Anesthetic Management of a Systemic Right Ventricle

Katherine Markes, SAA and Adam Petersen, CAA
University of Missouri Kansas City, 2411 Holmes St, Kansas City, MO 64108

Introduction

This study will review anesthesia management in a patient who has significantly outlived their life expectancy after a correction for Transposition of the Great Arteries (TGA) with a Mustard procedure. The patient presents for robotic inguinal hernia repair post Mustard procedure (1964).

Learning objectives:

1. Increased anesthetic risk factors due to cardiac and pulmonary function.
2. Patient risk factors from lifestyle choices.
3. The overlap of personal and cardiac risk factors and their effect on anesthetic risk.

Why we care

Patient had a Mustard procedure in 1964. Patient's Mustard procedure was performed shortly after the procedure's invention. Studies show long-term survival beyond 20 years post procedure is considered extremely uncommon and there is a lack of data concerning patients in this group. Patients followed in the studies typically experienced loss of sinus node function due to the stress put on the right ventricle after the operation. A study by Jensen et al. indicated the most common cause of death in adolescence was sudden cardiac death, and in children >10 years old it was heart failure. Patient has led a relatively unrestricted life for approximately 60 years with a complex cardiac physiology. He presents for a non-cardiac surgery, but now has additional complicating factors due to health choices including smoking, chewing tobacco, and obesity.

Patient Description

A 60 year old male who is 5'10", 100kg, and BMI of 32.5 presents for robotic inguinal hernia repair.

Past medical history:

- Atrial Flutter/Fibrillation
- Obstructive Sleep Apnea with the use of CPAP
- Transposition of the Great Arteries status post Mustard procedure in 1964
- Pulmonary Hypertension
- Eisenmenger's Syndrome
- Stage 3 Chronic Kidney Disease
- Acute respiratory failure with hypoxia and hypercapnia
- Peripheral vascular disease

The patients most recent right heart catheterization indicated:

- pulmonary capillary wedge pressure of 28
- Fick cardiac output 5.9
- Fick cardiac index of 2.6
- Pulmonary Vascular resistance f 9.3

The most recent echo indicated:

- chronic combined systolic and diastolic heart failure
- Severe right atrial dilation
- mild regurgitation of the systemic Av valve.

The most recent Pulmonary Function Test:

- Moderate Restrictive Diseases,
- Total Lung capacity of 60-69%.

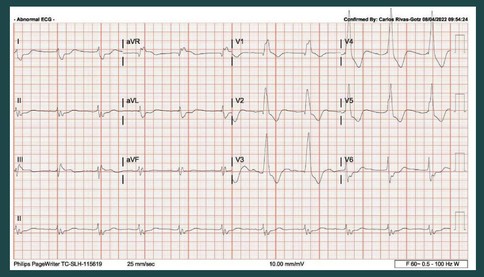
Labs were unremarkable for stage 3 chronic kidney disease.

The patient takes Albuterol, Coreg, Digoxin, Eplerneone, Hydralazine, Warfarin.

Social history:

