Demystifying the Palliated Heart - Emergent Exploratory Laparotomy in a patient post Bidirectional Glenn Shunt

Moderators: Robert Bryskin, M.D., Katrin Post-Martens, M.D.

Institution: Nemours Children’s Specialty Care, Jacksonville, Florida

Goals: The participant will be able to

1) Describe the bidirectional Glenn shunt anatomy and understand its sequelae.

2) Discuss the anesthetic implications of elevated intra-abdominal pressure, positive pressure ventilation, dehydration, acidemia and blood loss on maintenance of adequate cardiac output in a patient with a bidirectional Glenn.

3) Recognize the technologies available for intra-operative monitoring of a child with palliated CHD receiving emergent non-cardiac surgery

4) Compare the advantages and disadvantages of TAP catheters, IV opioids, and neuraxial analgesia for post-operative pain management.

Case History:

An eight month old infant with hypoplastic L heart syndrome, asplenia and abdominal situs invertus status post palliation with Norwood (1 week of age) and bidirectional Glenn (1 month ago) presents emergently with bowel obstruction secondary to malrotation.

Questions:

What is a bidirectional Glenn shunt? What are the typical indications for this palliative procedure? What would you expect the SpO2 to be in a child status post bidirectional Glenn? What is the incidence of associated intra-abdominal abnormalities? Are these children at higher risk for intestinal ischemia? Why?

Physical Examination: SpO2 of 78% on 4LNC, delayed capillary refill, tachycardia to 160’s with blood pressure of 51/32. The abdomen is distended without bowel sounds.

Questions:

What else would you like to know before proceeding with the anesthetic? Any interventions you would consider before proceeding to the OR? Would you delay going to the OR for preoperative IV access, labs and hydration? What labs would you order and why? What blood products would you have on stand-by and why? What would you expect the baseline hematocrit to be in a child s/p bidirectional Glenn? Do these children have a normal coagulation profile?
**Case Progression:**

You decide to gain IV access, and to send STAT labs including CBC and chemistries, lactic acid, and type and cross for cryoprecipitate, pRBCs, plasma and platelets. You fluid bolus the infant in the ICU, just before taking him to the OR.

**Questions:**

What induction drugs will you use and why? Are there any special considerations for induction (RSI vs. bag mask ventilation)? Do you keep the infant spontaneously breathing? Why or why not? What hemodynamic monitors will you place pre-induction? What is your plan for intra-operative monitoring? What FiO2 do you plan to use for induction? For the case?

**Intra-operative Course:**

You place standard ASA monitors and pre-oxygenate your patient with 100% FiO2. Immediately after rapid sequence induction with opioid and paralytic and uneventful intubation, with initiation of positive pressure ventilation, you notice acute desaturation.

**Questions:**

What is the likely etiology of this desaturation? What are the treatment strategies? What ventilator settings would you choose and why?

**Intra-operative Course (continued):**

Your surgeon insists on muscle paralysis. You add nitric oxide to the breathing circuit and adjust the ventilator settings to allow more expiratory time and a slower respiratory rate to maximize periods of pulmonary blood flow. These interventions result in some improvement in saturation.

You gain arterial and central venous access. You note that the infant’s CVP is 3.

Opening the abdomen results in a further improvement of saturation. The surgeon notes several areas of dusky bowel and tells you she will likely need to resect several areas. As she starts resecting, she notes continuous oozing.

**Questions:**

What is the value of following the CVP in this patient? Discuss the utility of an oximetric central line and cerebral oximeter to monitor end organ function and guide blood product administration. What SvO2 would you expect at baseline in a patient s/p bidirectional Glenn? What is your transfusion threshold?

**Intra-operative Course (continued):**

During extensive bowel dissection and resection, and well into your resuscitative effort with pRBCs, platelets, plasma and cryoprecipitate, the surgeon reports continued poor hemostasis and requests administration of recombinant factor VIIA.
Questions:
Do you agree? Discuss blood conservation techniques, use of antifibrinolytics and possible effects on Glenn shunt function? What is the risk associated with using recombinant factor VIIa in Glenn shunt?

