Anesthetic Considerations on Obesity and Bariatric Surgery

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1 Introduction

The obesity is presented as the modern disease affecting several organs. An increasing number of obese patients are annually presented to surgery for various reasons and surgical procedures. Morbid obesity leads to a number of serious pathophysiological changes, which the anesthesiologist must deal with. The main issues are evaluation of obesity pathophysiological disturbances (cardiac, respiratory, and metabolic), airway management difficulties, changed pharmacokinetic and pharmacodynamic profile for a lot of drugs, perioperative management (hemodynamic, respiratory, and hyperglycemia). This chapter address to the most important anesthetic issues of obese patients’ management for bariartric and non-bariartric surgery.

2 Epidemiology of Obesity

The incidence is increasing as different countries reported in their own statistics. In 2003-2004, 17.1% of US children and adolescents were overweight and 32.2% of adults were obese. According to National Health and Nutrition Examination Survey (NHANES) data for the 2007–2008 periods, 68% of adults in the U.S. aged 20–74 years are overweight or obese, with rates of 72% for men and 64% for women. The prevalence of obesity (Figure 1) was relatively low and stable from 1960 to 1980, but doubled in the period following 1980, jumping from 15% in 1980 to 34% in 2006 (Prevalence of overweight, obesity and extreme obesity among adults: United States, trends 1976–80 through 2005–2006. Available at: http://www.cdc.gov/nchs/products/pubs/pubd/hestats/overweight/overweight_adult.htm). The incidence reported in the UK and Australia is approximately 25%, whereas in Japan and China, and in the Netherlands, were respectively 1 in 20 women, and 1 in 10 women (Ogden et al., 2006; Flegal et al., 2010; Berghöfer, et al., 2008; Stevens, 2003). The WHO estimates that by 2015, 2.3 billion people will be overweight and 700 million will be obese. Figure 1 summarizes various country reported data (www.oecd.org).

3 Definition and preoperative morbidity risk

The definition of obesity and the clinical significance is well determined and accepted all over the world. The obesity is defined as a body-mass index (BMI) greater than 30kg/m2. Table 1 summarized the values of BMI and nutritional status and obesity.

Although BMI is not the only method used to measure the obesity, and does not take in consideration the lean muscle mass. Other methods are available to measure obesity, including triceps skinfold thickness, hydrodensitometry, bioelectric impedance assay, dual-energy X-ray absorptiometry, and CT scan or magnetic resonance imaging. Several studies suggest that central adiposity, as measured by waist circumference, hip circumference or waist-to-hip ratio, rather than total body fat content may better predict obesity-related cardiovascular disease or cancer-related outcomes (Kumanyika et al., 2008).

The morbidity increases substantially with increase in body weight with subsequent increase in risks of hypertension, diabetes mellitus, coronary artery disease, dyslipidemia, gall bladder disease, osteoarthritis, respiratory problems, and cancers of various organs (Calle et al., 1999).
Various countries reported data regarding overweight and obesity incidence.

**Weight Category Classification**

<table>
<thead>
<tr>
<th>Category</th>
<th>BMI (kg/m²)</th>
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<tbody>
<tr>
<td>Under weight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal weight</td>
<td>≥ 18.5 - 24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>≥ 25.0 - 29.9</td>
</tr>
<tr>
<td>Obesity</td>
<td>≥ 30</td>
</tr>
<tr>
<td>Morbid obesity</td>
<td>≥ 35</td>
</tr>
<tr>
<td>Super Morbid Obesity</td>
<td>≥ 55</td>
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</table>

There are differences in the reported risk of surgery in the obese. Dindo et al. (2003) reported that obesity did not pose a particular risk of morbidity or mortality for general elective surgery, but the mortality risk of gastric bypass surgery is high. Courcoulas et al. (2003), reported a mortality rate 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. More cases performed, lower is the risk of morbidity.
The morbidity and mortality risk is proportional to grade of obesity, to the duration, and finally to the form of obesity (Adam et al., 2000; Murphy et al., 2000). There are 2 forms up to the fat distribution form: an android form and a gynaecoid form. The android form occur when the fat distributes in a central way (liver, omentum, intraperitoneal), whereas the gynaecoid fat distribution includes fat distribution in buttocks, arms, and legs. The android form is associated with a higher morbidity and mortality risks.

