Anesthetic Considerations in the Morbidly Obese Patient

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There is a worldwide obesity epidemic. In the U.S. nearly two-thirds of all adults are obese (BMI $\geq$ 25) and almost 30% are classified as obese (BMI $\geq$ 30). Many believe that obesity has replaced smoking as the health issue of our time. For anesthesiologist this means that we will be seeing an increasing number of these patients as they come to the operating rooms for a variety of procedures, including bariatric surgery. Disturbingly, this epidemic includes children as well. Over 12% of all children over 6 years of age are now obese, up from 4% in 1970.[1]

This means that anesthesiologists of all stripes will have to increase their awareness of the special anesthetic management issues posed by obesity. These problems range from from airway difficulties, to disturbances in respiratory physiology, to the many co-morbidities which accompany obesity, including diabetes, hypertension, and heart disease. The purpose of the lecture is to discuss some of these issues and suggest management approaches.

There are differences in the reported risk of surgery in the obese. Dindo et al.[2] reported in the Lancet that obesity did not pose a particular risk of morbidity or mortality for genereal elective surgery. However, the mortality risk of gastric bypass surgery is quite high. While the overall mortality rate reported by Courcoulas et al.[3] was 0.6%, it was as high as 5% for surgeons doing less than 10 procedures per year and 0.3% if the surgeon did ten or more. This compares with 2.6% for CABG recently reported by Peterson et al. from the Society of Thoracic Surgeons National Cardiac Database. Interestingly, high-volume surgeons in low-volume hospitals ($\leq$ 4 cases) had a 55% risk of morbidity.

As mentioned earlier, obesity prevalence is rising in children.[1] Typically, children are routinely excluded from bariatric surgery programs because of the difficulties involved in psychologically and cognitively preparing this population for surgery. As in adults, morbid obesity rarely responds to nonsurgical therapy. Abu-Abeid et al.[4] demonstrated that adolescents will benefit from bariatric surgery if an effort is made to properly prepare patients, together with their families.

The obese can suffer from two forms of sleep apnea, obstructive and central. Obstructive sleep apnea (OSA) is defined as 10 seconds or more of total cessation of airflow despite respiratory efforts. This becomes clinically relevant if there are 5 episodes/h or >30 episodes/night. Such individuals usually have floppy upper airways and fat deposition in the lateral pharyngeal walls. Profound muscle relaxation during sleep or anesthesia worsens syndrome and the pharynx tends to collapse due to Bernoulli effect. This will result in partial or complete obstruction.[5]

We all know that there is a correlation between OSA and difficulty with intubation. Let's examine the logic behind this relationship. First, 15% of obese pts are difficult to intubate (approximately half of these require awake intubation). Second, a short thick neck is associated with difficult intubation. Third, obesity and a short thick neck are significantly related to OSA and to each other. Fourth, fat in lateral pharyngeal walls may not be appreciated during awake exam. Therefore, routine questioning about OSA should occur in all obese patients. Patients may not appreciate that they have OSA, afterall, snoring, snorting and apnea happen when they are asleep. However, they may notice nocturnal diaphoresis, frequent nocturia, morning HAs, abnormal cardiovascular or neuropsych function that are related symptoms to OSA.[5]

One of my colleagues at Northwestern was famous for opining that the morbidly obese, BMI $\geq$ 40, have great airways. His rationale was that to get that big they had to eat and breathe at the same time. If they didn't have great airways, they couldn't get that big.

Along this line of rationale, Brodsky et al.[6] examined 100 consecutive intubations in patients that had BMIs $\geq$ 40. Ninety-nine were successfully intubated via direct larygoscopy and only one required fiberoptics. There was a correlation between OSA and 'problematic' intubation (poor view or multiple attempts) as well as correlations with neck circumference and Mallampati.

In a more recent study Juvin et al.[7] a higher incidence of difficult intubation in obese (BMI > 35) patients compared to those with a BMI < 30. However, all patients in both groups were successfully intubated under direct vision.

Unrelated to the airway, per se, is central sleep apnea. Here, one sees diminished or absent respiratory effort. This is a disorder of ventilatory control, neuromuscular function caused by excessive respiratory muscle loading. Profound muscle relaxation during sleep or anesthesia worsens syndrome. As a result, sedating this individuals is a tricky business.

The most important test is NPSG (Nocturnal polysomnography) and routine pre-op PFT's and spirometry are less important in detecting this syndrome. Patients with sleep apnea of any etiology are at risk for systemic problems:

- Neuropsychological
  - Sleepiness, impaired memory and cognition, depression
- Cardiovascular
  - Hypertension, ischemia, stroke, right heart failure
- Pulmonary
  - Hypoxemia, hypercapnia, pulmonary hypertension
- Miscellaneous
  - Glucose instability, reflux

Obesity is associated with worsened pulmonary mechanics. The most characteristic change is a decrease in total pulmonary compliance (up to 70%). Mostly this is a result

of reduced chest wall compliance (tissue accumulation around ribs, diaphragm, intraabdominal), but is also caused by the secondary kyphotic thorax and lumbar hyperlordosis. Less important is reduced lung compliance. These individuals also have increased pulm blood volume and a decreased FRC.

