Challenges of Maintaining General Anesthesia in a Patient with Coronary Artery Disease Undergoing Retroperitoneal Tumor Resection and Major Vascular Reconstruction

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Citation

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Abstract

The anesthesia management of patients with coronary artery disease undergoing resection and reconstruction of aorta and it major branches poses several unique challenges, including managing massive blood loss and maintaining hemodynamic stability during aorta clamping and unclamping. We report the case of a 62-year-old man with coronary artery disease who underwent surgery for a recurrent right retroperitoneal sarcoma invading the inferior vena cava, aortoiliac artery, ureter, and L4 vertebral body.

The difficult resection and reconstruction of aortoiliac segment and bilateral common iliac veins necessitated nearly 5 hours of vessel clamping time. The interruption of arterial flow by isolation of diseased vessel segment and the production of anaerobic metabolites caused by ischemia in a cardiac patient put this case in a high-risk procedure list. The successful anesthetic management of this case provided us with some valuable lessons to share.

INTRODUCTION

Depending on the extent of tumor invasion, retroperitoneal tumor resection can become a complicated surgery entailing complex anesthesia management. Anesthesia management in such case is even more challenging when the patient has preexisting cardiac disease. We report the case of a 62-year-old man with compromised cardiac function who had recurrent sarcoma of the right retroperitonium with extensive invasion of surrounding tissue and who underwent radical en bloc resection of the inferior vena cava and aorta; L4 vertebrectomy; and right nephrectomy. Challenges in the patient's anesthesia management included managing massive bleeding and maintaining hemodynamic stability during aorta clamping and unclamping. Aggressive perioperative medical management to optimize patient's cardiac condition, careful planning of his intraoperative anesthetic management, and proactive communication among members of the anesthesia, surgery, nursing teams, and blood bank staff played critical roles in achieving the best possible outcome for the patient. This in-depth analysis of the case provides important insight that can be used to improve anesthesia management in similar cases.

CASE DESCRIPTION

In May 2013, a 62-year-old man undergoing serial surveillance computed tomography (CT) at our institution was found to have a large progressive retroperitoneal mass. The mass was identified as sarcoma, which measured 6x10 cm in size. The image showed that the tumor directly abutted and compressed the distal lumen of the inferior vena cava and appeared to be inseparable from the right iliac vessels and descending aorta and to encase the right ureter. The patient's medical history included coronary artery disease (CAD), obesity, sleep apnea and anxiety. The patient consented to undergo radical resection of the tumor, L4 vertebrectomy, right nephrectomy, and resection and reconstruction of the major vessels.

Preoperative 12-lead electrocardiography revealed a 3-mm ST elevation in the lateral leads and reciprocal changes in the inferior leads, indicating ischemic changes in cardiac tissue. An emergency left cardiac catheterization revealed areas of stenosis in the proximal right coronary artery. The ST changes resolved after the patient was given 100 µg of intracoronary nitroglycerin. The cardiologist made the diagnosis of coronary vasospasm and placed the patient on

oral diltiazem. The information was communicated to the anesthesia and the surgery teams.

The day before the patient's surgery, the primary surgery, anesthesia, cardiology, and thoracic surgery teams discussed the patient's planned intraoperative management as well as concerns about major blood loss and the patient's compromised coronary function and tendency to develop coronary vasospasm. All agreed that this case represented a premier anesthetic challenge owing to the dramatic physiologic changes caused by aorta clamping and unclamping and massive blood loss in addition to the patient's complex disease states. Maintaining effective communication among all team members was considered key to the success of this case.

On the day of the patient's surgery, the anesthesia setup in the operating room included an epidural catheter, a bispectrum index monitor, a cardiac output monitor, an arterial line, a 12-French triple-lumen central line, two large-bore intravenous lines, a rapid blood transfuser, and a transesophageal echocardiography machine. In addition, the anesthesia team contacted the blood bank to request that six units of red blood cells (RBCs) and six units of fresh frozen plasma (FFP) be immediately available for the surgery.

The patient was brought into the operating room after 2mg of versed was given and positioned optimally. General anesthesia was induced with lidocaine, sufentanil, propofol, and cisatrcurium. The trachea was intubated with an 8.0-mm endotracheal tube. Anesthesia was maintained with sevoflorane, sufentanil, and cisatracurium via infusion. As recommended by the cardiologist, a low-dose nitroglycerin infusion at 10mcg/minute was started immediately after the induction and maintained throughout the case to prevent major cardiac vasospasm.

The 14-hour surgery involved four surgery teams which included general oncology, thoracic, orthopedic and urology. Most of the blood loss occurred during aorta and vena cava resection and reconstruction period. A total blood loss of 6000 ml required the transfusion of 14 units of RBCs and 14 units of FFPs at a 1:1 ratio. Six units of platelets were also transfused early in the surgery. The 12-French triple-lumen central line was used for blood transfusion. A Belmont rapid blood transfuser was used to manage the high-volume rapid blood transfusion. With its capacity to deliver 500 ml of blood product per minute, the Belmont transfuser allowed its operator to manage the blood transfusion precisely. The anesthesia providers were familiar with the transfuser's feature and functionality and practiced extreme caution during its operation.

