationship of the tumor thrombus to the liver, hepatic veins, diaphragm, and right atrium (Table 1).

In this article, we present the anesthetic management of a RCC patient with a vena cava thrombus extending into the right atrium, which was successfully operated.

## CASE REPORT

A 58-year-old male patient was admitted to the hospital with complaints of dysuria and hematuria. His medical history revealed no underlying conditions, except for chronic obstructive pulmonary disease and depression. His physical examination and laboratory tests were within the reference range. A posteroanterior chest X-ray was unremarkable. However, on echocardiogram, a moving structure compatible with a thrombus was observed from the right atrium extending toward the interatrial septum with dimensions measuring 1.5×6.1 mm. The ejection fraction was 55.1% with minimal mitral and tricuspid valve regurgitation. Coronary angiography indicated normal coronaries. On thoracic CT, a hypodense thrombus material (tumoral thrombus) was observed within the lumen of the right

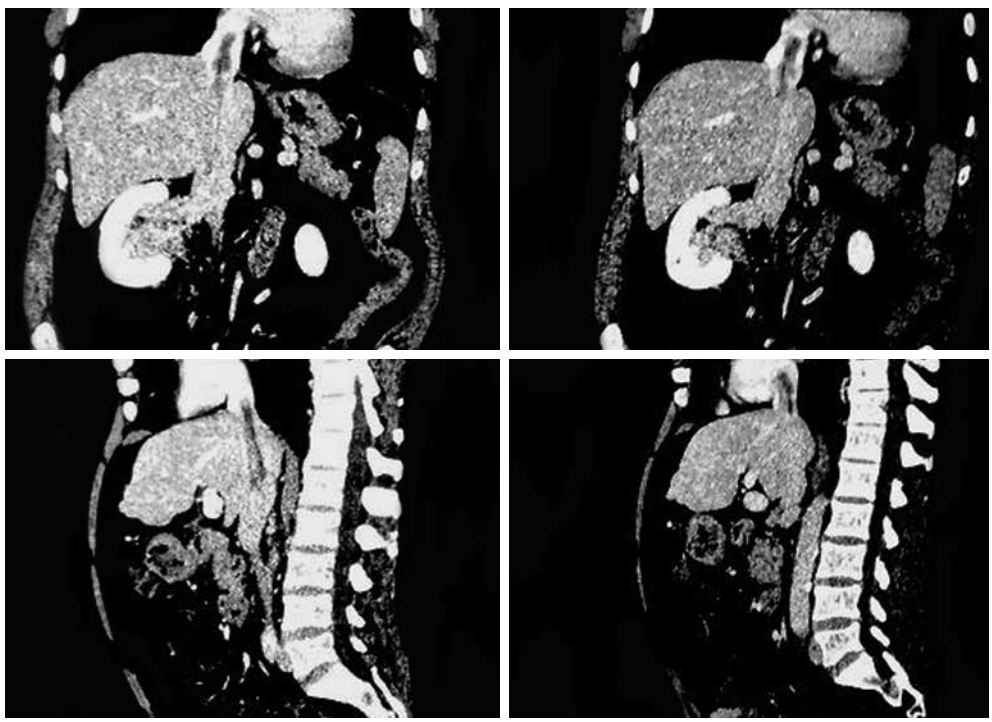

**Figure 1.** A computed tomography image of a hypodense thrombus in the left renal vein extending into the inferior vena cava and right atrium low attenuation.

atrium. Moreover, triphasic abdominal CT demonstrated a lesion, considered RCC, in the mid-posterior of the right kidney. Its dimensions were 55×44 mm, and the lesion showed heterogeneous intense contrast enhancement. The center of the lesion contained cystic areas which could have resulted from necrosis. In the left renal vein, following the administration of intravenous contrast material, a hypodense thrombus material extending into the inferior vena cava (IVC) and right atrium was also observed (Figure 1). Finally, hepatobiliary ultrasonography showed an echogenic level, similar to the hepatic levels, present in the lumen of the IVC.

