MORBID OBESITY
Perioperative Anesthetic Considerations for the Morbidly Obese Patient.
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Introduction:

Morbid obesity has become a significant public health problem in the USA. Recent reports indicate that one-third of the population suffers from obesity. The prevalence is higher in Americans of Mexican and African ancestry, although obesity is seen in all Americans. A significant number of patients do no respond to diet and exercise as a means of weight loss. Surgical treatment by gastric bypass surgery is increasingly used as an alternative for weight loss.

Obesity is defined as a Body Mass Index (BMI) of 30 kgm$^{-2}$ with morbid obesity defined as $> 35$ kgm$^{-2}$. More recently the categories of super morbid obesity, $>50$ kgm$^{-2}$, and ultra obesity, $>70$ kgm$^{-2}$ have been recognized.

Morbidly obese patients, especially those with a central distribution of fat, often have significant cardiopulmonary changes that affect the pulmonary and cardiovascular system. This often is a challenge to the anesthesiologist both in the intra-operative and post-operative setting.

These patients also have co-existing diseases including diabetes, hypertension arthritis and acid-reflux disease. Pain management also poses a significant problem as some these patients have a narcotic tolerance due to frequent use for chronic pain. Finally a significant number of individuals may have the Pickwickian syndrome either as obstructive Sleep Apnea (SAS) or as Obesity Hypoventilation Syndrome.

Preoperative Considerations

Morbid obesity and Respiratory Changes:

Respiratory compliance decreases with BMI (up to 70%) mainly by the lung component due to the FRC reduction and the increased pulmonary blood volume. The chest wall compliance may decrease for the progressively increased mass added to the chest wall and abdomen in these patients. Also the respiratory system resistance increase with increasing BMI mainly because of an increase in lung resistance for the large decrease in FRC and/or and intrinsic narrowing of the airways in obesity.

Spirometry reveals decreases in lung volumes underlying a restrictive pulmonary disease. In particular, the expiratory reserve volume (ERV) is probably the most sensitive indicator of obesity on pulmonary function test. The reduction in ERV is mediated by a combination of factors:

- Encroachment of abdominal contents on the diaphragm
- Chest wall fat decrease respiratory system compliance
- Impairment of respiratory muscle strength due to chronic respiratory muscle loading associated with increased work of breathing
- Mechanical disadvantage caused by overstretching of the diaphragm (particularly in the supine position)
- Fatty infiltration of the respiratory muscles in extreme obesity

The oxygenation decrease with increasing BMI is due to the reduction in FRC and the increase of shunt fraction (the lung bases are well perfused but they are unventilated because of airway closure and alveolar collapse). Oxygen consumption is increased especially with mild exercise in the morbid obese.

![Figure 1](image1.png)

**Figure 1**
Effect of Obesity on Lung Volumes and Closing Pressures

The question remains on whether preoperative pulmonary function testing is necessary. While there is no consensus in the literature, there is no evidence that preoperative pulmonary function tests may significantly change intraoperative management. Many clinicians may opt pre-operative room air blood gas, which will provide information on ventilation as well as oxygenation. The same may be said about sleep tests, for obstructive sleep apnea, the diagnosis can be may based on clinical symptoms. For those
suspected with the obesity hypoventilation syndrome, an assessment for the severity of pulmonary hypertension may be necessary.

**Airway management:**

There is limited information in the literature about the airway assessment. Some variables must be considered such as the sterno-mental and thyromental distance, the mouth opening, the Mallampati score but the most important seems to be the neck circumference. In fact it has been showed that there is a proportional relation between the increasing of the neck circumference and the probability of problematic intubation. In a study in 2002 involving airway management of morbidly obese patients, Brodsky et al. that in patients with a neck circumference greater than 50 cm and wit a Mallampta score of 3 or 4, an awake fiberoptic intubation technique may be indicated for elective cases, (See Figures below). Neither absolute obesity nor increasing BMI is indicators of difficult airway.

It is important to evaluate if the patient deserve a rapid sequence intubation or an awake intubation. In some patients it could be indicated to spray the airway with Lidocaine 4% and take an awake look of the cords: if the cords are not visualized easily a fiberoptic intubation is mandatory.

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<th>75th pct</th>
<th>Median</th>
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Positioning for Laparoscopic Surgery:

For Laparoscopic Surgery, the initial surgery involves a head down position (*Trendelenburg*) and the insufflation of the abdomen with CO$_2$ 11-15 mmHg. The cephalic shift of the abdominal viscera and the diaphragm lead to a decrease of the total lung volume and the compliance. The shunt fraction also increase due to the V/Q mismatch resulting in hypoxemia.

After insufflation, a steep head up position (*Reverse Trendelenburg*) is needed to facilitate the surgical dissection. Casati et al. demonstrated in a recent study that this position does not have any beneficial effects on gas exchange and on lung/chest compliance as previously believed. In fact, only after deflating the abdomen and the end of anesthesia with the patient supine the lung/chest compliance comes back to its baseline value.

