LAPAROSCOPIC PYLOROMYOTOMY

Surgical Specialty:	Pediatric Surgery
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Background:

- General Considerations
  - Pyloric stenosis results from hypertrophy of the smooth muscle of the pylorus and leads to gastric outlet obstruction. It presents approximately between 2-6 weeks of age and is more common in males than females. There is a decline in risk with increasing birth order.[1]
  - Patients present with nonbilious projectile vomiting, failure to thrive, and dehydration. Classically, this lesion is associated with a palpable olive-shaped mass on abdominal exam, however, ultrasonography provides a definitive diagnosis.
  - Vomiting of gastric secretions leads to hypochloremic, hypokalemic metabolic alkalosis.
  - A superimposed metabolic acidosis is indicative of severe hypovolemia.
  - Medullary chemoreceptors in the brainstem are affected by changes in the pH of cerebrospinal fluid (CSF). A lower pH (i.e., higher concentration of hydrogen ions) stimulates ventilation. Metabolic alkalosis can lead to respiratory depression and apnea in an effort to restore pH neutrality through compensatory respiratory acidosis via CO_2 retention (i.e., hypoventilation). This combined with the effects of general anesthesia and neonatal physiology, can increase the risk of postoperative apnea. Equilibration of CSF pH with plasma pH can take several hours, and it is possible to lag behind plasma pH that has normalized.[1,2] Additionally, preoperative alkalosis has been associated with increased time to extubation at the end of surgery.[3]
- Patient Considerations
  - Disease Specific Considerations
    - This condition is a medical emergency, not a surgical emergency. Adequate treatment of dehydration with fluid resuscitation and improvement of metabolic derangements is of utmost importance prior to surgery.
    - There is a high risk of significant gastric content despite an otherwise appropriate fasting interval.
- Associated Comorbidities/Syndromes
  - No specific associated comorbidities/syndromes.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - Laboratory evaluation for adequacy of resuscitation:
    - Metabolic alkalosis must be corrected: pH 7.3-7.45, Chloride (Cl) >90 mEq/L, Bicarbonate (HCO_3) < 30 mmol/L, K >3.0 mEq/L. These values represent approximate ranges and specific endpoints of resuscitation may be institution dependent.
    - Normal urine output can be used as indicator of appropriate volume resuscitation.
  - Discussions to have with surgeon/family
    - Whether the patient is adequately resuscitated
    - Low but real possibility of the need for postoperative ventilation
- Specific or Unique Room Set-Up Requirements
  - Airway
    - Appropriately sized equipment for intubation and mask ventilation. Video laryngoscopy is recommended and may assist in successful intubation.
    - Functioning suction and appropriately-sized orogastric (OG) tube for awake suctioning in multiple positions to evacuate the stomach.
  - Drugs/Infusions
    - Induction medications (propofol and/or ketamine) and muscle relaxant (succinylcholine and/or rocuronium). Neuromuscular blockade reversal (sugammadex or glycopyrrolate/neostigmine) if rocuronium is administered.
    - Consideration of spinal anesthesia for open pyloromyotomy.
    - Pain control: rectal or IV acetaminophen, ketorolac or other IV NSAIDs if appropriate and local anesthetic infiltration by the surgeon. Avoid the administration of opioids secondary to the risks of postoperative apnea.
    - Fluids: continue preoperative maintenance fluids and have isotonic crystalloid available.
  - Monitors and Access
    - Standard American Society of Anesthesiologists monitors
    - Prewarm the operating room, place a forced air warmer, and have radiant warming (“French fry lights”) available.
    - Patients usually have preoperative intravenous (IV) access, given ongoing fluid administration
    - Glucometer for blood sugar monitoring
  - Blood Availability
    - Usually not required. Blood loss is minimal.
  - ICU Bed Availability
    - Institutional guidelines will likely determine postoperative disposition; these patients are unlikely to require ICU care if surgery is uneventful in an appropriately resuscitated child.

Intraoperative Considerations:

- Full stomach precautions
  - Proper gastric suctioning with a large-bore multi-orifice catheter in supine, right, and left lateral decubitus, and prone position can recover over 95% of gastric contents.[4]
  - Pretreating with an anticholinergic such as atropine or glycopyrrolate may help to prevent a vagal response to this simulating procedure.
  - Patients may arrive from the floor with a nasogastric (NG) tube; anesthesia providers should have a high index of suspicion for a blocked or malpositioned device, in which case it should be removed and replaced with an OG tube[1].
- Induction
  - Classic rapid sequence induction and intubation can be performed, but gentle bag-mask ventilation, as in the modified rapid sequence technique, may optimize intubating conditions and improve oxygenation due to infants' rapid desaturation while apneic.
  - Inhalational induction has also been described in a large retrospective case series; however, the risk of aspiration should be weighed carefully[5].
  - Regardless of which method is chosen, care must be taken to prevent coughing or gagging during laryngoscopy, which may be facilitated with neuromuscular blockade.
- Positioning
  - Supine for both open and laparoscopic approaches.
  - Some surgeons may prefer turning the baby 90 degrees on the bed to gain surgical exposure.
- Maintenance
  - Shorter-acting inhalational agents are less associated with postoperative apnea (sevoflurane vs. isoflurane).
  - Avoid nitrous oxide due to expansion of bowel gas.
  - Continue fluid resuscitation perioperatively (NaCl, D5 1/2NS + K^+), avoid free water (D5) and monitor blood glucose levels.
- Hemodynamic/Physiologic goals
  - Avoid aspiration
  - Avoid hyperventilation which can worsen CSF alkalosis and increase the risk of postoperative apnea
- Surgical Considerations
  - Open or by laparoscopy, procedure generally takes 0.5 to 1 hour
  - After myotomy, surgeon may request insufflation of air through an OG tube to assess for a leak
- Emergence/Disposition
  - Ensure full reversal of neuromuscular blockade
  - Infant should be fully awake prior to extubation
  - ICU admission is usually not necessary
  - Most patients can start feeding within 4-6 hours
- Post-operative analgesia:
  - Acetaminophen and NSAIDs (if possible)
  - Local anesthetic infiltration into incision sites by surgeon
  - Opioids should be avoided or used with extreme caution as they can delay emergence and predispose the patients to postoperative apnea.

Case Specific Complications/Pitfalls

- Proceed with surgery only when the infant is clinically euvolemic and labs have normalized.
- Recognize the possibility of residual gastric contents despite a sufficient fasting interval, therefore, the stomach should be emptied prior to induction of anesthesia with an NG or OG tube.
- Abdominal insufflation is generally well tolerated but ventilator adjustments may be needed to ensure an acceptable minute ventilation and avoid hypercapnia.
- Postoperative respiratory depression may occur as a result of the effect of preoperative metabolic alkalosis on the pH of the CSF, and subsequent decreased drive to breathe through central CO_2 chemoreceptors. Opioids and hyperventilation should be avoided to prevent hypocarbia.
- Infants should be carefully monitored for 12-24h postoperatively.

References

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