Intra-operative Course (continued):
With a single dose of recombinant factor VIIa, hemostasis improves, and the surgeon is able to complete her procedure without further significant blood loss.

At the conclusion of surgery, and with the goal to extubate, the surgeon asks for a caudal catheter. The patient has been on aspirin therapy for his Glenn circuit, but recently switched to therapeutic Lovenox for a central line associated thrombosis.

Questions:
With pain control likely an issue, do you extubate at the end of the procedure? Why or why not? Would you consider placing a caudal catheter in the setting of recent Lovenox use using US guidance? What other regional techniques might be employed to facilitate early extubation?

Intra-operative Course (continued):
After placement of bilateral Transverse Abdominis catheters for post-operative pain control, you successfully extubate the patient at the end of the case.

Discussion:
In light of the increasing number of children born with complex congenital heart disease that are surviving infancy through palliative (or definite) surgical procedures, the interface between anesthesia and the cardiac patient is expanding from the cardiac anesthesiologist as the sole caregiver. More and more general pediatric anesthesiologists are faced with providing anesthesia for non-cardiac procedures in these children. In patients with complex CHD, abdominal pathology is relatively common as a result of gut ischemia from hypoxia and/or associated congenital abnormalities that predispose to malrotation and bowel obstruction, and consequently, these children frequently present to the OR with abdominal emergencies.

In hypoplastic L heart syndrome, the L side of the heart is severely underdeveloped and unable to support peripheral circulation, a function that the R heart must provide in addition to pulmonary blood flow in order for the infant to survive. Postnatally, these children rely on systemic blood flow primarily via their PDA for survival, and surgical intervention to reconstruct the aorta using the pulmonary vein (Norwood) and augment pulmonary blood flow (BT shunt or Sano shunt) becomes imperative. The Glenn shunt provides continuous, non-pulsatile pulmonary blood flow as a connection from the superior vena cava to the pulmonary arteries in the second stage of palliation, and is an effort to unload the R heart.

The intra-operative challenge for the anesthesiologist involves maintaining adequate pulmonary blood flow through the (non-pulsatile, continuous) Glenn circuit in the face of increased abdominal pressures, and surgical requirement for muscle paralysis and positive pressure ventilation. Since the Glenn shunt functions best in the spontaneously ventilating patient with low intra-thoracic/-abdominal pressure, we
will explore intra-operative strategies to maintain adequate Glenn flow even in the presence of PPV and abdominal distention such as avoidance of excessive PEEP, hypoventilation with permissive hypercapnia, adjusting the I:E ratio, inhaled nitric oxide, head elevation, adequate volume loading and avoidance of tachycardia. Moreover, increases in pulmonary vascular resistance secondary to pain, hypoxia, hypothermia or acidosis must be avoided in order to prevent flow reversal when PVR exceeds SVR.

We will discuss utility of using oximetric central lines and cerebral oximeters to guide transfusion in the patients with Glenn physiology. It has been shown that Glenn patients are deficient in both pro- and anticoagulant factors, and the risk of thromboembolism depends on the balance of these deficiencies as well as on the functional status, with low flow states being more prone toward thromboembolism. This has to be weighed against the risk of bleeding when considering factor concentrates.

In addition to intra-operative management strategies, we would like to invite discussion on postoperative pain control in this unique patient population. The child with CHD in particular benefits from early extubation because any pulmonary pathology related to prolonged intubation will greatly impact cardiac function. Regional anesthetic techniques can be a simple and very effective way to achieve early extubation and avoid the impact of hypoventilation and pain on PVR. Consideration has to be given to anticoagulation status and potential contra-indication to neuraxial techniques, and we aim to use our illustrative case to guide learners through the decision making process.

References:


