Review Article

Airway management in patients with obesity

ABSTRACT

Airway management in patients with obesity remains a complex and evolving topic that is becoming more pertinent given the increasing prevalence of obesity and bariatric surgery worldwide. Obesity is associated with increased morbidity and mortality secondary to anesthetic complications, especially related to airway management. Preoperative assessment is especially vital for the bariatric patient so that potential predictors for a difficult airway can be identified. There are several airway management strategies and techniques for the bariatric population that may help reduce postoperative pulmonary complications. This review aims to discuss assessment of the airway, ideal patient positioning, intubation techniques and devices, apneic oxygenation, optimal ventilation strategies, and extubation and post-anesthesia care.

Key words: "Bariatric patients", "difficult airway", "intubation".

Introduction

From 2000 to 2018, the prevalence of obesity (defined as having a body mass index [BMI] ≥30 kg/m^2) increased in the United States from 30.5% to 42.4%, and the prevalence of morbid obesity (defined as having a BMI ≥40 kg/m^2) increased from 4.7% to 9.2%.[1] Bariatric surgery has been indicated as a long-term treatment for morbid obesity or for patients with a BMI ≥35 kg/m^2 and at least one serious obesity-related comorbidity.[2] Therefore, patients with obesity are increasingly presenting for surgery and it is essential for anesthesiologists to understand the potential challenges and complications that may arise when caring for these individuals.[2-4]

Increased adiposity in patients with obesity alters anatomy and physiology which complicates perioperative airway management. Patients with obesity often have decreased pulmonary compliance and functional residual capacity (FRC).[3,5,6] The increase in central fat distribution also has a negative impact on respiratory function, which puts patients with obesity at particular risk for rapid oxygen desaturation following induction.[7,8]

Given the increasing prevalence of obesity worldwide and the unique set of challenges associated with airway management, anesthesiologists must be aware of the current best practices for the bariatric patient. This review aims to highlight these practices by examining the assessment of difficult airway, strategies for dealing with DI and difficult mask ventilation (DMV), use of apneic oxygenation during attempts to secure the airway, ideal ventilation strategies, and extubation and post-anesthesia recovery.

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Literature Review

A literature review was conducted in January 2021 using the PubMed Search Engine and the search terms "bariatric" along with either "difficult intubation," "difficult airway," or "airway management." Publications were filtered by a publication date within "10 years." Any articles that were not in English were excluded. More articles were found beyond this initial search from key studies referenced within the articles. A total yield of 77 articles were included based on their relevancy to the subject matter and publication date.

Preoperative assessment

Obesity is linked to an increased incidence of difficult airway, though various studies have conflicting outcomes on the degree to which obesity can be considered a risk factor for DI and DMV. The common definition of difficult airway is "the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation, or both."[9,10] Patients at risk for increased difficulty in airway management are thus at greater risk of perioperative complications and should be properly assessed for difficult airway during preoperative evaluation.

Predictors of difficult airway

Several studies find the primary risk factors for DMV to be a high Mallampati score (3-4), history of snoring/OSA, male gender, high BMI, and older age.[8,11,12] Impossible mask ventilation (IMV), which has a low incidence of 0.16%, is not associated with obesity. The strongest risk factors for IMV are a history of neck radiation, male gender, history of OSA, and a high Mallampati score.[8,13] Risk factors for DI are age >46 years, male gender, a high Mallampati score, thyromental distance <6 cm, and increased neck circumference.[12,14]

Difficult airway assessment scales

Several scales have been utilized to objectively define the degree of DI. The Cormack-Lehane system is commonly used to classify the degree of DI based on the laryngoscopic view. However, it only represents one aspect of the intubation process and can be subjective in nature.[12,15-17] The Intubation Difficult Scale (IDS) is the most comprehensive scale as it combines multiple parameters known to be associated with DI into a single number to give an estimate of intubation difficulty [Table 1].[14,18] Between the two, the IDS is more comprehensive and is a previously validated score that accounts for multiple predictors of DI.

