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GASTROSTOMY TUBE PLACEMENT (LAPAROSCOPIC VS. OPEN)

Surgical Specialty:	General Surgery
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Background:

- General Considerations
  - Gastric tube (G-tube) placement involves inserting a tube into the gastrointestinal (GI) tract via the stomach wall to allow direct, percutaneous access for feeding and administration of medications when oral intake is compromised or inadequate
    - Less frequently may be placed for stomach decompression
  - The general indication is failure to thrive or risks thereof (see Associated Comorbidities/Syndromes below for a list of common causes of this)
  - Contraindications to g-tube placement include uncorrectable coagulopathy and hemodynamic instability given the elective nature of the procedure, as well as distal GI obstruction[1]
  - The surgical approach to g-tube placement is determined primarily by the surgical team, given patient anatomy and surgical history. Percutaneous g-tube (percutaneous endoscopic gastrostomy, PEG) placement has been preferred over open placement due to efficiency and efficacy[2], however, laparoscopic g-tube placement is increasingly used because it does not require a follow-up procedure to place a low-profile tube[3]. Moreover, laparoscopy is indicated over the percutaneous approach when the stomach is inaccessible due to upper GI occlusion, prior upper abdominal or gastric surgery, overlying transverse colon, hiatal hernia with cranial displacement of stomach, hepatomegaly or previously failed PEG[4]. At present, open placement is much less commonly used, but surgical indications include significant intraabdominal adhesions and/or prior upper gastric surgery[2]
- Patient Considerations
  - Associated Comorbidities/Syndromes[5]
    - Neurologic disorder leading to dysphagia (most commonly due to cerebral palsy in the pediatric population)
    - Craniofacial abnormalities
    - Head trauma
    - Oncologic state/chemotherapy complicated by anorexia
    - Chronic aspiration as in cases of severe gastroesophageal reflux disease (GERD)
    - Severe oral aversion as seen in children unable to feed orally since birth

        - Other diseases leading to chronic malnutrition such as metabolic disorders, cystic fibrosis, chronic kidney failure, congenital short bowel syndrome, inflammatory bowel disease, or Human Immunodeficiency Virus (HIV)

Anesthetic Planning:

- Pre-Anesthetic Evaluation:
    - Evaluate for any comorbid conditions that increase the risk of intraoperative complications and optimize as able
    - Consider the surgical approach (laparoscopic versus open) and whether comorbidities necessitate an open approach from the anesthetic perspective, for example, patients with cyanotic heart disease may not be candidates for laparoscopic surgery given the risk of paradoxical gas embolism (due to right-to-left intracardiac shunt)[6]. Additionally, patients unable to tolerate the hemodynamic effects of pneumoperitoneum may require an open procedure (see Intraoperative Considerations below)
    - Consider alternatives to general anesthesia in patients whose comorbidities make them too high risk (for example, severe neuromuscular disease). Open g-tube placement is possible under regional anesthesia though data is limited. PEG placement is more likely possible under alternative anesthetic techniques to general anesthesia such as sedation. Coordination in these cases is critical.
    - Additional labs/tests indicated during work-up
        - No special labs are required
        - Review chemistry and complete blood count and coagulation panel as appropriate to assess kidney and liver function, electrolyte derangements, and bleeding concerns
        - For laparoscopic cases, confirm cardiopulmonary history and review pertinent studies[4] (see Pre-Anesthetic Evaluation above and Intraoperative Considerations below)
    - Discussions to have with surgeon/family:
        - Many of these patients are at increased risk for aspiration and complications associated with this need to be disclosed
        - Discuss surgical preference regarding the use of the g-tube for medications and/or nutrition in the post-anesthesia care unit (PACU)
        - Code Status as indicated by patient factors
    - Pre-Anesthetic anxiolysis
        - Premedication may be indicated to ease anxiety and/or facilitate peripheral IV (PIV) placement in patients requiring PIV for rapid sequence intubation (RSI)
        - Consider intranasal midazolam (0.2-0.4 mg/kg) or dexmedetomidine (1-2 mcg/kg) for patients at high risk of aspiration with oral medications
- Specific or Unique Room Set-up Requirements
    - Airway
        - Whether open or laparoscopic, endotracheal tube (ETT) placement with rapid sequence intubation (RSI), as indicated, for airway securement and reduction of aspiration risk
            - Use cuffed ETT to allow for positive pressure ventilation, particularly in laparoscopic cases
    - Drugs/Infusions:
        - Standard induction and maintenance medications (anxiolytic, analgesic, amnestic, paralytic) unless patient-specific factors indicate otherwise
        - Antibiotics per surgeon preference and patient-specific indications

        - Postoperative nausea and vomiting prophylaxis based on patient risk factors
            - Dexamethasone 0.1 mg/kg IV
            - Ondansetron (3 years and older) 0.1 mg/kg IV
            - Consider propofol infusion (20-25 mcg/kg/min) for high-risk PONV
        - Consider dexmedetomidine (total of 0.5 mcg/kg IV) for postoperative delirium prevention
    - Monitors:
        - Standard ASA monitors
        - If the patient has significant cardiac or pulmonary comorbidities, consider an arterial line
    - Blood Availability
        - Not indicated
    - PICU Bed Availability
        - Not indicated as a direct outcome of this surgery unless the patient has other comorbidities necessitating ICU level of care
    - Other Indicated Resources (ex. ECMO standby)
        - None

