Initiation of Cardiopulmonary Bypass in a High-Risk Patient Under Regional Anesthesia: A Case Report

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A 34-year-old man presented with a large right ventricular (RV) intracardiac mass obstructing RV inflow and outflow as well as a concomitant pericardial effusion displaying physiological signs of tamponade. The patient underwent awake femorofemoral cannulation for cardiopulmonary bypass (CPB) under regional anesthesia with initiation of CPB before induction of general anesthesia. This unconventional approach avoided hemodynamic perturbations in this high-risk patient. Regional anesthesia provided predictable analgesia compared to local infiltration for improved toleration of cannulation. (A&A Practice. 2020;14:e01246.)

GLOSSARY

ASIS = anterior superior iliac spine; **BMI** = body mass index; **CPB** = cardiopulmonary bypass; **DCA** = deep circumflex artery; **EO** = external oblique muscle; **EQUATOR** = Enhancing the Quality and Transparency of Health Research; **IO** = internal oblique muscle; **HIPAA** = Health Insurance Portability and Accountability Act; **LAST** = local anesthetic systemic toxicity; **MAC** = multi-access catheter; **RA** = right atrium; **RV** = right ventricle; **TA** = transversus abdominus; **TEE** = transesophageal echocardiogram; **TTE** = transthoracic echocardiogram

Intracardiac tumors can involve any part of the heart, and they are rare with an estimated incidence of 0.001%–0.3%.^{1,2} Right ventricular (RV) masses, in particular, pose a challenge when outflow becomes obstructed because the RV has limited ability to compensate for hemodynamic changes. The induction of general anesthesia for surgical resection can precipitate hemodynamic collapse due to changes in intrathoracic pressure, RV failure, and cardiogenic shock. Previous case reports involving intracardiac masses obstructing right-sided outflow document this hemodynamic instability after induction that then required urgent initiation of cardiopulmonary bypass (CPB).^{3,4}

The use of awake CPB is rare and reserved for patients at the highest risk for airway compromise or hemodynamic collapse on induction of anesthesia.^{5–8} While this approach successfully avoids induction complications, the cannulation process causes anxiety and pain that may lead to unwanted hemodynamic changes in an already hemodynamically compromised patient.

Here, we described a 34-year-old man who presented with a large RV intracardiac mass that extended into both the right atrium (RA) and RV outflow tract, as well as a large pericardial effusion. In an attempt to avoid hemodynamic

instability on induction of anesthesia, the patient underwent ultrasound-guided femoral and ilioinguinal/iliohypogastric blocks before awake femorofemoral cannulation and initiation of CPB. Written informed consent and Health Insurance Portability and Accountability Act (HIPAA) authorization were obtained from the patient. Manuscript adheres to Enhancing the Quality and Transparency of Health Research (EQUATOR) guidelines.

CASE DESCRIPTION

A 34-year-old man with a medical history of treated malaria and asthma presented with increased dyspnea on exertion. On physical examination, the patient had 2+ bilateral lower extremity, scrotal, and truncal edema as well as ascites, which were concerning for RV failure. His platelet count was 48,000/μL, which was believed to be due to tumor-related thrombocytopenia. The remaining hematologic and biochemical tests were normal. His height and weight were 163 cm and 81.6 kg, respectively, with a body mass index (BMI) of 31.4. Diagnostic workup included a transthoracic echocardiogram (TTE) showing a dilated RV with a multilobular mass in its entirety. The mass prolapsed into the RA and abutted the pulmonic valve causing almost complete obstruction of the RV. RV function was moderately to severely reduced. In addition, a large pericardial effusion was present with evidence of diastolic collapse of the RA. Cardiac magnetic resonance imaging was performed that showed the mass measuring 8.4 × 5.5 × 4.9 cm and attached to the basal-inferior wall. These findings were concerning for cardiac sarcoma. The patient was referred to cardiovascular surgery for urgent resection.

