General anaesthesia for operative obstetrics

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Abstract

General anaesthesia in obstetrics is reducing with a reported use in only 4% of caesarean sections in 2017–2018. Obstetric surgery is often urgent, requiring effective team communication and a rapid, focused preoperative assessment. Physiological changes of pregnancy increase the incidence of aspiration, desaturation and failed intubation. In addition, the rapidly evolving circumstances add additional stress, impacting on performance. Hypotension from aortocaval compression is common and minimized by left lateral tilt or uterine displacement. Rapid sequence induction with tracheal intubation remains gold standard but supraglottic devices are advocated in the event of failed intubation. Awareness remains relatively common and adequate depth of anaesthesia should be maintained and monitored. Complications are more common in obese pregnant patients. Whilst women with pre-eclampsia are at particular risk of hypertensive responses to intubation and extubation, intravenous opiates can ameliorate this. Improved multidisciplinary communication on the delivery suite allows for pre-emptive assessment of patients at risk of requiring an operative delivery. With diminishing individual experience of general anaesthesia in obstetrics and delivery suite often being covered by junior doctors, simulation exercises can improve confidence, performance and team working.

Keywords Aspiration; awareness; general anaesthesia; obesity; obstetrics; preoxygenation; rapid sequence induction

Royal College of Anaesthetists CPD Matrix: 2A09, 2B02, 2B05

Learning objectives

After reading this article, you should be able to:

- discuss the specific increased risks posed by GA in the obstetric population
- explain the importance of preoxygenation, aspiration prophylaxis and proper positioning in obstetric patients
- describe a systematic approach to conducting a GA for caesarean section

Indications for general anaesthesia

Surgery during pregnancy may be:

- antenatal surgery (e.g. cervical suture)
- peripartum surgery (e.g. caesarean section, ex utero intrapartum treatment (EXIT) procedure, management of antepartum or postpartum haemorrhage including laparotomy)
- postpartum surgery (e.g. perineal repair, manual removal of placenta)
- non-obstetric surgery (occurs in up to 2% of all pregnancies).[1]

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The risks and benefits of surgery during pregnancy should be evaluated in all cases and non-emergency surgery is usually postponed until after delivery. During pregnancy, regional techniques are preferred but some situations where general anaesthesia (GA) is considered most appropriate are:

- contraindication to regional anaesthesia
- maternal refusal or lack of cooperation
- failure or complication of regional anaesthesia
- insufficient time to establish regional anaesthesia for urgent delivery
- nature of surgical procedure.

There is no obstetric surgical procedure for which GA is mandatory, but it is most often used for time-critical caesarean section. The incidence of this continues to fall due to better antenatal optimization of comorbidities, advanced planning for anaesthetic management, establishing epidural analgesia early in labour in high-risk women and an increased multidisciplinary willingness to facilitate regional anaesthesia.

Preparation

The overall approach to GA in the obstetric population is outlined in Table 1.

Effective communication on the delivery unit is vital so that women at risk of operative intervention or those with significant comorbidities are identified early. This allows medical optimization and administration of appropriate acid-aspiration prophylaxis. Also, the anaesthetist can preoperatively assess patients and discuss relevant options prior to transfer to theatre.

Induction of anaesthesia

Aortocaval compression should be minimized using a 15-degree left lateral table tilt or manual uterine displacement. The patient's head, neck and shoulders should be optimally positioned for airway management, with the neck flexed at the cervicothoracic joint and extended at the atlanto-occipital joint. A 20–30 degree head up ramped position increases functional residual capacity (FRC), reduces difficulty in laryngoscope insertion due to large breasts, improves the view at laryngoscopy and may reduce gastro-oesophageal reflux.[2]

Rapid sequence induction (RSI) with endotracheal intubation is recommended for GA after 20 weeks' gestation, although modifications to traditional RSI are common in practice. The airway management plan should be discussed amongst the anaesthetic team prior to induction. A theatre team checklist approach is recommended. This should include a preliminary