Additional deleterious effects derive from increased of total pulmonary resistance, mainly due to increased lung resistance (airway resistance), and respiratory muscle insufficiency, mainly from abnormal diaphragm position. These result in a significantly increased work of breathing.

These mechanical changes result in the most telling physiologic effect: a decreased FRC. There is a direct inverse relationship between BMI and FRC. The closing capacity also increases which results in increased ventilation/perfusion mismatch and intrapulmonary shunting. Expiratory reserve volume and total lung capacity are also decreased. It is important to realize that all of these mechanical and physiologic perturbations are made worse by the supine position.

Reverse Trendelenburg position (RTP) can ameliorate the deleterious effects of the supine position. Perilli et al.[8] showed that RTP increased pulmonary compliance, increased FRC and returned $P(A\text{-}a)O_2$ to baseline (even with subcostal retractors in place. It was suggested that RTP may be a better solution than controversial maneuvers such as large tidal volumes and (15-20 ml/kg IBW) and PEEP. Similarly, opening the abdominal wall improves pulmonary function as well.[9]

Surprisingly both Dumont et al.[10] found very little change in PaO_2 or intrapulmonary shunt in 15 patients with a mean BMI of 45. This was somewhat surprising as non-obese subjects show significant changes in these measures.

Demiroluk et al.[11] found very little difference in pulmonary function between open and laparoscopic gastric bypass patients. Intergroup similarities may be from 'canceling' effects of pneumoperitoneum and 30^o RTP.

There are cardiovascular effects of morbid obesity. These individuals have larger blood volumes, increased risks of systemic and portal hypertension and ischemic heart disease. Fifty to 60 percent of obese patients will have mild to moderate hypertension. Again, there is a correlation with BMI and elevation in BP. The causes for this are thought to be multifactoral (hormonal, renal and hemodynamic).

Obesity is an independent risk factor for ischemic heart disease. Hypertension, diabetes, and hypercholesteremia compound the problem and are additional risk factors associated with obesity. Significant number of these patients have angina but without demonstrable coronary artery disease. The incidence of pre-existing CV disease in patients scheduled for elective bariatric surgery may be as high as 20%. Often the patients have LVEDP increased with LVH (eccentric). Also the incidence of right and left heart failure advances with increasing weight. These patients may have a cardiomyopathy associated with morbid obesity with a decreased ventricular systolic function impaired.

Position the morbidly obese is not only physically challenging to operating room personnel, but may have serious consequences for the patient if not done with due care and consideration. In the supine position, cardiac output, pulmonary blood flow and arterial blood pressure all increase. Pulmonary compliance and the FRC decreases, both are made even worse by the induction of anesthesia. Relieving the high intraabdominal pressure increases FRC and improves oxygenation. This can be accomplished with either opening the abdomen or lifting the panniculus.

While the Trendelenburg Position improves surgical exposure and reduces bleeding, it accentuates all the negative physiologic effects of the supine position. It should be avoided and if cannot controlled ventilation with an endotracheal tube should be used.

Extremely obese patients should never lie completely flat. At a minimum they should be placed in the semi-Fowler's position (upper body elevated 30-40^{o}). RTP is even better. Intubate and extubate in this position. However, be sure improved oxygenation not offset by decreased cardiac output because of decreased venous return. Also, semi-recumbent position should be maintained during post-operative convalescence.

In the Prone Position, CV and pulmonary function much improved over supine if the patient is positioned so that the abdomen is hanging freely. In very large patients the thorax and pelvis may need to be elevated 2 feet above the table. Care should be taken with supports as compression of vena cava or femoral veins could reduce cardiac output. For the prone position one should consider awake intubation. Then the patient can position him or herself.

The Lateral Decubitus position is sometimes used as a substitute for the prone position. It should be taken as a positive that few reports are in the literature of problems placing obese patients in this position. Morbidly obese patients seem to tolerate this position well. Brodsky et al. (Anesthesiology 57:132, 1982) found that oxygenation during thoracotomy in the LDP and one-lung ventilation (FIO_2 1.0) was satisfactory.

Obese patients in the lithotomy position probably have CV and pulmonary function probably similar to Trendelenburg (studied in normals). Of great concern is compartment syndrome that may develop due to the extreme weight of the lower extremities pressing against leg holding structures or even 'torquing' on itself. Similarly these patients are at greater risk for transient neurologic symptoms, particularly following spinal anesthesia.

One does not have to look far to find things to consider when taking care of these challenging patients. Not even covered in this brief lecture are issues such as severe GERD, thomboembolic risks, complex psychosocial issues, abnormal pharmacokinetics and pharmacodynamics and the list just goes on.

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