Obesity and incidence of DI and DMV

While obesity has been found to be a risk factor for DMV, many studies report conflicting evidence for an increased risk of DI in patients with obesity.[12,14,19] In a prospective controlled study, Lavi *et al*., found that patients with obesity tended to have higher IDS scores than non-obese patients.[14] Another study conducted by Kaya *et al*., found an increased incidence of a high Mallampati score in patients with obesity compared to non-obese patients.[19,20] This is likely due to the presence of more oropharyngeal tissue fat in patients with obesity, which makes it more difficult to view the airway.[19] Since OSA is a common comorbidity of obesity, Toshniwal *et al*., studied the correlation between STOP-Bang scores and a difficult airway.[19,21] In patients with obesity and undiagnosed OSA, those with higher STOP-Bang scores show a significantly higher risk for difficult airway than patients with lower STOP-Bang scores.[9] While these studies indicate that obesity and obesity-related comorbidities influence the predictors of difficult airway (*i.e.* IDS score, Mallampati score, etc.), Moon *et al*., found in a large-scale prospective, observational cohort study that morbid obesity itself is not a significant independent predictor of DI even though it is a predictor for DMV.[12] Outcomes from several other studies support this finding in that there is no statistically significant association between a higher BMI and increased incidence of DI.[22-24] Airway characteristics such as abnormal thyromental distance, decreased jaw mobility, a high Mallampati score, and a history of DI are far more predictive of DI. This may be because patients' anatomical features widely vary even at the same BMI. Therefore, BMI alone may not be a good predictor for DI.[12,22]

Best predictors of difficult airway

Many studies indicate that the best predictor of DMV is an increased neck circumference.[23,25,26] A study conducted by Leoni *et al*., specifically found that the risk for DMV increases in a linear fashion with an increase in neck circumference size.[25,27] Vegesna *et al*., noted that increased neck circumference was not only one of the best predictors of DMV, but that it was one of the most statistically significant values in predicting DI.[23] Combinations of several factors are often more predictive than their individual counterparts alone, and other studies suggest the best combination, more than individual risk factors or tests, to predict difficult airway are the Mallampati score and thyromental distance.[8,28] A prospective observational study conducted by Hashim *et al*., further validated these findings and found a more comprehensive predictor of DI to be the ratio of neck circumference to thyromental distance as this value best indicates how fat is distributed around the neck.[29-31] Using these statistically significant indictors of difficult airway to evaluate a patient with obesity's risk is an important step during preoperative evaluation so that these following strategies be utilized.

Table 1: IDS Score Calculation

Parameter	IDS Score
Number of additional intubation attempts	N_1
Number of additional operators	N_2
Number of alternative intubation techniques used	N_3
Laryngoscopic view (Cormack-Lehane grades) minus one	N_4
Lifting force required (Normal, Increased)	(N_5=0, N_5=1)
Laryngeal pressure (Not applied, Applied)	(N_6=0, N_6=1)
Vocal cord mobility (Abduction, Adduction)	(N_7=0, N_7=1)
Total IDS Score	Summation of N_1-N_7

Strategies and techniques for intubation

Positioning

The first step towards ensuring a successful intubation, especially in patients with obesity, is positioning the patient correctly. In patients without obesity, the 'sniffing position' in which the patient's head is extended and neck is flexed is advocated as the standard position to improve airway visualization in direct laryngoscopy (DL). However, many studies have found the 'ramped position' to be more appropriate for patients with obesity.[2,3,19,32-34] In the ramped position, the patient's head and shoulder are elevated to align with an imaginary line drawn from the external auditory meatus to the sternal notch. This is typically done utilizing specialized devices, ramps, or blankets. The ramped position has been found to improve oxygenation and laryngoscopic view during intubation by allowing for important anatomic alignment.[2,3,33] In a direct comparison of the ramped and sniffing positions, patients in the ramped position had an improved Cormack-Lehane grade for laryngoscopic view compared to patients in the sniffing position.[8,33,35,36] Additionally, the ramped position is known to improve lung mechanics and minimize the negative effects of obesity on respiratory function and hemodynamics, ultimately assisting in oxygenation and maximizing the safe apnea time.[32,34]

