LAPAROSCOPIC CHOLECYSTECTOMY

Surgical Specialty:	Pediatric General Surgery
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Background:

- General Considerations
  - As the etiology of pediatric biliary disease changes, laparoscopic cholecystectomy for cholelithiasis is being more commonly performed in the pediatric population.
- Patient Considerations
  - Classic biliary colic is described as sharp, crampy right upper quadrant pain that can radiate to the right shoulder and is often associated with nausea and vomiting. Biliary colic often occurs after ingestion of a fatty meal.
  - Done on an elective/urgent basis – never emergencies.
  - Associated Comorbidities/Syndromes
    - The leading cause of cholelithiasis, and cholesterol gallstones, is childhood obesity. The increase in cases of pediatric cholelithiasis over the past few decades mirrors the rise in obesity in children.[1]
    - Patients with hemolytic diseases such as, sickle cell disease, hemolytic anemia, and hereditary spherocytosis develop pigmented gallstones from hemoglobin breakdown and increased levels of bilirubin. These numbers have remained stable.
    - Increased survival of critically ill infants with prolonged use of total parenteral nutrition and short gut syndrome has also increased cases of pediatric cholelithiasis and the need for cholecystectomy.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - Standard thorough pre-operative evaluation with emphasis on any comorbid conditions.
  - *Sickle cell disease and hemolytic anemias*
    - Pre-procedural complete blood cell count (CBC) is needed
    - Hematology consultation for the possibility of pre-procedural admission for hydration or transfusion for optimization
    - Plan for perioperative pain control and possible pain service consultation to decrease the risk of postoperative pain crisis
  - *Congenital heart disease*

        - In cases of congenital heart disease with a shunt, single ventricle physiology, cardiomyopathy, or pulmonary hypertension, a preoperative discussion with their cardiologist and surgeon to evaluate the risk/benefit ratio of the laparoscopic approach is helpful.[2]
- Specific or Unique Room Set-up Requirements
    - Airway
        - Standard endotracheal intubation
        - Consider a rapid sequence induction (RSI) if significant gastroesophageal reflux disease (GERD) symptoms, recent nausea, or vomiting.
        - If obese, be prepared for more difficulty with mask ventilation and airway visualization.
    - Drugs/infusions
        - Premedication
            - Midazolam – oral or IV as needed
        - Antibiotic prophylaxis
            - Cefazolin (30mg/kg) – up to max 3g – within 1 hr of incision
                - If true allergy to cephalosporins, consider alternatives vancomycin and/or clindamycin
        - Glucagon (0.1mg/kg, max 1mg) is sometimes used for intraoperative cholangiogram and sphincter of Oddi relaxation.
        - Muscle relaxation
            - Usually desired for optimizing surgical field with abdominal insufflation
            - Rocuronium (0.6-1.2 mg/kg) or other paralytic of choice
        - PONV prophylaxis
            - Ondansetron (0.1-0.15mg/kg) – max dose 4mg
            - Dexamethasone (0.1mg/kg) – max dose 4mg
        - Pain management
            - Opioids titrated
            - Acetaminophen – oral or IV
            - Ketorolac (0.5mg/kg) – max 15-30mg
                - Surgeon dependent
                - Avoid if the patient has recent gastrointestinal bleeding or severe renal impairment
            - Regional anesthesia
                - Many techniques have been described including transverse abdominal plane (TAP) blocks, rectus sheath blocks, quadratus lumborum (QL) blocks, and paravertebral blocks.
                - Surgeon delivered local anesthetic to port sites
    - Monitors
        - Standard American Society of Anesthesiologists monitors
        - Consider processed electroencephalograpy if total intravenous anesthesia (TIVA) is used
    - Blood Availability, PICU, and other resources
        - Not usually required

Intraoperative Considerations:

- Capnoperitoneum
    - Alters cardiovascular and respiratory physiology
        - Infants/children are more susceptible to bradycardia with abdominal insufflation secondary to increased vagal tone or light anesthesia

