Case 13

A 37-year-old woman presents for weight loss surgery. She is 5 ft 3 in and 245 lb, yielding a BMI (body mass index) of 43.4 kg/m^2. She has tried for many years to lose weight through diet and exercise without success. She has a history of hypertension treated with lisinopril, type II diabetes mellitus controlled with metformin, gastroesophageal reflux disease (GERD) well-controlled with omeprazole, and her husband states that she snores at night. She has no allergies, no family history of problems with anesthesia, and has never had surgery before. After discussion with her surgeon, she is electing to have a laparoscopic gastric banding procedure.

- What additional history would be helpful in the management of this patient?
- What preoperative testing should be done?
- How will you manage her airway?
- How can her postoperative pain be safely and effectively controlled?

ANSWERS TO CASE 13:
Anesthesia and the Obese Patient

Summary: A morbidly obese 37-year-old woman with hypertension, type II diabetes mellitus, GERD, and possible obstructive sleep apnea (OSA) presents for weight loss surgery via laparoscopic gastric banding.

- **Additional history:** A detailed history with an emphasis on evaluating her functional capacity and other comorbid conditions.
- **Preoperative testing:** Cardiac testing such as echocardiography may be indicated to look for heart failure. Polysomnography (sleep study) may be indicated to document the presence or absence of sleep apnea and initiate CPAP therapy.
- **Airway management:** A cautious approach to induction and intubation is essential. Patient positioning and adequate preoxygenation are critical, as obese patients do not tolerate prolonged periods of apnea. Airway rescue devices such as a laryngeal mask airway and additional personnel should be readily available.
- **Postoperative pain control:** Maintain patient comfort without causing oversedation and respiratory depression.

ANALYSIS

Objectives

1. Understand the special considerations for the preoperative evaluation of obese patients.
2. Become familiar with the alterations in physiology and pharmacodynamics in obesity.
3. Outline the anesthetic considerations specific for the obese patient.

Considerations

This patient has several comorbid conditions related to her obesity. Her hypertension, type II diabetes, and GERD may all improve after weight loss surgery. It is important to find out in her preoperative assessment whether or not these conditions are controlled. Also, this patient may have OSA, especially since she has a history of snoring. It would be beneficial to screen for OSA using polysomnography prior to her surgery.

APPROACH TO
Anesthesia and the Obese Patient

DEFINITIONS

GERD: Gastroesophageal reflux disease.
OBESITY: Body mass index (BMI) > 30 kg/m^2
MORBID OBESITY: Body mass index (BMI) > 40 kg/m^2
OBSTRUCTIVE SLEEP APNEA (OSA): Condition characterized by repeated episodes of upper airway obstruction during sleep, causing oxyhemoglobin desaturation and awakening.
OBESITY-HYPOVENTILATION SYNDROME (OHS): The syndrome of obesity, chronic daytime hypercapnia, alveolar hypoventilation leading to hypoxemia, polycythemia, hypersomnolence, and right ventricular failure. OHS is also associated with alterations in the central nervous system, and in particular, the ventilatory response to CO_2.
POLYSOMNOGRAPHY: A formal test or "sleep study," in which a patient is continuously monitored as they sleep and specific physiologic variables are recorded. These variables include EEG, eye movements, ECG, muscle movements (EMG), respiration, and leg movements. Information gathered from this test can be used to diagnose OSA and provide appropriate settings for treatment with CPAP.
CPAP: Continuous positive airway pressure. This treatment is provided via a face mask to treat OSA. It works by forcing air through nasal or oral passages at pressures high enough to overcome upper airway obstruction, effectively stenting open the patient's airway.

CLINICAL APPROACH

Preoperative Evaluation

Morbidly obese patients often have a number of comorbid conditions, including cardiovascular disease, type II diabetes, hypertension, GERD, OSA, dyslipidemia, chronic back or joint pain, and headaches, which may or may not be medically controlled. Functional capacity should be carefully assessed (ie, exercise tolerance and overall activity level), since obese patients may develop congestive failure and/or pulmonary hypertension. Either of these conditions is associated with an increase in the risk of surgery. A social history should also be obtained, especially regarding tobacco use. Obese patients who are current smokers should be strongly encouraged to quit smoking at least 6 weeks prior to surgery.

