EJA

Eur J Anaesthesiol 2024; **41:**668–676

ORIGINAL ARTICLE

The role of supraglottic airway devices for caesarean section under general anaesthesia. A scoping literature review with a proposed algorithm for the appropriate use of supraglottic airway devices for caesarean sections

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This review aims to assess the published evidence on airway management with a supraglottic airway device (SGA) for general anaesthesia in patients requiring a caesarean section. Physiological changes during pregnancy can make airway management in parturients challenging. At the same time, pregnant patients are at risk of pulmonary aspiration due to hormonal and mechanical alterations. The standard airway management for parturients undergoing caesarean section is rapid sequence induction followed by tracheal intubation. Evidence exists that using second-generation SGA devices is well tolerated and effective in selected patients. In this review, we provide an overview of the existing evidence and provide an algorithm to make an evidence-based clinical decision on the use of SGA devices. An online literature search was performed in Medline, Embase, PubMed, Emcare, Cochrane Library and CINAHL. The search terms used were 'supraglottic airway', 'supraglottic airway device', 'supraglottic airway management', 'supraglottic tube', 'i-gel', laryngeal mask', 'laryngeal mask airway', 'LMA', 'SGA', 'Proseal', 'Supreme', 'obstetric surgery', 'obstetric operation', 'general anaesthesia', 'caesarean' or 'caesarean section', 'abdominal delivery'. Full-text articles in English, Dutch and French were included. Case reports and studies in which the surgery was not a caesarean section were excluded. The initial search yielded 815 results. Following screening, deduplication and removal of publications that were unrelated to the topic or did not fit the inclusion criteria, 13 manuscripts were included in our analysis. A total of 7722 patients were described in the articles included. In the majority of manuscripts, second-generation SGA devices were used. There were seven cases of failed insertion and a need for conversion to tracheal intubation; first-generation SGA devices were used in these cases. There were no cases of pulmonary aspiration, and only one case of gastric regurgitation was described. Growing evidence suggests that the use of second-generation SGA devices might be well tolerated as the primary method for securing the airway for caesarean sections requiring general anaesthesia, in selected patients with a low risk for aspiration and difficult intubation.

Published online 19 June 2024

KEY POINTS

- In selected low-risk patients, second-generation supraglottic airway devices seem to be well tolerated.
- Growing evidence suggests that a second-generation supraglottic airway device can be used in selected patients as the primary method for securing the airway for caesarean sections requiring general anaesthesia.

Introduction

Several changes occur during pregnancy that can make airway management in the parturient challenging. Physiological changes such as decreased functional residual capacity and increased oxygen requirements can lead to limited tolerance of apnoea.[1] Pregnant patients have an increased risk of pulmonary aspiration of gastric contents due to the hormonal and mechanical effects of pregnancy.[2] Laryngoscopy may be difficult, as there can be limited space to position the handle of the laryngoscope due to the upward movement of a woman's breasts when she is supine. It has been demonstrated that the

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DOI:10.1097/EJA.0000000000002024

Mallampati score increases during labour and delivery due to oedema and increased vascularisation of the larynx.[3,4]

Alongside these physiological changes are organisational factors that can make airway management in the parturient challenging. General anaesthesia is most frequently used in the emergency setting, with associated concerns about minimising the decision to delivery interval.[5] In some countries, obstetric emergencies, particularly overnight, are carried out by anaesthetists in training. Trainees may start obstetric on-calls with minimal general anaesthesia experience in the obstetric patient.[5,6] Many obstetric units are remote from the main hospital theatre suites, which can increase the time to obtain assistance when required.

One of the most feared complications of obstetric general anaesthesia is pulmonary aspiration of gastric contents. Tracheal intubation is still perceived as the gold standard of airway management in obstetric general anaesthesia to minimise the risk of pulmonary aspiration. However, greater use of neuraxial anaesthesia, acid prophylaxis, fasting guidelines, developing and using difficult airway guidelines, and better training have contributed to a decline in maternal deaths from pulmonary aspiration.[7–10]

There is growing interest in using supraglottic airway (SGA) devices for airway management during general anaesthesia for caesarean section. Second-generation SGA devices are recommended over first-generation SGA devices.[5] They have properties that potentially afford better airway protection against pulmonary aspiration.[11–14] However, this has never been proven *in vivo*. These second-generation devices functionally separate the respiratory and gastric tracts. Many also have a port through which an orogastric tube can be passed to aspirate stomach contents. The second-generation SGAs offer higher oesophageal leak pressures allowing for appropriate positive pressure ventilation.[11–14] They are now recommended as rescue airway devices after failed tracheal intubation in international guidelines.[5]

This review aims to assess the published evidence on airway management with an SGA for caesarean section under general anaesthesia, and to provide clinical guidance on how to use these devices safely and effectively for an elective caesarean delivery. The previously published systematic review by White *et al.* looked for an answer to two primary questions; whether, compared to an endotracheal tube, the first-pass success rate was higher for an SGA, and its time to insertion was shorter for elective caesarean delivery (CD). Safety was a secondary outcome. We additionally focused on the limitations of the literature and the potential research gaps.

