Anesthetic management of primary cardiac tumor in the coronary sinus and right atrium

ABSTRACT
The patient presented with complete atrioventricular block and dyspnea. They had a primary cardiac tumor originating in the coronary sinus, a rare site of origin. It filled the sinus and involved the right atrium. The patient might have presented with complete atrioventricular block due to tumor invasion and respiratory distress due to elevated LVEDP as the tumor filled the coronary sinus. As for anesthesia management, in addition to the usual management, we observed CS obstruction and also considered myocardial protection methods. It is important to anticipate the risks and develop an appropriate anesthetic plan accordingly.

Key words: Anesthetic management, coronary sinus, primary cardiac lymphoma, primary cardiac tumor

Introduction
We report a case of a primary cardiac tumor that originated in the coronary sinus, which is a rare site of origin. The tumor filled the sinus and involved the right atrium.

Case Report
A 55-year-old female patient presented to her former doctor with dyspnea on exertion. She had previously undergone robot-assisted laparoscopic total hysterectomy with bilateral salpingo-oophorectomy and pelvic lymphadenectomy for endometrioid adenocarcinoma. She had also received methotrexate (8 mg) and folic acid (5 mg) for the treatment of rheumatoid arthritis.

Her electrocardiogram was notable for a complete atrioventricular block (cAVB) [Figure 1]. She was referred to our hospital for a more thorough examination. She underwent a transthoracic echocardiographic (TTE) examination which revealed an intracardiac mass in the right atrium.

The TTE showed a left ventricular ejection fraction (LVEF) (2D) of 71.3% and a tricuspid regurgitation pressure gradient (TRPG) of 14.4 mmHg. It also showed a mass that measured 50 × 34 × 58 mm invading the basal atrial septum, aortic annulus, and posterior cusp of the tricuspid valve [Figure 2]. The patient was scheduled for resection of the mass under cardiopulmonary bypass (CPB).

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All the American Society of Anesthesiologists standard monitors were started in the operating room, and transcutaneous pacing pads were placed. Her vital signs immediately before the operation were as follows: heart rate: 46 beats per minute; blood pressure: 135/86 mmHg; and \( \text{SpO}_2 \) 96% (ambient air).

General anesthesia was induced with thiamylal, rocuronium, and fentanyl and maintained during CPB with sevoflurane, remifentanil, and propofol. We inserted an endotracheal tube, transesophageal echocardiogram (TEE) probe, and a central venous catheter in the right internal jugular vein, using TEE to monitor the guidewire tip.

The procedure was performed via a median sternotomy after establishing CPB. However, the surgeon could not insert a retrograde cardioplegic cannula into the coronary sinus (CS); the color flow was noted, although the CS appeared closed in the TEE [Figure 3a]. Therefore, we attempted anterograde cardioplegic delivery, and cardiac arrest was achieved.

After achieving cardiac arrest, the right atrium was incised and expanded to reveal a luminal white mass occupying the lumen. The lesion surrounded the CS, and examination from the outside revealed a palpable mass throughout the CS, with a small portion found in the epicardium. The tumor was thought to have originated from the CS.

Since surgical removal of all tumors was deemed impossible, the surgeons resected the tumor to the maximum extent and manually compressed the coronary sinus from the dorsal side of the heart to excise the emerging tumor. In addition, they cauterized the area around the CS to the maximum extent by cryoablation.

After resecting the mass, an anterograde cardioplegic solution was injected, and the CS, which was also narrowing on the TEE, widened and showed color flow [Figure 3b]. The patient was then weaned off CPB, and the chest was closed. She was admitted to the intensive care unit and was intubated with sedation. On postoperative days (POD) 1 and 4, she received therapy comprising rituximab, cyclophosphamide, vincristine, doxorubicin, and prednisolone. On POD 7, a diagnosis of diffuse large B-cell lymphoma was confirmed. She is currently being followed up as an outpatient and remains in remission without relapse.

**Discussion**

There are three critical aspects to be considered for anesthetic management during tumor excision surgery in the right atrium: arrhythmia, tumor embolism, and collapsing circulation. Our patient presented with cAVB due to the involvement of the AV node, probably due to the positional relationship, and a percutaneous pacing pad was applied; however, we did not activate it because the hemodynamic status remained stable, and the shock to the heart caused by pacing could have caused the collapse and tumor embolism. TEE helped manage anesthesia by evaluating the intravascular volume, the presence of tumor impaction in the tricuspid valve, and tracking the catheter tip during insertion.
In most other cases, patients with a partially occluded CS are often asymptomatic because they connect with each other in the CS, with some cardiac veins, and with the right atrium. However, fatal cardiac tamponade due to venous congestion caused by thrombosis in CS has been reported earlier. The normal pressure of CS is approximately 0 mmHg. In patients with CS orifice atresia, CS pressure might increase to 10 mmHg. The elevation of CS pressure can alter LV diastolic function, thereby increasing the volume of blood in the coronary vessels and increasing the stiffness or decreasing LV extensibility.

Since the diastolic function and CS pressure are closely related, the pressure in the CS, occluded by the tumor, could increase and cause left ventricular diastolic dysfunction and elevated filling pressure. In this case, the patient had normal LVEF and TRPG, and dyspnea might have been caused by increased LV end-diastolic pressure due to coronary sinus pressure. Additionally, the surgeons could not insert a retrograde cannula but could induce cardiac arrest by anterograde injection of the cardioprotective solution.

In cases when achieving cardiac arrest with anterograde cardioplegia is challenging, anesthesiologists may consider inducing cardiac arrest via systemic hypothermia or hyperkalemia with intravenous potassium administration. It is important to note that inadequate myocardial protection during induced anesthesia may make weaning from CPB difficult. Upon noticing a tumor filling the RA, it is crucial to determine whether or not the CS is obstructed and to discuss with the surgeon the method of myocardial protection.

In conclusion, it is essential to consider proper anesthetic management of cardiac tumor resection depending on the tumor location and size. In addition to usual volume management and circulatory monitoring, intraoperative TEE helped identify CS obstruction after inducing anesthesia.

Even if the preoperative LVEF is good, anesthesia should be managed with attention to the possibility of decreased cardiac function due to elevated LVEDP. The patient should be carefully monitored with TEE and other anesthesia monitors to avoid heart failure, especially while weaning off CPB. It is essential to anticipate the risks associated with the location and size of the tumor and develop an appropriate anesthetic plan.

Ikuko Miyawaki critically revised the article and approved the final version of the manuscript. Hiroyuki Mima approved the final version of the manuscript.

**Declaration of patient consent**
Informed consent was obtained from the patient for the publication of this case report and accompanying images.

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**Conflicts of interest**
There are no conflicts of interest.

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