On examination, special attention should be paid to the patient's height and weight (which determines BMI), the airway, the heart and chest, and the extremities. A thorough airway examination should include Mallampati classification; assessment of mouth opening, hyomental distance, neck circumference and extension, and the evaluation of dentition. In addition to auscultation of the heart and lungs, chest physiognomy should also be examined in obese patients. Excess chest wall adipose or soft tissue, and large breasts (especially in female patients), adds additional weight to the chest wall thus restricting chest compliance. Restrictive respiratory mechanics are not unusual results in pulmonary function testing. Since obese patients may have congestive failure, the extremities should be examined for overall shape and evidence of edema.

Basic laboratory tests that are recommended within 6 months of weight loss surgery include: hematocrit, blood glucose, creatinine, and blood urea nitrogen. Additional lab tests, such as electrolytes, thyroid function tests, or coagulation studies may be indicated based on the patient's other comorbidities. In 20% to 30% of obese patients, liver function tests may be elevated due to fatty liver, but this usually does not have any clinically significant effect on drug metabolism.

In patients with a very high BMI (> 50 kg/m^2), a baseline arterial blood gas (ABG) may be useful to detect OHS. Screening for obstructive sleep apnea is similarly important in morbidly obese patients. Studies estimate that more than 70% of patients presenting for weight loss surgery may have OSA. Because they are prone to upper airway obstruction, patients with OSA may be more difficult to mask ventilate. Morbidly obese patients also have higher rates of difficult intubation and postoperative respiratory failure. Pulmonary function testing is likely to demonstrate a restrictive breathing pattern. However, given the marginal respiratory mechanics associated with obesity, any potential reversible obstructive defect should be diagnosed and treated preoperatively.

OSA, if present, can significantly affect a patient's overall cardiovascular health. The frequent episodes of apnea during sleep lead to repeated oxyhemoglobin desaturation and awakening during the night. Consequently, these patients have an increased baseline sympathetic tone, which is thought to contribute to higher rates of hypertension, arrhythmias, acute coronary events, congestive failure, and sudden death. Patients at high risk for OSA should have a formal polysomnography study prior to their surgery. Starting these patients on CPAP as soon as possible can reduce hypoxic pulmonary vasoconstriction, and may help decrease their overall cardiovascular risk. Patients should be instructed to bring their CPAP devices with them on the day of surgery for use in the recovery room and throughout their hospital stay.

Intraoperative Course

A careful approach to induction and intubation is essential in morbidly obese patients. Patients should be placed in the appropriate "sniffing" position in

order to facilitate intubation. When obese patients lie flat, excess soft tissue and breast tissue may slide up toward their neck, interfering with mask ventilation and intubation. An intubating "wedge," additional padding, or blankets may be placed under the patients' shoulders. Elevating the shoulders creates a "ramp," allowing excess tissue to fall caudally, away from the patient's airway.

The oxygen saturation declines quite rapidly in obese patients during periods of apnea. This is due in part to the decreased functional residual capacity in obese patients, as well as their increased cardiac output and oxygen consumption due to their large body mass. Time must be taken for adequate "preoxygenation" prior to induction. Breathing 100% oxygen for 3 to 4 minutes prior to induction accomplishes two things. First, the partial pressure of oxygen is increased in blood. But second, and more importantly, hypoxemia is attenuated because "denitrogenation" has also occurred. Seventy-nine percent of room air is nitrogen. Since the N_2 in room air equilibrates with plasma across the alveolus, N_2 is also the predominant gas in blood. When pure oxygen is inspired, N_2 in blood again seeks equilibrium across the alveolus, so N_2 is expired. But during this process, N_2 can quickly become the predominant gas in the alveolus, leading to alveolar hypoxia. The breathing of 100% oxygen allows safe "washout" of N_2 from the blood stream by allowing the alveolus to be filled predominantly with oxygen and thus attenuating any hypoxemia that may occur with apnea at induction. In addition, the functional residual capacity (FRC) may fall below FRC, leading to alveolar collapse with ventilation/perfusion mismatch. The use of CPAP during preoxygenation and induction increases FRC, and extends the length of time until clinically significant oxygen desaturation occurs, also known as the "safe apnea period". In obese patients, *the importance of a long (3-5 minutes) period of preoxygenation cannot be underestimated*.

