Pekka Jalava

A REVIEW OF RECENT RESEARCH INTO THE EFFICACY OF SUPRAGLOTTIC DEVICES IN PREVENTING GASTRIC CONTENT ASPIRATION IN ADULTS

Syventävien opintojen kirjallinen työ

Syyslukukausi 2023

Pekka Jalava

A REVIEW OF RECENT RESEARCH INTO THE EFFICACY OF SUPRAGLOTTIC DEVICES IN PREVENTING GASTRIC CONTENT ASPIRATION IN ADULTS

Kliininen laitos
Syyslukukausi 2023
Lähiohjaaja: Ulla Ahlmén-Laiho; ohjaaja: Teijo Saari

TURUN YLIOPISTO
Lääketieteellinen tiedekunta

JALAVA, PEKKA:
A review of recent research into the efficacy of supraglottic devices in preventing gastric content aspiration in adults

Syventävien opintojen kirjallinen työ, 19 s.
Anestesiologian ja tehohoidon oppiaine
Syyskuu 2023

Aspiration of gastric contents is considered one of the most serious anaesthesia-related complications. Second-generation supraglottic airway devices (SGAs) are standard practice in modern operating room anaesthesia, resuscitation, and pre-hospital care. However, endotracheal intubation is still considered as the golden standard in high-aspiration-risk patients. This review surveyed recent literature regarding the risk of aspiration when using second-generation SGAs.

A literature search was performed using total of six databases. Exclusion criteria included: studies based on manikins, cadavers, or animals; studies conducted on solely paediatric patients; studies where clinical aspiration was not an outcome; studies where only first-generation SGAs were used. Data points extracted from included studies: specific SGA model used, whether SGA was compared to intubation or other SGAs, the surgical procedure, the patient characteristics of ASA physical status, age, gender, BMI, and whether there was preoperative knowledge of particular risks of aspiration, how aspiration was identified and defined, and the sample size.

A total of 26 studies were included in the analysis. No statistically significant difference between SGA types or results favouring endotracheal tube over SGA was found in these studies. In conclusion, there doesn't appear to be a risk difference between different SGAs — or potentially even between SGAs and the endotracheal tube when administering anaesthesia to adults for elective operations or in an emergency setting.

Keywords: supraglottic airway device, SGA, aspiration

A review of recent research into the efficacy of supraglottic devices in preventing gastric content aspiration in adults

Pekka Jalava[1], Ulla Ahlmén-Laiho[2], Teijo Saari[3]

[1] Faculty of Medicine, University of Turku, Turku, Finland
[2] Department of Anaesthesiology and Intensive Care, University of Turku, Finland and Turku University Hospital, Finland
[3] Department of Anaesthesiology and Intensive Care, University of Turku, Finland and Turku University Hospital, Finland

Abstract

Background: Aspiration of gastric contents is considered one of the most serious anaesthesia-related complications. Second-generation supraglottic airway devices (SGAs) have been used for over two decades and are standard practice in operating room anaesthesia, prehospital care, resuscitation, and as a rescue device in unanticipated difficult airway scenarios. However, endotracheal intubation is still considered as the golden standard in high-aspiration-risk patients. This review will survey recent literature regarding the risk of aspiration when using second-generation SGAs.

Methods: A literature search was performed using PubMed, Cochrane, Embase, BioMed Central, Scopus, and Web of Science databases. Exclusion criteria included: studies based on manikins, cadavers, or animals; studies conducted on solely paediatric patients; studies where clinical aspiration was not an outcome; studies where only first-generation SGAs were used. Data points extracted from included studies: specific SGA model used, whether SGA was compared to intubation or other SGAs, the surgical procedure, the patient characteristics of ASA physical status, age, gender, BMI, and whether there was preoperative knowledge of particular risks of aspiration, how aspiration was identified and defined, and the sample size. PRISMA guidelines were then employed in evaluating the studies.

Results: After employment of the exclusion criteria, a total of 26 studies were included in the analysis. They consisted of fifteen studies compared SGA to an endotracheal tube and eleven studies compared an SGA to another SGA or simply evaluated one specific SGA. No statistically significant difference between SGA types in risk of aspiration was found in these studies. There were also no statistically significant results favouring endotracheal tube over SGA in any of the included studies that compared SGAs to endotracheal tubes. One study concluded that patients in the ETT group had a higher risk of postoperative pneumonia compared to SGA group.

Conclusion: According to the recent studies analysed, there doesn't appear to be a risk difference between different SGAs — or potentially even between SGAs and the endotracheal tube when administering anaesthesia to adults for elective operations or in an emergency setting.

A review of recent research into the efficacy of supraglottic devices in preventing gastric content aspiration in adults

Introduction

Aspiration of gastric contents is among the most significant and serious anaesthesia-related complications. It can lead to an extended hospital stay due to pneumonia and other respiratory problems, require intensive care, even cause excess mortality. Its incidence is reported to be 1.4 per 10 000 general anaesthesias.[1] This incidence was reported in a population of over 18 years old non-obstetric patients undergoing elective or emergency procedure in general anaesthesia. The risk of aspiration depends on different factors such as patient-related (e.g. obesity, pregnancy), provider-related (e.g. experience, training), and situation-related (e.g. emergency).[2,3] Anticipating and managing the risk of this complication particularly in high-risk patients can impact anaesthesia safety in a meaningful way both for patients and the healthcare system.