Given the size of the intracardiac mass, the degree of RV inflow and outflow obstruction, and the pericardial effusion demonstrating signs concerning for tamponade, there was a high degree of concern for hemodynamic instability on induction of anesthesia. After discussion with the

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Figure 1. Ultrasound image of an ilioinguinal/iliohypogastric nerve block. ASIS indicates anterior superior iliac spine; DCA, deep circumflex artery; EO, external oblique muscle; IO, internal oblique muscle; TA, transversus abdominus muscle.

cardiovascular surgeon, a plan was made to undergo awake cannulation and initiation of CPB using right-sided femorofemoral access with the induction of anesthesia immediately following.

In the preoperative holding area, a right radial 20-gauge Arrow arterial line (Arrow, Reading, PA) was placed followed by 2 ultrasound-guided regional blocks. The patient received an ilioinguinal/iliohypogastric nerve block with 10 mL of 0.5% ropivacaine (Figure 1) and a femoral nerve block, with 15 mL of 0.5% ropivacaine. The patient was brought to the operating room and underwent placement of a 9F dual-lumen multi-access catheter (MAC) central venous catheter (Arrow, Reading, PA) via the right internal jugular vein. Before cannulation, vital signs included a heart rate of 90 beats/min and a blood pressure of 145/110 mm Hg. On the arterial wave tracing, the patient's blood pressure demonstrated pulsus paradoxus, consistent with a significant pericardial effusion. One milligram of lorazepam and 1 mg of midazolam were administered to relieve patient anxiety.

Common femoral artery and vein access was obtained using a micropuncture set, and 7F sheaths were placed. A total of 30,000 units of systemic intravenous heparin was

administered. A wire guide was introduced, and, following serial dilations, a 17F arterial cannula and a 25F venous cannula were placed. Full CPB was initiated with 200 µg of neosynephrine in the CPB pump prime. Vital signs remained at preoperative values, and the patient did not display any signs of discomfort indicating that he had adequate coverage from the regional nerve blocks. The patient then underwent induction of anesthesia with 1 mg lorazepam, 1 mg midazolam, 150 µg fentanyl, 50 mg lidocaine, 10 mg etomidate, and 100 mg rocuronium followed by endotracheal intubation. No additional vasoactive medications were required.

An intraoperative transesophageal echocardiogram (TEE) confirmed the preoperative TTE findings (Figure 2; Supplemental Digital Content, Video 1 <http://links.lww.com/AACR/A323>; Supplemental Digital Content, Video 2, <http://links.lww.com/AACR/A322>). In addition, the mass now extended through the pulmonic valve and created a ball-valve obstruction in the proximal pulmonary artery (Supplemental Digital Content, Video 3, <http://links.lww.com/AACR/A321>).

The patient underwent RV intracardiac mass excision, 33-mm Mosaic bioprosthetic (Medtronic, Minneapolis, MN)

VIDEO+

VIDEO+

VIDEO+

Figure 2. RV inflow and outflow transesophageal image illustrating the large mass that occupies the entire RV. The tricuspid valve is no longer visualized as the mass extends into the RA. RA indicates right atrium; RV, right ventricular.

tricuspid valve replacement, and pericardial effusion drainage. In preparation for cessation of bypass, a dobutamine infusion was started at 2 µg/kg/min. A postbypass TEE showed a moderately dilated RV with moderately decreased systolic function. Unresectable residual tumor was noted in the RV wall (Supplemental Digital Content, Video 4, <http://links.lww.com/AACR/A320>).

The patient's postoperative course was complicated by hypoxic respiratory failure requiring reintubation, third-degree atrioventricular heart block requiring a dual-lead St. Jude Medical pacemaker (St. Paul, MN), as well as reaccumulation of his pericardial effusion requiring subxyphoid drainage. The patient was ultimately discharged home in stable condition. The pathology report showed a spindle cell malignant tumor.

DISCUSSION

We described the use of ultrasound-guided regional anesthesia to secure peripheral cannulation for the initiation of awake CPB in a patient with a large, obstructing RV mass and significant pericardial effusion.

