LAPAROSCOPIC SLEEVE GASTRECTOMY

Surgical Specialty:	General Surgery (Bariatric)
Authors:	Mingfei Wang, M.D. and Angela Lee, M.D. Children's National Medical Center Washington, D.C.

Background:

- General Considerations
  - High prevalence of obesity. Currently, more than 18% of children in the USA are obese.[1]
  - Indication and eligibility for bariatric surgery[2]
    - Body mass index (BMI) > 35 with at least one severe comorbidity
    - BMI > 40 with less serious comorbidities
    - Failure of dietetic, behavioral, and pharmacological intervention after 12 months of intensive treatment
    - Social infrastructure in place capable of supporting bariatric postoperative care
    - Patient able to assent to surgery.
  - Benefits of bariatric surgery[3]
    - Sustained weight loss
    - Improvement or resolution of metabolic comorbidities
    - Improved life expectancy
  - Most common bariatric surgeries include the Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy. Adjustable gastric banding is not commonly performed anymore.
    - Sleeve gastrectomy
      - Non-reversible, removing approximately 80% of the stomach
      - New stomach holds less food and liquid, reducing caloric intake
      - Decreases hunger and increases satiety

- Patient Considerations
  - Obesity definition and classification in children
    - BMI is age and sex specific
    - > 85^{th} percentile: Overweight
    - > 95^{th} percentile: Obese
    - > 99^{th} percentile: Severely obese
  - Physiological changes of obesity[4]
    - Respiratory
      - Increased metabolic requirement, oxygen consumption, CO_2 production, and respiratory rate

            - Restrictive physiology due to increased weight on chest wall and adipose tissue in the abdomen restricting diaphragm motion
            - Functional residual capacity (FRC) and expiratory reserve volume (ERV) are decreased
            - Ventilation perfusion mismatch
            - Supine position further worsens respiratory mechanics
            - Increased upper airway resistance, poor anatomical landmarks
            - Decreased safe apnea period
        - Cardiovascular
            - Increased blood volume
            - Decreased systemic vascular resistance
            - Increased cardiac output
            - Left ventricular hypertrophy
            - Long-standing hypoxia/hypercarbia leading to right ventricular dysfunction
        - Gastrointestinal
            - Increased intra-abdominal pressure
            - Decreased lower esophageal sphincter tone
            - Liver dysfunction due to nonalcoholic fatty liver disease
            - Increased biliary disease
            - Decreased gastric emptying time, increased aspiration risk in patients with severe GERD, poorly controlled diabetes, or autonomic neuropathy. Consider premedication in patients with these comorbidities.
        - Endocrine
            - Insulin resistance
        - Hematologic
            - Venous stasis with increased risk for venous thromboembolism
    - Associated Comorbidities/Syndromes
        - Obstructive sleep apnea (OSA), obesity hypoventilation syndrome, hypertension, type 2 diabetes mellitus, GERD, dyslipidemia, polycystic ovarian syndrome, fatty liver disease, psychiatric disorders
        - Down syndrome, Prader-Willi syndrome, Bardet-Biedl syndrome, Fragile X syndrome, Turner syndrome, Cohen syndrome, Klinefelter syndrome

Anesthetic Planning:

- Pre-Anesthetic Evaluation
    - Should be seen weeks or months ahead in a pre-operative clinic to optimize comorbidities and allow for multidisciplinary coordination
    - Relevant studies on a case-by-case basis:
        - Hemoglobin A1C, complete blood cell count, comprehensive metabolic profile, polysomnography, cervical x-ray, thyroid function test
        - Echocardiogram in patients with chronic severe OSA to evaluate for pulmonary hypertension, left and right heart dysfunction
- Specific or Unique Room Set-Up Requirements
    - Airway
        - Obesity itself is not a predictor for difficult intubation with proper preparation and positioning

        - Predictors for difficult laryngoscopy: short thyromental distance (TMD), limited neck extension, neck circumference > 40 cm, Mallampati score 3 and 4, lack of sub-mental compliance, inter incisor gap < 4 cm, inadequate lower mandibular protrusion.[5]
    - Predictors for difficult mask ventilation: BMI > 26, OSA.[6]
    - The availability of a video laryngoscope is recommended.
- Drugs
    - Obese patients have increased amount of fat and lean body weight
    - Physiological changes such as increased cardiac output, total blood volume, changes in regional blood flow will affect the pharmacokinetic and pharmacodynamics of many anesthetic drugs.[7]
    - Dosing of commonly used anesthetic medications based on ideal body weight (IBW), total body weight (TBW) or lean body weight (LBW).[7]

Anesthetic Agent	Induction	Maintenance
Propofol	LBW	TBW
Thiopental	LBW	TBW
Fentanyl	LBW	LBW
Remifentanil	LBW	LBW
Succinylcholine	TBW	
Rocuronium	IBW	
Vecuronium	IBW	
Cisatracurium/Atracurium	IBW	

