The bariatric airway

ABSTRACT

The prevalence of obesity in the UK is increasing. Airway management in the obese patient can be challenging. Face mask ventilation is frequently difficult, and while the incidence of difficult laryngoscopy is only marginally raised, the consequences of failed intubation and the rate at which the obese patient desaturates makes this an unforgiving population. Emergence from anaesthesia requires particular care and attention. This article addresses the problems of airway management in the obese patient and looks at measures which can be taken to overcome them.

The terms 'bariatrics' and 'obesity' are often used interchangeably. Bariatrics, which is derived from the Greek prefix 'bari-' meaning weight or load, refers to the medical speciality specializing in weight loss. This includes non-surgical treatments. Patients are often described as being bariatric if they are obese. The bariatric airway ultimately means the airway and its management in an obese patient undergoing general anaesthesia.

A person's weight is classically categorized by calculating his/her body mass index which takes into account the person's weight and height (Keys et al, 1972). This simple formula helps to classify people as being underweight, a normal weight, overweight or obese. On the basis of body mass index, obesity is defined as >30 kg/m^2, severe obesity is a body mass index between 35 and 40 kg/m^2, morbid obesity 40–50 kg/m^2 and super obesity >50 kg/m^2. The World Health Organization divides obesity into classes depending on the body mass index; class I (30–35 kg/m^2), II (35–40 kg/m^2), III (>40 kg/m^2) and IV (>50 kg/m^2). A limitation of body mass index is that it does not take into account a person's body frame and musculature. For example, a lean, muscular athlete might be deemed to be overweight or obese based on his/her body mass index alone.

Measuring central obesity might be more appropriate, as patients with more central, intra-abdominal distributed fat are at higher risk of perioperative events and are more likely to exhibit the metabolic syndrome. This distribution of intra-abdominal fat is referred to as the 'apple' body shape as opposed to the 'pear' body shape where the fat distribution is more peripheral (*Figure 1*). Waist circumference measurement is a method of screening for central obesity, being defined as a waist circumference greater than 88 cm in a woman and 102 cm in a man, or a waist to height ratio greater than 0.55 (Schneider et al, 2007; Glance et al, 2010).

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Obesity: prevalence and problems

The prevalence of obesity in the UK is increasing. In 2016, 26% of adults in England were classified as being obese (NHS Digital, 2016), compared to 15% in 1993. The percentages are similar for Scotland, Wales and Northern Ireland (NHS Digital, 2018). The prevalence of morbid obesity has more than tripled since 1993 with 2% of men and 4% of women in 2016 considered to be morbidly obese.

Currently, the UK has one of the highest rates of obesity in Europe. In the USA, the rate is approaching 40%, whereas Japan reports obesity levels of less than 10% (Organisation for Economic Cooperation and Development, 2017).

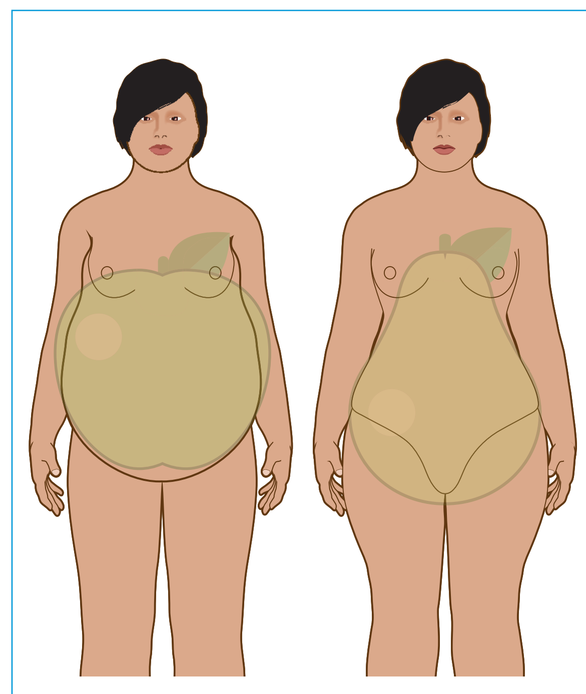

Figure 1. The 'apple' and 'pear' body shapes.

