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Supraglottic airway devices for Caesarean delivery under general anaesthesia: for all, for none, or for some?

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The gold standard for airway management in obstetric general anaesthesia remains rapid sequence induction and tracheal intubation because of the perceived risk of regurgitation and aspiration in pregnant women. However, there has been a change in attitude to airway management and a gradual acceptance of the use of supraglottic airway (SGA) devices in obstetric anaesthesia. A survey in the UK in 1995 showed that 72% of anaesthetists would only use the Teleflex Laryngeal Mask Airway® (Teleflex Medical Ltd, Athlone, Ireland) to maintain oxygenation when tracheal intubation and face-mask ventilation had failed, and 11% did not think this SGA had a place in obstetric anaesthesia.[1] Recent evidence has shown that, since the late 1990s, there has been a gradual increase in the use of SGA devices to continue anaesthesia when failed tracheal intubation has been declared.[2] Furthermore, second-generation SGA devices that have better, although not complete, protection against aspiration are now recommended as rescue airway devices after failed tracheal intubation, particularly in patients at increased risk of aspiration.[3] Since 2001, there is emerging evidence for use of an SGA device as the primary airway device during general anaesthesia for Caesarean delivery.[1,4–16]

Accurate assessment of gastric contents and quantifying the risk of aspiration in pregnant women are important when planning airway management. Currently, there is no routine or objective method of assessment. The recently introduced qualitative and quantitative assessment of gastric contents using ultrasound in non-pregnant subjects has the potential to address this in pregnant women, and may help inform our choice of airway technique during general anaesthesia for Caesarean delivery. This editorial examines the evidence and consider whether SGA devices should replace tracheal tubes for elective Caesarean delivery under general anaesthesia in selected patients.

Supraglottic airway devices in pregnancy

Maternal morbidity and mortality from failed intubation and aspiration remain the most feared complications of general anaesthesia in the parturient. However, maternal mortality from pulmonary aspiration has declined to negligible levels.[17–22] This decline has been attributed to greater use of neuraxial anaesthesia, acid prophylaxis, stricter adherence to fasting guidelines, airway control with rapid sequence induction and tracheal intubation, development and adherence to

Table 1 Studies of women undergoing general anaesthesia for Caesarean delivery using supraglottic airway devices. El, elective; Em, emergency; *n*, number studied; TT, tracheal tube.

Author (year)	Device	n	RCT	El/Em	Fasting (h)	Average weight (kg)	Induction agent	Neuromuscular blocking agents
Han and colleagues[16] (2001)	LMA	1067	No	El	6	67	Thiopental	Suxamethonium chloride; vecuronium
Halaseh and colleagues[15] (2010)	ProSeal™	3000	No	El	8	—	Propofol	Rocuronium
Yao and colleagues[9] (2012)	Supreme™	700	No	Mixed	4	65	Propofol	Rocuronium
Ahmed and Hasan[6] (2015)	I-gel™ *vs* TT	40	Yes	El	6	77	Thiopental	Rocuronium
Saini and colleagues[13] (2016)	ProSeal *vs* TT	30	Yes	El	6	51	Thiopental	Suxamethonium chloride; vecuronium
Amin and Fathy[4] (2016)	I-gel	1000	No	El	8	82	Propofol	Rocuronium
Li and colleagues[8] (2017)	Supreme	584	No	Em	4	—	Propofol	Suxamethonium chloride; rocuronium
Geng and Wang[14] (2017)	Supreme *vs* TT	56	No	Mixed	0	75	Propofol	Suxamethonium chloride
Panneer and colleagues[5] (2017)	I-gel *vs* TT	40	Yes	El	6	50	Propofol	Suxamethonium chloride; vecuronium
Fang and colleagues[7] (2018)	Supreme	1039	No	Em	0	67	Propofol	Cisatracurium
Yao and colleagues[10] (2019)	Supreme *vs* TT	460	Yes	El	6	65.6	Propofol	Suxamethonium chloride; rocuronium

difficult airway guidelines, and better training.[18,20,21] A study by Olsson and colleagues[23] in 1986 reported an incidence of pulmonary aspiration of 1:661 in women undergoing Caesarean delivery, whereas more recent studies show a lower incidence of between 1:1095 and 1:4500.[20–22] Having achieved such a high safety profile of obstetric general anaesthetic, it is with some concern that a more liberal approach to fasting and reduced antacid use are being advocated at the same time that alternative airway management strategies are being introduced. Recent National Institute for Health and Care Excellence guidelines on the intrapartum care of pregnant women recommend allowing women in 'low'-risk labour to drink and have a light diet, and those with 'high'-risk labour to drink only.[24] In contrast, the American Practice Guidelines for Obstetric Anesthesia are more restrictive in oral intake during labour, especially when solid food is concerned, and recommend considering the administration of non-particulate antacid prophylaxis, histamine receptor (H_2) antagonists, or prokinetics.[25]

