

# Airway management in patients suffering from morbid obesity

## ABSTRACT

Obesity is no longer a disease of the affluent. The prevalence of obesity has risen at an exponential rate globally, with an increasing burden on healthcare resources. Perioperative management of patients with morbid obesity is known to be challenging, and this is particularly so in the management of their airway, a crucial procedure that requires meticulous planning and modifications. Anesthesiologists will expect to see more patients with obesity in their practice presenting for both bariatric and non-bariatric surgery, or even for emergency surgery. Hence, any generalist anesthesiologist should be confident in managing such a patient, with the appreciation that these patients often pose a significant challenge to the practice of anesthesia. This article describes different techniques and looks at the evidence for airway management in the morbidly obese. Other aspects of perioperative management of such patients are beyond the scope of this article.

**Key words:** Airway, anesthesia, obese

## Introduction

The World Health Organization (WHO) has defined obesity as “abnormal or excessive fat accumulation that may impair health.”<sup>[1]</sup> Persons suffering from obesity is an umbrella term for any adult whose body mass index (BMI) is greater than or equal to 30 by the WHO definition. The severity of obesity is further subcategorized according to BMI: 30–34.9 kg/m<sup>2</sup> as class I obesity, 35–39.9 kg/m<sup>2</sup> as class II obesity, and ≥40 kg/m<sup>2</sup> as class III obesity.<sup>[2]</sup> Morbid obesity is a popular term in the literature. It is commonly used to refer to patients whose BMI is ≥40 kg/m<sup>2</sup>, or ≥35 kg/m<sup>2</sup> with at least one serious obesity-related condition.

Economic and social progress across the globe and agricultural advancements have enabled access to varied food sources


and perhaps increased food consumption. This has resulted in an exponential rise in the prevalence of obesity.<sup>[3]</sup> As a result, there is an increasing burden on healthcare systems due to the growing population of individuals suffering from obesity. This trend is observed not just in affluent countries but increasingly in developing nations as well.<sup>[4]</sup>

Obesity should be regarded as a multisystemic disease. Patients suffering from obesity are at risk of developing a multitude of medical issues, including but not limited to cardiovascular disease, diabetes mellitus and insulin resistance, certain types of cancers, sleep disorders such as obstructive sleep apnea (OSA) or obesity hypoventilation syndrome (OHS), liver disease, and kidney disease.<sup>[5]</sup> For the anesthesiologist, altered airway anatomy and respiratory

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mechanics are at the top of the problem list, and other details such as altered pharmacokinetics and altered drug dosing should be considered during the management of such a patient.

#### **Airway challenges in a patient with morbid obesity**

Patients suffering from obesity develop anatomical changes due to redundant tissue in the upper airways and the head and neck areas. Increased adipose tissue deposition in the pharynx and hypopharynx results in narrowing of the airway. A larger tongue is more difficult to displace in the submental space for adequate exposure during laryngoscopy. Large tonsils may further narrow the oropharyngeal space for manipulation of the laryngoscope. Together, these changes make laryngoscopy more challenging.<sup>[6]</sup> Furthermore, due to the deposition of adipose tissue in the neck, shoulder, and back, positioning the patient in the “sniffing the morning air position” for laryngoscopy requires specific adjustments. Additionally, excessive soft tissue around the face and cheeks makes effective mask seal and bag-mask ventilation difficult.

Manipulating the airway in a patient with morbid obesity is a high-risk procedure due to difficult bag-mask ventilation and tracheal intubation, compounded by unfavorable respiratory mechanics. This includes reduced functional residual capacity (FRC), reduced chest wall compliance, microatelectasis, early airway closure, and increased oxygen demand. In combination, the patient is at risk of rapid desaturation after induction of anesthesia, therefore requiring the anesthesiologist to secure the airway as quickly as possible to provide adequate ventilation and oxygenation.<sup>[6]</sup>

A “difficult airway” is defined by the American Society of Anesthesiologists (ASA) as “The clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both.”<sup>[7]</sup> It is no surprise that the incidence of a difficult airway is higher among this subset of patients compared to the general population due to the anatomical and physiological changes described above.