4 Obesity Related Path-physiological Changes

4.1 Anesthesia and Metabolic Disturbances

Obesity increases the risk for cardiovascular and respiratory diseases, because is often associated with diabetes, dyslipidaemia, increased basal metabolic rate, greater oxygen consumption and carbon dioxide production (Lotia et al., 2008; Elamin et al., 2005). This makes the obese patient prone of rapid desaturation during the anesthesia’s induction, and increased risk for perioperative cardio-respiratory complications.

4.2 Cardiac Diseases due to Obesity and Anesthesia’s Risks

Obesity leads several cardiovascular changes. The increased blood volumes, increased risks hypertension and ischemic heart disease are common findings. Recently it is well established the correlation between BMI and hypertension. Hormonal, renal and hemodynamic mechanisms are often accused for this relationship. Approximately 60 % of obese patients may have mild to moderate systemic hypertension (Poirier, et al., 2006). The reasons for hypertension include hypervolemia due to sympathetic activation and sodium retention, and increased cardiac output.

Progressive increasing in BMI values is associated with hypertrophy and/or dilatation of left ventricle (Backman et al., 1983). The contractility may be reduced decreasing the stroke volume and ejection fraction. Electrocardiography examination shows leftward shift of QRS axis, prolonged PR, QRS, and QTc (Pontiroli et al., 2004).

The obesity is considered as an independent risk factor for coronary artery disease because of high incidence of hypertension, tachycardia, ventricular hypertrophy, diabetes mellitus, and hypercholesterolemia.


Obese persons have a prevalence of arterial hypertension ranging from 38% (women) to 42% (men). Mean systolic and diastolic blood pressures rise with increased BMI in men and women (Brown, et al., 2000). Pericardial fat is visceral adipose tissue and is a risk factor for atrial fibrillation (Al Chekakie et al., 2010). Obese individuals have a 49% elevated risk of atrial fibrillation compared with persons of normal weight. Risk increases with greater BMI (Wanahita et al., 2008). Left-ventricular dilation, left-ventricular hypertrophy and left-ventricular dysfunction can commonly be observed, as well right ventricle.

The incidence of right and left heart failure (Kenchaiah et al., 2002; Horwich et al., 2001) tends to be proportional with BMI. Due to obstructive sleep apnea hypoxia, hypercapnia, and the pulmonary hy-
pertension can be faced leading to right ventricle hypertrophy and then dilatation. These pathophysiological changes can explain the right heart syndrome and right ventricle failure. Ischemic heart disease contributes on both ventricular dysfunctions.

4.3 Airway Management and Respiratory Changes in the Obese Patient

Important respiratory disturbances are commonly findings in obese patients (Lazarus et al., 1997; Practice Guidelines for the Peri-operative Management of Patients with Obstructive Sleep Apnoea. A report of the American Society of Anesthesiologists Task Force 2006; Altermatt et al., 2005). Obesity is generally associated with impaired pulmonary and total chest compliances. Decreased pulmonary compliance reduces functional residual capacity, which can’t overpass the closing capacity, inducing increased intrapulmonary shunt, V/Q mismatching. As a consequence obese patient may be hypoxic, with increased P (A-a) O₂, and increases the risk for postoperative atelectasis. General anesthesia and postoperative pain can deteriorate these pathophysiological changes.

Obstructive Sleep Apnea (den Herder et al., 2004) is a common problem as well, faced in majority of the patients. Obstructive Sleep Apnea (OSA) is defined as 10 seconds of total respiratory cessation, for more than 30 times in a night. OSA results from the increased adipose tissue in the pharyngeal walls, increasing the pharyngeal wall compliance and the likelihood of phaeryngeal collapse during negative pressure of inspiration. These patients are sleepiness, suffering from depression, with morning headache (due to hypercapnia). Pulmonary hypertension, right heart failure, stroke, and hypertension may be encountered in the advanced cases. Nocturnal polysomnography helps to confirm the diagnosis.

The decreased leptin (O’Donnell et al., 1999) blood level (a frequent finding in obese individuals), makes the obese patient insensitive to carbon dioxide retention, producing the so called “obesity hypoventilation syndrome”. This syndrome can be deteriorated by general anesthetics and sedative drugs, and predisposes the patients to resting hypoxemia.