Overall approach to general anaesthesia in the obstetric population

Multidisciplinary team approach	Obstetricians, anaesthetists, midwives, neonatologists and other surgical specialties. Confirm category of LSCS and indication with team
Effective communication	To include all team members, including patient
Thorough preoperative assessment	Particular attention to airway assessment and comorbidities
Appropriately trained assistance and equipment	
Aspiration prophylaxis	H_2-antagonist 0.3 M sodium citrate
Use of World Health Organization surgical safety checklist	This should be modified for obstetric patients
Positioning	15° left lateral tilt or leftwards manual displacement of the uterus Ramped position for obese patients
Monitoring	As per Association of Anaesthetists of Great Britain and Ireland guidelines. Cardiotocography
Antibiotic prophylaxis	NICE recommend antibiotic administration prior to skin incision which is superior for the prevention of endometritis but without reduction in overall infectious morbidity
Preoxygenation	100% oxygen via a close-fitting mask to fractional end-tidal oxygen concentration >0.9 High-flow oxygen delivery through nasal cannula for apnoeic oxygenation THRIVE at 30 L/min, increased as tolerated up to 60 L/min once asleep. Mouth closed and jaw thrust to maintain patent airway post-induction
Rapid sequence induction	Almost always with intubation of the trachea with a size 7.0 cuffed oral endotracheal tube Correctly applied cricoid pressure Rehearsed and articulated 'airway plan B' in case of failed intubation
Induction Drugs	Propofol 2.5 mg/kg, Thiopentone 5–7 mg/kg
Broca Calculation for Ideal body weight = height (cm) −105	Suxamethonium 1–1.5 mg/kg Rocuronium 1–1.2 mg/kg (Ensure sugammadex available) Opiates (alfentanil/remifentanil). Especially if pre-eclampsia or cardiac comorbidities)
Maintenance	Adequate depth of anaesthesia Aim for normotension and normocapnia for pregnancy Monitor neuromuscular blockade
Extubation	Fully reversed and awake in the left lateral or semi-recumbent position Consider extubation directly onto THRIVE, particularly for obese patients
Planning for appropriate post-anaesthesia care	Antiemetics Simple analgesics, opioids and local anaesthetic techniques, e.g transversus abdominis plane (TAP) blocks

Table 1

decision about whether to wake the patient versus continuing with surgery should tracheal intubation fail, and an escalation plan in case help is required. Proseal laryngeal mask airway has been successfully used for airway management in carefully selected patients undergoing elective caesarean section.[3]

Preoxygenation, to an end-tidal oxygen fraction ≥0.9, is essential prior to induction. This can be achieved by tidal breathing through a circle system with tight-fitting facemask and a fresh gas flow rate of ≥10 L/min. Computer modelling indicates that 2 minutes of pre-oxygenation is sufficient in a term pregnant patient.[3] In pregnancy, reduced FRC and increased oxygen requirement result in quicker onset of desaturation during apnoea with time to SaO_2 less than 90% being reduced by approximately 35%. Labour, obesity and sepsis shorten this time further.[4] Nasal oxygenation during efforts securing a tube (NODESAT) uses high-flow (15 L/min) oxygen via nasal cannula to fill the pharynx with oxygen during apnoea and has been shown to increase time to desaturation.[5] Transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) has gained popularity in obstetrics. Advantages offered by THRIVE include the ability to pre-oxygenate the patient while preparing drugs, equipment or attempting regional anaesthesia; a reduced time to achieve target end-tidal oxygen fractions, apnoeic oxygenation, and application of CPAP which may counteract the impairment to FRC. THRIVE is initiated on arrival in theatre at 30 L/min, flows are titrated as tolerated, up to a maximum of 60 L/min in the anaesthetized patient. Importantly, to ensure effective preoxygenation, the patient must keep a closed mouth and a patent airway must be maintained with jaw thrust following induction. THRIVE can also be used at extubation, and may be most beneficial in obese patients.

Cricoid pressure is recommended. An initial force of 10 N should be applied prior to induction of anaesthesia, increasing to 30 N after loss of consciousness. Table tilt must be appreciated when applying cricoid pressure to provide reliable midline oesophageal compression and not distort the laryngoscopic view. It should be maintained until correct placement of the endotracheal tube, but in the event of intubation difficulty may be gently released.[6]

Thiopentone (5–7 mg/kg) remains the most popular induction agent in obstetrics despite a survey showing that 55% of UK anaesthetists rarely use thiopentone outside of obstetrics. NAP5 noted that thiopentone was implicated in 23% of awareness reports; subsequently, use of thiopentone has reduced from 97% to 62.7%. Concerns regarding propofol included its slower onset, short distribution half-life, reduced titratability and cardiovascular depression.[7] Nonetheless, evidence of increased awareness with thiopentone, and increasing familiarity with propofol support the use of propofol as a standard induction agent for GA in caesarean section in non-compromised patients.[6] A dose of 2.5 mg/kg is sufficient to prevent maternal awareness but is associated with hypotension. In a hypovolaemic patient alternatives include, co-induction with a reduced dose of propofol and an opioid, or ketamine (1–2 mg/kg). The sympathomimetic effects of ketamine make it unsuitable for women with pre-eclampsia or cardiovascular disease.