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> Obese and morbidly obese patients featured highly in reported cases of aspiration, failed cricothyroidotomy, failed intubation, difficult awake tracheal intubation, hypoxic brain injury and death.

In 2016–17, approximately 5700 bariatric surgical (weight loss) procedures took place on the NHS in the UK. This number has been static for the past 4 years (British Obesity and Metabolic Surgery Society, 2018).

As the rates of obesity increase, so do the number of obese patients presenting to hospital for both emergency and elective procedures. Obese patients are more likely to have other significant comorbidities and this can make them a very challenging patient group to manage (Nightingale et al, 2015).

Respiratory physiology

Obesity has a significant impact on lung volumes, respiratory mechanics and gas exchange. The weight of chest wall fat, together with diaphragmatic splinting from abdominal fat, reduces functional residual capacity and lung compliance. Airway resistance is increased, as is the work of breathing (Pelosi et al, 1998). Basal minute oxygen requirements in the obese are increased, with baseline oxygen consumption dedicated to respiration approaching twice that of the non-obese patient during quiet spontaneous breathing (Kress et al, 1999). Baseline functional residual capacity may be very markedly reduced in obese patients, with oxygen stores in the functional residual capacity of only a few hundred millilitres. These effects mean that following the induction of anaesthesia, hypoxaemia can occur early and desaturation can be very rapid. Airway management must be prompt and alternative strategies well planned in the event of failure.

Obstructive sleep apnoea

Obstructive sleep apnoea is the periodic partial or complete obstruction of the upper airway and causes hypoventilation or apnoea. This leads to poor quality sleep, daytime fatigue, poor concentration and headaches. Tonsillar hyperplasia is a frequent finding. Waking in the middle of the night causes catecholamine surges and, in more severe cases, can lead to hypertension, left and right ventricular strain and eventually failure, pulmonary hypertension and arrhythmias. A typical patient with obstructive sleep apnoea will be obese, male and over the age of 55 years, with a large neck collar size.

Because sleep apnoea is undiagnosed in a large proportion of the population, screening tests are very useful to raise suspicions and lead to further investigation. One such test is the STOP-BANG questionnaire (Chung et al, 2012). The severity of sleep apnoea is described by a composite analysis of the number of apnoeas and desaturations that occur each hour, and the severity of desaturation that results from each episode. Unsurprisingly, severe obstructive sleep apnoea, together with a large neck circumference, appears to correlate with a more difficult grade of laryngoscopy view (Gentil et al, 1994; Hiremath et al, 1998; Lee et al, 2011).

Obesity and airway complications

Obesity is a common feature in major airway problems and complications. The Royal College of Anaesthetists and Difficult Airway Society's joint National Audit Project (Cook et al, 2011) highlighted these problems. Obese and morbidly obese patients featured highly in reported cases of aspiration, failed cricothyroidotomy, failed intubation, difficult awake tracheal intubation, hypoxic brain injury and death.

Obese patients were twice as likely to have a major airway complication. This increased to four times the risk in the morbidly obese. This can result in serious morbidity or mortality. The report suggested that contributing factors were failure to recognize obesity as a risk factor in airway management and the failure of standard rescue techniques. It also suggested that alternatives to general anaesthesia, e.g. regional anaesthesia, were feasible but not sought.

It is important to remember that operator experience plays an important role. The National Audit Project highlighted this with junior anaesthetists more often being involved in airway complications (Cook et al, 2011).

Can we predict potential airway difficulties?

Predicting difficulties in airway management is an inexact science. Certain features are clearly associated with increased difficulty, but many patients without these specific features may turn out to be problematic.

The 'difficult airway' in the obese population may reflect one of several issues. The most common problem is difficult face mask ventilation. Other studies refer to the view of the larynx obtained (difficult laryngoscopy) while others refer to the number of attempts, and the time taken to intubate the trachea (difficult intubation) (American Society of Anesthesiologists Task Force on Management of the Difficult Airway, 2003; Ezri et al, 2003; De Jong et al, 2015).

The intubation difficulty scale has been proposed as an objective way of assessing intubation difficulty by using a scoring system (Adnet et al, 1997). The scale includes parameters such as number of attempts, number of operators (clinicians attempting intubation), the use of alternative techniques and the Cormack and Lehane view obtained.