Ventilation by mask may be difficult in obese patients, and particularly in patients with OSA because the excess soft tissue in the oropharynx can make patients prone to upper airway obstruction. Airway management can be optimized by carefully positioning the patient as previously described, placing head straps in position prior to starting the case, and having an appropriately-sized laryngeal mask airway available for rescue if needed. In patients with particularly difficult airways, a four-handed ventilation technique, where one anesthetist elevates the mandible and holds the mask, and another manages the bag and valve, may be required.

Most obese patients can be intubated via direct laryngoscopy. If difficult airway management is anticipated, the safest approach is to initially use a special intubating device such as a fiberoptic laryngoscope (used awake, with topical spray for the most extreme cases), or a Wu or Glide scope, or a videolaryngoscope such as the McGrath or Glidescope. In patients with severe GERD, rapid sequence induction may be indicated. Rescue airway devices, such as an Eschmann stylet (bougie), LMA or intubating LMA, and fiberoptic or video laryngoscopes, should always be readily available in

the OR, in case an unanticipated difficult airway is encountered. Additional anesthesia personnel and members of the nursing and surgical teams should also be nearby and ready to provide assistance in the event of a difficult intubation.

It is particularly important to comprehensively document the ease of, and techniques used for ventilation and intubation. Knowing that a patient's airway can be easily managed by mask can save him or her from the need for an awake intubation. Similarly, understanding which laryngoscope blades, head positions, etc. were successful or unsuccessful allows the anesthetist to approach management of the airway in the most expeditious manner.

In the absence of significant medical comorbidities, standard monitors are sufficient for an obese patient having a laparoscopic gastric banding procedure. Morbidly obese patients frequently have a conical shape to their arms, which may make it difficult to get an adequate fit from a noninvasive blood pressure cuff. In these cases, the cuff may need to be placed on the forearm or calf, or an arterial line may need to be placed to facilitate the measurement of blood pressure.

The anesthetic for laparoscopic gastric banding is maintained using a balanced technique of inhaled anesthetic gas, muscle relaxation, and low-dose opioids. As stated previously, morbidly obese patients frequently have a restrictive pattern of respiratory mechanics due to the excess weight restricting the chest wall and extra adipose tissue that accumulates around the ribs and under the diaphragm. Peak inspiratory pressures are typically elevated in morbidly obese patients. As the surgeons insufflate the abdominal cavity during laparoscopy, inspiratory pressures become even higher. It is important to provide adequate muscle relaxation to facilitate mechanical ventilation and to maximize the surgical workspace. The addition of positive end-expiratory pressure (PEEP) may also help improve oxygenation and ventilation in morbidly obese patients.

Inhaled anesthetic agents that have lower tissue/blood partition coefficients will achieve induction and recovery at faster rates than more soluble agents. Sevoflurane and desflurane have lower solubility coefficients than isoflurane, and will therefore have faster rates of tissue "wash-in" and "wash-out" than isoflurane. These less soluble agents are preferred in morbidly obese patients because they allow for more rapid recovery from anesthesia, which is important to ensure that obese patients are fully awake prior to extubation. Returning the patient to the 30 degree reverse Trendelenburg position will help facilitate return of adequate spontaneous ventilation. Neuromuscular blockade should be completely reversed, and patients should be alert and following commands prior to removal of the endotracheal tube. Inadequate strength could lead to loss of a patent airway and the need for re-intubation. Prior to extubation, preparations should be made to ensure that the patient can be ventilated and re-intubated if necessary.

When dosing medications, it is important to consider the class of drug when deciding whether total body weight (TBW), lean body mass, or ideal body weight is most appropriate to be used when calculating drug dosage.

The pharmacodynamics and pharmacokinetics of many drugs are altered by obesity, but specific data regarding specific drug dosing is limited. Obese patients have a higher TBW, but they also have more adipose tissue, which is poorly perfused when compared to muscle. Though counterintuitive, this relatively poor perfusion actually somewhat reduces the volume of distribution (V_d) of a lipid soluble agent. When dosed based on TBW, opioids may achieve higher blood levels than anticipated, especially when infusions are used. A conservative approach would be to dose lipid soluble medications according to a patient's lean body mass (ideal body weight + 20%), and titrate to effect. Neuromuscular blocking agents should be dosed according to lean body mass. Obese patients typically have an increase in pseudocholinesterase activity. Since pseudocholinesterase metabolizes succinylcholine, succinylcholine should be dosed according to TBW to facilitate ideal conditions for intubation .