- 0.5 pack years smoking
- current smokeless tobacco
- 1 drink a week

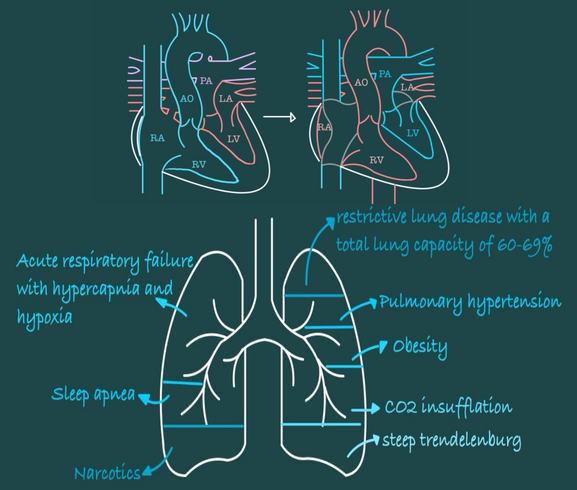
Physiologic concerns



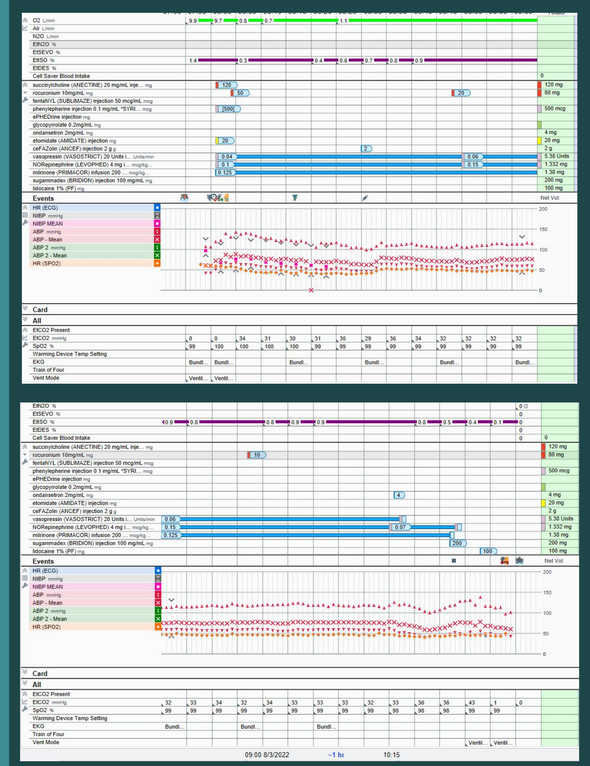
Gellatt et al. noted patients developed sinus node dysfunction/ atrial fibrillation/ atrial flutter due to the excessive work that is put on the right ventricle caused by a mustard procedure. Another common side effect noted was pulmonary hypertension. Both are present in this patient.

These physiologic changes not only cause concern for safely securing the airway, but also for various pressure changes within the abdomen and thorax during a robotic case. In a study of COPD patients by Kilic et al. discussed the effect of steep Trendelenburg and CO2 insufflation on lung compliance, and discovered a p value of <0.0001. This study noted that lung compliance was decreased, and the effects lasted longer than five days in those with illness, while those without illness recovered in five days.

The other main cardiac risk factor is the understanding the physiologic right ventricle is responsible for systemic circulation. Christensen et al. performed a retrospective analysis of general surgical procedures on patients post correction for TGA, while most patients had an arterial switch procedure, five had undergone a mustard procedure. In these adult patients the surgical team decided on invasive monitoring because of the risk for heart failure and other cardiac complexities observed.



Anesthetic Plan



Preoperative Management

The patient received a pre-induction arterial line and central line for hemodynamic monitoring as well as medication administration. Placement of these lines were uneventful.

Induction:

This patient underwent an uneventful induction of anesthesia. The induction sequence included: 20 mg of Etomidate, 120 mg of succinylcholine, 500 mcg of phenylephrine Succinylcholine was the relaxant of choice to allow for rapid securement of the airway. Prior to induction the following drips were started and maintained throughout the case: 0.04 units/ min of Vasopressin, 0.1 mcg/kg/min of Levophed, 0.125 mcg/kg/min of Milrinone.

Maintenance

Maintenance of anesthesia was achieved with isoflurane as well as the previously mentioned drips, as well as redosing of rocuronium to achieve paralysis for the robotic portion of the case.

Emergence

Emergence was uneventful with termination of drips when end tidal isoflurane was at 0.5 and sugammadex was given. 100mg of lidocaine was also given proactively to help blunt coughing on the tube.