This scale has been used in studies which have reported higher rates of difficult intubation in the obese compared to patients with normal body mass indexes (Juvin et al, 2003; Lavi et al, 2009). However, multiple patient factors, including obstructive sleep apnoea, have been

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found to be associated with airway difficulties in the obese. These are discussed below.

Body mass index

Body mass index alone is a weak predictor for a difficult airway, whether this is a problem obtaining a view of the larynx or difficulty in intubating the trachea (Brodsky et al, 2002; Lundstrøm et al, 2009). A patient with an elevated body mass index can rapidly desaturate and become hypoxaemic following the induction of anaesthesia. This means that any airway intervention performed needs to be prompt, well planned and effective.

The Mallampati score

The Mallampati score is a test to assess the visibility of a patient's oropharynx. It is a grading system (I–IV) based on the ability to visualize the uvula, faucial pillars and soft palate (Mallampati et al, 1985). It requires the patient to open his/her mouth and protrude the tongue. Grades III and IV are associated with more difficult laryngoscopy and intubation but not always difficult face mask ventilation (Ezri et al, 2001; Brodsky et al, 2002; De Jong et al, 2015).

Neck circumference

Neck circumference is an important feature to assess in the obese patient. As neck circumference increases, so does difficulty of intubation in terms of the view of the larynx obtained, and the number of attempts required and time taken to intubate the trachea.

In the first study on this topic, patients with a neck circumference of 40 cm had a probability of a problematic intubation of approximately 5%, whereas in patients with a neck circumference of 60 cm the probability of a problematic intubation was approximately 35% (Brodsky et al, 2002). Subsequent studies have tended to support this finding (Gonzalez et al, 2008). However, large neck circumference is particularly prevalent in males, and gender may play a large part in this association. It is noteworthy that obstructive sleep apnoea, also frequently associated with male gender and neck circumference, is another predictor of difficulty in intubation.

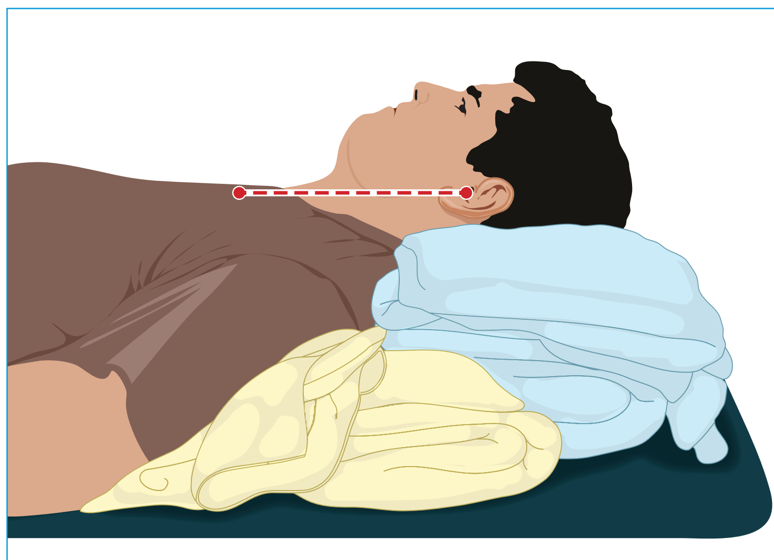

Figure 2. The ramped position. Note the horizontal line between the external auditory meatus and sternum.

Airway management

Positioning

It is widely accepted that having the patient in the 'ramped' position optimizes the conditions for laryngoscopy. This involves achieving a horizontal line between the external auditory meatus and the sternal notch (Collins et al, 2004) (*Figure 2*). This can be achieved in a number of ways: using pillows, blankets or foam wedge devices. At the authors' institution, the trolley or operating table is adjusted so that the patient is in the 'head-up' position – together with use of a pillow, this means that the horizontal line can be achieved. The ramping should begin at the mid-thoracic level not simply at the hip joint.

Not only does this position optimize intubating conditions, it also ensures that the detrimental effects of obesity on respiratory mechanics are minimized, prolonging the time to desaturation and safe apnoea time. These measures increase safety when it comes to securing the airway in an obese patient (Boyce et al, 2003; Dixon et al, 2005).