Supraglottic airway devices (SGAs or SADs) are designed to secure patient's upper airway. Terms such as supraglottic airway and extraglottic or periglottic airway device has also been used. Supraglottic airway devices manufactured by Teleflex Incorporated are called laryngeal mask airways (LMAs).[4] These terms refer to the anatomical positioning of the device. Supraglottic airway devices were developed in the 1980's, one of the first being the LMA-Classic as designed by Dr Brain in 1982.[5] Second-generation supraglottic devices were introduced in the first decade of the 2000's. Since then, these devices have become standard practice in modern operating room anaesthesia to replace intubation when deemed safe. In the UK, 56 % of general anaesthesia are now performed using supraglottic devices for airway management.[6] They are also used in pre-hospital care, resuscitation, and as a rescue device in unanticipated difficult airway scenarios. Second-generation supraglottic devices have replaced largely their predecessors; they feature less airway leak and seem to carry a smaller risk of gastric content aspiration compared to the first generation.[7]

Tracheal intubation is still considered as the golden standard in high-aspiration-risk cases. However, there are other adverse events such as hoarseness, sore throat, and coughing associated with their use. These aren't life-threatening, but they are much more common than pulmonary aspiration, and cause discomfort to patients. They are less common with supraglottic devices.[8,9] In adults endotracheal intubation also usually requires the use of muscle relaxant drugs which carries its own risks and challenges. If the risk of aspiration associated with newer SGA models could be demonstrated to be the same or lesser than with tracheal intubation in certain patient populations and those populations could be identified, it would be possible to recommend the use of the less invasive supraglottic devices in patients where intubation is the current standard based on aspiration risk assessment.

This review will survey recent literature regarding the risk of aspiration of gastric contents when using second-generation SGAs. Particular attention was given to whether recent research could suggest novel groups of patients eligible for SGA use that have been traditionally considered too high-risk for aspiration and thus routinely intubated. This review will also evaluate if there are significant risk differences between different SGAs.

Methods

Protocol

This review was conducted according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).

Eligibility criteria
The research question was the following: "Is there a significant difference in aspiration risk between different second-generation SGAs and between the examined second-generation SGAs and ETT in low-risk patient populations?"

Exclusion criteria
The following were excluded: studies based on manikins, cadavers, and animals; studies conducted only using paediatric patients; studies where clinical aspiration was not an outcome; studies only considering first-generation SGAs. Studies published in other languages besides English were excluded. Case reports, opinion pieces, editorials, book chapters, and conference abstracts were excluded. Potentially eligible studies that had no full text available were excluded.

Inclusion criteria
To ensure that the data reflected recent research, only studies published between January 2011 and July 2021 were included.

Search methods
A search was conducted using six different databases: PubMed, Cochrane, Embase, BioMed Central, Scopus, and Web of Science. Search terms were the following: (supraglottic device* OR supraglottic airway* OR laryn* tube OR laryn* mask OR laryn* airway OR i-gel) AND (aspiration OR regurgitation OR pneumonia) AND (prevent OR risk)**.** This search strategy was used with Cochrane, Embase, BioMed Central, Scopus, and Web of Science. When conducting the search in PubMed, Medical Subject Heading (Mesh) terms were also used. One person conducted all the searches on the 19th and 20th of July 2021.

Study selection
One person reviewed all the titles and abstracts of the studies. Microsoft Excel was used to handle the records. First, duplicates were removed after which case reports, opinions, editorials, book chapters, and conference abstracts were excluded. The titles and abstracts of the remaining studies were screened again. Studies clearly fulfilling the exclusion criteria or not affiliated to the search question were excluded. After this, studies were excluded because of lack of publication, language not English and no availability to the full text. A full-text screening of the remaining articles was performed by the same aforementioned person. The reasons for exclusion after a review of the full text were lack of reporting of meaningful clinical outcomes, cadaver study, and exclusion of SGA devices. (Figure 1)

Data extraction
Data from the studies were extracted by one person using a pre-piloted form. The extracted data included: article title, the name of the journal, the year of publication, the full abstract, type, and design of the study reported. Data collected on the study method included the specific SGA used, whether SGA was compared to intubation or other SGAs, the surgical procedure, patient type (ASA physical status[10], age, gender, BMI, and known risks of aspiration), how aspiration was identified and defined, and the sample size. If an article otherwise met the criteria for inclusion but did not

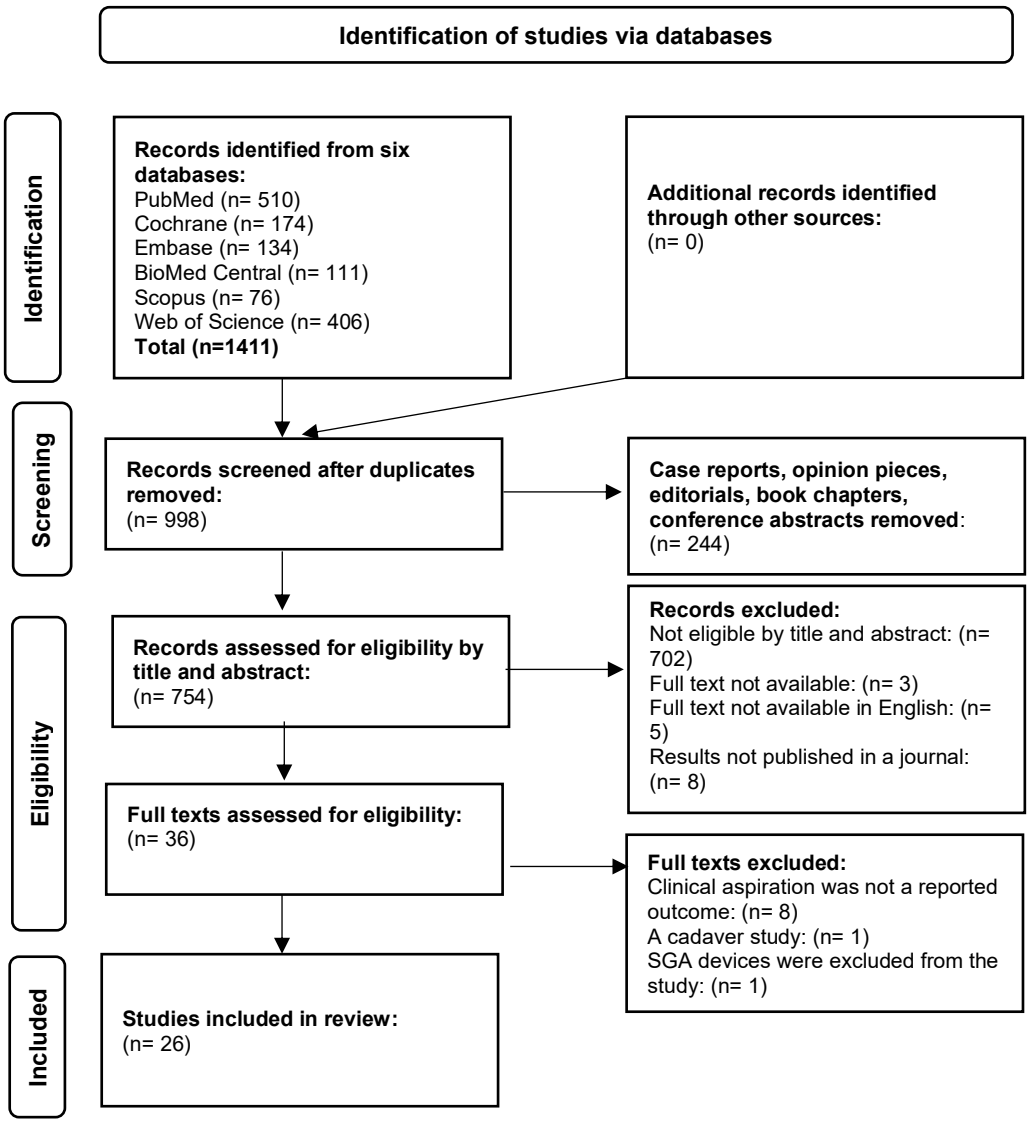
include all the aforementioned parameters, it was not excluded; the data points that were available were recorded. (Figure 3)