Opioid analgesia has tended to be avoided until clamping of the umbilical cord due to concerns regarding reduced placental flow secondary to maternal hypotension, and respiratory depression in the neonate due to trans-placental drug transfer. However, in patients with pre-eclampsia or cardiac disease, opioids provide haemodynamic stability and protection from increases in MAP and ICP at intubation. Additionally, omission of opioids is a risk factor for awareness.[8] Short-acting opioids (e.g. alfentanil and remifentanil) are recommended in patients in whom marked haemodynamic fluctuations are dangerous. Opiates in healthy women are more controversial but supported due to their benefit in reducing awareness;[6] but neonatal resuscitation must be immediately available.

Suxamethonium (1–1.5 mg/kg) has traditionally been used due its rapid onset, quick offset (thought to be helpful in the event of failed intubation) and low trans-placental transfer. It does have a number of significant side effects and NAP6 revealed suxamethonium as almost twice as likely to cause anaphylaxis than non-depolarizing alternatives, although it stressed that this should not be the overriding factor in choice of muscle relaxant. Rocuronium use for rapid sequence induction has increased and at 1–1.2 mg/kg provides excellent intubating conditions rapidly, maintained conditions for airway management and an increased time to desaturation. In the event of profound neuromuscular block requiring rapid reversal, sugammadex (16 mg/kg) given 3 minutes after a 1.2 mg/kg bolus dose of rocuronium can achieve a train-of-four ratio of 0.9 within 2 minutes. The speed of recovery following sugammadex is dependent on both dose and administration interval. The duration of action of rocuronium is prolonged in pregnancy due to relative reduction in hepatic blood flow. Together with the higher RSI dose prolonged paralysis can result, which may make reversal and extubation problematic following completion of surgery. Lower initial doses of 0.6 mg/kg require longer to produce optimal intubating conditions and are not advocated as part of traditional RSI approach. Rocuronium does cross the placenta in a dose-dependent fashion but subsequent consequences for the fetus are unknown. The safety profile of sugammadex is not yet completely established in parturients and there are concerns regarding allergic reactions, although sugammadex could be of use in cases of anaphylaxis to rocuronium.[6]

Maintenance of anaesthesia

The goals of anaesthetic maintenance are adequate feto-maternal oxygenation with normocapnia for pregnancy (4–4.2 kPa), adequate depth of anaesthesia and minimal effects on both uterine tone and the neonate. Hypotension should be minimized because the uteroplacental unit has no autoregulation and fetal hypoxia may result. Volatile anaesthetic agents are most commonly used but no one agent is superior to another. Minimum alveolar concentration (MAC) is reduced in pregnancy by 25–40%, particularly if there has been prior labour, but end-tidal vapour concentration should be maintained at more than 0.8 MAC to prevent awareness.[7] A MAC >1 may result in neonatal depression from transplacental drug transfer and there is also a dose dependent reduction in uterine tone and contractility.[6] Nitrous oxide may be added to reduce the amount of volatile agent required to prevent awareness while limiting the effect on uterine tone.

TCI propofol with remifentanil infusion has also been described for induction and maintenance and may be used where volatile based anaesthesia is contraindicated. Infusions need to be titrated to effect and processed EEG should be used to monitor depth of anaesthesia. Further research is required to advise on specific recommendations in the obstetric population, but general TIVA safety principles apply.

Postoperative analgesia should be multi-modal using intravenous patient-controlled analgesia in conjunction with regular oral paracetamol and non-steroidal anti-inflammatory drugs (assuming no contraindication). The use of local anaesthetics, including transversus abdominis plane (TAP) block, can be helpful.

Risks associated with general anaesthesia

Aspiration of gastric contents

Pregnancy is a risk factor for pulmonary aspiration. While gastric emptying remains unchanged during pregnancy, active labour can cause delay, which may be compounded by parenteral opiate administration. NICE recommends labouring women are restricted to light diet and clear fluids during labour. For elective procedures, clear carbohydrate energy-rich drinks or fluids are acceptable until 2 hours before surgery.[3]

A high risk of pulmonary aspiration is reported in the presence of a high gastric volume and low pH (<2.5). Antacids (as single agent prophylaxis) are superior to H_2-receptor-antagonists which, in turn, are superior to proton-pump inhibitors for raising gastric pH but the effect on gastric volume is less consistent. Labouring women at risk of requiring operative intervention should receive ranitidine 150 mg 6-hourly. Non-particulate antacids such as 0.3 M sodium citrate should be given just prior to induction.

Risk of aspiration is also present at extubation; residual neuromuscular blockade must be reversed and emergence from anaesthesia should occur in the left lateral head-down position or semi-recumbent. The use of a wide-bore oro/nasogastric tube to empty the stomach may be indicated prior to extubation.