Materials and methods

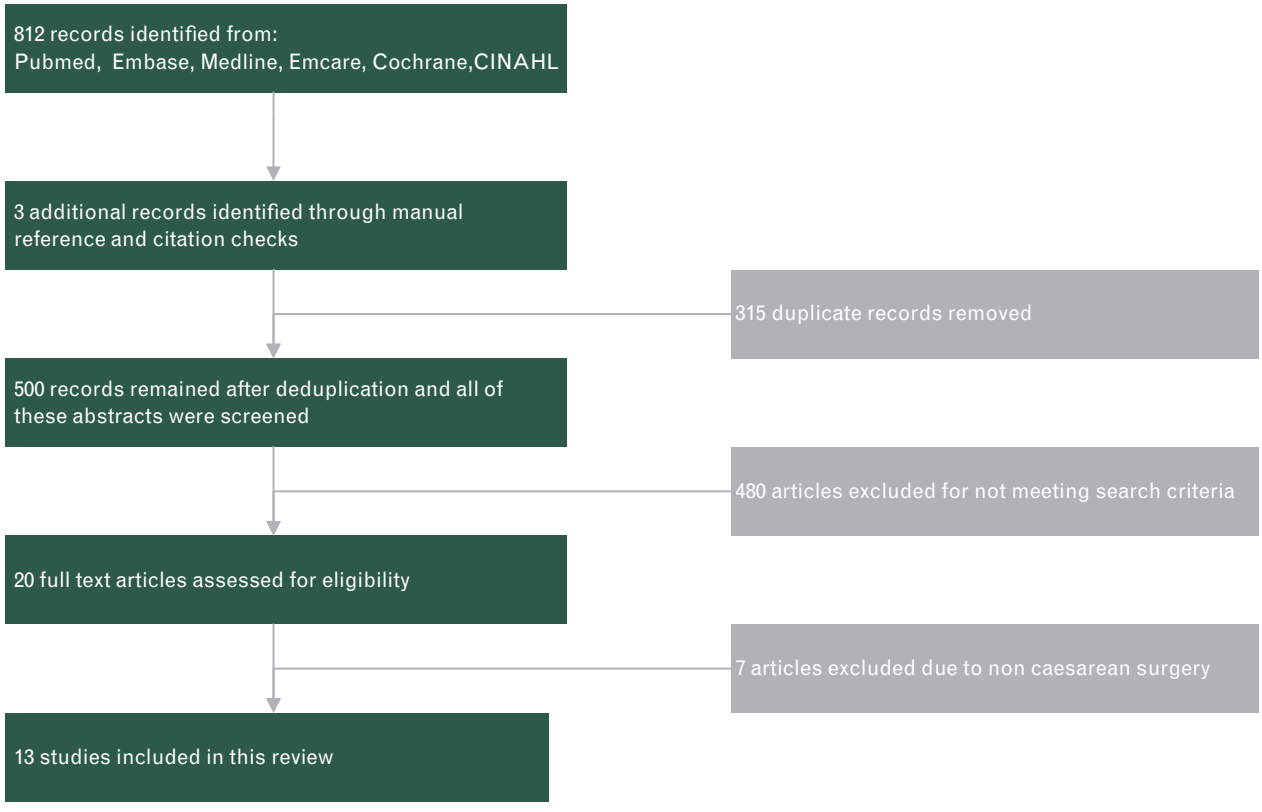
Our scoping review was registered at Open Science Framework. We performed an electronic literature search in Medline, Embase, PubMed, Emcare, Cochrane Library and CINAHL for all material published up to August 2022 (Fig. 1). The search terms used were 'supraglottic airway', 'supraglottic airway device', 'supraglottic airway management', 'supraglottic tube', 'i-gel, laryngeal mask', 'laryngeal mask airway', 'LMA', 'SGA', 'Proseal', 'Supreme', 'obstetric surgery', 'obstetric operation', 'general anaesthesia', 'caesarean' or 'caesarean section', 'abdominal delivery'. There were no language restrictions when assessing abstracts, but only full text articles that were available in English, Dutch or French were included. The search was independently performed by two researchers. The resulting list was deduplicated and the abstracts of the remaining publications were screened for relevant articles. Subsequently the full text articles were read to assess eligibility. We included randomised control trials, meta-analyses, observational and cohort studies. We excluded case reports and studies in which the surgical procedure was not a caesarean section. The references of the selected articles were also reviewed to find additional relevant articles. The algorithm was formed after authors' consensus following the literature review.

