Complications during a Laparoscopic Fundoplication in a 3-Month-Old

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Goals:
Understand the pathophysiologic consequences of gastroesophageal reflux disease (GERD) in children
Identify the potential complications that can develop during laparoscopic surgery in infants
Distinguish how these problems, while possible in any child during laparoscopic surgery, are more pronounced in infancy
Identify the hemodynamic and respiratory effects of pneumoperitoneum; how is cardiorespiratory physiology altered during these procedures?
Identify the most effective interventions that can be instituted when problems develop.
Recognize the early signs that complications are evolving, so that intervention can be taken before disaster ensues.
Identify the most effective monitoring tools and methods during laparoscopic surgery.

Case:
A 5.2 kg 3 month old child was to undergo a laparoscopic Nissen fundoplication and gastrostomy tube placement under general anesthesia. He was born at term with no complications, but developed intractable gastro-espohageal reflux that could not be successfully treated with medical management. He has continuing feeding intolerance and vomiting despite anti-reflux measures. A pH probe and barium swallow showed reflux to the level of the vocal cords. He is on omeprazole twice a day and thickened feeds. He has no past surgical history, nor any other medical problems. His physical examination is unremarkable.

Question 1: Reflux is described in many infants and usually resolves by one year of age. At what point does reflux become a disease?
What are some of the medical measures used to manage gastroesophageal reflux disease?
What are the indications for surgical management? What are the criteria for deciding on fundoplication? What studies are useful, and what are their limitations?

The child is brought to the operating room. He was NPO for 7 hours for formula and 3.5 hours for clear liquids. No premedication is given. Monitors are placed (standard non-invasive monitors: 3 lead ECG, pulse oximeter, oscillometric blood pressure, temperature, precordial stethoscope, end-tidal gas analysis, volume spirometry), and anesthesia is induced by mask with sevoflurane while holding cricoid pressure (Selleck maneuver). A 22 gauge IV is placed in the hand as soon as consciousness is lost. A 2 mg/kg dose of propofol is administered at this time and the trachea is easily intubated; no evidence of reflux in the pharynx is identified. Vital signs are HR 148, BP 78/39 prior to intubation, HR 160, BP 86/51 immediately following intubation.
Question 2: is a rapid sequence induction necessary in every case of GE reflux, and are there alternatives that can be used? How effective is cricoid pressure? Is a premedication useful or contraindicated?

Anesthesia is maintained with 1.5% isoflurane in air and oxygen and 2 mcg/kg of fentanyl is administered. Neuromuscular blockade is induced with 0.1mg/kg of cisatracurium. Lactated Ringers solution is administered at 30ml/hr. The patient is positioned, prepped and draped. Vital signs are: HR 124, BP 68/33, ETCO₂ 33 with pressure controlled ventilation at 16/4, rate of 22. The first incision is made and the first port placed. Blood pressure and heart rate increase, so the isoflurane concentration is increased to 2.3%.

Question 3: What are the advantages and disadvantages of PEEP (at “physiologic” levels) during laparoscopic surgery in infants?
Would you use nitrous oxide in this case?
What are the advantages, if any, to the use of a neuromuscular blocking agent?

The abdomen is insufflated with CO₂ to an intra-abdominal pressure of 8cmH₂O. The other ports are placed in the abdomen and surgery commences. Approximately 10 minutes into the surgery, the blood pressure monitor begins to take a very long time to cycle, and repeatedly inflates and deflates without obtaining a reading. The other vital signs remain essentially unchanged.

Question 4: What are the possible causes of oscillometric blood pressure device failure?
What are the critical steps in troubleshooting a problem like this, and in what order?

You cannot get the cuff to cycle successfully after checking the connections and the module. You check the monitor setup, and it is correctly configured for an infant. Heart rate remains stable at 118; ETCO₂ has fallen to 28. You decrease the ventilator rate and call the anesthesia tech for a new BP module, hose, and cuff.

5 minutes later, the anesthesia tech brings a new module, hose and cuff, and the two of you replace the device and struggle under the drapes to replace the blood pressure cuff. When you emerge, the heart rate has fallen to 58 and the end-tidal CO₂ is reading 18. The ECG shows an elevation of the ST segments; the pulse oximeter signal continues to read 100%.

Question 5: What is most likely going on? What is the pathophysiology behind this event?
What is the first immediate step to take? What things should immediately follow this step?
What hints were most likely missed earlier, and what should have been done at that time?
What are the limits of effectiveness of the monitoring devices employed in this case (that is, how do they work and why do they fail)?
What is the implication of a falling ETCO₂ in the face of CO₂ installation for the pneumoperitoneum?
Were there any things that could have been done differently during the early stages of the case that might have prevented this, or is there a possible (or probable) undiagnosed underlying condition in this patient that led to this sequence of events?
The surgeons are asked to immediately release the pneumoperitoneum, and you open the IV line to full flow while turning off the isoflurane. The heart rate increases to 135 within 5 seconds, and the blood pressure cycles without problems, reading 69/38. Once you have administered 20ml/kg of lactated Ringers, you inform the surgeons they may proceed with the operation.

**Question 6:** Are fluid requirements different in laparoscopic vs open fundoplication? Is postoperative respiratory function likely to be less impaired following a laparoscopic or open technique?

**Additional questions for discussion:** What are the analgesic needs of an infant following a laparoscopic fundoplication? Are they different from an open procedure? What are the options available to you in this case?

How much local anesthetic can be given to infants? What about systemic analgesics—are opioids a greater risk in infancy?

Bibliography and suggested references: (starred references are especially recommended)


Rowney D, Aldridge LM. Laparoscopic fundoplication in children: anesthetic experience of 51 cases. Paediatr Anaesth 2000:10;291-96