Intraoperative Considerations:

- General
    - A laparoscopic approach is primarily associated with physiologic effects related to:
        - Peritoneal stretch and carbon dioxide (CO_2) absorption secondary to insufflation
        - Use of reverse Trendelenberg positioning
    - Pneumoperitoneum effects include the following:[6]
        - Increased intraabdominal pressure
            - Causes compression of splanchnic vessels leading to increased sympathetic tone and vasoconstriction with an initial increase in venous return and cardiac output, followed by a reduction in cardiac output due to decreased venous return and increased afterload[7]
        - Rapid insufflation can trigger increased vagal tone
            - Manifests as bradycardia; may lead to cardiac arrest if untreated
            - Treat vagally induced bradycardia with glycopyrrolate (0.005-0.01 mg/kg IV, up to 0.2 mg in adults), consider as pretreatment in high-risk patients[8]
        - Reduced lung volumes and compliance
            - Causes atelectasis and resultant V/Q mismatch
            - Manifests as hypercarbia and hypoxemia
    - Reverse Trendelenberg positioning can lead to decreased venous return causing reduced cardiac output and resultant hypotension. This can be exacerbated by sustained pneumoperitoneum, which is also associated with decreased venous return and cardiac output[7]
- Induction
    - Given associated comorbidities, preoperative peripheral intravenous (PIV) line placement may be preferable to allow for RSI
    - If a PIV cannot be placed ahead of time, or for lower-risk patients, an inhalational approach may be used
- Positioning
    - Typically supine with arms tucked and appropriately padded

- Reverse Trendelenberg positioning is often required; see Anesthetic & Physiologic Implications above
    - Confirm ETT placement with any position change
- Maintenance
    - Volatile anesthetic unless specific comorbidities indicate otherwise
- Hemodynamic/Physiologic goals
    - Normal heart rate, normotension, normovolemia
    - Monitor end-tidal CO_2 ($ETCO_2$) and prevent excessive hypercarbia due to absorbed CO_2 from insufflation by adjusting the ventilator with increased tidal volume and/or respiratory rate as appropriate for patient size
- Surgical Considerations
    - Orogastric tube (OGT)
        - Insert after intubation to decompress the stomach
        - Keep in place to insufflate the stomach during the laparoscopic approach
    - Muscle Relaxation
        - Paralysis may be indicated in larger children to minimize intraabdominal pressures and diaphragm movement interfering with the surgical field, but can often be omitted in infants and small children
        - Reverse neuromuscular blockade as indicated with sugammadex or neostigmine and glycopyrrolate
    - Blood and fluid losses should be minimal, particularly with a laparoscopic approach
- Emergence/Disposition
    - Awaken to extubate postoperatively
    - Transfer to PACU then the floor, unless the patient has other comorbidities requiring ICU level of care
- Post-op Pain
    - The surgical team can inject local anesthetic intraoperatively. Alternatively, a caudal block may be utilized in appropriate patients.
    - Consider IV versus enteric (if g-tube acceptable for immediate use) acetaminophen and opioids as indicated
    - Ketorolac or other NSAIDs may be an option if intraoperative bleeding is minimal, confirm with the surgical team[9]

Case-Specific Complications/Pitfalls

- Pneumoperitoneum
    - Common secondary to insufflation of air and needle puncture of the gastric wall, rarely the consequence of damage to other structures such as the colon
    - Inconsequential in the absence of peritonitis (see next section)
- Peritonitis
    - Due to accidental placement of the g-tube in the peritoneal cavity at the time of surgery or due to dislodgement
    - If symptoms suggest peritonitis, a radiologic study using water-soluble contrast is warranted to confirm g-tube placement and evaluate for any other intraabdominal pathology
- Dislodgement of the G-tube
    - Initial placement is not typically emergent, but g-tube *replacement* after being dislodged can be
        - A g-tube tract can stenose or close within hours of tube removal, even with a mature tract[5]

        - G-tubes established less than 4-6 weeks prior to dislodgement should not be replaced without operative or fluoroscopic guidance[1,5]
- Complications associated with laparoscopy and insufflation, including, but not limited to:
    - Subcutaneous administration of insufflation[6,10]
        - May lead to hypercarbia, which can be addressed via an increase in minute ventilation and fresh gas flows, but if not resolving may need to stop insufflation and verify trocar placement
        - Associated subcutaneous emphysema, which is common after laparoscopy and presents with postoperative crepitus in abdominal, chest, or neck tissues. Inconsequential in the absence of massive subcutaneous emphysema with respiratory compromise and typically self-resolves[11]
    - Post-operative referred shoulder pain secondary to insufflation
        - Due to residual sub-diaphragmatic gas, typically self-resolves within 24-48 hours[10]
    - CO_2 embolism
        - Due to the introduction of CO_2 from insufflation to vasculature via direct injection or injury causing sudden hypotension, hypoxemia/cyanosis, arrhythmias[12]
        - Notify the surgical team, desufflate the abdomen, turn FiO_2 to 100% and increase fresh gas flow, and provide supportive care as indicated

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