Results

After a manual search of the abstracts, 13 articles were included in the literature review. These were four randomised control trials, four observational and four cohort studies and one meta-analysis and systematic review (Table 1).[15–27] Eleven studies were conducted in Asia and one in Egypt. The meta-analysis of White *et al.*[25] was performed by an Australian team. The articles included were all Asian except for that by Ahmed and Hasan.[15] Nine studies only included parturients with American Society of Anaesthesiologists physical status (ASA) score of 2.[15,18–20,22–24,26,27] One included parturients with ASA score 2 and 3[21] and two others included ASA scores 2 to 4.[16,17] Parturients with high BMI or gastro-oesophageal reflux disease (GERD) were excluded in nine studies. High BMI was defined as BMI more than 30, 35 or 40 $kg\,m^{-2}$.[15,18–21,23,24,26,27] Known or predicted difficult airway was an exclusion criterion in 10 articles.[15,18–24,26,27] Definition of difficult airway was often not well described.

Only elective caesarean sections were included in six articles, emergency in three, and both, elective and emergency, in four articles. Pre-operatively, where fasting data were documented, patients were fasted for a minimum of 4 to 6 h for elective and 4 h for emergency sections.[15,18–21,23,24,26,27] Patients also received one or more antacid prophylaxis drug(s). Only the retrospective studies did not mention aspiration prophylaxis administration.[16,17] The common features in most articles were that most used a rapid sequence induction (RSI) technique to provide suitable conditions for inserting SGA devices. Four of these studies only used slow acting neuromuscular blocking drugs (e.g. cisatracurium) or

Fig. 1 Flowchart.



moderate dose ($<1\,mg\,kg^{-1}$) rocuronium at induction.[15,16,18,26] Cricoid pressure was applied in eight studies.[15,17–20,24,26,27] The others did not mention this explicitly. Induction was followed by insertion of an orogastric tube through the port of the second-generation device in nine studies.[15,16,18,20,21,24,26,27] One study placed a nasogastric tube in the i-gel group.[22] Two studies did not place a gastric tube.[19,23] Seven studies with placement of a gastric tube attempted to aspirate the gastric contents.[16,18,20,21,24,26,27] Halaseh *et al.*[18] used a self-developed technique to place the oropharyngeal tube and SGA. These investigators fed a size 14 gastric tube through the oesophageal port of a Proseal SGA until 10 cm protruded. Then, after induction, they used a laryngoscope to observe placement of the orogastric tube with a Magill forceps in the oesophagus. Then, the SGA was advanced over the orogastric tube after which the laryngoscope was removed.[18] The group of Han *et al.*[19] who used a classic SGA, and the group of Saini *et al.*,[23] did not place a gastric tube.

Different SGAs were used in the different articles. Limited studies exist on the use of the classic, first-generation SGA device in the obstetric population. Han *et al.*[19] used a first-generation SGA in 1067 parturients undergoing elective caesarean section in a prospective observational study. The Supreme SGA (SLMA) was used in eight studies, the i-gel in three and the ProSeal SGA (PLMA) in three.

Five studies compared the second-generation SGA with tracheal intubation for caesarean section during general anaesthesia.[15,17,22,23,27] One cohort study compared the use of a SGA in category 2 versus category 3 caesarean sections.[20] Lim *et al.*[21] investigated whether being in labour had an effect on the success rate of SGA insertion.

Outcome parameters concerning airway management included first-attempt insertion rate, number of insertion attempts, difficulty of insertion, insertion time, reinsertion, conversion to ETT and time to effective ventilation. Haemodynamic and ventilation parameters, such as peak airway pressures, air leakage and seal pressures, were recorded. Secondary outcomes related to adverse events were hypoxia, pulmonary aspiration, SGA inner bowl surface pH, volume and pH of gastric aspirate, airway spasm, airway trauma, blood on SGA surface, coughing, voice hoarseness, sore throat or dysphagia, maternal mortality, maternal satisfaction, ICU admission, Apgar scores and umbilical cord pH. Pulmonary aspiration was defined as diagnosis on imaging, as presence of bile-stained fluid

