Anesthetic Challenges in Morbid Obesity

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The Challenge – Postoperative pain management of the morbid obese patient

- The number of patients who present for elective surgery, with a BMI of greater than 30 kg/m² has increased significantly.
- Patients who are morbidly obese, also present with multiple co-morbid conditions including pulmonary and cardiac disease
- Other associated conditions include Obstructive Sleep Apnea, Type II Diabetes, Degenerative Joint Disease

PHYSIOLOGICAL CHANGES IN PATIENTS WITH MORBID OBESITY THAT MAY IMPACT INTRA-OPERATIVE CARE

- Pulmonary Mechanics in Morbid Obesity
  - Decrease of total pulmonary compliance (up to 70%)
    - Reduced chest wall compliance (tissue accumulation around ribs, diaphragm, intraabdominal)
    - Reduced lung compliance (increased pulmonary blood volume, ↓ FRC)
  - Increase of total pulmonary resistance
    - Mainly due to increased lung resistance (airway resistance)
  - Respiratory muscle insufficiency and increase work of breathing
Respiratory Physiology in the Morbid Obese Patient

Effect on Lung Volumes
- FRC decreased; declines with increasing BMI (positional)
- ERV and TLC decreased
- RV normal or increased
- Minute ventilation increased


Respiratory Physiology in the Morbid Obese Patient

Pulmonary Gas Exchange
- Oxygen consumption increased
- Carbon dioxide production increased
- Increased A-aDO₂ and shunt fraction
- Oxygen consumption increases sharply with exercise


Morbid Obesity and the Cardiovascular System
- Blood Volume
  Total blood volume is increased and as a result increased resting cardiac output
- Hypertension
  High incidence of hypertension in obese patients
- Ischemic Heart Disease
  Obesity is independent risk factor for ischemic heart disease. The high incidence of hypertension, diabetes, hypercholesteremia compound the problem
Cardiac Function

- Increased cardiac output
- LVEDP increased with LVH (eccentric)
- Ventricular systolic function impaired
- Cardiomyopathy

Obstructive Sleep Apnea

- Defined as 10 seconds or more of total cessation of airflow despite respiratory efforts
- Clinically relevant are 5 episodes/hour or >30 episodes/night
- Persistent effort without airflow
- Floppy upper airway
- Profound muscle relaxation during sleep or anesthesia worsens syndrome
- There is a significant association between morbid obesity and sleep apnea.

Diagnostic Criteria for OSA.

- Current a normal cutoff for the AHI is less than 5/hour.

The severity of OSA can be defined based on the AHI

- Mild: AHI = 5-15 per hour
- Moderate: AHI = 15-30 per hour
- Severe: AHI >30 per hour
Examination of Patient with OSA.

- The physical examination is frequently unremarkable in OSA, other than the presence of obesity (defined as a body mass index greater than 30 kg/m²) and hypertension.
- The clues to the presence of OSA usually come from family members who complain of snoring at night.
- As in all patients scheduled for surgery, an airway exam is necessary. The upper airway should be evaluated in all patients, particularly in non-obese adults with symptoms consistent with OSA.

Common Features in Patients with Sleep Apnea

- Loud snoring
- Disrupted sleep
- Nocturnal gasping and choking
- Witnessed apnea
- Daytime sleepiness and fatigue

Diagnosis of OSA

Nocturnal polysomnography is the gold standard for diagnosing obstructive sleep apnea.

In this technique, multiple physiologic parameters are measured while the patient sleeps in a laboratory.

Diagnosis of OSA

Typical parameters in a sleep study, (Nocturnal Polysomnography) include

- eye movement observations (to detect rapid-eye-movement sleep),
- an electroencephalogram (to determine arousals from sleep)
- chest wall monitors (to document respiratory movements)
- nasal and oral air flow measurements,
- an electrocardiogram
- an electromyogram (to look for limb movements that cause arousals) and oximetry (to measure oxygen saturation).
- Apneic events can then be documented based on chest wall movement with no airflow and oxyhemoglobin desaturations.
Sleep vs Anesthesia

- **Sleep** Unlike anesthesia, sleep is a state of *rousable* unconsciousness.
- **Anesthesia** In contrast to sleep, anesthesia is a state of *unrousable* unconsciousness.