            - Slow insufflation and low pressures (< 12mmHg) decrease this risk
            - *Communicate with the surgical team to stop insufflation*
            - Glycopyrrolate (0.005-0.01mg/kg) or atropine (0.01-0.04mg/kg) as needed
        - Pushes diaphragm cephalad decreasing functional residual capacity and thoracic compliance[3]
            - Increased inspiratory pressures to maintain appropriate Tidal Volumes/Minute Ventilation
            - Can cause atelectasis and VQ mismatch resulting in hypoxemia, consider positive end-expiratory pressure (PEEP)
- Induction
    - Standard induction – mask or intravenous induction depending on the age of the patient and comorbid conditions
    - Rapid sequence induction – indicated if concern for recent nausea/vomiting or full/residual stomach contents, severe reflux
    - An oral or nasogastric tube is usually placed after induction to decompress the stomach to allow for better surgical visualization
- Positioning
    - Supine with reverse Trendelenburg and left side down for maximizing surgical exposure to the right upper quadrant
        - Improves some of the negative effects of capnoperitoneum on ventilation
        - Decreases venous return to the heart and increases the risk of hypotension especially if the patient is hypovolemic from losses or has nausea/vomiting: consider prophylactic fluid load with 10cc/kg of balanced IV solution
    - Positioning and diaphragm displacement can cause right main stem intubation
- Maintenance
    - Volatile anesthetic (sevoflurane or isoflurane) or TIVA (propofol infusion)
        - Avoid nitrous oxide to minimize bowel distention and emetogenesis
    - Muscle relaxation for improved visualization and ventilation with capnoperitoneum
- Hemodynamic/Physiologic goals
    - Maintain normal hemodynamics
        - Hypercarbia is common from carbon dioxide (CO_2) insufflation. Minute ventilation may need to be increased to compensate.
        - Risk of hypotension and gas embolism at time of positioning and deflation of capnoperitoneum.
- Surgical Considerations
    - Creation of capnoperitoneum for surgical visualization
        - Laparoscopic insufflation with CO_2 results in hypercarbia. Minute ventilation may need to be increased to compensate.
        - High insufflation pressures can impair hemodynamics by reducing preload and can contribute to increased atelectasis.
- Emergence/Disposition
    - Standard emergence criteria
    - Ensure adequate reversal of neuromuscular blockade to avoid post-operative weakness
- Post-op Care
    - Standard post-operative care
    - Multimodal pain therapy effective
    - Complaints of referred pain often to the right shoulder are not uncommon after laparoscopic surgeries and result from residual capnoperitoneum

    - Ambulating and multimodal therapies are effective at providing relief.

Case-Specific Complications/Pitfalls

- Risk of vessel or bowel injury during needle/trocar insertion
    - More common during blind insertions
    - Treat supportively if hemorrhage occurs
- Venous gas embolism
    - Risk most significant at insufflation and deflation of the capnoperitoneum
    - Increased risk in small infants and neonates.
    - Abrupt decrease in end-tidal carbon dioxide ($EtCO_2$) and hemodynamic instability
    - Stop insufflation and treat supportively
        - External cardiac massage in case of hemodynamic collapse or cardiac arrest to force gas lock of pulmonary outflow tract[4].
        - Consider early postoperative hyperbaric oxygen treatment in case of cardiac arrest and the presence of a patent foramen ovale.
- Capnothorax
    - Increasing $EtCO_2$ and airway pressures with decreasing oxygen saturation. It is often erroneously considered a pneumothorax. It is caused by the diffusion of inflated CO_2 across diaphragmatic defects or dissection around the esophageal hiatus. The treatment is stopping inflation and providing PEEP to force CO_2 out of the pleural cavity[5].
- Ductal injury or bile leak[6]
    - Surgical injury to the common bile duct and many necessitate additional procedures

References

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