Results

Study selection

In total, 1411 records were identified through database search. After duplicates were removed, total of 244 case reports, opinion pieces, editorials, book chapters, and conference abstracts were excluded. The titles and abstracts of the remaining 754 studies were screened for eligibility. Of these, 36 full-text articles were assessed for eligibility. Total of 26 studies were included in this review. (Figure 1).

Figure 1 *PRISMA flowchart depicting the identification, screening, eligibility, and inclusion process of studies identified from the databases*



Study characteristics

A total of eleven studies compared SGA to another SGA or just evaluated the aspiration risk of one specific SGA type. Nine of these studies were performed on elective patients[11–19] and two studies in emergency situations (cardiac arrest[20] or emergency caesarean delivery[21]).

Fifteen studies evaluated the aspiration risk differences between SGAs and endotracheal tubes. Four of these studies were performed in emergency situations[22–25] and eleven in elective anaesthesiological practice.[26–36] (Figure 2).

Figure 2 *Flowchart depicting the airway management devices and the patient populations of included studies*

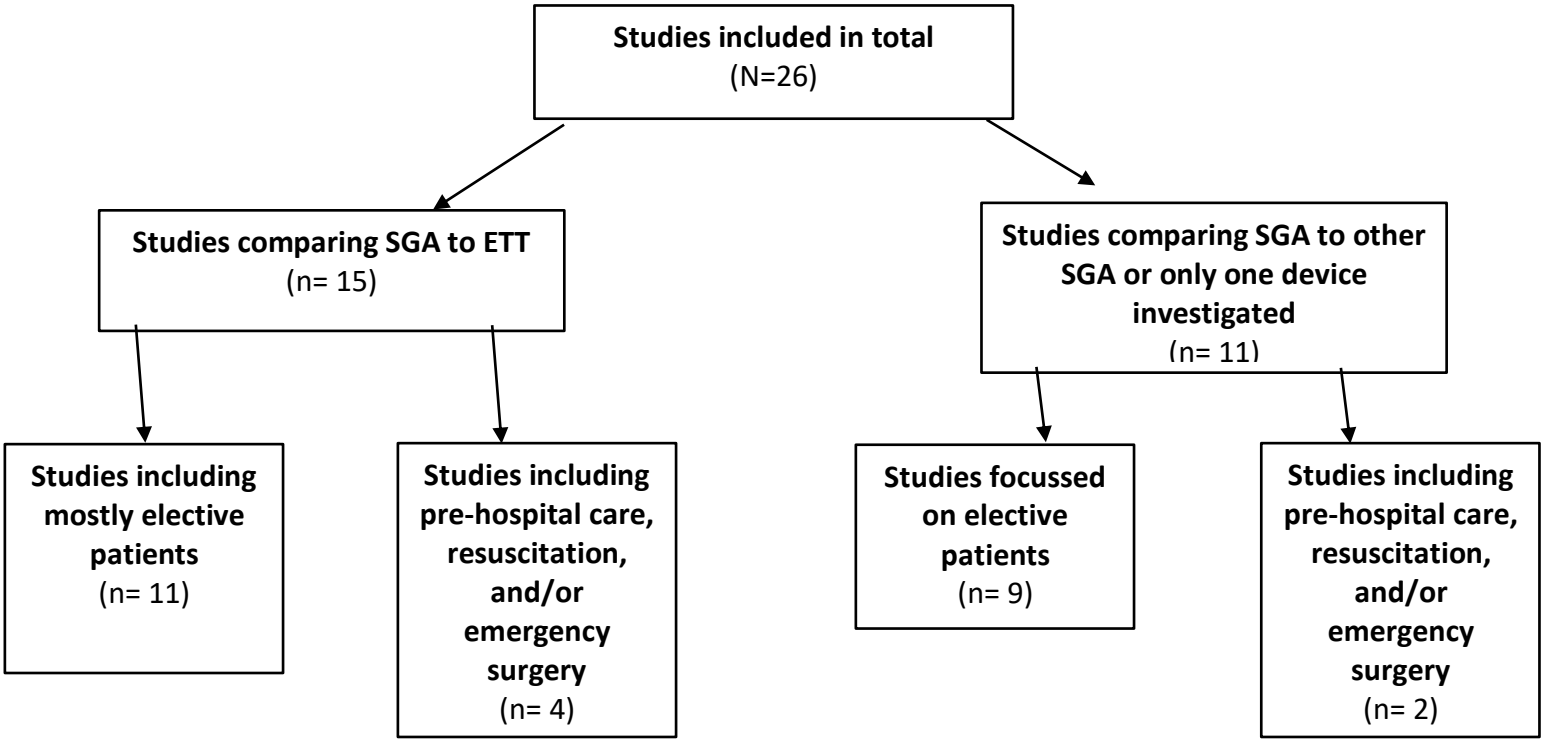


Figure 3 *Table depicting the data extracted from the included studies*

Article author and the year of publication	Name of the journal	Type	Design of the study reported	The specific SGA used	The device compared to	The surgical procedure	Patient type	Sample size	How aspiration was identified and defined
Ye et al. (2020)[29]	BMC Anesthesiology	research article	randomized observational study	LMA Supreme™, i-Gel®	ETT	elective laparoscopic gynecological procedure	ASA I–II, over 18-year-old, female patients, no known risks of aspiration	99	Aspiration was identified using an ultrasound.
Kluger et al. (2019)[34]	Anaesthesia and Intensive Care	research article	retrospective study	not specified	ETT	all included	all included	3229 reported anaesthesia incidents	Reported aspiration case or an X-ray indicating aspiration
Yao et al. (2019)[27]	BMC Anesthesiology	research article	randomized controlled trial	LMA Supreme™	ETT	elective cesarean section	ASA II, 18 to 50 years old obstetric patients	920	clinical
Tan et al. (2019)[16]	BMC Anesthesiology	research article	prospective cohort study	LMA Supreme™	-	elective cesarean section	ASA II, obstetric patients	584	clinical
Fang et al. (2018)[21]	Scientific Reports	research article	retrospective study	LMA Supreme™	-	emergency cesarean section	all included	1039	clinical
Benger et al. (2018)[25]	JAMA - Journal of the American Medical Association	research article	randomized controlled trial	i-Gel®	ETT	pre-hospital care	over 18-year-old, nontraumatic OHCA patients	9296	Stomach contents visible below vocal cords or inside ETT or SGA.
Li et al. (2017)[11]	BMC Anesthesiology	research article	prospective cohort study	LMA Supreme™	-	elective cesarean section	not specified	584	clinical
Geng et al. (2017)[22]	Chinese Medical Journal	research article	retrospective cohort study	LMA Supreme™	ETT	emergency and elective cesarean section	all included	180	bile-stained fluid seen in the lungs or radiological