Airway management (Domi et al., 2012) may be problematic. Small oral cavity, small mouth opening, large amount of adipose tissue, impaired joint movements (diabetes, adipose tissue), thick neck, impaired neck and head movements, and finally probably short sterno/thyro-mental distances, are suggestive for difficult laryngoscopy and tracheal intubation. However obesity does not correlate with difficult intubation, but with difficult mask ventilation and postoperative respiratory failure. Several studies (Domi, 2010) reported a weak relationship between obesity and difficult intubation.

4.4 Gastrointestinal Changes

Dyslipidemia causes reversible fatty-liver, but rare can progresses to steato-hepatitis and cirrhosis (Marchesini et al., 2008). An increased risk for gastro-oesophageal reflux and hiatus hernia is associated with obesity. The mechanisms include increased intra abdominal pressure, and abnormal anatomy (Friedenberg et al., 2008).

4.5 Thromboembolic Risk in Obesity

Increased hematocrite and hemoconcentration due to polycytemia, deep venous stasis due to increased intrabdominal pressure, are the factors that increase the risk for deep venous thrombosis in obese patients. Each 1-unit increase in BMI was associated with a multiple-adjusted increase of 4% in the risk of ischemic stroke and 6% for hemorrhagic stroke (Hansson et al., 1999; Kurth et al., 2002).
5 Anesthetic Problems

5.1 Preoperative Evaluation

Preoperative evaluation is a crucial moment of daily anesthesiologist practice. The information must be focus on previous surgery and anesthetic problems like difficulties in airway management, hypersensibility, unexpected ICU admission, possible mechanical ventilation etc.

The preoperative evaluation should also include the screening of cardiovascular and respiratory system (hypertension, heart failure, arrhythmias, and obesity-hypoventilation syndrome), and metabolic disorders (diabetes).

The cardiovascular evaluation generally is addressed to the presence of suggestive clinical sings for cardiac pathologies as angina, dyspnea, headache, palpitations, and activity capacity. The clinical examination includes cardiac tones, jugular vein, and peripheral edema. The instrumental examination is composed by electrocardiography, echocardiography, and coronary angiography if indicated.

The evaluation of respiratory system (Patis et al., 2007; Hillman et al., 2004) includes clinical (e.g. dyspnea) and imagining assessment. Chest X-ray examines heart size and pulmonary vasculature (for evidence of pulmonary hypertension). The blood gases analyses are useful to determine the respiratory function and plan of airway management. Functional respiratory test is useful to predict the possible postoperative respiratory problems, and to determine the respiratory regimen during mechanical ventilation. The sleep study (Patis et al., 2007; Hillman et al., 2004) (nocturnal oximetry and polysomnography) is important. An apnea/hypopnea index (AHI) score greater than 30 is a sign for rapid desaturation at induction.

The recommended laboratory evaluations include blood glucose, lipid profile, serum chemistries (to evaluate renal and hepatic function), and complete blood count.

Liver test abnormalities are common findings, being a determining factor for perioperative risk. Cirrhotic liver disease with portal hypertension is often considered a relative contraindication to bariatric surgery. Dyspepsia indicates the presence of Helicobacter pylori and heart burn is significant to gastroesophageal reflux, which requires preoperative medical treatment.

5.2 Difficulties of Monitoring and Vascular Access

The blood pressure (Bevers et al., 2001) must be monitored using a corrected sized cuff (40-45 cm), in order to give real values. The peripheral intravenous access may be difficult because of adipose tissue. The central venous catheter insertion is generally difficult because hidden anatomical landmarks. The success rate is increased by using ultrasound examination (Gann et al., 2003).

5.3 Premedication and Risk Aspiration Prevention

Because of respiratory depression risk and airway management difficulties, it is advisable to avoid over sedation for premedication purposes (Dhonneur et al., 1999). The gastric aspiration prevention is an important issue. H2 blocker, metoclopramide, and sodium citrate are appropriate choices to reduce the risk of aspiration during induction of anesthesia and endotracheal intubation.
5.4 Airway management

Mallapamti classification, thyromental and sternomental distances, small mouth opening, large protuberant teeth, limited neck mobility, retrognathia, and Wilson sum score must be always evaluated in obese patients (Ezri et al., 2003). Based on the several study (Collins et al., 2004) on the airway management of obese patients, the ramped position can guarantee easy intubation using conventional direct laryngoscopy. The equipment for emergency airway management, including laryngeal masks and a fiberoptic bronchoscope, should be immediately available. An awaked fibreoptic intubation sequence can be performed when a difficult intubation is predicted.