Compared with tracheal tube insertion, SGA device placement requires less expertise and time for insertion, and is associated with fewer complications, especially at extubation and in the postoperative period,[26] which account for their popularity in elective and emergency non-obstetric general anaesthesia. Until recently, their SGA use in obstetrics has been limited to airway rescue after failed intubation. However, use of an SGA as the primary airway device in selected patients having Caesarean delivery under general anaesthesia has been shown in several prospective, retrospective, and randomised studies (Table 1) in more than 8000 patients.[1,4–16] The biggest single study to date included 3000 patients who underwent Caesarean delivery with the LMA® ProSeal™ (Teleflex Medical Ltd), and there was one case of regurgitation, and no aspiration.[15]

Currently, the LMA® Supreme™ (Teleflex Medical Ltd) is the most extensively studied device and has been investigated in five studies (two randomised) in a total of 2839 patients.[7–10,14] The LMA Supreme was compared with tracheal intubation in 920 elective Caesarean deliveries[10] with no difference between groups. The same device was used as the airway of choice in 584 parturients undergoing Category 2 or 3 Caesarean delivery.[8] There were no reported cases of aspiration in any of those studies. Four of the studies investigating the LMA Supreme were conducted in the same hospital by the same team, and hence, the ease in reproducing similar clinical conditions.[7–10]

The I-gel™ (Intersurgical Ltd, Wokingham, UK), introduced in 2007, has the advantages of easier insertion and creation of greater seal pressure without the need of cuff inflation when compared with other SGA devices.[27] It provides a more stable haemodynamic profile at insertion with lower mean arterial pressure and heart rate than tracheal intubation in patients undergoing elective Caesarean delivery.[5] Its use in elective Caesarean deliveries has been shown to provide comparable control of the airway (in 9 *vs* 10 s),[6] but was associated with fewer airway complications, such as bronchospasm, sore throat, regurgitation, and dysphagia.[5,6]

Most of the aforementioned studies included fasted non-obese patients and excluded patients with gastro-oesophageal reflux or anticipated difficult airway. Such stringent patient selection criteria were not universal amongst the 11 studies (Table 1). In one retrospective study, all 1039 women undergoing emergency Caesarean delivery under general anaesthesia with the LMA Supreme were unfasted and

included high-risk groups, such as those with ASA physical status 3 or 4, preeclampsia, and obesity (181 women had BMI >30 kg m^{-2}).[7] The majority of studies used one or more antacid prophylaxis medications, such as oral or i.v. ranitidine and metoclopramide, or sodium citrate.[4–6,9,13,15,16] The choice of anaesthetic drugs was variable, but neuromuscular blockers were often used to ensure paralysis for insertion of the SGA device and for surgery. The benefits of avoiding muscle paralysis have not been studied in pregnant patients. Cricoid force was used in seven studies.[6,8–10,14–16] It was released after the SGA device was in place in all but one study, in which it was briefly released during the insertion.[15] An orogastric tube was inserted in the majority of studies using second-generation SGA devices.[4,5,8–10,15,16] The success rate of laryngeal mask airway insertion was 99%, whereas all studies that used second-generation SGA devices had a 100% success rate. There was one case of regurgitation at the point of applying fundal pressure to deliver the baby,[15] which meant that, out of the 8000 women studied so far, there was one case of regurgitation and no cases of aspiration. As a result of the one case of regurgitation, reduction of fundal pressure at delivery was recommended in seven studies.[4,5,5,8–10,16] Complications, such as sore throat and blood on the cuff of the SGA device, were few. However, in the studies that were randomised, there was a higher incidence of problems in the tracheal tube group, such as failed intubation[13] and laryngospasm at extubation.[6]

Aspiration risk in pregnancy and assessment of gastric contents

The landmark paper by Mendelson[28] in 1946 described 66 cases of aspiration of gastric contents in pregnant patients who received anaesthesia with 'gas, oxygen, and ether' delivered by face mask. He concluded that gastric retention of food and liquid was prolonged in labour and that pulmonary aspiration could occur when laryngeal reflexes were abolished during general anaesthesia. In the 1958–63 Confidential Enquiry into Maternal Deaths, there were 33 maternal deaths attributable to aspiration. After the enquiries, tracheal intubation was recommended to protect the lungs from aspiration in pregnant women undergoing general anaesthesia.[29] The anaesthetic technique of i.v. induction, muscle blockade, and rapid tracheal intubation for Caesarean delivery was described by Hodges and colleagues[30] in 1959. In 1970, the classic rapid sequence induction and tracheal intubation technique with the use of cricoid force was described as the standard of care for obstetric airway management by Stept and Safar.[31]

In the biggest audit of complications of airway management in the UK, the National Audit Project 4 (NAP4) published in 2011, aspiration was the commonest cause of death accounting for 50% of anaesthesia-related deaths in the general population.[32] There was one case of aspiration in an obstetric patient that occurred as a complication of failed intubation. A key recommendation from NAP4 was that the risk of aspiration should be assessed, and where higher than baseline risk was identified, consideration should be given to minimising volume and raising pH of gastric contents and performing rapid sequence induction and tracheal intubation to protect the lungs. In an editorial, Asai[33] discussed ways to assess the risk of aspiration, patient factors, anaesthetic factors, surgical factors, and device factors.