Xu et al. (2016)[30]	PLoS ONE	research article	systematic review and meta-analysis	FLMA	ETT	elective surgery	not specified	2 studies	not specified
Hammer et al. (2021)[36]	British Journal of Anaesthesia	research article	retrospective cohort study	LMA Unique, i-Gel®	ETT	All surgery types that had been conducted with both SGA and ETT.	adults	56 068	pneumonia
Beleña (2015)[19]	World Journal of Gastrointestinal Surgery	review	systematic review	LMA Supreme™, LMA ProSeal™, i-Gel® LMA® Classic™	ETT/LMA	elective laparoscopic cholecystectomy	adults	706	not specified
Park et al. (2016)[31]	Medicine	review	systematic review and meta-analysis	LMA ProSeal™, i-Gel® LMA® Classic™	ETT	laparoscopic surgery	not specified	4 studies, total of 229 patients	not specified

Zaballos et al. (2019)[12]	Anaesthesia	research article	prospective cohort study	LMA Protector™	-	elective surgery	ASA I–III, 18 to 75 years old, no increased risk of aspiration	280	clinical
Lim et al. (2020)[14]	BMC Anesthesiology	research article	prospective cohort study	LMA Supreme™	-	elective cesarean section	ASA I–III, obstetric patients	584	clinical
Hagan et al. (2020)[13]	Anesthesia and Analgesia	research article	prospective observational study	LMA Gastro™	-	elective endoscopic retrograde cholangiopancreatography	adults, no increased risk of aspiration	30	clinical
Lønvik et al. (2021)[20]	BMC Emergency Medicine	research article	prospective observational study	i-Gel®	King LTS-D™	pre-hospital care	adult patients with OCHA	250	not specified
Shariffuddin et al. (2020)[15]	BMC Anesthesiology	research article	prospective cohort study	LMA Protector™	-	elective open surgical procedure	BMI 30–35, no increased risk of aspiration	29	clinical
Lai et al. (2017)[26]	BMC Anesthesiology	research article	randomized controlled trial	i-Gel®	ETT	elective gynecologic laparoscopy	ASA I–II, 20 to 80 years old, no increased risk of aspiration	40	clinical
Dünnebier et al. (2017)[28]	European Journal of Anaesthesiology	research article	randomized controlled trial	LTS II	ETT	elective laparoscopic radical prostatectomy	over 18-year-old males, no increased risk of aspiration	50	not specified
Gong et al. (2020)[32]	Anesthesia and analgesia	research article	randomized controlled trial	FLMA	ETT	elective radical thyroidectomy	ASA I–II, 20 to 80 years old, no increased risk of aspiration	132	not specified
Steuerwald et al. (2018)[23]	Air Medical Journal	research article	retrospective study	LMA Supreme™, LMA Unique™, Combitube	ETT	pre-hospital care	mostly adults	150	radiological
Carney et al. (2021)[24]	Prehospital Emergency Care	review	systematic review	not specified	ETT	pre-hospital care	not specified	2 studies	not specified
Jannu et al. (2017)[17]	Archives of Craniofacial Surgery	review	review	not specified	ETT	oral and maxillofacial surgery	not specified	-	not specified
Michalek et al (2015)[18]	BioMed Research International	review	review	LMA ProSeal™, LMA Supreme™, i-Gel®, SLIPA, LTS II	-	not specified	not specified	-	inhalation of material below the level of the vocal cords
Patel et al. (2020)[35]	Current Anesthesiology Reports	review	review	second generation SGAs	-	cesarean section and non-obstetric surgery	obstetric patients	-	not specified
Gordon et al. (2018)[33]	Minerva Anestesiologica	review	review	LMA ProSeal™, LMA Supreme™, i-Gel®	ETT	not specified	not specified	-	not specified

