Introduction

There is an increasing population of pediatric heart failure patients supported with ventricular assist device (VAD) technology and presenting for non-cardiac surgery. Unfortunately, guidelines on the perioperative anesthetic management of these patients are lacking, especially in patients with non-pulsatile VADs. However, it is evident that this patient population poses unique management challenges in the perioperative period and instituting strategies to reduce their complications is imperative.

Case Series

We present a 17 year old male with history of acute myeloid leukemia, and dilated and restrictive cardiomyopathy secondary to anthracycline toxicity who received a HVAD implant as a bridge to transplant. Approximately one month after HVAD implantation, the patient was scheduled to undergo diagnostic cardiac catheterization for evaluation of right heart hemodynamics. The patient was induced with etomidate and succinylcholine, and maintained under general endotracheal anesthesia with sevoflurane. Although he tolerated induction, he subsequently became hypotensive as the interventional cardiologist was obtaining femoral access. The patient had a notable decrease in HVAD flow to <2L/min, requiring boluses of crystalloid, colloid, and a dopamine infusion of 5mcg/kg/min to maintain MAP. At the end of the case he was weaned off of vasoactive support and extubated (Table 1).

Several weeks later the patient was readmitted with a sternal wound infection that required incision and drainage. The patient received general anesthesia with an LMA and again experienced a decrease in HVAD flow towards the beginning of the case, requiring vasoactive support. Despite the wound debridement, the patient experienced persistent fevers and required antibiotics.

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Despite the wound debridement, the patient experienced persistent fevers and required anesthesia for transesophageal echocardiography to evaluate for endocarditis. He was given intravenous sedation with ketamine and dexmedetomidine and had no hemodynamic compromise; however he experienced significant post-operative dysphoria (Table 1).

Conclusions

Perioperative management of patients with HVADs is challenging and standardized perioperative management guidelines are lacking. The approach to managing these patients’ starts with ensuring the anesthesiologists has a solid understanding of the unusual physiology and monitoring and should focus on minimizing complications and treating cardiovascular changes appropriately.

References

Roshan Patel MD, Nina Deutsch MD, Jamie Schwartz MD, Chinwe Unegbu MD. Ventricular Assist Device: Case 3 and had no hemodynamic compromise; however he experienced significant post-operative dysphoria (Table 1).

Discussion

The HVAD is unique because it is a centrifugal continuous-flow pump with a hybrid magnetic bearing that creates pulsatile waveforms by changing pump speed. It has gained popularity with the advantage of being smaller than previous LVADs, while still supporting circulation up to 10L/min.

In our patient, anesthesia-associated hypotension was a recurrent problem. A systematic approach is required to manage perioperative hemodynamic instability from multiple inter-related causes.

• Preoperative stability is often a poor predictor of intraoperative stability. Our patient had stable hemodynamics with adequate cardiac output prior to each anesthetic.
• Preoperative optimization of preload is critical and intraoperative hypotension can initially be treated with volume administration.
• Intravascularly, induction should be directed at maintaining stability, as the HVAD is sensitive to changes in preload, afterload, heart rate, and rhythm. Furthermore, standard intraoperative monitors such as pulse oximetry and NIBP are unreliable in this population given the non-pulsatile HVAD flow so arterial access may be preferred.

• In patients with an HVAD, RV dysfunction is common and may require inotropic support with dopamine or epinephrine. Positive pressure ventilation adds RV afterload and decreases venous return, thus spontaneous ventilation is preferred when possible. Furthermore, patients with elevated pulmonary vascular resistance (PVR) may have additional RV strain; inhaled nitric oxide should be available. Inadequate RV function will decrease LA, LV and HVAD filling, causing systemic hypotension and compromising HVAD function. Our patient had a known history of RV dysfunction and elevated PVR which likely contributed to his intraoperative instability.

• Maintenance of normal sinus rhythm is important as arrhythmias can impair RV function, decrease LV preload, and impact HVAD filling.

Additionally, the anesthetic plan should be tailored to the patient and specific surgery. In some cases sedation or regional anesthesia may be preferred over a general anesthetic.

Table 1. Intraoperative Management Details

<table>
<thead>
<tr>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Procedure</td>
<td>Cardiac Cath</td>
<td>Medastinal I&amp;D</td>
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<tr>
<td>Anesthetic</td>
<td>General</td>
<td>General</td>
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<tr>
<td>Airway</td>
<td>Intubation with PPV</td>
<td>LMA with SV</td>
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<tr>
<td>Monitoring hemodynamics</td>
<td>Arterial line</td>
<td>NIBP</td>
</tr>
<tr>
<td>Induction</td>
<td>Etomidate</td>
<td>Etomidate</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Sevoflurane</td>
<td>Sevoflurane</td>
</tr>
<tr>
<td>Complications</td>
<td>Hypotension Decreased HVAD flows</td>
<td>Hypotension Decreased HVAD flows</td>
</tr>
<tr>
<td>Treatment</td>
<td>Crystalloid Colloid Phenytoine Epinephrine Dopamine infusion</td>
<td>Crystalloid Phenytoine Epinephrine</td>
</tr>
</tbody>
</table>

5.1 L/min
2800 RPM
4.0 Watts
Fixed
% Off
Speed
Time
Current
VAD: ON
VAD: OFF