#### **Preoperative management**

The preoperative anesthesia assessment clinic visit is a good opportunity to review the patient’s airway, and ascertain and predict difficult airways, such that appropriate preparations can be made in advance.<sup>[8]</sup>

A thorough airway examination involves examining the face and cheeks, degree of mouth opening, presence of any facial hair, Mallampati scoring, thyromental distance, range of movement of the neck, mandibular movement, and neck

circumference. The anesthesiologist should examine the patient’s dentition, and a referral to the dentist should be initiated if necessary. Airway examination and anticipated difficulty should be clearly documented. The anesthesiologist should conduct an open discussion with the patient regarding a difficult airway and its management strategies.

Clinical indicators of difficult tracheal intubation and difficult bag-mask ventilation have long been an area of interest. It is widely accepted and taught that there is no single clinical indicator of a difficult airway. There have been multiple small observational studies looking at factors predicting difficult airway or intubation in the obese. Some identified factors include male sex, increasing age, larger neck circumference, higher BMI, presence of OSA, high Mallampati score, higher ASA score, and short thyromental distance.<sup>[9-19]</sup> None of these factors have a high enough specificity and sensitivity to be used reliably as a predictor of a difficult airway. Instead, risk assessment of the airway should be a combined consideration of all the identified factors that may indicate difficulty. Snoring, tiredness, observed apnea, high blood pressure-BMI, age, neck circumference, and gender (STOP-BANG) questionnaire may be applied to identify patients at risk of OSA.<sup>[11]</sup> Interestingly, a few studies have found that obesity is associated with a higher incidence of difficult bag-mask ventilation, but it is not predictive of a difficult intubation.<sup>[20-22]</sup>

More recently, there has been increasing interest in advanced techniques for airway assessment, such as the use of neck X-rays and ultrasound assessment of the airway to predict difficult intubations.<sup>[23-25]</sup> However, no clear radiographic or sonographic parameters have been validated for predicting a difficult airway, although many parameters have been proposed.<sup>[24,25]</sup> Other advanced imaging modalities may be of use, such as computerized tomography (CT) or magnetic resonance imaging (MRI) scans of the neck, but their utility would be limited to airway assessment in complex head and neck pathologies rather than routine airway examination.

There should be adequate preparation for a difficult airway situation in emergency settings where thorough preoperative assessment is not possible. This will be elaborated on in the “difficult airway management” section below.

#### **Preoxygenation**

The role of preoxygenation in routine anesthetic induction and intubation is to achieve denitrogenation of the FRC, hence extending safe apnea time for intubation.<sup>[26]</sup> Good quality preoxygenation is crucial for managing patients suffering from morbid obesity as they have reduced FRC and

greater oxygen consumption. Safe apnea time is reduced, and therefore time to desaturation is faster in such patients as compared to a patient with a normal BMI.

Standard preoxygenation involves a tight-fitting face mask and getting patients to inhale 100% oxygen. There have been comparisons between preoxygenation techniques, such as tidal volume breaths for 3 min versus eight vital capacity breaths.<sup>[27]</sup> In any case, preoxygenation should be optimized for the patients who are morbidly obese to extend safe apnea time as much as possible.

Oxygen supplementation via nasal prongs with a tight-fitting face mask has been shown to extend safe apnea time and delay significant desaturation. Oxygen delivery can continue via the nasal cannula even during the apneic phase, allowing for apneic oxygenation, which is postulated to delay time to desaturation as there is a continuous supply of oxygen.<sup>[28,29]</sup>

The use of a high-flow nasal cannula (HFNC) to improve preoxygenation has been studied in patients suffering from morbid obesity.<sup>[30,31]</sup> HFNC is a novel technique that allows insufflation of up to 60 L of warm humidified 100% oxygen through modified nasal prongs. Proposed mechanisms include the generation of positive end-expiratory pressure (PEEP) from high flows of O<sub>2</sub> even during the apneic phase while also achieving apneic oxygenation.