So why are we concerned about the perioperative risks for morbidly obese patients with sleep apnea?

Perioperative Concerns for Morbidly Obese Patients with Obstructive Sleep Apnea

Sedative and analgesic agents will aggravate or precipitate OSA by decreasing pharyngeal tone, depressing ventilatory responses to hypoxia and hypercapnia, inhibiting arousal responses to obstruction, hypoxia and hypercapnia. The end result is that varying degrees of central respiratory depression can occur. This problem is compounded in the morbidly obese patient with OSA.

The Obesity Hypoventilation Syndrome

The obesity hypoventilation syndrome (OHS) is defined by extreme obesity and alveolar hypoventilation during wakefulness. In its classic form, it is also characterized by the following findings:

- Hypersomnolence
- Dyspnea
- Hypoxemia, with resulting cyanosis, polycythemia, and plethora
- Pulmonary hypertension, leading to right ventricular failure and peripheral edema

Pathophysiology Of Alveolar Hypoventilation. Alveolar hypoventilation associated with OHS occurs as a result of one or both of the following factors:

- An increase in the work of breathing to a level that is inconsistent with maintenance of normal alveolar ventilation.
- A decrease in the "drive" to breathe
**Arterial Blood Gases and Nocturnal Oximetry**

<table>
<thead>
<tr>
<th>Variables</th>
<th>OSA</th>
<th>OHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.42</td>
<td>7.4</td>
</tr>
<tr>
<td>$\text{PaO}_2$ mmHg</td>
<td>75</td>
<td>59</td>
</tr>
<tr>
<td>$\text{PaCO}_2$ mmHg</td>
<td>38</td>
<td>49</td>
</tr>
<tr>
<td>Sat. $\text{O}_2$ %</td>
<td>94</td>
<td>86</td>
</tr>
<tr>
<td>t Sat. &lt;90%</td>
<td>9</td>
<td>52</td>
</tr>
</tbody>
</table>

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**The Airway in Morbid Obesity**

- Assessment
- Who deserves a rapid sequence intubation?
- Who deserves an awake intubation?

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**Assessment of the Airway.**

- Limited information in the literature.
- Most recently:

  **Morbid Obesity and Tracheal Intubation**

  Jay B. Brodsky, MD*, Harry J. M. Lemmens, MD PhD*, John G. Brock-Utne, MD PhD*, Mark Vierra, MD, and Lawrence J. Saidman, MD*  
  (Anesth Analg 2002;94:732–6)
### Patient Characteristics Stratified by Problematic and Easy Intubation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Problematic intubation (n = 12)</th>
<th>Easy intubation (n = 88)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>Median 44, 25th pct 39.5, 75th pct 49.5</td>
<td>Median 44, 25th pct 36, 75th pct 51.5</td>
<td>0.9957</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168, 159.7, 179.9</td>
<td>168, 140.3, 171.2</td>
<td>0.0471</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>124.8, 124</td>
<td>123.3, 156.8</td>
<td>0.858</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>46.5, 42.5, 47.3</td>
<td>48.9, 58.1</td>
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</tr>
<tr>
<td>Neck circumference (cm)</td>
<td>44.7, 54</td>
<td>46, 48</td>
<td>0.0326</td>
</tr>
<tr>
<td>Sternoental distance (cm)</td>
<td>15.5, 12.7, 16.2</td>
<td>12, 17</td>
<td>0.4979</td>
</tr>
<tr>
<td>Thyromental distance (cm)</td>
<td>9.5, 7.5, 10</td>
<td>9.5, 11</td>
<td>0.6556</td>
</tr>
<tr>
<td>Mouth opening (cm)</td>
<td>5, 4.5</td>
<td>5.5</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Association of Neck Circumference and Other Risk Factors With Problematic Airway Intubation.

