Why is the Morbidly Obese Patient at Increased Risk for Perioperative Morbidity?
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Objectives
1. Describe objective criteria for obesity and morbid obesity
2. Identify the metabolic and physiologic changes that lead to increased perioperative morbidity in the morbidly obese patient
3. Identify anesthesia practices that mitigate risks to morbidly obese patients

Defining Adult Obesity
Common & Increasing: 36% in adults, 17% in children (2011-2014)
Highest in women & middle-aged adults between 40-59
Categorized by Body Mass Index kg/m² (BMI)
Class 1: ≥ 30
Class 2: ≥ 35 severely
Class 3: ≥ 40 morbidly (≥ 50 super obese)

Body Mass Index vs. Central Obesity
BMI: Global measure of body mass (adipose + lean)
Central obesity may be better predictor of mortality
• Higher insulin resistance
• ↑ coronary atherosclerosis
Central fat distribution measured by
• Waist circumference
  >102 cm (≥ 40 in) men
  >88 cm (≥ 35 in) women
• Waist-to-hip ratio
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Perioperative Complications Increased in Morbid Obesity
Obesity is associated with multiple medical problems
Morbid Obesity (BMI > 40 kg/m²) more frequently associated with perioperative morbidity & mortality involving all organ systems
Difficult to determine if obesity or presence of specific co-morbidities contributes to the poor outcomes
What is morbid about the morbidly obese patient?

**Chronic Inflammation of Obesity**
- Adipose cells outgrow blood supply
- Chronic tissue hypoxia activates immune system
- Inflammatory mediators (TNF-α and IL-6) lead to insulin resistance
- Metabolic Syndrome develops

**Metabolic Syndrome defined:**
- **Central Obesity**
- 2 of these

**CV Comorbidities in Obesity**
- Coronary artery disease (CAD) common
  - Worsened by increased inflammation & pro-thrombotic state
- Obesity masks symptoms of CAD
  - “out of shape”, “poor mobility”, poor echocardiogram images

**Hypertension common**
- Increased insulin resistance, sodium retention, sympathetic nervous system activation & increased renin-angiotensin

**Arrhythmias common**
- Increased catecholamines, hypoxemia, hypercarbia, left atrial & ventricular enlargement & electrolyte changes
- Post operative atrial fibrillation increase 2-3 fold in morbidly obese

**Cardiovascular (CV) Changes in Obesity**
- Increased body mass requires increased cardiac workload
  - Increased metabolic demands: ↑ Blood volume, stroke volume & end diastolic volume & pressure
  - Compensatory left ventricular hypertrophy

Cardiac Steatosis important role in pathogenesis cardiomyopathy
- 31% of morbidly obese patients develop cardiomyopathy
- Worsened by insulin resistance & neuro-humoral over activation

**CV Complications in Morbid Obesity**
- No significant correlation between BMI & rate of cardiovascular complications with most procedures (both VASQIP* & NSQIP* databases)

Cardiac Arrest is increased for Total Joint Arthroplasty (TJA) and CABG for morbidly obese patients
- TJA: morbid obesity independent predictor for cardiac arrest requiring CPR (VASQIP data)
- CABG: morbid obesity increased odds of postoperative cardiac arrest & MI (NSQIP data)

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*VASQIP = Veterans Affairs Surgical Quality Improvement Program*
*NSQIP = National Surgical Quality Improvement Program*
Pulmonary Hypertension (PH) Increased in Obesity

Chronic hypoxemia with secondary polycythemia increases risk of PH

Obese patients have comorbidities that increase risk for PH
- Obesity hypoventilation syndrome
- Obstructive sleep apnea (OSA)
  20% of OSA patients have PH but severity of OSA does not correlate with degree of PH
- Left heart dysfunction
- Chronic pulmonary thromboembolism

PH is associated with significant perioperative morbidity
26% have post-operative congestive heart failure, respiratory failure, hemodynamic instability, and/or sepsis

Respiratory Changes in Obesity

Restrictive pattern
Pressure from excess fat increases respiratory workload
Respiratory impairment proportional to increasing BMI
Most significant if BMI ≥ 45 or central obesity present

Morbid Obesity Worsens Lung Volumes

Many respiratory parameters not affected with simple obesity
Severe Obesity (BMI ≥ 35) decreases lung volumes
Total lung capacity
Forced expiratory volume 1 s
Forced vital capacity
FEV1/FVC

Respiratory Comorbidities in Obesity

Airway hyper-reactivity common
- ↓ airway caliber, altered smooth muscle function & chronic inflammation
- Asthma more common, more likely to be severe & is difficult to treat perioperatively

Obstructive Sleep Apnea (OSA) common
- Fat deposits impair dilator activity & increases upper airway collapse
- Viscous cycle – ↓ energy & motivation causes more weight gain
- 25% of morbidly obese patients have undiagnosed OSA

Obesity Hypoventilation Syndrome significantly increases morbidity
- Defined as obese patient with daytime hypercapnia (PaCO2 >45mmHg) & sleep-disordered breathing

Morbidly Obese = Highest Risk for OSA

Induction of anesthesia is high-risk time for hypoxic event
- Induction ↓ FRC by 50%
- FRC = closing capacity = Atelectasis occurs
- SHUNT + ↑ O2 consumption
- Rapid desaturation

Perioperative Hypoxemia is Common in Obesity

Obese patients have increased O2 demands & increased propensity for atelectasis

Functional residual capacity (FRC) serves as O2 reservoir during apnea

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Pulmonary Complication & Obesity

Postoperative hypoxemia, ICU admission, increased use of resources & increased length of stay.