In general, pneumoperitoneum results in systemic absorption of CO$_2$ and alteration of acid-base balance. Absorption of CO$_2$ across the peritoneum is normally eliminated.
through the lungs because of its high aqueous solubility and diffusibility. If intraoperative ventilation is impaired, CO₂ absorption can result in hypercapnia and acidosis. Hypercapnia can cause cardiac arrhythmias, vasoconstriction of the pulmonary vessels, and a mixed response in cardiac function. Acidosis associated with hypercapnia has a depressive effect on myocardial contractility, whereas hypercapnia can stimulate the autonomic nervous system leading to tachycardia and increased myocardial contractility. All of these effects are detrimental in the morbidly obese patient with pulmonary vessel disease.

Figure 2

Effect of Positioning in Morbid Obese Patients

During laparoscopic surgery the patient is positioned to produce gravitational displacement of the abdominal viscera away from the surgical site. Gravity has profound effects on the cardiovascular and pulmonary systems. The head-down tilt of 10–20 degrees commonly used both in gynecologic procedures and for the initial trocar insertion in laparoscopic gastric bypass is accompanied by an increase in central blood volume and a decrease in vital capacity and diaphragmatic excursion, whereas the reverse Trendelenburg (rT) position favors improved pulmonary dynamics but reduced venous return. These changes associated with positioning may be influenced by the extent of the tilt, the patient’s age, intravascular volume status, associated cardiac disease, anesthetic drugs administered, and ventilation techniques.

Sleep Apnea Syndrome (SAS):
Sleep Apnea is associated with morbid obesity patients and may present with an obstructive or central pattern. The obstructive sleep apnea is defined as the presence of 10 seconds or more of total cessation of airflow despite the respiratory efforts while the central sleep apnea is characterized by the diminished or absent respiratory effort and may be due to a disorder of ventilatory control or neuromuscular function or excessive respiratory muscle loading. Severe SAS can be treated with nocturnal nasal continuous positive airway pressure (CPAP). Unfortunately many patients cannot tolerate the device because it is cumbersome, noisy and tends to dry out the upper airway. The most important test to study this pathology is the nocturnal polysomnography (NPSG).

### Obstructive Sleep Apnea

- Persistent effort without airflow
- Floppy upper airway
- Profound muscle relaxation during sleep or anesthesia worsens syndrome
- Pharynx tends to collapse due to Bernoulli effect with resultant partial or complete obstruction

### Central Sleep Apnea

- Diminished or absent respiratory effort
- Disorder of ventilatory control, neuromuscular function, excessive respiratory muscle loading
- Profound muscle relaxation during sleep or anesthesia worsens syndrome

### 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

In addition most patients have Alveolar hypoventilation associated with OHS. This 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.

It is prudent that in order to avoid post-operative ventilation and oxygenation problems, the use of medications that ventilatory depressants should be minimized. The can be done by the use of pre-emptive analgesia with medications that do not cause respiratory depression. 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.

Drugs that can be used for pre-emptive analgesia are elaborated in the figure below

- Pharmacologic agents:
- NMDA (N-methyl-D-aspartate) antagonists
- alpha-2-receptor agonists
- NSAIDs (non-steroidal anti-inflammatory drugs)
- GABA – like compounds

**Morbid Obesity and Cardiovascular changes:**

Cardiovascular disease is prevalent in most individuals who are morbidly obese. Hypertension is the most common obesity-related disease. It is mild to moderate in 50–60% and severe in 5–10% of obese patients. Studies have demonstrated that for every 10 kg of weight gained, systolic arterial pressure increases by 3–5 mmHg and diastolic pressure by 2 mmHg. The most plausible explanation for increased occurrence of hypertension in obesity is the presence of hyperinsulinemia, which contributes to hypertension by activating the sympathetic nervous system and causing sodium retention. This results in expansion of the extra-cellular volume and an increase in cardiac output is characteristic of obesity-induced hypertension. Several studies have demonstrated that weight loss decreases hypertension in obesity.

In addition to Hypertension, cardiac failure, ischemic heart disease, cardiomyopathy, sudden cardiac death, cardiac arrhythmias and dyslipidemia cause an increased mortality and morbidity in obesity. Obesity is an independent risk fact for Coronary Heart Disease. For each BMI increase of 1, the increase of CHF increases by 5% for men and 7% for women. Over time by systolic and diastolic dysfunction develop. Weight loss will decreases body oxygen consumption, blood volume, cardiac output, stroke volume and
blood pressure. More important with weight loss, left ventricular volume and diastolic pressures are reduced at rest and during exercise.

Morbid obesity patients have an increased total blood volume, which is correlated with the body fat and an increased resting cardiac output. They poor tolerate the supine position due to the increased preload and work of breathing by increasing the cardiac output. Also oxygen consumption significantly increases in obese individuals lying supine. Compression of inferior vena cava must be avoided either by tilting the operating table slightly to the left or by placing a wedge under the patient.

Effects of Hypertension on the Heart in Morbid Obesity.

Conclusion

The morbid obese patient represents a significant challenge for the anesthesiologist. Careful evaluation and planning are necessary for a successful outcome. Also limiting the use of medications that may cause ventilatory depression may also improve outcome.
Bibliography.