Figure 2. Effect of weight, body position, and abdominal insufflation on alveolar-to-arterial oxygen tension difference (A-aDO2) in normal-weight and morbidly obese patients.


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Why Morbidly Obese Patients Merit Special Consideration for Postoperative Pain Management

- High incidence of myocardial disease and increased susceptibility to post-operative events.
- Changes in respiratory physiology limits tolerance to opioids and other analgesics that cause respiratory depression.
- The high incidence of Sleep Apnea and the Obesity Hypoventilation Syndrome also makes Morbid Obese patient intolerant of respiratory depression.
- Challenge for securing the airway outside the OR
Post-Operative Analgesia for Morbid Obese Patients.

- Intravenous Opioids via Patient Controlled Analgesia or health care worker administration
- Potential Problems
  - Large amounts of opioids needed for operations with large incisions.
  - Increased incidence of respiratory depression which may require emergent tracheal intubation.

Pre-Emptive Analgesia

- Preemptive analgesia is an antinociceptive therapy whose aim is to prevent both peripheral and central sensitization, thereby attenuating (or, ideally, preventing) the postoperative amplification of pain sensation.
- Treatment can be aimed at the periphery, at inputs along sensory axons, or at CNS sites using single or combinations of analgesics applied either continuously or intermittently.

Pharmacological Agents and Techniques of Preemptive Analgesia

Regional anesthesia induced prior to surgical trauma and continued well into the postoperative period is effective in attenuating peripheral and central sensitization.

Pharmacologic agents:
- NMDA (N-methyl-D-aspartate) antagonists (KETAMINE)
- alpha-2-receptor agonists (DEXMEDETOMIDINE)
- NSAIDs (non-steroidal anti-inflammatory drugs)
- GABA – like compounds, (GABAPENTIN)
Ketamine As An Adjunct To Opioids For Postoperative Analgesia

Advantages of using Ketamine:
- In low doses, Ketamine reacts synergistically with opioids to produce analgesia.
- The use of Ketamine allows for use of decreased amounts of opioids.

Disadvantages of using ketamine:
- Hallucinations


Dexmedetomidine As An Adjunct To Opioids For Postoperative Analgesia

- An alpha2-agonist similar to clonidine but with 10 times the potency
- Used in the operating room, PACU and ICU for sedation and analgesia.
- The drug does not cause significant cardiovascular instability.
- Dexmedetomidine also possesses several properties that may additionally benefit post-operative patients who have opioid tolerance or who are sensitive to opioid-induced respiratory depression.
- The best use of dexmedetomidine is as an adjunct to opioids.

What about NSAIDs???

Intravenous Opioids
- Toradol (IV/IM)
- Caldolor (intravenous ibuprofen)
- Diclofenac (Injectable formulation)
- Acetaminophen (IV)

Post-Operative Care of the Morbidly Obese Patient

- Patients with challenging airways or with airway edema should be cared for in the ICU, these patients may merit post-operative intubation.
- For morbidly obese patients receiving high dose post-operative opioid analgesia, an open step-down unit with capnography and pulse oximetry may be helpful.
- Reduction of use of opioid analgesia and increasing the use of non-opioid analgesia may also be helpful.
In Summary

Perioperative management of the patient with morbid obesity should include:

- Detailed preoperative assessment.
- Using good judgment with regards to the type of procedures performed in an outpatient setting.
- Limiting the use of opioids in the operating theater and use of pre-emptive analgesia.
- Post operative use of devices such as CPAP.

Conclusion

- Patients with morbid obesity are a challenge with significant risk factors and hence good preoperative preparation is important.
- Intraoperative management should include a reduction of opioid use in favor of non-opioid analgesics.
- Careful post-operative management is important.
- Pain management is key to recovery from surgery and individuals may have different thresholds for pain, every effort should be made to reduce pain after surgery.