To manage the aorta clamping and unclamping effectively, the anesthesia team communicated closely with the thoracic surgeon. According to plan, the surgeon notified the anesthesia provider when it was time to perform the clamping and provided the location of the cross-clamp. At the completion of the vessel reconstruction, the surgeon notified anesthesia provider when it was time to perform the unclamping. Small doses of nicardipine and esmolol were used to combat the hypertension and tachycardia caused by aorta occlusion. Anticipating the metabolic and hemodynamic changes caused by the prolonged aorta clamping, the anesthesia provider administered 1 liter of albumin with 1 g of calcium chloride and 50 mEq sodium bicarbonate prior to the clamp release. The unclamping caused transient hypotension that was successfully managed by administering more fluid and giving intravenous phenylephrine.

During the 14-hour surgery, the patient remained relatively stable with no cardiac ischemia as indicated by ST segment changes on electrocardiography. After surgery, the patient remained intubated and was transferred to the intensive care unit. He remained stable overnight and was extubated the following day with no problems. The patient was discharged home one week after the surgery.

Figure 1

Preoperative Pelvic MRI showed left retroperitoneal sarcoma

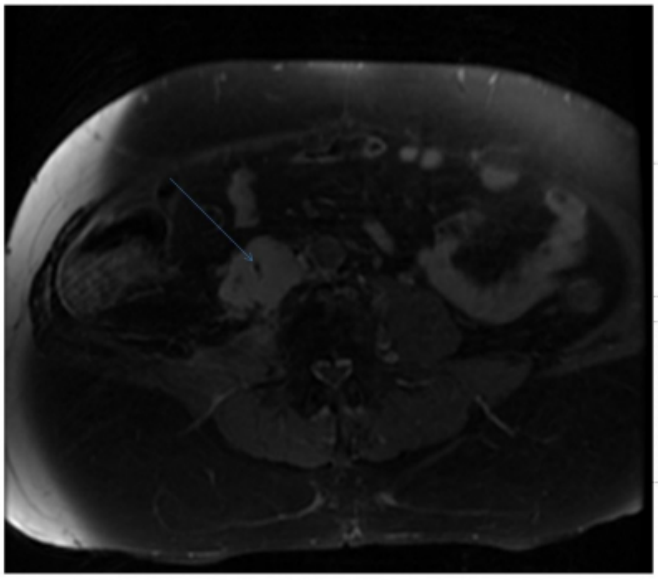
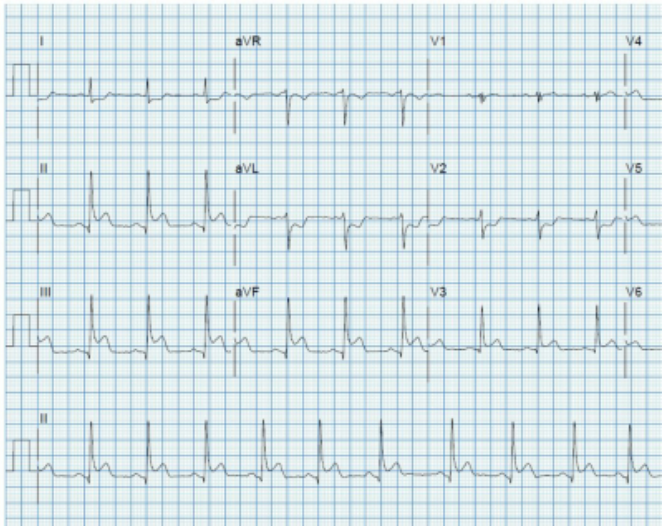


Figure 2

Preoperative stress EKG showed that the patient had ST elevation in inferolateral leads during recovery



DISCUSSION

A proactive anesthesia care plan, vigorous intraoperative anesthesia management, and effective communication among surgery, anesthesia, and nursing teams were essential to this patient's successful anesthetic management.

A number of special considerations regarding potential intraoperative events and the surgery itself dictated the anesthesia care plan. Because the mass involved the infrarenal vena cava and aortoiliac bifurcation, our foremost concerns for procedure-related complications were massive blood loss and the requirement for a transfusion of a large amount of blood. We addressed these concerns in several ways. First, we contacted the blood bank the previous day to inform them about the surgery and to ensure that they had enough time to prepare additional blood supplies. Second, we inserted a 12-French triple-lumen central venous catheter at the beginning of surgery and connected two of its ports to the rapid blood transfuser to ensure that a good intravenous access was secured. Third, we used a rapid blood transfuser rather than a traditional pressure bag to ensure that large amount of blood could be delivered immediately if necessary. Fourth, we made our decisions regarding what blood products to give and at what ratio based on the literature search and our own past experience in similar cases.