The increased risk of pulmonary aspiration in pregnancy is primarily because of hormonal and mechanical factors that reduce lower oesophageal barrier pressure. However, there is still the question of whether the pregnant woman should be considered to have a full stomach at all times, including when fasted, and hence require routine rapid sequence induction and tracheal intubation to protect against regurgitation and aspiration.[34] Alternatively, could accurate assessment of gastric content allow consideration of the use of an SGA device as the primary airway device if the volume of gastric content is below a threshold, above which there is a risk of aspiration, and could this be applied to emergency or elective general anaesthetics?[35]

Point-of-care ultrasound examination of gastric contents is now a well-described method to directly assess quantitative (antral cross-sectional area) and qualitative (Perlas score) gastric contents in non-pregnant adults,[36] but the results of studies using ultrasound to assess gastric emptying after oral intake are inconsistent.[37–41] A recent paper found that 38% of term pregnant women had gastric fluid above the arbitrary risk threshold of 1.5 ml kg^{-1} after 6 h of fasting.[37] Another study found that 95% of term fasting women (solid food 6 h and clear fluid 2 h) had gastric contents $\leq$1.5 ml kg^{-1}.[38] The wide variations in results could be attributed to many factors: varying patient characteristics, positioning, differing ultrasound techniques or skills, and different meal compositions. Nevertheless, these results support the use of ultrasound to assess the gastric emptying for individual patients, rather than relying on arbitrary starvation intervals.

Gastric ultrasound in pregnancy is more technically challenging because of the upward displacement of the stomach and its rotation by the gravid uterus, movement of the fetus, and increased ventilatory frequency. In addition, the relationship of antral cross-sectional area to volume of stomach contents determined for non-pregnant subjects may not apply to term pregnant women.[39] The position of the woman during measurement is critical to obtain accurate readings. These factors are likely to make accurate ultrasound assessment of gastric volume challenging, especially in the labouring parturient or before emergency Caesarean delivery. In addition, most studies on ultrasound assessment of gastric contents exclude parturients who are obese, have oesophageal reflux, or have higher American Society of Anesthesiologists (ASA) physical status classifications. We believe that accurate assessment of gastric contents in pregnant women is not at a stage where it can be used reliably to decide whether the stomach is empty enough to consider the use of an SGA device is a safe option in either emergency or elective situations.

The future...

Currently, there is insufficient evidence to recommend universal or selective replacement of tracheal tubes with SGA devices during general anaesthesia for Caesarean delivery. Aspiration remains the main concern. However, with the current extremely low incidence of aspiration, a study in which pulmonary aspiration is the primary outcome would not be feasible. The quality of data currently available on the use of SGA devices for Caesarean delivery is low (randomised studies that are few and not powered enough to detect risk of aspiration, retrospective data collection, and dominance of studies from a single unit). The studies mentioned previously

were carried out in countries, such as Korea, Jordan, Egypt, China, and India, where body habitus and diet differ from Europe and North America. Matters, such as patient selection criteria (e.g. fasting status, BMI, and co-morbidities), type of SGA device, and anaesthetic technique (induction agents, neuromuscular blocking agents, cricoid pressure, and orogastric tube) have yet to be addressed fully.

Ultrasound assessment of gastric contents in pregnant women is evolving. With greater attention to patient position, mathematical models for antral cross-sectional area for pregnant women, and expertise in gastric ultrasonography, clinicians may be able to assess stomach contents and might aid decision-making particularly in the event of failed tracheal intubation.[42–44] The use of gastric ultrasound to obtain reliable information to aid in risk stratification and choice of airway device for obstetric anaesthesia requires further research.

Whatever airway strategy modifications take place, it is important to remember that changing our practice of airway management in pregnant women should not go against decades of improving maternal safety. With further progress and more widely available expertise in gastric ultrasonography, we might be able to identify women at low risk of aspiration (non-solid contents and low volume), and depending on body habitus and co-morbidities, these women might be candidates for airway management with an SGA device.

Authors' contributions

Study conception/design: both authors
Drafting of article: both authors
Critical revision of article: both authors
Final approval of article: both authors.

Declaration of Interest

The authors declare that they have no conflicts of interest.

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