Aspiration risk comparison between different SGAs

Four studies and one literature review considered the aspiration risk of the Supreme™ laryngeal mask airway (SLMA). However, three of the studies[11,14,16] were based on the same data. The aim of these studies was to evaluate the performance of the SLMA in obstetric patients undergoing a Caesarean section in general anaesthesia. Clinical aspiration was a secondary outcome in these cohort studies. The patient pool consisted of 584 obstetric patients undergoing a category 2 or 3 Caesarean delivery. Category 2 Caesarean delivery refers to an urgent section with not immediately life-threatening maternal or fetal compromise and category 3 to a scheduled section when there is a need for an early delivery without maternal or fetal compromise.[37] All patients in these studies had fasted for at least four hours. No aspirations occurred.

The fourth study[21] was a retrospective analysis performed in the same Chinese hospital as the aforementioned three cohort studies. For this study, a total of 1039 parturients underwent an emergency caesarean section in general anaesthesia induced with intravenous propofol, cisatracurium, and fentanyl. Their airways were secured with the SLMA. No aspirations occurred.

The literature review[18] consisted of a meta-analysis and an observational study of 700 patients. No cases of aspiration were observed to have occurred with the SLMA.

The LMA Protector™ was evaluated in two studies. In the first[12], the device was employed in 280 elective ASA I–III patients. Patients estimated to have a high aspiration risk were excluded. The patients underwent mainly four types of surgeries: vascular (34 %), orthopaedic (14 %), general (19 %), and gynaecological (24 %). No aspirations were identified to have occurred. The second study[15] considered the use of the LMA Protector™ in 29 moderately obese (BMI 30–35kg/m²) whose body weight was their only identified aspiration risk factor. These patients underwent general, orthopaedic, gynaecological, or urological surgery. No aspirations occurred.

The LMA Gastro™ was evaluated in one American study.[13] Thirty ASA class III patients with no identified risk factors of aspiration underwent an elective endoscopic retrograde cholangiopancreatography with their airways secured using the LMA Gastro. No aspirations occurred, although it is notable that there was no follow-up on this outcome after the patients left the post-anaesthesia care unit.

One review[17] considered the use of SGAs in oral and maxillofacial surgery. The conclusion was that the SGA offers an excellent protection against aspiration of saliva and blood from the surgical field. However, the review stated that the use of these should still be considered contraindicated in high-aspiration-risk patients.

One study[20] compared the i-Gel® and the Kings LTS-D™. This was an observational study on out-of-hospital resuscitation by ambulance personnel in Central Norway. Patients were adults experiencing an out-of-hospital-cardiac-arrest (OCHA). The i-Gel® was used with a total of 191 patients and the LTS-D™ in 59 patients. There were 24 aspiration cases (13 %) with the i-Gel® and eight cases (14 %) with the Kings LTS-D™. No statistically significant differences could be demonstrated between the devices. The quality of the data is diminished by the fact that aspiration was defined very vaguely in this study.

The second review[19] considered the use of SGAs in elective laparoscopic cholecystectomy. It was based on ten RCTs, case series, and prospective observational studies with a total of 706 patients. No cases of pulmonary aspiration were observed.

The differences in aspiration risk between SGAs and ETTs

Two studies compared the Supreme™ laryngeal mask airway (SLMA) with endotracheal intubation. The first one[22] was a 5-year retrospective cohort study including both elective and emergency caesarean sections performed under general anaesthesia in Peking University First Hospital, China. During the five-year period, an endotracheal tube was used in 124 cases and an SLMA in 56 cases. No cases of aspiration were reported to have occurred.

The second study[27] considered only elective caesarean sections. The study was performed in a Chinese hospital around the same time as the three aforementioned studies.[11,14,16] This study compared the SLMA to the endotracheal tube. A total of 920 ASA II patients were randomized to SLMA and ETT groups, and no clinical signs of aspiration occurred in any patients.

A third study[23] considered emergency cases in prehospital environment in the USA. The LMA Supreme™ was used in 36 % of the SGA cases. Other devices used were LMA® Unique™ (40 %), Combitube (25 %), and King LTS-D (1 %). In total, aspiration data was available for 161 patients. Aspiration was diagnosed in 5 (8 %) of 59 SGA patients and 11 (12 %) of 91 ETT patients. However, there was no statistically significant difference between the groups, and it was not reported with which SGA devices these aspiration cases occurred and whether there was a difference in the severity of the aspiration sequelae between the intubation and SGA patients. The fourth study[29] compared SLMA to ETT as well. A total of 99 patients were randomly divided into SLMA, i-Gel®, and ETT groups. The patients were ASA I–II patients undergoing laparoscopic gynaecological surgery in Anhui, China. No aspiration occurred.