Given the size of the tumor in the RV, the obstruction of the RV outflow tract, and the large pericardial effusion, the risk for this patient to have hemodynamic instability on induction of anesthesia was very high. Awake CPB has been used to avoid this instability^{5,6}; however, to achieve desired flow rates on CPB, appropriately sized large-bore cannulas needed to be inserted. The incision and cannulation process are associated with pain and anxiety leading to unwanted hemodynamic changes in an already compromised patient. Therefore, adequate analgesic coverage of the cannulation site is essential.

Previous case reports describe blind local infiltration⁵⁻⁷ at the site of cannulation for pain control. Local infiltration lacks precision because the user determines the directional placement and volume of medication used. As a result, it can require supplementation in the form of additional local anesthetic or sedation if the patient voices discomfort. One case report described the use of a femoral nerve block in a patient with a compromised airway, but it did not describe whether an ultrasound-guided or landmark-based technique was used for the block.⁸ None of the previous reports documented how well the procedure was tolerated or the adequacy of pain relief from cannulation.

In contrast to local infiltration, the use of ultrasound-guided regional anesthesia for awake cannulation of a hemodynamically compromised patient has not been explored. We performed 2 sets of ultrasound-guided regional nerve blocks to ensure sufficient coverage and analgesia for awake femorofemoral cannulation. The femoral nerve block was selected to cover most of the anterior thigh, and the ilioinguinal/iliohypogastric blocks were selected to cover the more superior areas of the thigh and groin.

Compared to local infiltration, our method allowed for a more targeted and predictable approach to analgesia for peripheral bypass cannulation. In peripheral nerve blocks, Spiliopoulos et al⁹ and Neal et al¹⁰ demonstrated improved analgesia when comparing ultrasound-guided regional anesthesia versus local infiltration. Spiliopoulos et al⁹ showed a decrease of 3 points in mean visual analog score when they compared common femoral artery cannulation with ultrasound-guided local deposition versus landmark infiltration. They also demonstrated a decrease in the volume of local anesthetic injected when using an ultrasound-guided technique.⁹

For ilioinguinal/iliohypogastric nerve blocks, Neal et al¹⁰ and Wang et al¹¹ demonstrated improved accuracy and analgesia in ultrasound-guided blocks versus landmark approaches. Specifically, patients who received an ultrasound-guided ilioinguinal/iliohypogastric nerve block had a significant reduction in pain scores and required less additional intraoperative analgesia compared to a landmark technique.¹¹

The use of regional anesthesia has potential limitations or complications. When combining 2 different regional blocks to provide broader anesthetic coverage, the possibility of local anesthetic systemic toxicity (LAST) must be considered as the total dosage of local anesthetic is increased. This especially applied in our patient with a compromised heart. Therefore, we decreased the volume of our injections to stay well below the maximum suggested dosage of ropivacaine for our patient's weight. Ultrasound-guided regional anesthesia has its own potential limitations. Patient factors, such as increased BMI and a high American Society of Anesthesiologists classification, are associated with increased technical difficulty and decreased procedure success rate.¹² Our patient had truncal edema from his right heart failure which could have made the ilioinguinal/iliohypogastric blocks more challenging and less reliable due to increased fluid disrupting the fascial planes. Additionally, in an acutely decompensating patient, this approach may not be appropriate given the necessary equipment needed and time associated with block placement.

The use of awake CPB provided an alternative approach to avoiding hemodynamic instability during induction of anesthesia. In high-risk patients, it is imperative to prevent pain-induced hemodynamic fluctuations during cannulation that can decompensate the patient. Our use of regional anesthesia in the form of femoral and ilioinguinal/iliohypogastric nerve blocks successfully provided adequate analgesia with stable hemodynamics for one such high-risk patient. Therefore, the use of regional anesthesia offered a safe alternative to local infiltration as a means to transition a patient onto awake CPB. ■■

DISCLOSURES

Name: Coby Tran, MD.

Contribution: This author helped with literature search and writing of the case report.

Name: Marco Aguirre, MD.

Contribution: This author helped obtain images from the case and reviewed the case report.

Name: Suzanne Dellaria, MD.

Contribution: This author participated in the care of this patient, constructed the anesthetic plan, and reviewed the case report.

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