Over the past two decades, the approach to addressing massive blood loss during surgery has changed substantially. Historically, in a massive bleeding situation, large amounts of fluids were given until RBC transfusion was absolutely needed. FFP transfusion was performed even later, usually after the RBCs had been transfused and blood tests proving a prolonged prothrombin time had been performed. The landmark study by Borgman et al. in 2007 changed the concept of blood transfusion in a massive bleeding situation. The authors found that the mortality rates of wounded soldiers who required massive transfusions of blood products differed dramatically based on the ratio of FFP units to RBC units. Soldiers who received 1 unit of FFP or less for every 4 units of RBCs had a mortality rate of 65%, whereas those who received 1unit of FFP or more for every 2 units of RBCs had a mortality rate of only 23%. (Borgman et al., 2007). Clinical practice has changed accordingly. The new practice trends towards the early use of blood products, especially plasma, and the early support of the coagulation system. The results of the study by Borgman et al. informed our decision to transfuse FFP and RBCs at a 1:1 ratio.

Our decision to transfuse FFPs and RBCs at a 1:1 ratio was also informed by our own experience of providing anesthesia during hemipelvectomies, extensive surgeries that require transfusion of as many as 40 units of blood products. We observed that giving FFP and RBC at a 1:1 ratio early in those surgeries yielded much better patient outcomes than those achieved by the traditional method of giving FFP only after 4 or more units of RBCs have been administered. We managed the present case using a similar strategy so the

patient could achieve the optimum coagulation state. As a result, the patient's vital signs remained stable; no ST segment changes were detected; and surgical field was optimally dry in the end.

The second surgery-related concern regarding the anesthesia care plan in this patient was the hemodynamic consequences of aorta occlusion and release. During clamping, the most consistent hemodynamic response to aorta occlusion is an abrupt increase in afterload (Kahn, Stone & Moskowitz, 2013). At the same time, there is an increase in preload, attributable to the redistribution of blood from the veins distal to the aortic occlusion. These increases in preload, afterload, and cardiac contractility increase the myocardia oxygen demands and the possibility of myocardiac ischemia (Kahn, Stone & Moskowitz, 2013). In contrast to aorta clamping, which is associated with hypertension, aorta unclamping is associated with severe hypotension. The extent of the hemodynamic changes varies according to the following factors: 1) the extent to which the ischemic tissue has been reperfused; 2) the total occlusion time; and 3) the administration of fluid and therapeutic agents during the cross-clamping period and at the moment preceding to unclamping (Longnecker, Tinker & Morgan, 1998). The hypotension is thought to be caused by central hypovolemia (due to blood pooling to the reperfused tissue), hypoxia-generated vasodilation, and the accumulation of vasoactive metabolites such as lactate.

In the present case, the cross-clamping was on the infrarenal aorta, and the total clamping time was 4 hours and 49 minutes. Although the cross-clamping site was not a major concern, the total occlusion time of 289 minutes was. In preparation for the unclamping, we administered 1 liter of 5% albumin with calcium chloride and sodium bicarbonate. After the unclamping, the patient's systolic blood pressure still dropped to the 80s transiently, but a stable blood pressure was quickly achieved with additional fluid bolus and vasopressor support. The direct communication between the thoracic surgeon and the anesthesia provider at the crucial moments helped to maximize the patient's hemodynamic stability. The early warnings from the surgeon allowed anesthesia provider adequate time to take measures to prevent major fluctuations in vital signs.

Our third anesthesia concern of this patient was his potential to develop intraoperative coronary artery spasm (CAS). CAS has been implicated as a cause of sudden unexpected circulatory collapse. In general, mechanisms associated with the occurrence of acute CAS during the intraoperative period include increased catecholamine response, imbalance of vasoconstrictive and vasodilator forces, excessive alpha activity, and manipulation of the coronary artery (Sidi, Dahleen & Gaspardone, 2007). The key to preventing intraoperative CAS is to avoid hemodynamic extremes during induction, incision, surgical manipulation, and extubation. To prevent intraoperative CAS in the present case, we kept the patient adequately sedated and paralyzed during the entire procedure to avoid major fluctuations in vital signs. Taking the cardiologist's recommendation, we infused nitroglycerin at a low dose of 10mcg/min during the case and kept nifedipine, a calcium channel blocker, immediately available in the event that coronary vasospasm should occur.

Owing to the above measures, at the end of the surgery, the patient exhibited stable vital signs, a normal coagulate state, and no signs of cardiac compromise. He was subsequently extubated the next day and transferred from the intensive care unit the day after that.

SUMMARY

The extraordinary aspects of the anesthesia management of a patient with cardiac disease undergoing aorta and vena cava occlusive repair as part of invasive tumor resection made the present case challenging. Achieving optimum perioperative medical condition; aggressive intraoperative anesthesia management, and maintaining open communication among the team members are the keys to successfully managing this type of case. To meet the anesthesia challenges of managing massive bleeding in cardiac patients, we recommend that anesthesia providers proactively collaborate with cardiology, surgery, nursing, and blood bank to achieve the best possible patient outcome.

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