Three other studies compared the performance of the i-Gel® to endotracheal intubation. The first one[26] was a Taiwanese randomized controlled trial considering laparoscopic gynaecological procedures. A total of forty ASA I–II patients were divided in i-Gel® and ETT groups. Patients estimated to have a high aspiration risk were excluded. No aspiration cases were detected during the postoperative hospital stay. The second study[36] was a retrospective cohort study considering 56 068 patients in years 2008 to 2018. Patients were mostly elective. The study only included types of surgery where both an ETT and an SGA were feasible solutions in standard care. The surgeries were conducted in two hospitals and one ambulatory clinical centre in Massachusetts, USA. The i-Gel® or the LMA® Unique™ was used in 48.9 % of patients, and ETT was used in 51.1 % of the cases. The primary outcome of the study was emergent postoperative intubation after general anaesthesia. Incidence of pneumonia as a marker of aspiration was a secondary outcome. The conclusion was that patients in the ETT group had a higher incidence of both postoperative intubation and pneumonia. In this study medicating SGA patients with a non-depolarising NMBA seemed to re-introduce a higher risk of postoperative intubation.

A randomized clinical trial conducted in the UK[25] compared the i-Gel® to ETT in out-of-hospital cardiac arrest. A total of 9296 patients were divided into two groups: a total of 4886 patients were in the i-Gel® group and 4410 patients in the ETT group. A total of 729 aspiration cases (15.1 %) were noted in the SGA group, and 647 aspiration cases (14.9 %) were noted in the ETT group.

Aspiration was a secondary outcome, and there was no significant difference in aspiration risk between the two groups.

Two studies considered flexible laryngeal mask airways (FLMAs). The first study[30] was a systematic review and meta-analysis consisting of ten randomized, controlled trials comparing the FLMA to the endotracheal tube. Aspiration was an evaluated outcome in two of the ten trials. A total of 167 elective patients were included in these two trials. There was no significant difference in the risk of aspiration between the FLMA and ETT groups, but the conclusion was that the FLMA should not be used with high-aspiration-risk patients. The second study[32] was a Chinese randomized controlled trial comparing FLMA and ETT in elective radical thyroidectomy. A total of 138 ASA I–II patients were recruited. No aspiration cases were identified.

The search found only one study[28] comparing the Laryngeal Tube Suction II (LTS II) to endotracheal intubation. In this German study, a hundred ASA I–II patients undergoing radical prostatectomy were intended to be randomized to an LTS II group and an ETT group. The study was interrupted after fifty patients because fifteen patients in the LTS II group needed their LTSs to be exchanged for ETT tubes due to too much air leakage or a swollen tongue. No aspiration cases were noted. The conclusion was that LTS II is an inferior choice to the ETT in patients undergoing radical prostatectomy.

There were four other reviews comparing SGAs to ETTs. One review on the airway management of obstetric patients[35] concluded that second generation SGAs can be used safely in elective non-abdominal procedures with obstetric patients before 18 to 20-week gestation. After this, an endotracheal tube was recommended and the review stated that in labour, SGAs should have a role only as a rescue device.

In a second review[24], SGAs were compared to ETTs in prehospital settings. The review identified only two studies comparing the aspiration risk differences between SGAs and ETTs. The conclusion was that there was no difference in their risk levels. A third review[31] based on data from four different RCTs considered the risk of aspiration in laparoscopic surgery. A total of 199 patients were included, and there were no cases of aspiration.

The final included review[33] concluded that risk of aspiration with SGAs is between 1–3 per 10 000 patients, which put it at the equivalent level to the ETT.

The final individual study[34] included compared SGAs and ETTs considered the latest 4000 incidents from the webAIRS[38] anaesthesia incident reporting database in Australia and New Zealand. A total of 121 reports of aspiration were found, and the conclusion was that the ETT should be preferred over SGAs with high-aspiration-risk patients.

Discussion

In this review, a total of 26 studies considering the aspiration risk in use of SGAs were evaluated. The review demonstrated that recent research on the topic has focussed on three scenarios: elective surgery (where a patient's risk of aspiration can be assessed preoperatively), caesarean sections (where the aspiration risk is always considered elevated due to late pregnancy and patients are often not fasted), and pre-hospital care (where there is also no guarantee of a fasted patient). SGAs have become commonplace in out-of-hospital emergency care due to what is now

known about the risks of using an ETT without the provider having regular and recent practice of intubation and the management of a patient with an ETT in place.

There is a long tradition of considering the ETT to be the golden standard in aspiration protection. For these reasons it is understandable that little research has been performed using SGAs on high-risk patients undergoing elective surgery. Due to the exclusion of high aspiration risk patients in the recent studies focussed on elective surgery, this review cannot make any recommendations for changing this current gold standard of using an ETT in high-risk patients. Recent research does seem to demonstrate that in several types of laparoscopic procedures and SGA might well be a viable option in low-risk patients, assuming that the demands of the surgery itself allow it to be selected over an ETT. One study investigated the feasibility of a flexible type LMA for radical thyroidectomy, a surgery where the proximity of the surgical field to the airway has traditionally been thought to require endotracheal intubation. No aspirations occurred, but an LMA well may carry other challenges and risks in such procedures.

The findings regarding caesarean sections were encouraging regarding the use of SGAs instead of ETTs. At least in these evaluated studies, SGAs seemed to carry a very low risk of aspiration even in late pregnancy where the aspiration risk is considered to be significant in all patients. General anaesthesia necessitating the securing of the airway is used in emergency caesareans and when neuraxial blocks are contraindicated. The emergency or urgent caesarean patient is not always fasted for a significant time period, raising the risk of aspiration further. These studies seem to demonstrate that when endotracheal intubation proves difficult or is otherwise not considered to be the primary option, the SGA does not pose a significant risk of gastric contents traveling into the lungs.