Other proposed methods of preoxygenation include the application of continuous positive airway pressure (CPAP), non-invasive ventilation (NIV), or pressure support to maintain PEEP and prevent atelectasis. These techniques increase FRC and extend safe apnea time with adequate oxygenation.<sup>[32,33]</sup> There is no consensus on the gold standard method of preoxygenation for patients with morbid obesity as there is no identified superior method.<sup>[31,34,35]</sup> However, there should be an emphasis on quality preoxygenation (regardless of technique) to aim for an end-tidal oxygen concentration of at least 90% which extends safe apnea time and consequently improves the safety margin for intubation.

### Positioning

Patients are normally laid supine in the “sniffing the morning air” position for routine anesthetic induction (neck flexion and head extension) which aligns the laryngeal, oral, and pharyngeal axes to obtain the best view during laryngoscopy.<sup>[36]</sup> However, in patients suffering from morbid obesity, a supine position further decreases FRC and exacerbates early airway closure and atelectasis, reducing desaturation time. Fat pads on the patient’s back may hinder optimal positioning of the head relative to

the neck. A ramped-up position has been described and widely utilized in managing these patients. This position involves aligning the external auditory meatus to the sternum.<sup>[37,38]</sup> This can be achieved by elevation of the head and shoulder through additional blankets or pillows. Commercial pillows such as the Troop elevation pillow are adjuncts to achieving the ramped-up position. This positioning achieves two purposes – it firstly improves preoxygenation by optimizing respiratory mechanics as the patient is not completely supine, and secondly helps in attaining a better laryngoscopic view as the three axes are well aligned.<sup>[39-42]</sup>

An alternative to the ramped-up position is the 25° head-up position, which is also postulated to improve the view on laryngoscopy.<sup>[38]</sup> Some small observational studies have shown that the head-up position also improves the quality of preoxygenation, increasing the safe apnea time.<sup>[43,44]</sup>

Overall, the evidence favors optimal positioning of the patient with morbid obesity in the ramped-up position rather than the supine position during preoxygenation and intubation to enhance laryngoscopy view and consequently increase intubation success.

### Laryngoscopy and intubation

Laryngoscopy is defined as the visualization of the larynx and can be performed with direct laryngoscopes, video laryngoscopes (VLs), optical stylets, and fiberoptic scopes. VLs are thought to be advantageous over direct laryngoscopes, as they provide a better glottic view.<sup>[45-49]</sup> In addition, having a video camera system with VLs also allows other anesthesiologists and assistants to see the glottic view and perform maneuvers or prepare additional airway adjuncts. Many studies have been conducted examining the use of different VL in the morbidly obese airway.<sup>[45-50]</sup> So far, there is no VL that has been identified as being superior to the rest.<sup>[48,51]</sup> There is also an interest in the role of using VLs with preloaded endotracheal tubes to increase the speed of successful intubation and hence reduce the risk of complications during intubation. However, there is no compelling evidence that VLs with preloaded endotracheal tubes confer a better outcome.<sup>[52]</sup>

One of the problems with VL is difficulty in landing the endotracheal tube correctly, despite an excellent glottic view. This is possibly contributed by the more acute angle of the VLs view, which is poorly negotiated by the natural curvature of the endotracheal tube. Rigid metal stylets to enhance the curvature of the endotracheal tube should be used to optimize the intubation attempt. In fact, some small studies

demonstrate no difference in intubation success between direct laryngoscopy and VL.<sup>[53-55]</sup>

Rigid fiberscopes such as the Bonfils have garnered less interest in the management of obese airways, partly because they are not as widely available as VLs or fiberoptic scopes. It was found to be more difficult to intubate a patient with obesity with the Bonfils, likely due to redundant soft tissue impeding the glottic view. Similarly, an asleep fiberoptic technique is of less interest as it does not circumvent airway collapsibility after induction, and hence may be more difficult to maneuver.<sup>[56]</sup>

Ultimately, the laryngoscope of choice should be dependent on the comfort of the operator.<sup>[57]</sup> However, the approach to laryngoscopy and intubation should be that of “the first attempt is the best attempt,” and the goal is to secure the airway as quickly as possible.

