Anaesthesia in the obese patient

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Abstract

Obesity is an increasing problem and its burden on healthcare resources is well documented. This article gives an overview of the physiological and pharmacological considerations when anaesthetizing the obese patient. It will look at key aspects of assessing obese patients, and planning and delivering a safe anaesthetic to them. Special areas of focus include correct drug dosing, as well as equipment, monitoring and environmental aspects involved in delivering the anaesthetic.

Keywords Body mass index; lean body weight; obesity; obstructive sleep apnoea; pharmacology in obesity

Royal College of Anaesthetists CPD Matrix: 1A01, 1A02, 1C01, 1E06, 2A03, 3A13

Learning objectives

After reading this article you should be able to:

- recall four factors which may predict difficult intubation/airway management
- describe the respiratory changes which occur with obesity and how to manage them during anaesthesia
- describe six significant pathophysiological changes which occur in chronic obesity
- calculate Ideal body weight and Lean body weight and use these to correctly dose commonly used anaesthetic drugs
- discuss four practical considerations associated with delivering safe anaesthesia to an obese patient.

Introduction

Obesity is increasingly prevalent within the UK population and in the long term presents a significant burden on healthcare resources.[1] The World Health Organization (WHO) categorizes obesity using body mass index, which is measured in kg/m^2. Use of BMI alone can lead to errors in certain patient groups (e.g. athletes) and the National Institute for Health and Care Excellence (NICE) guideline CG189 recommends using BMI in conjunction with waist circumference (Table 1) when assessing risk and planning treatments.[2] An increased waist circumference is associated with increased risk of complication. This is because central (also known as visceral) fat is highly metabolically active and known to cause several concomitant disease states, some of which are discussed below.

In England, the prevalence of obesity among adults rose from 14.9% to 26.9% between 1993 and 2015. The prevalence of population classed as overweight rose from 36% to 39%, meaning that now only 30% of men and 39% of women in England are of a healthy weight.[1]

Whilst this upward trend of obesity has significant public health consequences it also will have a significant impact on anaesthetic and theatre resources going forwards.

Systemic considerations

The pathophysiological signs and effects of obesity are outlined in Box 1. They are discussed in further detail below.

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Airway

In 2015 De Jong et al. demonstrated that obesity increased the risk of a difficult intubation in an emergency situation, and that this was associated with a 20-fold increase in life-threatening complications in the obese ICU patient.[3] Whilst some centres have shown that obesity itself does not increase the risk of difficult intubation in the hands of experienced operators other studies have shown an increased risk of up to 30%.[4]

Adipose deposition occurs in all areas of the upper airway. The face, neck and tongue are all enlarged with anterior laryngeal displacement also occurring. This can increase the difficulty of bag mask ventilation and airway instrumentation, requiring use of airway adjuncts and new-generation video laryngoscopes respectively. Male gender, high-grade Mallampati and Wilson scores, along with known obstructive sleep apnoea or previous difficult intubation are strong risk indicators for difficulty and should be explored in detail during preoperative assessment. The benefit of head-up positioning or use of a 'ramp' pillow has been well documented. Extra adipose tissue can obliterate anatomical landmarks and complicate emergency front of neck access. The 2015 Difficult Airway Society (DAS) guidelines for difficult intubation emphasizes the importance of this assessment and good 'Plan A' preparation as well as familiarity with equipment and techniques of Plan B through to Plan D.[5]

Breathing

Obesity places additional demands upon the respiratory system with the additional body mass undergoing cellular respiration creating an increased basal metabolic rate. Oxygen demand is increased and greater CO_2 clearance is required. At the same time obesity impairs the structural function of the respiratory system. Chest wall compliance is decreased and the enlarged adipose mass of the abdomen in obesity reduces diaphragmatic excursion further. The result is an increase in the work of breathing. In addition, the functional reserve capacity (FRC), expiratory reserve volume (ERV) and total lung capacity (TLC) decrease in an inverse relationship to BMI. Closing capacity increases, and can encroach onto the FRC as the patient lies supine resulting in gas trapping and a V/Q mismatch, hypoxaemia and hypercarbia.