Video laryngoscopy (VL)

While VL has been shown to be effective in cases of predicted difficult airway, there is no conclusive evidence to show that VL is better than DL in patients with obesity, although VL does provide a better view of the glottis.[5,10,37,38] VL is commonly thought to be more convenient than DL because it allows for intubation without the need to align the oral cavity, pharynx, and larynx axially.[39,40] However, in a study comparing DL and VL, the group of patients intubated with VL had longer intubation times, although a better glottic image was obtained in this group. There was no difference found between the VL and DL groups in terms of intubation success or hemodynamic changes.[39] Due to the improved glottic view when using VL compared to using DL, it is possible that primary use of VL may improve the probability of successful intubation on the first attempt and lead to a decreased risk of hypoxemia.[41]

Therefore, VL may be a good choice for the initial intubation attempt if the patient is known or suspected to have an increased risk of DI.[41,42] Preselecting special airway techniques such as VL or fiberoptic intubation (FOI) to use for the initial intubation attempt in patients with a predicted high risk of DI is associated with a lower incidence of DI than what is typically reported in patients with a BMI $\geq$35 kg/m^2 or higher.[43] In a prospective randomized study conducted by Castillo-Monzon *et al.*, comparing the DL and VL, the VL yielded more frequent easy airway visualization in the morbidly obese as assessed by a modified Cormack-Lehane classification and needed fewer optimization maneuvers for tracheal intubation. Despite these slight advantages, no statistically significant difference in the duration or success of intubation was found between the use of either the VL or DL.[44]

While VL was found to result in significantly faster tracheal intubation than fiberoptic intubation in patients undergoing bariatric surgery with predicted difficult airways, the FOI technique is well documented as being useful and important in cases of difficult airway.[8,45] Other techniques for managing difficult airway in patients with obesity include the Infrared Red Intubation System (IRRIS) and single lumen tubes with incorporated cameras.[41,46]

SGAs

Supraglottic airway devices (SGAs) are commonly used as rescue tool in cases of difficult and failed mask ventilation. In patients where SGAs were used to aid mask ventilation, Sinha *et al.*, found that SGAs could provide more effective positive end-expiratory pressure (PEEP) and prolong the safe apnea time more. SGAs can also be used to facilitate endotracheal intubation as well with the use of an airway exchange catheter.[47]

Apneic oxygenation

While there are many different techniques and methods available to assist in the process of intubation, apneic oxygenation is a method that can be used to increase the time between induction and the onset of hypoxia (the

safe apnea time).[5,48,49] The safe apnea time is inversely proportional to BMI and thus strategies to increase the safe apnea time can be useful in patients with obesity since physiological changes predispose them to rapid desaturation during induction.[5,7,50-52] Apneic oxygen increases the safe apnea time by supplying oxygen to the alveoli even when the patient is not being ventilated due to a negative pressure differential in the alveoli created by decreased carbon dioxide return to the alveoli during apnea.[50,53] One study found that oxygen insufflation at 15 L/min through a nasopharyngeal airway and standard nasal cannula significantly increases the safe apnea time in patients with obesity.[50] However, in patients with morbid obesity, high-flow nasal insufflation of oxygen (120 L/min) was not found to increase the duration of safe apnea compared to standard nasal apneic oxygenation (10 L/min).[48]

Ventilation

Once induction and intubation have been successfully completed, the next consideration for proper perioperative management of patients with obesity is optimal ventilation strategy. Protective mechanical ventilation with low tidal volumes, low driving pressure, and moderate PEEP has been shown to protect the lungs during surgery and has been associated with a reduced risk of postoperative pulmonary complications.[3,34]