#### **Awake techniques**

Awake fiberoptic intubation (AFOI) has been regarded as the safest method for intubation of the trachea. It preserves intrinsic airway tone, and allows patients to breathe spontaneously before intubation and visualize the tracheal tube in its correct position with the fiberoptic scope. However, undertaking an AFOI requires trained personnel, additional resources (fiberoptic scope), and can cause significant anxiety and discomfort for the patient. Furthermore, the patient may be anxious and uncooperative if encountered in an emergency setting, which may instead endanger them during the process of AFOI.<sup>[58]</sup>

Awake techniques employing VL are possible as well, with the benefit of requiring lesser equipment.<sup>[59]</sup> Furthermore, awake VL may be as efficient as an AFOI technique. However, the advantage of an awake VL over an AFOI technique is largely dependent on the operator’s familiarity with the equipment.<sup>[60]</sup>

#### **Difficult airway management**

As reiterated above, obesity is associated with an increased incidence of a difficult airway. Therefore, suboptimal airway management may result in significant adverse events for these patients. In Japan, an observational study found that obesity is a risk factor for adverse events and a lower first intubation success rate.<sup>[61]</sup> In addition, the fourth National Audit Project (NAP4) also found that adverse events occurred more frequently in patients with obesity when managed by inexperienced staff. Other contributing factors include lack of recognition of a difficult airway and failure to plan for potential airway problems.<sup>[62]</sup>

Therefore, when managing any patient with obesity, they should be considered to have a potentially difficult airway. The anesthesiologist should be well-versed in difficult airway drills to prepare for potential airway problems. The Difficult Airway Society (DAS) algorithm for difficult intubation is a commonly employed drill for the management of a difficult airway [Figure 1].<sup>[63]</sup>

The DAS does not have a specific guideline for the management of patients with obesity. Still, the approach to anticipated difficult intubation is of value in planning for airway management.

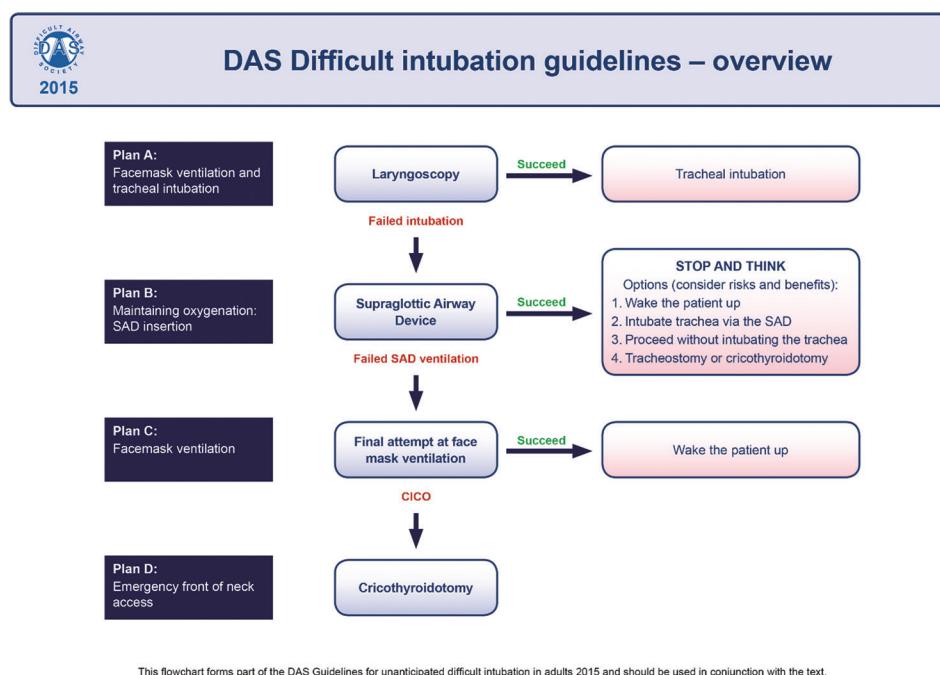
The anesthesiologist-in-charge should make adequate preparations before attempting intubation, such as bringing in the difficult airway trolley<sup>[64]</sup> with advanced airway equipment (oral airways and face mask in many sizes, different laryngoscope blades, VL, different sized endotracheal tubes, different supraglottic airway devices (SAD) in a range of sizes, front-of-neck-access (FONA) equipment). The operating theater team should be informed of the possibility of a difficult airway. The anesthesiologist should formulate an airway management plan (plan A, B, C) and communicate clearly to the anesthetic team. The most senior anesthesiologist should attempt the intubation to increase the chances of successful intubation at the first attempt. Ear, nose, and throat (ENT) surgeons should be informed early should their assistance be needed for emergency FONA.