Table 1 List of studies included

Ref.	Country	Study design	Number in trial	SGA device	Exclusion of						Aspiration prophylaxis	GT	Cricoid pressure	NMB at induction	Adverse events
					ASA	DA	GERD	Obesity	EI/Em	Fasted					
Ahmed *et al.*[15]	Egypt	RCT	80	i-gel	2	Yes	Yes	Yes	EI	> 6 h	Yes	OGT	Yes	Rocuronium 0.8 mg kg^{-1}	Airway spasm ($n = 4$) Sore throat ($n = 1$)
Fang *et al.*[16]	China	Retrospective observational	1039	Supreme	2 to 4	NS	NS	NS	Em	NS	NS	OGT	NS	Cisatracurium 0.3 to 0.6 mg kg^{-1}	Neonatal intubation ($n = 37$) Neonatal mortality ($n = 19$) Maternal desaturation ($n = 1$)
Geng *et al.*[17]	China	Retrospective cohort	192	Supreme	≥ 2	No	No	No	Both	NS	NS	OGT	Yes	Succinylcholine dose NS	Maternal ICU admission ($n = 25$) PICU admission ($n = 80$) Difficult ETT intubation ($n = 1$)
Halaseh *et al.*[18]	Jordan	Prospective observational	3000	ProSeal	2	Yes	Yes	Yes	EI	≥ 8 h	Yes	OGT	Yes	Rocuonium 0.9 mg kg^{-1}	Regurgitation ($n = 1$) Sore throat or dysphagia ($n = 21$) Voice hoarseness ($n = 1$)
Han *et al.*[19]	Korea	Prospective observational	1067	Classic	2	Yes	Yes	yes	EI	≥ 6 h	Yes	No	Yes	Succinylcholine 1.5 mg kg^{-1}	Conversion to ETT ($n = 7$)
Li *et al.*[20]	China	Prospective cohort	584	Supreme	2	Yes	Yes	yes	Em	≥ 4 h	Yes	OGT	NS	Succinylcholine dose NS	Sore throat ($n = 38$) Hoarseness ($n = 4$)
Lim *et al.*[21]	China	Prospective cohort	584	Supreme	2 – 3	Yes	Yes	Yes	Em	≥ 4 h	Yes	OGT	Yes	Succinylcholine 100 mg	Sore throat ($n = 38$) Hoarseness ($n = 4$)
Panneer *et al.*[22]	India	RCT	80	i-gel	2	Yes	No	No	EI	NS	Yes	NGT	NS	Succinylcholine 1.5 mg kg^{-1}	Sore throat ($n = 34$)
Saini *et al.* ([23]	India	RCT	60	ProSeal	2	Yes	Yes	yes	Both	≥ 6 h	Yes	No	NS	Succinylcholine 1.5 mg kg^{-1}	Sore throat ($n = 24$) Difficult ETT intubation ($n = 2$)
Tan *et al.*[24]	China	Prospective cohort	584	Supreme	2	Yes	Yes	Yes	EI	≥ 4 h	Yes	OGT	Yes	Succinylcholine dose NS	Sore throat ($n = 38$) Hoarseness ($n = 4$)
White *et al.*[25]	Australia	Systematic review and meta-analysis	2236	Classic i-gel Supreme ProSeal Tuoren Gardian	2 to 4	N/A	N/A	N/A	Both	Mixed	N/A	N/A	N/A	N/A	Absolute numbers not mentioned
Yao *et al.*[26]	China	Prospective observational	700	Supreme	2	Yes	Yes	yes	Both	> 4 h	Yes	OGT	Yes	Rocuronium 0.5 mg kg^{-1}	Sore throat ($n = 24$)
Yao *et al.*[27]	China	RCT	920	Supreme	2	Yes	Yes	yes	EI	≥ 6 h	Yes	OGT	Yes	Succinylcholine 100 mg	Sore throat ($n = 24$)

ASA, American Society of Anesthesiologists score; DA, difficult airway; EI, elective; Em, emergency; ETT, endotracheal tube; GERD, gastro-oesophageal reflux disease; GT, gastric tube; *n*, number; N/A, not applicable; NGT, nasogastric tube; NMB, neuromuscular blocker; NS, not specified; OGT, orogastric tube; PICU, paediatric intensive care unit; RCT, randomised controlled trial; SGA, supraglottic airway.

during bronchoscopy, as a pH less than 4 on the inner bowl of the SGA or as presence of suggestive clinical signs and symptoms.[16–23,26,27]