Many studies on optimal ventilation strategies have focused on the use of recruitment maneuvers (RM) with PEEP compared to the use of PEEP alone.[54-57] These studies all found RM with PEEP to be more effective and beneficial to both oxygenation and pulmonary compliance.[54-58] However, these benefits are not found to be sustainable as they did not persist after extubation into the postoperative period.[55,57,59] The Protective Intraoperative Ventilation with Higher Versus Lower Levels of Positive End-Expiratory Pressure in Obese Patients (PROBESE) Trial is a multicenter, international, randomized controlled trial to evaluate and compare the postoperative effects of intraoperative high PEEP with RM and low PEEP without RM. There was no statistically significant difference found in postoperative outcomes between these two groups.[60] Therefore, some advocate for RM only being used as a rescue method in the case of severe oxygen desaturation.[34,61]

Extubation strategies

Another concern for airway management in the bariatric patient is proper extubation. Just as for intubation, the patient should be placed in the ramped or 25° reverse Trendelenburg position for extubation.[5] The patient should ideally be awake with adequate reversal of neuromuscular blockade.[33] It is prudent to prepare for possible reintubation during extubation of difficult airway cases.[7] To this end, airway exchange catheter-assisted extubation can provide continuous airway access should the patient need to be reintubated.[8] Furthermore, potential obstruction after extubation can be alleviated using a lubricated and carefully inserted nasal trumpet prior to emergence.[5]

Postoperative strategies

Certain postoperative ventilation strategies can be used in patients with obesity to enhance postoperative recovery. Non-invasive pressure ventilation (NPPV) in the immediate postoperative period reduces the risk of respiratory complications and episodes of desaturation.[3,5,62,63] In patients with obesity and OSA, continuous positive airway pressure (CPAP) use in the postoperative period has been shown to reduce the risk of pulmonary complications, atelectasis, and reintubation.[3,34,64] Using bilevel positive airway pressure (BiPAP) immediately after extubation may be beneficial for maintenance of lung volumes and lung capacity.[65] A prospective, randomized, single-blinded study conducted by Alexandropoulou *et al*., found that in morbidly obese patients undergoing bariatric surgery, BiPAP at individualized pressures for 3 days postoperatively significantly reduced postoperative restrictive lung disease compared to the sham BiPAP control group.[66] Between CPAP and BiPAP, it is not clear which is superior.[3] Additionally, high-flow nasal cannula (HFNC) has advantages over noninvasive ventilation as it is more tolerable and easier to apply, so patients with obesity can be extubated directly to HFNC.[5,67]

Conclusion

The limitations of this review include the possibility that not all relevant recent publications were included due to the constraints of the literature search. Also, since the literature used was limited to those written in English (or those that had a form that was translated into English), the findings may be biased towards English-speaking countries.

The best practices in airway management of patients with obesity remains a prominent topic in bariatric anesthesia. These patients may be at increased risk for difficult airway and there are many different techniques at the anesthesiologist's disposal for properly identifying and managing this patient population.

There are many preoperative criteria and predictive scales the anesthesiologist can use to predict difficult airway, and special attention should be placed on assessing neck circumference, thyromental distance, and Mallampati scores. Currently, IDS is the most comprehensive scale for classifying

DI. Optimizing patient positioning assists in improving pulmonary dynamics and the success of in the bariatric patient. There are a plethora of intubation techniques and devices in addition to DL that can further aid in securing the airway in the patient with obesity. Studies on optimal ventilation strategies have conflicting results. While some studies advocate for the use of PEEP alone, others note that RM and PEEP together are more effective. Likewise, some studies advocate for low to moderate PEEP while others suggest a higher PEEP in patients with obesity. In addition, extubation and post-anesthesia care recommendations suggest that there are many methods the anesthesiologist can use to successfully manage the postoperative care of patients with obesity.

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Conflicts of interest
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