#### **Rescue: SAD**

SADs are featured in the difficult airway management algorithm after failed intubation as an alternate method for ventilation and oxygenation.<sup>[63]</sup> SADs are generally not favored in managing patients with morbid obesity due to the risk of aspiration. Higher pressures driving through SADs for adequate ventilation may open the lower esophageal sphincter and result in regurgitation and aspiration. However, newer generations of SADs such as the Proseal or Ambu have inbuilt gastric suction ports that allow for the passage of orogastric tubes within the SAD, reducing the risk of aspiration. Studies have demonstrated that safe ventilation and oxygenation are possible with SAD, even for patients suffering from morbid obesity.<sup>[64,65]</sup> In addition, SADs may be useful in aiding intubation, such as the use of an intubating supraglottic airway (e.g., Fastrach laryngeal mask airway),<sup>[66-68]</sup> or providing a conduit for low-skill fiberoptic intubation.

The use of SAD in airway management of a patient with morbid obesity is feasible. However, it is recommended that they be used in short procedures, and the patient





**Figure 1: DAS difficult intubation guidelines**

should have no other risk factors of aspiration. In the authors' opinion, their use should be limited to rescue devices for failed intubation attempts for ventilation and oxygenation.

### Rescue: FONA

Failed intubation drills invariably lead to FONA techniques in a can't intubate can't oxygenate (CICO) situation. Excess soft tissue around the neck in patients with morbid obesity makes FONA challenging, perhaps with a greater risk of failure, in line with the NAP4 observations. In general, there are two types of FONA techniques, namely, the scalpel-bougie-tube technique and the needle cricothyroidotomy technique. An emergency tracheostomy is not recommended as it requires time before oxygenation and ventilation can be achieved. It is recommended that tracheostomy be performed when cricothyroidotomy has failed. There is a relative paucity of studies on the ideal FONA technique in the morbidly obese airway, but the DAS has recommended the scalpel-bougie-tube technique over needle cricothyroidotomy.<sup>[62]</sup> In patients who suffer from morbid obesity, the increased depth from skin to trachea may increase the chances of kinking of the cannula in the needle cricothyroidotomy method. Hence, it is postulated that the scalpel-bougie-tube technique is less likely to fail.<sup>[69]</sup>

In an elective setting, pre-induction ultrasonographic evaluation of the airway and marking of anatomical landmarks can help clinicians decide and plan for the ideal FONA technique in the event of a CICO situation.