The observational study of Han *et al.*[19] showed a successful first-generation SGA insertion in 1060 (99%) of 1067 participants. Tracheal intubation was necessary for seven (0.7%) after two failed attempts to insert the SGA.[19] The use of the PLMA for general anaesthesia caesarean sections also had a successful first attempt insertion rate of 99.7% in a prospective, observational study of 3000 women[18]: eight parturients required reinsertion with a different-sized airway to prevent leakage greater than 100 ml tidal volume. Saini *et al.*[23] compared PLMA and tracheal tube intubation (ETT) in ASA 2 pregnant women, with a BMI less than 30 kg m^{-2} and no significant comorbidities. They found no statistical difference in time of insertion (less than 30 s in both groups) or difficulty in insertion between PLMA and ETT group (one difficult PLMA insertion and two difficult tracheal intubations).[23] An observational study by Yao *et al.*[26] in 2012 showed promising results regarding using the SLMA in elective and emergency caesarean section under general anaesthesia. The 700 participants all had successful insertion of the SLMA.[26] The investigators set up a randomised controlled trial (RCT) in 2019 to further assess the effectiveness and safety of the SLMA compared with tracheal intubation in elective caesarean section in 920 parturients.[27] No statistical differences were found in first-attempt insertion success rate.[27] However, in the SLMA group, the time to effective ventilation was significantly reduced by 22 s, and there were less haemodynamic changes during the induction of anaesthesia.[26,27] In a retrospective study, Fang *et al.*[16] investigated the routine use of the SLMA as the primary mode of securing the airway for emergency caesarean section. Of the 1039 parturients, two (0.19%) needed a second insertion attempt of the SGA. In a subgroup of 181 (17.4%) obese parturients, the SLMA was successfully inserted at the first attempt in all patients.[16] Geng and Wang[17] also showed good results in their retrospective cohort evaluating airway management during general anaesthesia for caesarean section (CS). They evaluated 56 cases using a SGA device with good results and no case of aspiration. In addition, there were 124 cases of tracheal intubation for airway management: one of these cases was a difficult intubation and the situation was rescued with the successful insertion of a SLMA.[17] Panneer *et al.*[22] randomised 80 ASA 2 pregnant patients undergoing elective caesarean section to receive airway management with an i-gel or tracheal intubation. The ease of insertion, insertion times and adequacy of ventilation were comparable between the groups. The i-gel was inserted easily in all parturients in its group. In contrast, tracheal intubation was difficult in eight of 40 (17.5%, $P < 0.01$) patients in the intubation group.[22] Of note, Tan *et al.*[24] showed that in nonlabouring patients, the Mallampati scores did not influence SLMA insertion success rates and time to effective ventilation in category 2 and 3 caesarean section. But Lim *et al.*[21] found that the chance of failure to insert the SLMA at the first attempt is significantly raised in labouring parturients. This latter observation would be supported by the fact that the Mallampati score increases during the process of labour. Out of 221 labouring parturients, nine had a failed first-attempt insertion, compared with one out of 363 nonlabouring parturients ($P = 0.0098$).[21]

Possible side effects were investigated. Adverse airway events, other than tracheal intubation related, were uncommon. Only one case of maternal desaturation, defined as an oxygen saturation less than 93% for 1 min, was noted in one emergency caesarean section for which a SLMA was used.[16] Four intubated parturients experienced laryngeal spasms on removal of the tracheal tube.[15] There was only one case of gastric regurgitation which occurred during the application of fundal pressure when the baby was delivered, but this did not result in clinical difficulties nor was pulmonary aspiration noted on follow-up radiological imaging.[18] Other studies did not detect any cases of gastric regurgitation or pulmonary aspiration.[15–17,19–24,26,27]

There was a significantly higher incidence of postoperative sore throat in the intubated patients compared with women whose airways were managed with an i-gel or PLMA.[22,23] In 0.7% of patients on the observational study of Halaseh *et al.*,[18] the use of the PLMA was associated with a sore throat and dysphonia in one patient where the cuff had been inflated to the maximum cuff volume, but this resolved within 24 h. However, Yao *et al.*[27] could not find significant differences in sore throat between the SGA or ETT group in their RCT. Apgar scores, neonatal umbilical cord pH values, neonatal or maternal ICU admission, and maternal satisfaction were also not significantly different.[17,27] The PLMA showed a smoother haemodynamic profile during insertion and removal, with a change in MAP of less than 25% from baseline.[18] In patients undergoing tracheal intubation, a significant increase in mean arterial pressure and heart rate was recorded during intubation and extubation compared with the insertion and removal of the second-generation SGAs.[22,23]

A systematic review and meta-analysis of 2236 patients in 14 studies compared different SGA devices with tracheal intubation in low-risk parturients for caesarean section.[25] Eight of the included studies in this systematic review were published in Chinese. First-attempt insertion rate was similar between any SGA device and tracheal intubation. Subgroup analysis did demonstrate a significantly higher successful first attempt insertion rate and a reduced incidence of difficult placement with the i-gel when compared with the other SGA devices. The SLMA might reduce the time to effective ventilation when compared with tracheal intubation, but these findings

are based on low quality evidence. The incidence of aspiration was similar, but no definite conclusions can be drawn for a difference in aspiration risk by SGA versus tracheal intubation given the low sample size.[25]