5.5 The Patient’s Position

The supine position is no preferred because of respiration’s difficulties so the patient may need to have the back elevated. Abdominal pressure and weight can compress the inferior vena cava reducing the venous return, and the aorta increasing the afterload, increasing the blood pressure, and decreasing the stroke volume (when exaggerated). These changes are more significant when Trendelenburg position is applied (Curet, 2000; McEwen, 1996). The prone position is also not well tolerated and may have potential complications (skin breakdown, reduced respiration, circulation, nerve damage, eye or ear damage, damage to the breasts in women, or genitals in men) (Curet, 2000; McEwen, 1996). The potential hazards in the lithotomy position include skin breakdown, peroneal nerve damage, musculoskeletal injury (improper raising and lowering of the legs), and circulatory compromise (hypotension by lowering the legs). The lateral position is usually well tolerated by obese patients.

5.6 Drug Dosage Regimen in Obese Patient

Several factors can affect the pharmacokinetic in obese patients. These include changes in volume of distribution (decreased body water, increased fat, increased lean body mass, increased cardiac output), increased free drug available, and changes in clearance (increased renal blood flow, increased glomerular filtration rate, decreased hepatic blood flow). The drug’s dosage can be calculated on total body weight, BMI, lean body mass (ideal body mass+ 20 %), or ideal body weight. It is well known that pharmacokinetics of most anesthetics are usually determined by adipose tissue, producing a prolonged effect. The dosage of a lipophilic drug is connected to volume of distribution. The increased volume of distribution may prolong the elimination (benzodiazepines and barbiturates). So the dose of benzodiazepine and barbiturates must be calculated on the ideal body weight. For some muscle relaxants (vecuronium, rocuronium), the ideal body mass should be used, instead atracurium and succinylcholine both calculated according to total body weight. Propofol, a highly lipophilic agent, seems to have the volume of distribution and clearance proportional to total weight. So the dosage of propofol will be calculated based on total body weight or ideal body weight. Fentanyl and sufentanil should be calculated on total body weight, whereas remifentanil (Egan et al., 1998; De Baerdemaeker et al., 2007) should be based on ideal body weight.

5.7 Respiratory Support during Intubation, Anesthesia and in Postoperative Period

Several previous paragraphs, we underlined the respiratory changes in obese patients. Obese patients are prone to faster desaturation, increased rate of atelectasis, and need for ventilator support. There are many options to reduce the respiratory complications. These include preoxygenation, CPAP application, and PEEP during intraoperative period. Preoxygenation prevents desaturation, which is much faster in obese
than in normal patients. The preoxygenation effect is augmented by 25 degrees head up, or by applying CPAP (Coussa et al., 2004; Gander et al., 2005; Dixon et al., 2005). During the surgery and anesthesia, the anesthesiologist must use Tidal Volume 8-10 ml/kg in order to increase functional residual capacity. Morohunfoloro et al. (2008) concluded that the morbidly obese patient may require more days of mechanical ventilation. Increased number of days under mechanical ventilation increases the risk of respiratory complications (Papadakos et al., 2012). So the patients must be extubated as early as possible. During anesthesia, pressure control ventilation (PCV) or volume control ventilation (VCV) have been shown to have no differences. Several authors concluded that no ventilation mode is superior (De Baerdemaeker et al., 2008).

Postoperative pulmonary complications are more frequently faced in obese patient undergoing general anesthesia and mechanical ventilation (Tusman et al., 2012). Including lung recruitment maneuvers and maintenance of an optimal PEEP the physician can prevent lung collapse (Pelosi et al., 2001). Table 2 summarizes ventilator strategies and postoperative care.

<table>
<thead>
<tr>
<th>Ventilator parameters</th>
<th>Postoperative care</th>
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<tbody>
<tr>
<td>Tidal Volume 8-10 ml/kg</td>
<td>Early extubation</td>
</tr>
<tr>
<td>PEEP 6-8 mmHg</td>
<td>Aggressive postoperative pain treatment</td>
</tr>
<tr>
<td>Respiratory rate 10-14/min</td>
<td>Sitting position</td>
</tr>
<tr>
<td>Plateau pressure ≤ 30 mmHg</td>
<td>Avoiding oversedation</td>
</tr>
<tr>
<td></td>
<td>Non invasive mechanical ventilation</td>
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<td></td>
<td>Respiratory physiotherapy</td>
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</table>

**Table 2:** Respiratory care in the obese patient

The neuromuscular blockade must be fully reversed before the extubation. Muscle relaxants ‘monitoring by nerve stimulator or by clinically aspects (muscular strength, following commands, lifting the head for 5 seconds) can give reliable information for safety during extubation. After the extubation, CPAP or Pressure Support Mask should be available and delivered to the patient.