Based on these findings, we decided to operate the patient, and a written informed consent was obtained from the patient. The surgical plan encompassed an open radical nephrectomy and partial bypass, in addition to thrombus excision at the right atrium and IVC. Following preoperative preparation, the patient was prescribed 0.15 mg/kg oral diazepam to be taken the night before surgery, and 0.1 mg/kg intramuscular morphine to be taken the morning of the surgery. Immediately before surgery, electrocardiogram and pulse oximetry monitoring were applied. Following cannulation with two 16- and 18-Gauge (G) venous catheters on the right arm and a 20-G arterial catheter in the radial artery, 0.9% saline at 100 mL/h infusion rate, was administered intravenously. Anesthesia was induced using 0.1 mg/kg midazolam (Dormicum®, Roche, Basel, Switzerland), 10 µg/kg fentanyl (Fentanyl Citrate®, Abbott, North Chicago, USA), and 0.6 to 0.9 mg/kg rocuronium bromide (Esmeron®, Organon, Brussels, Belgium). After a medically-induced coma was confirmed, endotracheal intubation was performed using an 8-French (Fr) G endotracheal tube. Following intubation, the patient was reclined into a Trendelenburg position with feet elevated 10 to 15° above the head, and an 8-Fr introducer with a 10 cm long sheath was placed into the internal jugular vein. For urine output, the bladder was catheterized with a Foley catheter. During the intraoperative period, ventilation parameters were as follows: 50% $O_2$ and 50% air via controlled mechanical ventilation mode; tidal volume, 8 to 10 mL/kg; respiratory rate, 10 to 12 breaths per min; Ti/T, 1/2; and positive end-expiratory pressure (PEEP), 0 cm $H_2O$ (Fabius Plus, Drager, Germany). Anesthesia was maintained with an infusion of 0.5 µg/kg remifentanil (Ultiva®, Glaxo Smith Kline İstanbul, Turkey) and 1.5 to 2% desflurane (Suprane®, Baxter, Eczacıbaşı, İstanbul, Turkey).

The neck of the patient was hyperextended and a mouth guard was provided. The TEE probe was sheathed and placed in the esophagus, passing through the mouth guard with the aid of a lubricant gel. Using the TEE probe, we confirmed the presence of a tumor at the right atrium and IVC (Figure 2) and the position of the catheters, which needed no adjustment. Throughout the operation, continuous monitoring for pulmonary embolism was carried out by TEE. Using laparotomy technique in the supine position, urologists and gastrointestinal surgeons mobilized the right renal vein, the right kidney, and the IVC. Although the central venous pressure was initially at 13 mmHg, it reduced to 5 mmHg during this stage of the operation. The patient was administered intravenous liquids during the episodes of tachycardia (110 heartbeats per minute [bpm]) or hypotension (85/54 mmHg), and anesthetic drug infusion doses were reduced to amend the hemodynamic parameters.

Following sternotomy, but before aortic cannulation, 300 to 400 IU/kg of heparin (Heparin sodium®, Vem Pharmaceuticals, Istanbul, Turkey) was administered to activate a clotting time within 400 to 500 sec. The aorta, superior vena cava, and IVC were cannulated from the distal infrarenal region. Following cannulation of the major blood vessels, extracorporeal circulation began and mechanical ventilation continued with low tidal volume and frequency (tidal volume: 2 mL/kg, respiratory frequency: 8 breaths per min). During extracorporeal circulation, a roller pump (Stockert SIII Perfusion System Sorin, Turkey) and membrane oxygenators (Compact Floevo Dideco Physio/M 050 516 Series) were used. A pump priming solution, including 1,000 mL of Ringer solution with lactate, 100 mL of 20% mannitol, and 500 mL of colloid (Voluven 6%, Kabi) was used. The pump flow was set at 2.2 to 2.4 L/$m^2$/min. To maintain anesthesia during

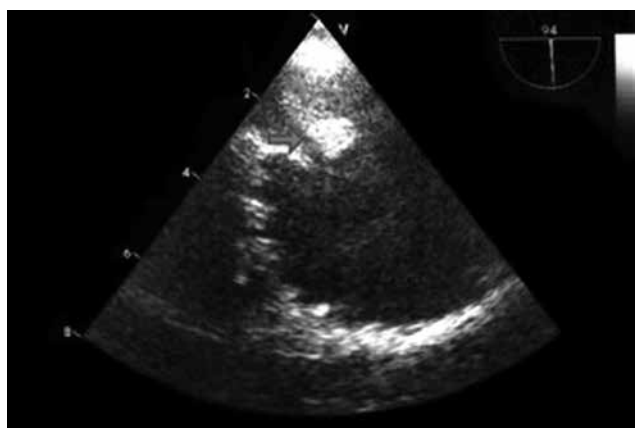

**Figure 2.** Intraoperative transesophageal echocardiography image showing the level inferior vena cava tumor thrombus extension (1.5×6.1 mm) in the right atrium.