Discussion

Currently, tracheal intubation remains the gold standard for airway management in obstetric caesarean sections requiring general anaesthesia. Second-generation SGA devices have been recommended in many difficult airway guidelines as the next airway device choice when failed tracheal intubation occurs.[5] In the current literature review, we identified that the use of second-generation SGA devices provides an effective method for securing the airway in selected, nonobese parturients who do not have risk factors for pulmonary aspiration and no features suggestive of a difficult airway. The first attempt insertion rate is high, ranging from 98 to 99%, and the overall success rate is even higher, ranging from 99 to 100%.[18–20,24,26,27] On the basis of the current published literature, after placement of a first-generation SGA conversion to tracheal intubation may be needed in 0.7% of elective caesarean sections.[19] No cases of failed second-generation SGA placement were seen in the observed, low-risk population. If the SGA, even after replacement, leads to excessive air leakage, partial airway obstruction, laryngospasm or bronchospasm, tracheal intubation must be undertaken, to ensure effective ventilation. Upper airway spasm can be avoided by ensuring adequate depth of anaesthesia. We recommend that a muscle relaxant is considered to aid device placement and to prevent adverse events. Using short-acting lipophilic opioids at induction of general anaesthesia might also be useful, as part of a balanced general anaesthetic technique.[28,29] The oropharyngeal leak pressure of the SGA device determines how effectively it forms a seal with the upper airway. Second-generation SGA devices offer greater oropharyngeal leak pressures, providing a better seal and allowing for more effective ventilation.[30,31] First-generation SGAs have an oropharyngeal leak pressure of about 20 cmH_2O, while second-generation SGAs have pressures of 30 to 35 cmH_2O.[31] Therefore, for obstetric anaesthesia, second-generation SGA devices are the preferred choice.[5] Less time is required to acquire the skills for SGA device insertion and management compared with tracheal intubation. Today, most trainees will have significant expertise in using SGA devices before joining the obstetric on-call schedule but, as a direct consequence of high SGA use, their intubation expertise may be lacking.

Very few cases of gastric regurgitation and pulmonary aspiration have been reported from published data of over 7000 parturients who received an SGA device. However, in most studies of parturients, apart from pregnancy itself, there were no other risk factors for pulmonary aspiration or for difficult tracheal intubation. Such risk factors include high BMI (>30 $kg\,m^{-2}$), known or suspected GERD, unfasted state, gestational diabetes, high Mallampati score and mouth opening less than 2.5 cm. Pre-eclampsia can be considered a high-risk situation due to airway oedema, prolonged surgical time and more risk of postpartum haemorrhage.

Compared with tracheal intubation, the reduced time to effective ventilation associated with a SLMA[27] could be beneficial when time is crucial, for example, for a category 1 caesarean section: but this reduced time is only about 22 s and, overall, might not be clinically relevant. The more favourable haemodynamic profile associated with insertion of a SGA could be helpful in patients in whom haemodynamic stability is particularly important, such as in patients with pre-eclampsia.[18,22,23,27] However, both category 1 caesarean section and pre-eclampsia are generally exclusion criteria in research studies so care is required when extrapolating results to such patients. Hence, further research is needed to prove the possible beneficial effects in these populations.

Gastric regurgitation occurs in 0.7% and pulmonary aspiration in 0.1% of women scheduled for caesarean section under general anaesthesia with RSI and tracheal intubation.[9] Due to the low incidence of such an adverse event, detecting significant differences in pulmonary aspiration between using an SGA and ETT requires a very large sample size. Existing trials are underpowered to detect significant differences. The meta-analysis by White *et al.*[25] confirms this finding. Adequately powered studies are difficult to perform given the very low incidence of general anaesthesia for elective caesarean section.

The advent of gastric ultrasound may offer a method to stratify the risk of pulmonary aspiration in obstetric patients. It can enable the quantitative and qualitative assessment of gastric contents.[32] The most widely used method for qualitative evaluation is the Perlas grading scale, which grades the ultrasound views as 0, 1, 2 or 3 depending on what is visualised in the semi-recumbent and right lateral semi-recumbent positions.[32] More training with point-of-care ultrasound and more research on the applicability of current measurements to pregnant women is required before it becomes a routine technique for assessing the risk of pulmonary aspiration. In time-limited emergencies such as category 1 caesarean sections, performing ultrasound assessments may be challenging and lead to an inappropriate loss of time.

