Anesthetic considerations for Pediatric Bariatric Surgery

Adolfo Gonzalez M.D.

Objectives
1. Prevalence of childhood obesity
2. How we define childhood obesity
3. Comorbidities associated with obesity
4. Pharmacology of obesity
5. Pediatric Bariatric Surgery
6. What we have learned

Childhood Obesity

Prevalence:
- 5% to 17% since 1960
- Not seen a generation ago
Approximately 22.7 million children are obese (CDC)

With urbanization and increasing affluence, obesity is becoming a worldwide problem
- Rival malnutrition as the most life threatening global disorder of childhood
- New challenges

How we Judge Obesity

BMI (adults)
- BMI = wt (kg) / ht (m2)
- Problematic as a pediatric measure due to the dynamic relationship between BMI and age

BMI

- Kids distribution of fat and muscle vary through ages
- 25 overweight
- 30 more obesity
- 40 or more morbid obesity

**BMI Percentage**
- BMI percentages much better indicator.
- BMI compared with a large population of age and sex matched peers.

BMI percentage:
- 85: overweight
- 95: obese
- 99: morbid obesity

**Obesity**
- 90% of obesity is a combination of consumption of high calories and decreased physical activity.
- 5% Environmental factors (socioeconomic).
- 5% Medical factors i.e. Genetic (Prader-Willi syndrome) and medical reasons (iatrogenic).

**Comorbidities of Obesity**
- Comorbidities parallel severity and longevity of obesity.
- "Pound Years".
- View that adult obesity begins in childhood.
- Cunningham et al. found that heavy 5 year olds are 4x more likely to become obese adolescents.

**Adipose Tissue**
- Adipose tissue is not benign and inactive.
- Communicates with brain and peripheral tissue.
- Releases or mediates the release of:
  - C reactive protein, Interleukin 6, Tumor Necrosis Factor alpha, Lipoprotein lipase and renin among others.

**Adipose Tissue and Metabolic Syndrome**
- Leads to:
  - Increases insulin resistance.
  - Central obesity.
  - Hyperinsulinaemia.
  - Hypertension.
  - Hypertriglyceridemia.
  - Obesity is a chronic inflammatory state.
Respiratory Comorbidities

- Pulmonary function tests in adults usually show a restrictive pattern.
- Low functional reserve capacity and forced vital capacity.

Respiratory Comorbidities

- Predispose to hypoxemia and rapid desaturation on induction of anesthesia.
- Exacerbated in supine position.
- Limited research in pediatrics.

Asthma

Weak link between obesity and asthma.

- Obese 30% have some component of reactive airway disease.
- Increased work of breathing.
- Chronic hypoxia.
- Poorly understood.

Obstructive Sleep Apnea

- OSA critical relationship.
- OSA rates increase as BMI percentage increases.
- For every BMI unit increase the likelihood of OSA rises 12%.
- Sleep disordered breathing 17% of obese children.

OSA

- Usually related to adenotonsillar hypertrophy.
- Visceral fat increasing incidence of airway collapse and increased pharyngeal fat.
- Mitchell et al demonstrated the incidence of OSA was 18%, 10%, and 0% following T/A for mild/moderate/severe OSA in normal weight children, compared to 4.6%/15%/15% respectively for obese children.

OSA

- Leads to chronic hypoxia.
- Chronic CO2 Retention.
- Day time sleepiness and less physical activity.
- Right Heart Strain.
- Pulmonary Hypertension.
Cardiovascular Comorbidities

- Incidence of Hypertension increase as BMI% increases.
- Obese children 3x more likely than normal weight peers to have HTN
- Strong association obesity and LV mass
- Strong predictor of adult cardiovascular disease

Cardiovascular effects of Obesity

- Increased heart rate and blood pressure secondary to increased sympathetic tone
- Increased cardiac output (0.1L/min/kg of adipose tissue)
- Left Ventricular myocardial strain and hypertrophy

Cardiovascular Comorbidities

- Increased plaque formation secondary to inflammatory proteins (CRP, IL6)
- Plaque formation starts in childhood
- All Shown to be reversible with weight loss

Gastroinstinal Comorbidities

- Conflicting report on gastric emptying
- GERD
- Nonalcoholic fatty liver disease present in 50-60% of obese
- Elevated Liver Enzymes
- Can progress to fibrosis
- Increase incidence of cholelthiasis