Preoxygenation

There is no accepted universal method of preoxygenation for the obese patient, despite this being of great importance, together with proper positioning, in preventing hypoxia and increasing the safe apnoea time. There is evidence that application of continuous positive airway pressure enhances preoxygenation and prevents desaturation (Harbut et al, 2014), as does the use of modest flow rates of supplemental nasal oxygen (Ramachandran et al, 2010).

Evidence is also emerging that the use of high flow nasal oxygen devices, which deliver humidified oxygen at rates of over 50 litres/min, are superior to continuous positive airway pressure for preoxygenation (Heinrich et al, 2014).

Face mask ventilation

Obesity can certainly make face mask ventilation more difficult (Langeron et al, 2000). Other predictors of difficult face mask ventilation include sleep apnoea, Mallampati class III or IV and a beard (Kheterpal et al, 2009). Beards often disguise facial abnormalities such as burns, scars or micrognathia so it is essential to assess the face thoroughly.

Difficulties in face mask ventilation can often be overcome by using an oropharyngeal airway, trimming or covering the beard with a large clear dressing or using a four-handed technique. Some anaesthetists will insert a supraglottic airway device while waiting for full neuromuscular block to take effect.

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Intubation: direct laryngoscopy *vs* videolaryngoscopy

Direct laryngoscopy refers to the use of a laryngoscope to move the tongue and mandible in order to directly visualize the patient's larynx and vocal cords. There are different handle lengths and many different shapes and sizes of laryngoscope blades. The commonest blade used is the curved Macintosh blade, designed by Robert Macintosh in 1943.

The studies discussed in this article thus far have all used a standard laryngoscope when referring to view of the larynx obtained, degrees of difficulty or optimizing the patient's position. Direct laryngoscopy remains the gold standard and is currently the most commonly used technique to intubate patients.

Videolaryngoscopy uses a rigid blade with a camera mounted on its end which connects to a screen that the user, and others, are able to see. Videolaryngoscopes were introduced in the early 2000s and their use has become more commonplace. Commonly used devices include Airtraq (Prodol Meditec, Guecho, Spain), Glidescope (Verathon UK, Amersham, UK), MacGrath (Medtronic, Watford, UK) and C-Mac (Karl Storz, Slough, UK). There are many other devices on the market.

It is accepted that in general videolaryngoscopy improves the view of the larynx obtained (Marrel et al, 2007) and that some devices might be superior to others (Yumul et al, 2016).

A Cochrane systematic review comparing videolaryngoscopy *vs* direct laryngoscopy (Lewis et al, 2017) concluded that overall, videolaryngoscopy increased easy laryngeal views and reduced difficult views and difficulty in intubation. Failed intubations were reduced with increased operator experience. They were unable to comment on use in the obese patient because of the lack of randomized control trials. This highlights the importance of being familiar with the videolaryngoscope before using it in an urgent or emergency clinical situation.

Supraglottic airway devices

Supraglottic airway devices are widely used in all domains of anaesthesia. The benefits include quick and easy insertion, less instrumentation of the airway, avoidance of neuromuscular blockade and encouragement of spontaneous ventilation. Despite these advantages, supraglottic airway devices do not provide a definitive airway, risk leakage during intermittent positive pressure ventilation and can increase gastric insufflation.

Second-generation supraglottic airway devices are those that include a second channel allowing any regurgitated stomach contents to clear the mouth. They offer more aspiration protection because of the presence of a gastric port, and the general consensus is that their use should be first line (Cook and Kelly, 2015). They can also be used as an alternative to face mask ventilation. This might be a useful technique to adopt for more junior anaesthetists who might struggle with facemask ventilation (Abdi et al, 2009).

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> **“If intubation fails then the priority becomes oxygenation, either with a supraglottic airway device or face mask ventilation.”**

The major limitation in the use of supraglottic airway devices is that the lungs of obese patients require higher airway pressures to ventilate. These pressures may be such that a leak occurs, with either a failure to adequately ventilate the lungs or air being forced down into the stomach, or both. Pulmonary aspiration remains the commonest cause of major airway complications in anaesthesia and the National Audit Project showed that this was more common with supraglottic airway devices and first-generation devices. Obese patients featured highly in adverse airway events when a supraglottic airway device was used (Cook et al, 2011).