A final consideration in the discussion around the use of SGA devices for caesarean sections is the impact of videolaryngoscopy for airway management. Videolaryngoscopy has transformed airway management in anaesthesia. The Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for managing difficult and failed tracheal intubation in obstetrics recommend that a videolaryngoscope should be immediately available for all obstetric general anaesthetics.[5] Videolaryngoscopy has

been extensively studied in many areas of anaesthesia, with the notable exception of obstetrics. The Cochrane Review evaluating videolaryngoscopy versus direct laryngoscopy for adult patients evaluated 222 studies, but very few studies specifically examined obstetric patients.[33] Nevertheless, the small number of studies and case reports available for obstetric patients, combined with information from nonobstetric populations, do support the use of videolaryngoscopy in obstetrics. In addition, recently published international guidance about preventing unrecognised oesophageal intubation recommends using a videolaryngoscope whenever feasible laryngoscope.[34] If videolaryngoscopes become the preferred choice, will this mitigate concerns around failed airway management and reduce the interest in using SGA in obstetrics?

On the basis of previous research, we suggest the following algorithm to guide clinicians in the use of SGA devices in pregnant patients who need a caesarean section under general anaesthesia (Fig. 2).

Step 1: Determine the pulmonary aspiration risk

The risk for pulmonary aspiration is the most critical determinant to help the clinician choose between an SGA device and an ETT. Parturients who have not fasted for 6 h will need an ETT to decrease the risk of pulmonary aspiration. Other factors increasing the risk for pulmonary aspiration include GERD, obesity (BMI $> 30\,kg\,m^{-2}$) and delayed gastric emptying due to labour, administration of parenteral or neuraxial opioid analgesics and all types of diabetes mellitus. There is limited information on the role of SGA for obese parturients having general anaesthesia for caesarean section. Only one study included women with BMI more than $30\,kg\,m^{-2}$. Fang *et al.*[16] had no adverse events with gastric regurgitation or pulmonary aspiration in 181 women with BMI more than $30\,kg\,m^{-2}$.

Step 2: Assess the difficulty of tracheal intubation

Given a low pulmonary aspiration risk, the anaesthetist can proceed to assess the difficulty of tracheal intubation using standard methods. Pre-operative assessment must always include rigorous airway assessment. Limited mouth opening, restricted neck movement, Mallampati score of 3 or more and lack of use of muscle relaxants are associated with difficulty passing an SGA and need to be considered.[35] If the tracheal intubation is anticipated to be difficult, we encourage the clinician to follow the Obstetric Anaesthetists' Association and the Difficult Airway Society guidelines for airway management in obstetrics.

Step 3: Caesarean section category

In elective or category 2 or 3 caesarean section, sufficient time is usually available to allow for a detailed risk assessment and choice of airway device. In a fasted patient with no additional risk factors for pulmonary aspiration or airway difficulties, either an ETT or a second-generation SGA device can be considered as the primary method to secure the airway. In an emergency caesarean section, particularly the Category 1 situation, the decision to deliver must be achieved as rapidly as possible while maximising safety for the mother. The clinician must consider all the available information to make a balanced decision on airway management. This includes the cause of the deterioration, the expected difficulty of tracheal intubation, experience obtaining an obstetric airway, pulmonary aspiration risk and available equipment. In addition, one must take into consideration the anticipated duration and difficulty of surgery. In these scenarios, the balance of risks favours first-line airway management with tracheal intubation, with a second-generation SGA device reserved as a rescue device. If the anaesthetist considers the use of an SGA device, we recommend using a second-generation device. Consultation with the obstetrician must be done concerning the application of gentle fundal pressure and the expected difficulty of surgery. A vacuum device might be used to assist birth.