    - Inhaled anesthetics[7]
        - Sevoflurane is by far the most commonly used inhaled anesthetic due to its rapid uptake and elimination.
        - Desflurane is the least lipophilic inhaled anesthetic. However, its emergence time compared to sevoflurane is inconclusive. Due to its high cost and detrimental environmental effects, desflurane is gradually being phased out of many operating rooms.
- Monitors and equipment
    - Standard American Society of Anesthesiologists monitors
    - NIBP: may need to use a forearm blood pressure cuff or place an arterial line to reliably measure blood pressure (BP)
    - Large bore intravascular (IV) access
        - Ultrasound for possible difficult IV placement
    - Oral gastric tube should be placed after intubation and removed prior to the insertion of a Bougie
    - Esophageal temperature probe is contraindicated because of the potential for inadvertent inclusion in the staple line[8]
    - Foley catheter
- Blood Availability
    - Usually not required
- PICU Bed Availability
    - Patients with severe OSA should be monitored postoperatively in the ICU

Intraoperative Considerations:

- General
  - Laparoscopic surgery
    - Benefits: faster recovery, reduced postoperative pain, reduced wound infections
    - Risks: venous gas embolism, visceral and vascular damage, hemodynamic changes due to pneumoperitoneum, complications due to extreme positioning, acute kidney injury, pulmonary atelectasis
- Induction
  - Pre-oxygenation is more effective with 25 degrees head-up position[9]
    - Reverse Trendelenburg position may also be helpful to unload the diaphragm
    - Improves lung mechanics, increase lung volumes and reserves
    - Thorough pre-oxygenation: SpO_2 100% and EtO_2 > 90%
    - Application of apneic oxygenation during RSI
  - RSI vs. Controlled induction
    - Obesity alone was previously thought to be an aspiration risk. However, recent studies show that the gastric volume and pH of non-diabetic obese patients are identical to normal weight patients[10]
    - Consider RSI in patients with the following comorbidities associated with increased aspiration risk: severe GERD, poorly controlled diabetes, autonomic neuropathy
  - Ramped and head up position for laryngoscopy
  - Bag mask until fully paralyzed and optimal conditions for tracheal intubation
- Positioning during surgical procedure
  - Steep reverse Trendelenburg position
  - Large or high-weight capacity operating room tables
  - Padded arm boards, positioning straps, and foot extender
  - Anti-embolism stockings or sequential compression device in addition to SQ heparin or enoxaparin
- Maintenance
  - Balanced anesthetic with inhaled anesthetics, opioids, and muscle relaxants
  - Total IV anesthesia may be considered
- Hemodynamic/Physiologic goals
  - Patients with h/o HTN should have their BP within 20% of their baseline
  - Steep reverse Trendelenburg in addition to pneumoperitoneum could severely decrease venous return to the heart and cause hypotension especially in patients who are hypovolemic
- Emergence/Disposition
  - Meeting all criteria for extubation
  - Full reversal of neuromuscular blockade
  - Head up with reverse Trendelenburg position to improve lung mechanics
  - Patient with OSA on CPAP at home should be placed on CPAP in the immediate postoperative period
- Post-operative Period
  - Pain management: Multimodal approach
    - Opioids: Short-acting opioids such as fentanyl are preferred over long-acting opioids
    - Acetaminophen
    - Dexmedetomidine
    - NSAIDS: Ibuprofen or ketorolac

    - Local anesthetic infiltration at laparoscopic sites
  - Early mobilization to minimize risk of venous thrombosis and pulmonary embolism

Case Specific Complications/Pitfalls

- Difficult IV access
  - Have near-infrared vein finder or ultrasound available
- Difficult airway
  - Follow the ASA difficult airway algorithm
  - Difficult airway cart in room
  - Additional personnel, oral airway, two-handed bag mask, or supraglottic airway
  - Have video laryngoscope available
  - Consider apneic oxygenation via nasopharyngeal airway and nasal cannula @ 15 L/min[11]
- Aspiration on induction
  - Place the patient in Trendelenburg, and turn the head to the side
  - Suction out vomitus as much as possible
  - Intubate, and if a large amount of emesis was aspirated, consider flexible bronchoscopy
- Severe hemodynamic changes due to steep reverse Trendelenburg position and pneumoperitoneum
  - IV fluid bolus, short-acting vasoconstrictors such as phenylephrine
  - Last resort is desufflation and placement in Trendelenburg position
- Damage to organs and vessels during Trocar insertion and, later, esophageal Bougie insertion
- Venous air embolism
  - Pneumoperitoneum with open systemic venous circulation
  - Reverse Trendelenburg position
  - Severity depends on rate and amount of air introduced into circulation
  - Can lead to pulmonary hypertension, right heart failure, or total cardiovascular collapse

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<u>Reviewed by:</u>

Reviewer #1: Titilopemi Aina, MD, MPH, FAAP, FASA, Texas Children's Hospital/Baylor College of Medicine

Reviewer #2: Anita Akbar Ali, MD, Arkansas Children's Hospital

Reviewer #3: Andrew Infosino, M.D., University of California- San Francisco

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Created: 11/18/22; Last revised: 11/18/22