**Figure 3.** Image of the thrombus removed from inferior vena cava.

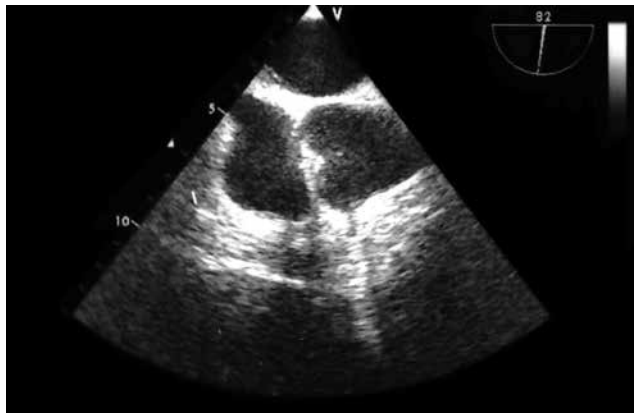


**Figure 4.** Intraoperative transesophageal echocardiography showing no residual thrombi after thrombus removal from the right atrium.

extracorporeal circulation, a remifentanil infusion with rocuronium bromide and midazolam was used.

The thrombus, originally located in the atrium, was pushed into the vena cava by cardiac surgeons via a right atriotomy. This process and the lack of fragmentation were confirmed by real-time TEE. The IVC was, then, clamped directly under the right atrium, opened with an incision of 5 cm, and the thrombus was removed (Figure 3). While the IVC remained clamped, a systolic and diastolic blood pressure of 70 to 80 mmHg was maintained through volume replacement. After the removal of the thrombus, TEE was used to perform a thorough examination of the affected area. After confirming the complete removal of the thrombus and the absence of fragments and mural thrombi, the IVC was repaired and the right atrium was closed. During recovery from CPB, the patient's adrenaline and dopamine levels were 0.01 μg/kg/h and 5 μg/kg/min, respectively. The pump flow was gradually reduced and adrenaline (0.03 μg/kg/h) and dopamine (10 μg/kg/min) were introduced. Following the successful pump detachment, neutralization of heparin was ensured with protamine. Using TEE, it was re-confirmed that there were no residual thrombi in the atrium or surrounding vessels (Figure 4). A nephrectomy was performed and the laparotomy incision was closed with packing. The adrenaline infusion was discontinued and the dose of dopamine was down-titrated.

Throughout the operation, the patient was administered eight red blood cell suspensions and six units of fresh frozen plasma. Through inotropic support (dopamine 10 μg/kg/min) and arterial blood pressure, 95/40 mmHg, the heart rate was 110 bpm. In this tachycardiac state, the patient was transferred to the intensive care unit. The inotropic support and controlled mechanical ventilation were continued in the intensive care unit. The patient's alertness was evaluated 12 h postoperatively. As the respiratory effort was insufficient, mechanical ventilation was continued until 48 h after surgery in the patient whose Glasgow Coma Scale score was 11. The need for inotropic support gradually diminished and it was discontinued. On the second postoperative day, the patient required another minor surgery to repair the laparotomy incision which was closed with packing. The patient was again taken to the intensive care unit for monitoring, and he was extubated five days following the initial operation. Finally, the patient developed stable vital signs and was successfully moved to recovery.

## DISCUSSION

It has been reported that cavoatrial thrombosis occurs in approximately 6% of patients with RCC.[1] The classification of caval thrombi in RCC is as follows: Level 1, venous thrombus in the renal vein that does not extended to the IVC; Level 2, infrahepatic IVC thrombus; Level 3, retro- or suprahepatic thrombus that does not reach the right atrium; and Level 4, thrombus in the right atrium.[8] All RCCs with a thrombus in the IVC and without metastasis require surgery. The surgical treatment required by patients with an invasive thrombus in the renal vein, IVC, or atrium is advanced and needs challenging techniques which necessitate a multidisciplinary approach. During the surgical operation, in addition to a team of urology specialists, there may be a need for experienced cardiovascular and gastrointestinal surgeons.