### 5.8 Fluid Therapy

Obese patients undergoing bariatric or non bariatric surgery may have protracted volume in the preoperative period as a result of preoperative fasting, forced urine output induced by diabetes, and antihypertensive drugs (e.g. diuretics). During the surgery, because of opening the cavities, evaporation can occur. This explains temperature and fluid loss. Major surgery is also associated with extravasations and third space loss.

### 5.9 Role of Spinal and Epidural Anesthesia in Obese Individuals

Regional anesthesia offers a lot of advantages to obese individuals undergoing to surgery. These include no airway manipulation, no anesthetic drugs, no cardio respiratory depression, and effective control of postoperative pain. Several studies (Cotter et al., 2004; Ingrande et al., 2009; Grau et al., 2003) confirm that obesity makes the regional anesthesia difficult to be performed. The hidden anatomic landmarks, difficulty in palpating bony landmarks or identifying the midline, the short needle, are the possible caus-
es. Another feature of regional anesthesia in obese patient is a tendency for cephalic spread of local anesthetic, more than normal patient. This phenomenon can be explained by smaller cerebrospinal fluid volume allowing the anesthesiologist to reduce the local anesthetic dose.

5.10 Post surgery Complications

The obese patients are prone of respiratory complications after the extubation. These complications vary from reintubation and mechanical ventilation, to hypoxemia and atelectasis. So the patient’s tracheal must be extubated when fully recovery of neuromuscular activity is present. The respiratory physiotherapy is an important step to prevent hypoxemia, atelectasis and pneumonia. The respiratory physiotherapy is realized encouraging the patient take deep breaths, and coughing. These exercises cannot be realized without an aggressive pain therapy.

An adequate pain therapy controls the pain, prevents respiratory complication, and reduces the tromboembolic events. Several pain therapy regimes are recommended, but the combination of patient controlled analgesia with epidural analgesia seems to be the most preferred technique.

Tromboembolic events can be prevented using anticoagulants in preoperative period. The selected anticoagulant agent is a protocol matter. In our institute, we prefer to use Enoxaparin, starting the evening before surgery (when general anesthesia is scheduled), and 12 hours before a regional block is to be performed.

The stress ulcer prophylaxis seems to be reasonable and effective especially a gastric bypass is to be performed. If the patient rest immobilized for a long period, the pressure ulcers in several parts of the body may occur. Activating and periodic rotating the patient are some effective measures to prevent this complication.

The surgery related complications are bleeding, infection, perforation, anastomotic leaks, dehydration, peritonitis, pneumonia, deep venous thrombosis, malnutrition, deficiency of vitamin K and B 12, and polineuropaties. Table 3 summarizes the postoperative care of the obese patient.

<table>
<thead>
<tr>
<th>Postoperative Care of the Obese Patient</th>
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<tbody>
<tr>
<td>Avoiding respiratory complications (ventilator induced-lung injury, atelectasis, pneumonia, hypoxemia)</td>
</tr>
<tr>
<td>Acute postoperative pain treatment</td>
</tr>
<tr>
<td>Deep venous and pulmonary embolic episode prevention</td>
</tr>
<tr>
<td>Stress ulcer prevention</td>
</tr>
<tr>
<td>Aggressive treatment of surgical complications (bleeding, anastomotic leaks, infection)</td>
</tr>
</tbody>
</table>

Table 3: Postoperative care of the obese patient

6 Conclusions

The obese patient present a great challenge to the anesthesiologist, who must deal with obesity induced comorbidities, and unique anesthetic considerations like airway management, different dosage drug regimen, difficulties in monitoring and vascular access, respiratory and cardiac complications, and positioning the patient. Working as a team (anesthesiologist, surgeon, endocrinologist, nutritional physician, nurse) can guarantee a higher success rate and fewer complications.
References