CABG & valve repair/replacement: morbid obesity significantly ↑ odds of pulmonary complications (NSQIP* data).

Morbidly obese patients have significantly increased incident of pulmonary complications when associated with following comorbidities:
- Advanced age, high ASA status, prolonged surgical duration, open approach, metabolic syndrome, OSA, asthma & CHF.

Major abdominal surgeries: BMI was NOT a risk factor for pulmonary complications (NSQIP* data).

*NSQIP = National Surgical Quality Improvement Program

Morbid Obesity & Difficult Airway

Morbidly obese patients are difficult to mask ventilate & maintain oxygenation.
- Establishing a seal during mask ventilation difficult
- Independent predictors include obesity & OSA
- Decreased pharyngeal airway size is proportional to increasing BMI
- High metabolic O₂ demand

Impact of obesity on intubation difficulty is controversial.
- Risk factors for “can’t intubate, can’t ventilate” increased in morbidly obese
  - Snoring
  - OSA
  - Thick neck
  - Mallampati classes III & IV
  - Decreased mandibular protrusion

Total joint arthroplasty: morbid obesity independent predictor for reintubation (Veterans Affairs Surgical Quality Improvement Program Database).

Co-morbidities Associated with Obesity

Diabetes: 7x more likely in morbidly obese
- Poorly controlled diabetes associated with wound infections, acute renal failure & post operative leaks in bariatric surgery
- Improving preoperative glycomic control can ↓ complications

Non-alcoholic fatty liver disease is common
- ↑ mortality from cardiovascular & liver-related causes
- Progresses to cirrhosis & hepatocellular cancer

Gastroesophageal reflux disease (GERD) common
- Gastric emptying normal in healthy obese patients

Hematologic Changes in Obesity

Venous thromboembolism (VTE) highest in morbidly obese
- Chronic inflammation & accelerated fibrin clot formation
- Elevated inherited & acquired thrombophilic markers
- Prolonged operative times
- Increased immobility & venous stasis
- History of OSA or obesity hypoventilation syndrome

Morbid obesity significantly ↑ VTE after CABG, total hip, colectomy, prostatectomy & pancreatectomy (NSQIP* database).

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Surgical Complications Increased in Obesity

Longer operative times
- Increased need for reoperation (VASQIP* data)
  - Bariatric & orthopedic surgery: BMI > 50 increases odds
  - Total joint arthroplasty: BMI > 40 independent risk factor
- Increased blood loss
- Increased infection rates (NSQIP* data)
  - All procedures except pneumonectomy: BMI ≥ 40 increased odds
- Peripheral neuropathy & muscle tissue damage
  - Rhabdomyolysis risk increased in morbidly obese & prolonged procedures

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What can anesthesiologist do to mitigate these risks?
Preoperative Evaluation

Optimize all factors that increase perioperative complications

2013 ACC-AHA* guidelines for evaluation of bariatric patient similar to other patient populations
- No further workup if MACE < 1%
- If MACE > 1% access functional status
- Revised Cardiac Risk Calculator valid in obesity

Perform a comprehensive respiratory assessment
- Focus on evidence of reactive airway disease & OSA
- Consider CPAP initiation for severe OSA

*ACC-AHA, American College of Cardiologists & American Heart Association

Prophylaxis & Premedication

Thrombo-Phrophylaxis Recommendations
- The American Association of Clinical Endocrinologists, Obesity Society & American Society of Metabolic & Bariatric Surgery
- Mechanical & Chemical prophylaxis (continued 10 days post-discharge)
- Encourage early ambulation
- Dose low molecular weight heparin based on total body weight
- IVC filter only if BMI > 50 or history of DVT, venous stasis, or hypercoagulable state

Routine Aspiration prophylaxis not necessary
- Avoid sedatives

Induction and Pre-oxygenation

Prolong "Safe apnea period" (SAP) & optimize FRC prior to induction
- AVOID supine position- reverse Trendelenburg to maintain head-up 30-45°
- Pre-oxygenate with 100% O2 until SpO2 100% & ETO2 90% (at least 3 mins)
- Use CPAP 10 cmH2O & PEEP with mechanical ventilation prior to intubation

Ramp head, shoulders & upper body to optimize direct laryngoscopy view

Intubation advised for all morbidly obese if muscle relaxant needed
- Higher airway pressures from ↑ airway resistance & ↓ compliance
- Supra-glottic airways acceptable in modestly obese & should be used to rescue

Dose most drugs on lean body weight
- Succinylcholine dose on total body weight
- Non-depolarizers dose on ideal body weight

Ramped vs Supine Position

Ramped Supine
Torso
3 airway axes
Auditory canal to sternum

Supine

Summary

Recognize obesity as a diverse condition affecting multiple organs

Morbid obesity (BMI > 40) & Central Obesity are more likely associated with poor perioperative outcomes

Develop an all-inclusive medical plan to address all comorbidities
- Avoid supine position: optimize FRC & pre-oxygenation
- Improve direct laryngoscopy & minimize injury: optimize positioning
- Use lung protective strategies: low tidal volumes & appropriate PEEP
- Adopt strategies that minimize infectious complications: minimally invasive, weight-adjusted antibiotic dosing & layered surgical closure