Due to the absence of distant metastases in the majority of cases with cavoatrial thrombus, and the observance of only caval occlusion findings, it has been suggested that radical surgical interventions positively affect the survival rate. Tribble et al.[9] showed that the complete resection of these tumors yielded higher survival rates, than incomplete resection.

In the removal of tumors that extend to the right atrium, CPB is a widely accepted practice performed with or without circulatory arrest.[10,11] In this case report, a Level 4 renal vein thrombus was present without distant metastases. Therefore, a CPB without circulatory arrest was planned to resect the tumor and completely remove all tumor extensions.

Venous return is impaired in patients with thrombi in the vena cava. As such, the volume status cannot be assessed by central venous pressure. Monitoring the volume status by TEE is useful, particularly in such cases. During the induction of anesthesia, hypotension can be observed, due to both the effect of general anesthetic on cardiac output and the resulting decrease in venous return. Therefore, hydrating patients before anesthesia induction can help them tolerate this situation. In our patient, we placed 16- and 18-G venous catheters before induction. Preoperative hydration was ensured by 1,500 mL of 0.9% saline solution. In addition, the cardiac index and arterial blood pressure can drop due to IVC clamping and the presence of a caval thrombus. To sustain arterial pressure at an adequate level and to begin intravenous fluids and positive inotropic drugs, two more 16-G venous catheters and an 8-Fr introducer with a 10-cm long sheath were inserted into the internal jugular vein. This length of sheath was preferred over longer central venous cannulae, which might have caused embolism due to interference with the atrial thrombus.

There are many publications on the preoperative and intraoperative use of TEE in patients with RCC invading the IVC.[12-18] There are several advantages of using TEE during the surgical management of RCC invading the IVC. In the present case, the anterior extent of the thrombus was accurately localized closer to the right atrium than, as detected by MRI. Also, TEE has been shown to be superior to CT, MRI, and inferior venacavography in identifying the extent of the tumor thrombus, as was the case in our patient.[12,13] Additionally, anesthesiologists can perform TEE monitoring during surgery in the real-time setting to allow for the detection of any thrombus fluctuations which may change vascular bypass and surgical technique.[6] A TEE also allows for the rapid identification of massive pulmonary embolisms and the presence of thrombi in the pulmonary artery, and provides information about right heart dysfunctions. With intraoperative TEE, LV volumes and potential malfunctions can be also assessed. In our patient, TEE played a critical role in demonstrating the extent of the tumor, monitoring cardiac functions during the surgical procedure, and reducing the risk of embolism.

A TEE can be also used during nephrectomy to identify tumor embolisms in the heart, in cases of severe hypotension,[19] and to validate the presence of residual mural thrombi after tumor excision.[20] Similarly, we used TEE to not only show the spread of the tumor, but also, during central venous catheterization, pilot the advancement of the guidewire and central catheter to prevent the fragmentation of the atrial thrombus and the potential development of embolism.

Important considerations for the anesthetic management of RCC with invasion of the IVC include a comprehensive preoperative identification of the extent of tumor spread, preparation for CPB, and/or extracorporeal venous shunting. Pre- and intraoperative use of TEE is valuable.[21] In addition, resection of RCCs with an IVC tumor thrombus poses a significant perioperative risk. Successful outcomes require a carefully crafted approach, integrated expertise and experience, and close inter- and intra-departmental collaboration between surgeons and anesthesiologists. Safe perioperative anesthetic management of these patients must also consider the importance of TEE-experienced anesthesiologists with liver transplantation and cardiac experience.[22]

In conclusion, as shown in the present case, intraoperative transesophageal echocardiography is useful in monitoring and evaluating cardiac functions and preventing tumor embolization in renal-cell carcinoma patients with a cavoatrial thrombus. Furthermore, we believe that a multidisciplinary approach and preoperative preparation positively affect patient outcomes.

**Declaration of conflicting interests**

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