At Cincinnati Children's Hospital Medical Center

- 100% incidence liver abnormalities
- 2/3 NASH
- 1/3 hepatic fibrosis in adolescents undergoing bariatric surgery

Endocrine Comorbidities

- NIDDM – 2x as common in adolescents as IDDM
- 25% of obese children ages 4-10 found to have glucose intolerance
- Metabolic syndrome

Psychological Factors
- Social stigmatization
- Isolation
- Higher rates of depression
- Depression
- Low self esteem

Other Comorbidities
Pseudotumour Cerebri
- Idiopathic intracranial hypertension - caused by decreased venous outflow from head
- Hypeandrogenism-
- Polycystic ovary disease
Orthopedic
- Slipped Capital femoral epiphysis
- Tibial vara (Blounts disease)

Pharmacology of Body Weight
Total body weight (TBW) – actual weight
- TBW not all is active and perfused
- Majority of blood still to vessel rich groups.

Ideal body weight: (IBW)–kg= height in cm^2 x 1.65/1000
- IBW associated with greatest life expectancy
- IBW does not account for changes in body composition

Pharmacology and Body Weight
Lean body weight (LBW)= TBW-adipose tissue
- LBW correlates with cardiac output.
- Drug clearance proportional to LBW
- In obese LBW is usually 20-40% less than TBW
  - The difference between IBW and TBW is not just adipose tissue

Difficult to determine LBW
- DEXA-scan (radiological)
- K-dilution (laboratory)
- Equation LBW = IBW + 0.29 (TBW – IBW)
There are web based calculators looking at age/weight/height
Calleghan et al: utilized a norm gram that is easy to use
Pharmacology
- Obesity affects pharmacokinetics
- Obesity effect: volume of distribution and clearance
- Maintenance/infusion dosing is determined by clearance
- Loading dose is determined by VD
- hydrophobic / lipophilic drugs have increased volume of distribution
- hydrophilic / lipophobic: unchanged pharmacology

In obese children
- Increased cardiac output
- Decreased pulmonary function
- Altered hepatic and renal function
- Altered protein binding, tissue perfusion
- Increased and changes in regional blood flow
- Often excluded from clinical trials
- Not very much data

Volatile anesthesia
- No pediatric studies
- Blood and lipid solubility impacted by obesity
- Studies show faster emergence with Desflurane or Sevoflurane
- No real difference between Desflurane and Sevoflurane
- Desflurane least lipophilic
- Anecdotal evidence shows Desflurane may be better

Propofol
- Lipophilic
- Duration of action based on redistribution
- Dosing based on LBW
- Infusion based TBW because of increased volume of distribution

Opioids
- 48% of adverse respiratory events secondary to opioids
- Fentanyl
  - Lipophilic
  - Dosage: LBW
  - Has a good correlation to cardiac output and clearance
**Opioids**

Remifentanil
- Dosage: LBW
- TBW may increase side effect profile

**Paralytics**

Succinylcholine
- Obesity associated with increased pseudocholinesterase
- Increased extracellular fluid
- Dosage: TBW

**Paralytics**

Vecuronium
- Dosage: IBW
- Recovery secondary to distribution

Rocuronium
- Lipophilic, highly ionized
- Limited volume of distribution
- Dosage: IBW

Cisatricurium
- Dosage: IBW

**Pharmacology**

- **Reversal Agents**  TBW
  - May be associated with increased side effects
  - So consider LBW

- **Local Anesthetics**  LBW

**Sugammadex vs. Traditional Reversal**

- Not studied in Pediatrics
- Sugammadex is faster and more predictable
  - 2.7min vs. 9.6min with TOF 2
- Less postoperative residual recurarization
- Less side effect
- Cheaper


**Review**

- **Induction agents**
  - Benzodiazepines  TBW (IBW if gtt)
  - Propofol  LBW (TBW for gtt)
  - Ketamine  LBW
  - Etomidate  LBW

- **Neuromuscular blockade**
  - Succinylcholine  TBW*
  - NDMNB inc. cisatricurium  IBW

- **Opioids**  LBW
  - Local anesthetics Dose depends on site
• First reported use of bariatric surgery in adolescents in 1975 by Soper et al.