With regard to emergency situations, several large studies considering aspiration risk in pre-hospital care were identified and evaluated. It comes as no surprise that more cases of aspiration were reported in these compared to studies considering only elective scenarios. It is notable that that one observational study[20] of 250 patients found no significant difference in the aspiration incidence between the i-Gel® group and the LTS-D group; the incidence was 13–14 %. In another retrospective study[23] of 161 patients the incidence was 8 % with an SGA and 12 % when an ETT was employed. Finally, there was a randomized clinical trial[25] with 9296 patients. A total of 729 aspiration cases (15.1 %) were noted in the SGA group, and 647 aspiration cases (14.9 %) were noted in the ETT group. There was no statistically significant difference between groups in any of these studies. There was also a fourth study considering over one thousand emergency caesarean sections.[21] This study was conducted in a hospital environment, but high aspiration-risk patients were not excluded in contrary to many similar studies considering elective patients. In all of these four studies high-aspiration-risk patients were included and still no significant difference between study groups could be found.

The search identified only one large study considering the risk of aspiration with mostly elective patients. This retrospective cohort study[36] included in a total of 56 068 patients during ten-year period and its primary outcome was emergent postoperative intubation after general anaesthesia. Incidence of pneumonia as a marker of aspiration was a secondary outcome. The authors discovered that using an SGA instead of an endotracheal tube was associated to lower incidence of both pneumonia and postoperative intubation. Interestingly, in this study medicating SGA patients with a non-depolarising NMBA seemed to re-introduce a higher risk of postoperative

intubation. This suggests that using NMBAs in elective low-risk patients may raise the risk of aspiration o some extent.

The risk of aspiration is around 1.4 per 10 000 in general anaesthesia.[1] Consequently, if the patient populations in aspiration studies are small, very few to no cases will transpire in the cohort, which makes demonstrating significant statistical differences between different airway management devices particularly challenging. Many but not all of the studies evaluated had relatively small patient populations, for instance most of the studies considering elective surgery had only 30 to 500 participants, which limits severely the reliability of their conclusions. Even in a randomized controlled trial[27] with sampling of 920 patients, not even one case of aspiration could be found. For the clinician this is good news but offers no help with formulating recommendations for airway management tool selection.

The main strength of this review is that it was conducted according to the PRISMA guidelines. Other strengths are that the literature search was conducted using a total of six different databases, making it unlikely that any significant recent studies were missed. RCTs, observational studies, reviews, and meta-analysis were all included to ensure as much material as possible. The limitations of this review include mainly the weaknesses of the studies, especially the patient population sizes. Other limitation is that selection of the studies included in the analysis phase was conducted by only one person. Excluding studies published in other languages besides English may pose a risk of missing relevant reports.

Conclusion

There is no new data to suggest deviating from the established standard of using an ETTs in high-risk elective surgical patients. However, in caesarean sections where the aspiration risk varies between elevated and very high, recent data suggests that SGAs offer a viable alternative to the ETT. In emergency situations and prehospital care where aspiration risk is often high, recent research seems to suggest that there may not be a significant aspiration risk difference between SGA models or even some SGAs compared with an ETT. This is an encouraging finding considering the widespread use of SGA devices in modern emergency care.

Conflicts of interest

The author has no conflicts of interest.

Funding

There was no need for funding.

Patient consent

None required.

Data availability statement

Not applicable for a review.

ORCID

Pekka Jalava https://orcid.org/0000-0002-5847-1337

References

1. Sakai T, Planinsic RM, Quinlan JJ, Handley LJ, Kim TY, Hilmi IA. The incidence and outcome of perioperative pulmonary aspiration in a university hospital: A 4-year retrospective analysis. *Anesth Analg*. 2006;103(4):941-947. doi:10.1213/01.ane.0000237296.57941.e7
2. Nason KS. Acute Intraoperative Pulmonary Aspiration. *Thorac Surg Clin*. 2015;25(3):301-307. doi:10.1016/j.thorsurg.2015.04.011
3. King W. Pulmonary aspiration of gastric contents. *Update in Anaesthesia*. 2010;26:28-31. www.anaesthesiologists.org
4. Ramachandran SK, Kumar AM. Supraglottic airway devices. In: *Respiratory Care*. Vol 59. American Association for Respiratory Care; 2014:920-932. doi:10.4187/respcare.02976
5. BRAIN AIJ. THE LARYNGEAL MASK—A NEW CONCEPT IN AIRWAY MANAGEMENT. *Br J Anaesth*. 1983;55(8):801-805. doi:10.1093/bja/55.8.801
6. Woodall NM, Cook TM. National census of airway management techniques used for anaesthesia in the UK: First phase of the Fourth National Audit Project at the Royal College of Anaesthetists. *Br J Anaesth*. 2011;106(2):266-271. doi:10.1093/bja/aeq339
7. Cook T, Howes B. Supraglottic airway devices: Recent advances. *Continuing Education in Anaesthesia, Critical Care and Pain*. 2011;11(2):56-61. doi:10.1093/bjaceaccp/mkq058
8. El-Boghdadly K, Bailey CR, Wiles MD. Postoperative sore throat: A systematic review. *Anaesthesia*. 2016;71(6):706-717. doi:10.1111/anae.13438
9. Yu SH, Beirne OR. Laryngeal mask airways have a lower risk of airway complications compared with endotracheal intubation: A systematic review. *Journal of Oral and Maxillofacial Surgery*. 2010;68(10):2359-2376. doi:10.1016/j.joms.2010.04.017
10. Mayhew D, Mendonca V, Murthy BVS. A review of ASA physical status – historical perspectives and modern developments. *Anaesthesia*. 2019;74(3):373-379. doi:10.1111/anae.14569
11. Li SY, Yao WY, Yuan YJ, et al. Supreme™ laryngeal mask airway use in general Anesthesia for category 2 and 3 Cesarean delivery: A prospective cohort study. *BMC Anesthesiol*. 2017;17(1). doi:10.1186/s12871-017-0460-x
12. Zaballos M, Zaballos J, López S, et al. The LMA ® Protector TM in anaesthetised, non-paralysed patients: a multicentre prospective observational study. *Anaesthesia*. 2019;74(3):333-339. doi:10.1111/anae.14534
13. Hagan KB, Carlson R, Arnold B, et al. Safety of the LMA®Gastro™ for endoscopic retrograde cholangiopancreatography. *Anesth Analg*. Published online 2020:1566-1572. doi:10.1213/ANE.0000000000005183
14. Lim MJ, Tan H Sen, Tan CW, et al. The effects of labor on airway outcomes with Supreme™ laryngeal mask in women undergoing cesarean delivery under general anesthesia: a cohort study. *BMC Anesthesiol*. 2020;20(1). doi:10.1186/s12871-020-01132-5
15. Shariffuddin II, Chaw SH, Ng LW, et al. Clinical performance of the LMA Protector™ airway in moderately obese patients. *BMC Anesthesiol*. 2020;20(1). doi:10.1186/s12871-020-01100-z
16. Tan H Sen, Li SY, Yao WY, et al. Association of Mallampati scoring on airway outcomes in women undergoing general anesthesia with Supreme™ laryngeal mask airway in cesarean section. *BMC Anesthesiol*. 2019;19(1). doi:10.1186/s12871-019-0796-5
17. Jannu A, Shekar A, Balakrishna R, Sudarshan H, Veena GC, Bhuvaneshwari S. Advantages, Disadvantages, Indications, Contraindications and Surgical Technique of Laryngeal Airway Mask. *Arch Craniofac Surg*. 2017;18(4):223-229. doi:10.7181/acfs.2017.18.4.223