Discussion

Overall the patient had a successful outcome following surgery. The patient was optimized to the best of the team's ability. The anesthetic team believes their plan was thorough and took into account the complex physiology of this patient. The team reflected on the potential of trying to optimize the patient better in terms of smoking cessation and ensuring he quit several months prior to surgery. The plan included appropriate pressors, inotropic support, as well as ventilatory management to ensure the patient remained as close to his physiologic normal as could be accomplished. Due to the potential for adrenal suppression by etomidate, the team speculated about a potential combo of propofol/ketamine or propofol/etomidate to potentially reduce this risk. Along with choice of induction agent, the team reflected on their use of succinylcholine due to the potential for histamine release as well as the potential issues this could have caused in a patient with chronic kidney disease. The care for this patient required an intimate understanding of the anatomy of his heart and what those implications would be in terms of support. Milrinone was the choice because of its ability to support right heart function, which was critical in this patient as his right ventricle is the systemic ventricle. Everything in this case was dependent on control and taking steps to prevent things from getting to the point the anesthetic team could not correct. This planning had to involve some very honest discussions with the patient and the risks associated with undergoing surgery in his state of health. The patient understood the risks and was comfortable proceeding as well as the anesthetic team felt that had a good plan to keep the patient safe under anesthesia.

Conclusions

The medical field has vastly improved since 1964 and will only continue to improve throughout our careers. The major accomplishments we have seen in congenital heart defect repair since the sixties will only continue to improve. While the mustard procedure has since fallen out of favor, I suspect this will be a common trend we will see throughout our careers as medical techniques continue to advance. It will become more common to help treat these patients who are living long after their initial life expectancy thanks to the advent of new surgical techniques.

References

Cannesson M, Earing MG, Collange V, Kersten JR. Anesthesia for noncardiac surgery in adults with congenital heart disease. Anesthesiology. 2009 Aug;111(2):432-40. doi: 10.1097/ALN.0b013e3181ae51a6. PMID: 19602959..

Christensen, R. E., Reynolds, P. I., Bukowski, B. K., & Malviya, S. (2010). Anaesthetic management and outcomes in patients with surgically corrected D-transposition of the great arteries undergoing non-cardiac surgery. *British journal of anaesthesia*, *104*(1), 12-15.

Jensen AS, Jørgensen TH, Christersson C, Nagy E, Sinisalo J, Furenäs E, Gjesdal O, Eriksson P, Vejlstrup N, Johansson B, Hlebowicz J, Greve G, Dellborg M, Skulstad H, Kvidal P, Jokinen E, Sairanen H, Thilén U, Søndergaard L. Cause-Specific Mortality in Patients During Long-Term Follow-Up After Atrial Switch for Transposition of the Great Arteries. J Am Heart Assoc. 2022 Jul 19;11(14):e023921. doi: 10.1161/JAHA.121.023921. Epub 2022 Jul 5. PMID: 35861834; PMCID: PMC9707826

Kilic OF, Börgers A, Köhne W, Musch M, Kröpfl D, Groeben H. Effects of steep Trendelenburg position for robotic-assisted prostatectomies on intra- and extrathoracic airways in patients with or without chronic obstructive pulmonary disease. Br J Anaesth. 2015 Jan;114(1):70-6. doi: 10.1093/bja/aeu322. Epub 2014 Sep 18. PMID: 25236948.

Mathew, Shaji et al. "Anesthetic management of a child with corrected transposition of great vessels undergoing non-cardiac surgery." *Saudi journal of anaesthesia* vol. 7.2 (2013): 200-2. doi:10.4103/1658-354X.114053

Vejlstrup, N., Sørensen, K., Mattsson, E., Thilén, U., Kvidal, P., Johansson, B., Iversen, K., Søndergaard, L., Dellborg, M., & Eriksson, P. (2015). Long-Term Outcome of Mustard/Senning Correction for Transposition of the Great Arteries in Sweden and Denmark. *Circulation*, *132*(8), 633–638.