Postoperative Care

Morbidly obese patients are at risk for complications in the postoperative period, and should be closely monitored. Obese patients, especially those with OSA, may become apneic with the administration of narcotics. Postoperative pain control should be tailored to provide patient comfort, without excessively sedating the obese patient. **Opioids dosed according to lean body mass and delivered via PCA (patient-controlled analgesia) are a good option.** Non-opioid adjuvants should also be considered, as these may reduce the opioid requirement while allowing for preservation of respiratory drive. Such adjunctive therapies include NSAIDs, ketamine, alpha agonists such as dexmedetomidine, and infiltration of the wound with local anesthetic. If an open gastric banding had been performed, an epidural for postoperative pain control would be an appropriate pain-management strategy.

Patients with CPAP machines should be encouraged to bring their devices with them to the hospital on the day of surgery. CPAP can be used in the recovery room and throughout the hospital stay. Even those patients without a prior diagnosis of OSA, but in whom OSA is suspected, will likely benefit from CPAP use and the care of a respiratory therapist in the PACU. ASA guidelines recommend that patients with OSA be monitored by continuous pulse oximetry until their room air saturation is 90% or greater during sleep. For this reason, obese patients may need to remain in the PACU for several hours or overnight for monitoring.

Management of the morbidly obese patient undergoing minor, ambulatory surgery under general anesthesia remains quite controversial within the anesthesia community today. Postoperative deaths have been reported, and no studies have demonstrated conclusively the predictive factors for morbidity and postoperative mortality. Whether morbidly obese patients should receive their care in a free-standing ambulatory surgery center, and whether they should remain in a monitored bed overnight following a general anesthetic varies widely across institutions, and to date, no consensus has been reached.

Comprehension Questions

13.1. Which of the following is an important test for patients with suspected OSA prior to weight loss surgery?
A. Complete blood count (CBC)
B. Electrolytes
C. Chest x-ray
D. Polysomnography
E. Exercise stress test

13.2. Morbidly obese patients have which of the following alterations in respiratory physiology?
A. Reduced FRC
B. Reduced peak inspiratory pressures
C. Increased lung volumes
D. Increased chest wall compliance

13.3. Which of the following medications should be dosed according to total body weight (TBW), instead of lean body mass in morbidly obese patients?
A. Morphine PCA
B. Vecuronium
C. Succinylcholine
D. Pancuronium

ANSWERS

13.1. **D.** A formal sleep study, or polysomnography, is an important test for patients with suspected OSA. In this test, a patient is continuously monitored as they sleep and variables such as EEG, eye movements, ECG, muscle movements (EMG), respiration, and leg movements are recorded. Using this information, OSA can be diagnosed and recommendations can be made for appropriate settings for treatment with CPAP.

13.2. **A.** Morbidly obese patients have restrictive pulmonary mechanics, and therefore have a reduced FRC in addition to decreased chest wall compliance due to an excess of soft tissue on the chest wall and fat between the ribs and under the diaphragm. The reduced FRC contributes to a rapid decline in the oxygen saturation following induction.

13.3. **C.** Succinylcholine should be dosed according to total body weight (TBW), not lean body mass. Morbidly obese patients have elevated activity of pseudocholinesterase, the enzyme responsible for the metabolism of succinylcholine. Thus, dosing by total body weight is

necessary to ensure complete relaxation prior to intubation. Morphine by PCA, vecuronium, and pancuronium should be dosed according to lean body mass.

Clinical Pearls

- Obstructive sleep apnea is extremely common in morbidly obese patients, and can increase the risk for difficult ventilation, intubation, and postoperative respiratory failure. Treatment for OSA should be initiated early, prior to surgery if possible.
- Pulmonary function and physiology are altered in morbidly obese patients. They desaturate quickly during periods of apnea, so adequate preoxygenation is essential prior to intubation. Rescue airway devices and additional anesthesia personnel should always be immediately available to help with difficult airway management.
- Obesity modifies both the pharmacokinetics and pharmacodynamics of anesthetic agents. Some agents should be dosed according to total body weight, and others, lean body mass. Insoluble inhalation anesthetics facilitate a more rapid recovery from anesthesia, and are thus favored in obese patients.
- Given the high incidence of OSA and adverse outcomes amongst morbidly obese patients, appropriate precautions must be taken when discharging patients from the post-anesthesia recovery unit.

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