Awareness

Obstetric general anaesthesia cases account for 0.8% of general anaesthetics but approximately 10% of the reported cases of accidental awareness making it almost ten-fold over-represented amongst surgical specialties. The NAP5 estimated incidence of

awareness under GA for caesarean section is 1:670, significantly greater than the estimated 1 in 19,000 for general anaesthesia as a whole.[8]

Risk factors for awareness include:

- rapid sequence induction
- use of thiopentone
- use of muscle relaxants
- omission of opioids
- difficult airway management
- obesity
- emergency surgery
- out of hours surgery
- short interval between induction and skin incision.

GA in obstetrics involves most of the above risk factors with an increased cardiac output promoting redistribution of induction agents and slower establishment of an adequate partial pressure of volatile agent. Adequate induction and maintenance doses should be used, and if needed, vasopressors to treat hypotension either as bolus doses or infusion. The over pressure technique of volatile administration (using high initial vaporizer setting to rapidly raise alveolar concentration) after induction should be employed with high fresh gas flows. Co-administration with nitrous oxide increases the alveolar partial pressure of volatile agent through the second gas effect. Concerns regarding placental transfer and the tocolytic effects of volatile agents may limit the dose administered, but the complications of fetal exposure to anaesthetics are reversible and the uterus maintains responsiveness to oxytocin up to 1–1.5 MAC.[7] NICE recommends use of depth of anaesthesia monitoring.

Failed intubation

The incidence of failed intubation in obstetrics is around 1 in 250 general anaesthetics or 1 in 25,000 deliveries. Weight gain and airway oedema in pregnancy make airway management more challenging, which may be exacerbated by pre-eclampsia. The incidence of Mallampati class 4 airways increases by 34% between 12 and 38 weeks' gestation and continues to increase during labour.[9] At full term the gravid uterus reduces FRC by 20% and a further 25% in the supine position. This, together with a 40% increase in oxygen consumption, makes pregnant women more susceptible to rapid hypoxia. Failed intubation is covered in more detail in a separate article in this month's edition.

Maternal and fetal morbidity

GA for caesarean section is associated with higher blood loss than regional anaesthesia, but the tocolytic effects of volatile agents are reversible with uterotonic measures. There also appears to be increased risk of surgical site infection, venous thromboembolism and anaesthesia-related complications but not of major maternal morbidity or mortality.[10] There is emerging evidence to suggest poorer neonatal acid-base status and Apgar scores with general anaesthesia but the long term clinical significance of this is uncertain.

Despite extensive animal and human research, no anaesthetic drug has been clearly shown to be teratogenic or increase the risk of stillbirth. There is a small increase in the risk of miscarriage or preterm delivery following surgery under GA, but the cause is likely to be multifactorial. Nitrous oxide affects DNA synthesis but there is still no convincing evidence that it is associated with teratogenicity in humans.[1]

General anaesthesia and maternal comorbidity

Obesity

The prevalence of obesity is increasing with one in five parturients being obese. Morbidly obese women (BMI >40 kg/m^2 at booking) have an increased morbidity relating to GA and increased risk of conversion to GA during caesarean section. Obese parturients often receive prophylactic low-molecular weight heparin antenatally as VTE prophylaxis. In the event of emergency surgery, RA is contraindicated within 12 hours of prophylactic dosing and within 24 hours of treatment dosing of LMWH hence GA becomes mandatory. Careful positioning and thorough pre-oxygenation is especially important. Drug dosing should be calculated to lean or adjusted body weight, excepting suxamethonium, which is dosed to total body weight.

Pre-eclampsia

Pre-eclampsia increases the risk of intracerebral haemorrhage under GA and the pressor response to laryngoscopy must be attenuated. Alfentanil (10 μg/kg), remifentanil (1 μg/kg), magnesium sulphate (2 g), lidocaine, labetalol and esmolol are all suitable agents according to the anaesthetist's preference. A hypertensive response to extubation must also be anticipated and can best be modified with β-blockers. Magnesium administration prolongs the effects of non-depolarizing muscle relaxants, monitoring of neuromuscular block is essential.

The future

It is recognized that exposure to GA in obstetrics is diminishing. Simulation-based training has been shown to improve anaesthetists' real-life performance and should be encouraged, especially the rehearsal of failed intubation drills. Anaesthetic technique must be appropriate to the individual patient's clinical situation and the experience of the anaesthetist. There is increasing evidence to support safety and efficacy of alternative techniques in obstetric anaesthetic practice other than a traditional RSI. ◆

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