### Postoperative management

Planned extubation of a high-risk patient, whether after an elective procedure or in the Intensive Care Unit (ICU), should be undertaken with caution. Patients with morbid obesity fall under the category of high-risk patients. If there is any doubt regarding the safety of the patient post-extubation, there should be a joint discussion with other members of the healthcare team to consider delayed extubation and optimization in a setting with an appropriate level of care. There is interest in developing a scoring system to identify patients at risk of extubation failure. However, this is still a work in progress, and to date, there is no validated scoring system to predict the success of extubation for patients with morbid obesity.<sup>[70]</sup>

In the operating theater, where advanced airway management equipment is readily available, the difficult airway trolley should be in the vicinity during extubation to prepare for extubation failure and the need for reintubation. Advanced extubation techniques can be employed to ensure safe and smooth extubation. The neuromuscular blockade should be completely reversed and the patient should be fully awake and be able to follow commands before removing airway devices.<sup>[71]</sup>

If clinically appropriate, extubation to NIV or CPAP for a short period can be considered. This is especially so for patients with a history of OSA/OHS. This has been found to reduce postoperative pulmonary complications and reduce the risk of

reintubation.<sup>[72,73]</sup> Other newer techniques include extubation to HFNC to improve oxygenation.<sup>[74]</sup> Routine postoperative care should be protocolized, such as encouraging early mobilization and concurrent chest physiotherapy to improve respiratory mechanics.

The patient should be monitored in a high-dependency or intensive care setting post-extubation for the purposes of closer respiratory monitoring and early escalation if necessary.

### Education and training

As anesthesiologists expect to encounter more patients who have obesity/morbid obesity with possible difficult airways, adequate education and training in airway management of such patients should be introduced early in the training of residents. Experiential learning via simulation training with difficult airway manikins improves the confidence in managing a difficult airway situation; and allows anesthesiologists to familiarize themselves with the range of advanced airway equipment available. Such training opportunities also inculcate the importance of an airway management plan and educate on communicating with team members in a stressful situation.<sup>[75]</sup> Anesthesiologists of all levels can benefit from such training - senior anesthesiologists have the opportunity to upkeep their skills, while junior anesthesiologists pick up new skills in managing a difficult airway.

### Combining it all

Airway management, especially intubation, is a highly stressful and dynamic process involving a concerted team effort from skilled anesthetic assistants and other anesthesiologists. The importance of a sound and safe airway management approach is further amplified in managing the airway of patients with morbid obesity. Adequate preparations can help reduce the risk of adverse events – and this includes a thorough preoperative assessment and meticulous preparation for a difficult airway situation. The anesthesiologist-in-charge should have an airway management plan and communicate clearly to members of the anesthetic team. Preparations should be made in advance, and equipment should be available in the vicinity. Anesthesiologists should be aware of the equipment available for troubleshooting difficult intubation, and help should be employed early when difficulty is encountered. A senior anesthesiologist should ideally be present and be the one to manage the airway to increase the chances of success. Similar to an airway management plan for intubation, extubation too requires meticulous planning to maximize its success. There should be a careful and thorough assessment of the patient's respiratory status before extubation. Other considerations include delayed extubation or extubation to NIV or HFNC to support the

patient's ventilation in the immediate postoperative period. Lastly, simulation training is invaluable in supporting and improving the skills and confidence of anesthesiologists in managing the airway of a patient with morbid obesity in terms of technical and non-technical skills.

### Conclusion

Airway management of patients with morbid obesity is challenging and can be daunting for many healthcare providers. There is no conclusive evidence that favors a particular practice. Still, one should also appreciate that performing clinical trials regarding airway management is limited by the study design (difficulty in randomization, blinding), hence practices are shaped by anecdotal evidence of what worked and where the techniques faltered without bad outcomes. Common practices include using the ramped-up position for preoxygenation and intubation and using VLs to enhance the view of the larynx. Familiarity with equipment and optimizing strategies can help to improve safety during airway manipulation. A good understanding and confident execution of difficult/failed airway drills are also important in managing the airway of the patient with morbid obesity in an emergency. Further research and analysis should be performed on multiple aspects of airway management (preoperative, intraoperative, and postoperative) to identify the ideal practice to enhance safety during airway management of such patients.

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### Conflicts of interest

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