These adverse physiological effects can be countered to some extent by adjusting the anaesthetic and surgical technique, including use of positive end expiratory pressure (PEEP), head-up

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Classification of BMI, and risk to health when combined with waist circumference. NICE CG189

Classification			BMI (kg/m²)
Healthy			18.5–24.9
Overweight			25–29.9
Obesity 1			30–34.9
Obesity 2			35–39.9
Obesity 3			40 or more
BMI classification	**Waist circumference effect on health**		
	Low < 94/80 cm	**High 94–102/80-88**	**Very High > 102/88**
Overweight	No increased risk	Increased risk	High risk
Obesity 1	Increased risk	High risk	Very high risk

Table 1

Systemic effects of obesity

Airway
- Adipose deposition in upper airway
- Increased difficulty to bag mask ventilate
- Increased difficult intubation rate

Respiratory
- Decreased compliance
- Decreased FRC, ERV and TLC
- Increased incidence of OSA and OHS
- Closing capacity encroaches on FRC when supine
- Increased V/Q mismatch
- Rapid desaturation during apnoea
- Pulmonary hypertension

Cardiovascular
- Increased CO
- Hypertension
- LV hypertrophy and diastolic dysfunction
- IHD and cerebrovascular accident (CVA) risk increased

Endocrine/metabolic
- Diabetes mellitis
- Fatty liver disease
- Gastric reflux
- Dislipidaemia

Other
- Increased risk of venous thromboembolism
- Osteoarthritis

CO, carbon monoxide; CVA, cerebrovascular accident; ERV, expiratory reserve volume; FRC, functional reserve capacity; IHD, ischaemic heart disease; LV, left ventricle; OHS, obesity hypoventilation syndrome; OSA, obstructive sleep apnoea; TLC, total lung capacity; VTE, venous thromboembolism.

Box 1

positioning, avoidance of de-recruitment (circuit de-connection) and regular recruitment manoeuvres perioperatively.

Obesity hypoventilation syndrome (OHS) and OSA are a significant risk[6] in the patient with a raised BMI affecting as many as 20% of patients with BMI greater than 35. Thorough preoperative assessment is essential with use of the 'STOP-Bang'[4] screening tool and referral for sleep studies as indicated. Patients with long-standing obesity can develop pulmonary hypertension which also poses a significant perioperative risk. These patients should be examined for signs of right-sided cardiac failure and investigated accordingly. Whilst local guidelines around BMI are variable, a diagnosis of untreated OSA would make a patient unsuitable for day case surgery. They may require HDU care and continuous positive airway pressure ventilation postoperatively. Untreated OSA can nearly double (44% vs 28%)[6] the risk of perioperative respiratory and cardiac events and a balance must be struck, in agreement with the surgical team, between the urgency of any surgery and establishing treatment of the OSA first to reduce perioperative risk.

Circulation

The heart: The increased total body tissue of obesity requires a larger circulating blood volume (albeit smaller in terms of ml/kg) and therefore cardiac output. This increased output is mostly provided by increasing stroke volume which results initially in concentric remodelling and left ventricle (LV) hypertrophy. Diastolic dysfunction then develops progressively which results in incomplete left atrial (LA) emptying, LA hypertrophy, LA dilatation and atrial fibrillation. In the severely obese systolic function also begins to fail, with decreased fractional shortening and reduced ejection fraction.[7]

Fatty infiltration of the conducting system at any level can result in arrhythmias. There is a risk of prolonged QT and sudden cardiac death in these patients. ECG analysis should be thorough and drug choice cautious.

In addition, pulmonary hypertension as discussed above can lead to similar changes in the right side which can manifest as paradoxical septal motion on echocardiogram.

Vascular: A complex series of dyslipidaemias, combined with a chronic inflammatory and prothrombic state, lead to endothelial dysfunction and accelerated atherosclerotic disease. This not only causes hypertension, but also increases the risk of stroke and myocardial infarction due to plaque rupture.[7]

All of these changes significantly reduce the reserve capacity of the cardiovascular system in a stressed physiological state and whilst obesity itself has not been found to increase the perioperative risk of MI or stroke, the systemic pathophysiology it causes – if present, have been well demonstrated to do so.

Endocrine/metabolic

The development of Type 2 diabetes mellitus secondary to obesity is well documented. Fat deposition around the islet cells of the pancreas impairs function and insulin resistance leads to impaired regulation of glucose and fat metabolism. This impaired fat metabolism in obesity is associated with raised liver enzymes, triples the risk of developing hepatic steatosis[8] (non-alcohol fatty

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