Supraglottic airway devices should be used with caution. Guidance suggests that they should only be used for short procedures and where the head can remain elevated and easily accessible, in case tracheal intubation is required (Nightingale et al, 2015).

Awake tracheal intubation

A major safety benefit of awake tracheal intubation is that the patient's airway can be secured with an endotracheal tube, either orally or nasally, while the patient is fully conscious or slightly sedated, and spontaneously breathing. It is an important technique to consider if there are anticipated difficulties.

There should be a low threshold for using awake tracheal intubation, especially in the context of obesity and head, neck or airway pathology. The National Audit Project once again highlighted cases where obesity was a factor and awake tracheal intubation was not appropriately used (Cook et al, 2011). Sedation, which can aid awake tracheal intubation, should be used with caution as the risks of respiratory depression or airway obstruction are high – these can lead to rapid desaturation or failure of the technique.

Failed intubation

If intubation fails then the priority becomes oxygenation, either with a supraglottic airway device or face mask ventilation. If these succeed then the decision to wake the patient up must be considered. If these fail then emergency front of neck access (a surgical cricothyroidotomy) should be performed (Difficult Airway Society, 2015). The problem in the morbidly obese patient is that excessive tissue and indistinct landmarks make front of neck access highly problematic, and in many patients effectively impossible. These factors mean that the use of awake intubation techniques is sometimes necessary in this population, and a low threshold for the use of such techniques is wise.

KEY POINTS

- Obesity is an increasing worldwide problem. The number of obese patients presenting for surgical procedures is also increasing.
- Airway management requires meticulous planning because of the risk of prompt desaturation and hypoxaemia.
- Pre-oxygenation with high-flow nasal oxygen and laryngoscopy with a videolaryngoscope should be considered.
- There should be a low threshold for awake tracheal intubation in the context of predicted difficulty.
- Extubation where possible should be in the upright position with full reversal of neuromuscular blockade.

Extubation

Safe extubation at the end of a surgical procedure is just as important as a safe intubation. The obese patient should be extubated in a head up position ('sitting position'), as awake as possible and with full reversal of neuromuscular blockade, in line with published guidelines (Difficult Airway Society, 2011; Nightingale et al, 2015).

The sitting position optimizes respiratory mechanics, while being full awake (i.e. eye opening or obeying commands) minimizes the risk of postoperative airway obstruction, hypoventilation or laryngospasm.

The reversal of neuromuscular blockade ensures the full return of airway reflexes, accessory muscle and diaphragmatic strength. Reversal should be guided by the use of a nerve stimulator.

Many anaesthetists routinely use rocuronium, with the calculated dose based on lean body weight, as their first-choice neuromuscular blocking agent and reverse its effects with sugammadex. This selectively and highly effectively binds the aminosteroid class of neuromuscular blocking agents (rocuronium and vecuronium), and thus enables rapid and complete reversal of neuromuscular block.

Suxamethonium should be used with caution. The dosing can be difficult, with effective doses calculated on the basis of total body weight, often at 1–2 mg/kg. Such large doses can have undesirable side effects such as decreasing the safe apnoea time and causing bradycardias (Tejirian et al, 2009; Taha et al, 2010).

Postoperatively, patients should continue to be nursed in the upright position and supplementary oxygen given. Continuous positive airway pressure devices should be commenced as normal if the patient already uses one or in the recovery area if supplementary oxygen does not maintain adequate oxygenation. Incentive breathing devices such as spirometers can also be used to encourage respiratory exercises by the patient, but require preoperative training.

Conclusions

Airway management in the obese patient is challenging. Face mask ventilation is frequently difficult, and while the incidence of difficult laryngoscopy is only marginally raised, the consequences of failed intubation and the rate at which the obese patient desaturates makes this an unforgiving population.

Emergence from anaesthesia requires particular care, and premature extubation before full reversal of neuromuscular blockade and return of normal respiratory muscle tone is highly likely to lead to failure. This is further compounded by the prevalence of diagnosed or undiagnosed obstructive sleep apnoea in the obese population. The surgical airway is frequently neither viable nor a safe back-up option, and thus there should be a lower threshold for the use of awake intubation techniques. **BJHM**

Conflict of interest: none.

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