• National Institutes of health established the Longitudinal Assessment of Bariatric Surgery consortium in 2003 (LABS)
  • 2007 adolescents were added (Teen-LABS)

### Preoperative Evaluation

**History and Physical**
- No standards
- Careful Attention
- BMI percentage
- OSA symptoms
- Symptoms of OSA consider sleep study
- Need for BPap

### Pre Op Evolution

- Exercise tolerance
- EKG
- Echo based on symptoms and exercise tolerance
- Gastro esophageal reflux
- Medications both prescription and over the counter
- Special attention to BP and Diabetic regimen
- Possible consults
Airway exam

- Thorough airway exam
  - neck circumference
  - Mallampati score
  - thyromental distance
  - incisor gap
  - TM and Neck mobility

Also look for sternal fat pad or large breasts, short neck, etc.

Labs

- CBC
- Chem 8
- PT/PTT
- INR
- Glucose testing
- Type and Screen

Monitoring

- Standard ASA
- Blood pressure cuff can be an issue
- American heart Association recommend 80% length 40% width in upper arm.
- Alternative sites can be calves or forearm.
- Means most important
- BIS Monitor

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Airway

General Endotracheal Intubation

- Increased risk of desaturation
- Preoxygenation is imperative
- Difficult mask
- Mixed reviews in airway difficulty
- Lower incidence of difficulty with appropriate position.
- Ramping very helpful

Airway

Nafiu et al:

- Increased difficult mask ventilation,
- difficult intubation
- greater postop airway obstruction

Cincinnati Children’s Hosptital Medical Center Experience

- with ramping and Preoxygenation, all (48) patients were intubated with standard DL. 95% had grade 1 view, 5% grade 2

Vascular Access

- Can be difficult IV
- Ultrasound can be useful
- Arterial and central venous access usually note needed
Morning of Procedure
• Start PIV in preoperative holding
• Preoperative administration of po Bicitra + IV Zantac
• Lovenox administration in OR (40 mg if BMI < 50 or 60 mg if BMI > 50)
• POC glucose

Intraoperative Management
• Have the patient position self as much as possible
• Hover mat, ramp
• Difficult airway equipment ready if needed
• Lovenox + SCDs
• Pre-oxygenate
• IV induction: Propofol, rocuronium, fentanyl
• General Endotracheal Anesthesia
• Maintenance: Desflurane vaporizer

Intraoperative Management
• Ventilatory strategies
  Tidal volumes 6-10 cc/kg LBW
  Use PEEP (7-12). Keep PIP < 30 cmH2O if possible
• Judicious crystalloid administration usually (1-2L)
• Administration of antihypertensive
• Tight glucose control
• Reversal of neuromuscular blockade
• Hydromorphone for pain control
• Extubate awake with head of bed elevated.
• Provide BiPAP/CPAP if necessary

Post Operative Care
• On-Q pump
• Opioids
  — Based on IBW - 25%
• Antiemetic
• Home BiPAP/CPAP

Study Results
• Elevated BP
  96% of Pts at baseline, normalized in 74%
• Dyslipidemia
  76% of Pts at baseline, normalized in 66%
• Abnormal kidney function
  17% of Pts at baseline, normalized in 86%
Study Results

- **T2DM**
  - 13% of Pts at baseline, normalized in 95% (A1c 6.3 → 5.3)
- **Pre-DM**
  - 10% of Pts at baseline, normalized in 76%
- **Quality of life (Pt reported)**
  - Mean score improved from 63 → 83 at 3 yrs. (p < 0.001)

Anesthesia complications

**Setzer et al:**

- Respiratory complications most common
- High incidence of desaturation
- High incidence of airway obstruction

The 99ers

- "Severely obese" children have weights above the 99th percentile
- 4% of American children
- Fastest growing category of obese children in the US
- Every obese child > 99th percentile will become obese adult (2/3 will be morbidly obese)
- Significant rise in Cardiovascular, Respiratory and Metabolic risk above this threshold

The 99ERS

- Cincinnati Children’s has adopted the 99th percentile as a marker for "high risk" obesity
- At risk in outpatient setting
- Highest risk for comorbidity
- Special attention

These Principles Not just for Bariatric Surgery