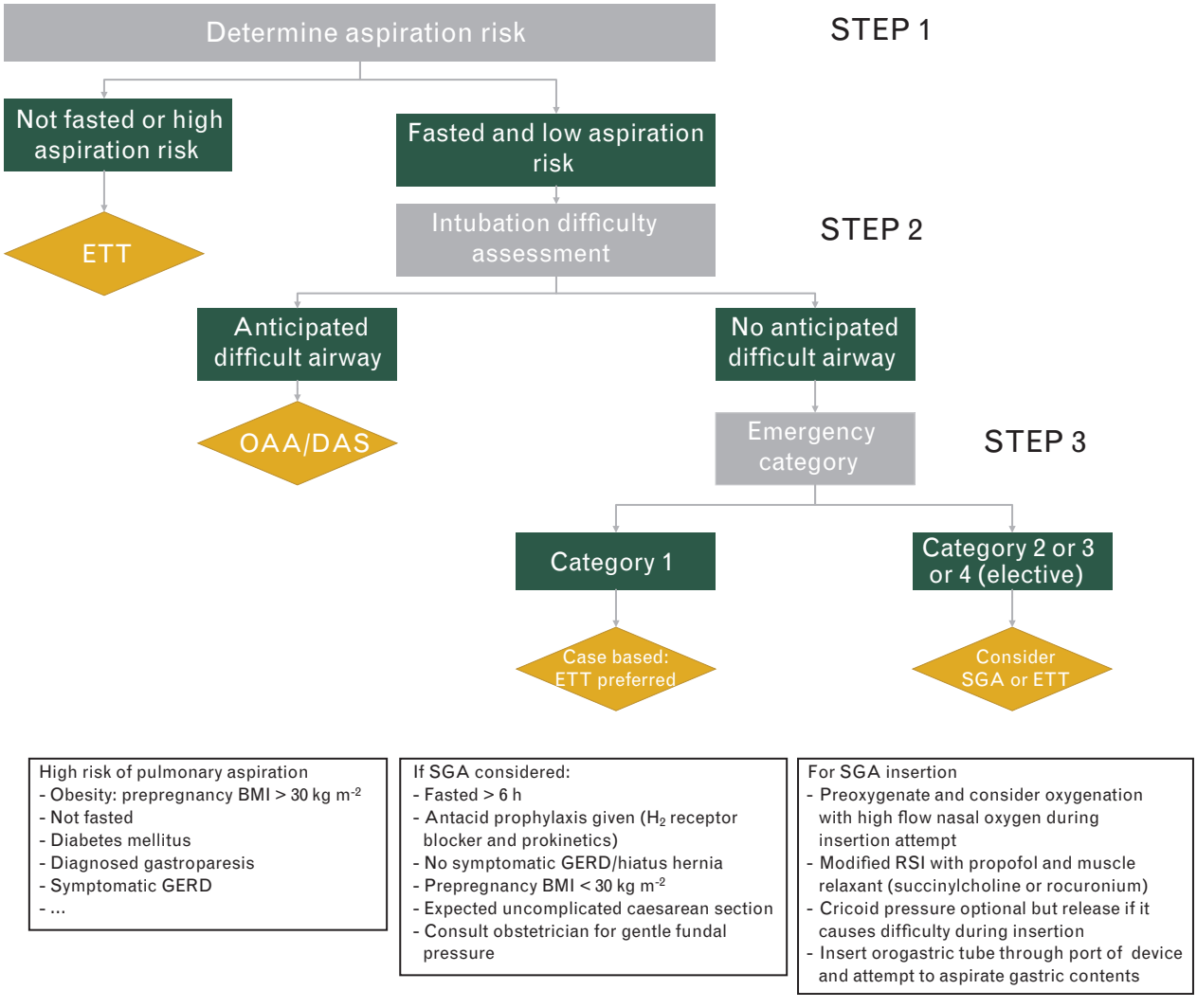
Limitations

Interpretation of the literature on the use of SGAs in obstetric anaesthesia is challenging. The evidence is often retrospective or observational and prospective studies are not powered to detect differences in pulmonary aspiration risk. In the majority of trials, a particular study population is evaluated: elective caesarean sections in healthy women with low BMI. Many studies are also restricted to very few institutions with a vast experience in general anaesthesia for caesarean section. This does not reflect the general population or anaesthetic practice in most other countries. In many countries, far less general anaesthesia is performed, and the population is often obese, of a higher ASA class and presents for an urgent delivery. In addition, parturients with an anticipated difficult airway were excluded from most published trials. These populations are the most interesting for future research. Case reports were not included in this review because of the low level of evidence and difficult interpretation to guide clinical decision making.

Conclusion

There is some reassuring evidence for the role of second-generation SGA devices in obstetric general anaesthesia, but it is not compelling. More widely used videolaryngoscopy may reduce concerns about airway management in general anaesthesia for parturients. Tracheal intubation should remain the primary airway management strategy in obstetric general anaesthesia. However, a second-generation SGA may be considered in certain circumstances, and we hope this review and algorithm will help guide the user when trying to decide if the use of an SGA device is appropriate for their obstetric patient. In patients at a low risk of a difficult airway and with a low risk of pulmonary

Fig. 2 Algorithm to guide the use of a supraglottic airway device in parturients.



ETT, endotracheal tube; GERD, gastro-oesophageal reflux disease; OAA/DAS, Obstetric Anaesthesia Association/Difficult Airway Society; SGA, Supraglottic airway.

aspiration and in which surgery is expected to be smooth and straightforward, a second-generation airway can be a well tolerated option to be used as the primary method of securing the airway.

Acknowledgements relating to this article

Financial support and sponsorship: none.

Conflicts of interest: NL is the current President of the Obstetric Anaesthetists' Association. This article expresses her personal views and does not represent the position of the OAA.

This manuscript was handled by Alistair F. McNarry.

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