18. Michalek P, Donaldson W, Vobrubova E, Hakl M. Complications associated with the use of supraglottic airway devices in perioperative medicine. *Biomed Res Int*. 2015;2015. doi:10.1155/2015/746560
19. Beleña JM. Role of laryngeal mask airway in laparoscopic cholecystectomy. *World J Gastrointest Surg*. 2015;7(11):319. doi:10.4240/wjgs.v7.i11.319
20. Lønvik MP, Elden OE, Lunde MJ, Nordseth T, Bakkelund KE, Uleberg O. A prospective observational study comparing two supraglottic airway devices in out-of-hospital cardiac arrest. *BMC Emerg Med*. 2021;21(1). doi:10.1186/s12873-021-00444-0
21. Fang X, Xiao Q, Xie Q, et al. General Anesthesia with the Use of SUPREME Laryngeal Mask Airway for Emergency Cesarean delivery: A Retrospective Analysis of 1039 Parturients. *Sci Rep*. 2018;8(1). doi:10.1038/s41598-018-31581-5
22. Geng ZY, Wang DX. Laryngeal mask airway for cesarean delivery: A 5-year retrospective cohort study. *Chin Med J (Engl)*. 2017;130(4):404-408. doi:10.4103/0366-6999.199833
23. Steuerwald MT, Braude DA, Petersen TR, Peterson K, Torres MA. Preliminary Report: Comparing Aspiration Rates between Prehospital Patients Managed with Extraglottic Airway Devices and Endotracheal Intubation. *Air Med J*. 2018;37(4):240-243. doi:10.1016/j.amj.2018.04.004
24. Carney N, Totten AM, Cheney T, et al. Prehospital Airway Management: A Systematic Review. *Prehospital Emergency Care*. Published online 2021. doi:10.1080/10903127.2021.1940400
25. Benger JR, Kirby K, Black S, et al. Effect of a strategy of a supraglottic airway device vs tracheal intubation during out-of-hospital cardiac arrest on functional outcome the AIRWAYS-2 randomized clinical trial. *JAMA - Journal of the American Medical Association*. 2018;320(8):779-791. doi:10.1001/jama.2018.11597
26. Lai CJ, Liu CM, Wu CY, Tsai FF, Tseng PH, Fan SZ. I-Gel is a suitable alternative to endotracheal tubes in the laparoscopic pneumoperitoneum and trendelenburg position. *BMC Anesthesiol*. 2017;17(1). doi:10.1186/s12871-016-0291-1
27. Yao WY, Li SY, Yuan YJ, et al. Comparison of Supreme laryngeal mask airway versus endotracheal intubation for airway management during general anesthesia for cesarean section: A randomized controlled trial. *BMC Anesthesiol*. 2019;19(1). doi:10.1186/s12871-019-0792-9
28. Dünnebier A, Gardill D, Kowalski I, et al. Laryngeal tube suction II or endotracheal intubation for laparoscopic radical prostatectomy in a head down position. *Eur J Anaesthesiol*. 2017;34(7):441-447. doi:10.1097/EJA.0000000000000547
29. Ye Q, Wu D, Fang W, Wong GTC, Lu Y. Comparison of gastric insufflation using LMA-supreme and I-gel versus tracheal intubation in laparoscopic gynecological surgery by ultrasound: A randomized observational trial. *BMC Anesthesiol*. 2020;20(1). doi:10.1186/s12871-020-01057-z
30. Xu R, Lian Y, Li WX. Airway complications during and after general anesthesia: A comparison, systematic review and meta-analysis of using flexible laryngeal mask airways and endotracheal tubes. *PLoS One*. 2016;11(7). doi:10.1371/journal.pone.0158137
31. Park SK, Ko G, Choi GJ, Ahn EJ, Kang H. Comparison between supraglottic airway devices and endotracheal tubes in patients undergoing laparoscopic surgery: A systematic review and meta-analysis. *Medicine (United States)*. 2016;95(33). doi:10.1097/MD.0000000000004598
32. Gong Y, Wang J, Xu X, Li J, Song R, Yi J. Performance of Air Seal of Flexible Reinforced Laryngeal Mask Airway in Thyroid Surgery Compared With Endotracheal Tube: A

Randomized Controlled Trial. *Anesth Analg*. 2020;130(1):217-223. doi:10.1213/ANE.0000000000003763
33. Gordon J, Cooper RM, Parotto M. Supraglottic airway devices: Indications, contraindications and management. *Minerva Anestesiol*. 2018;84(3):389-397. doi:10.23736/S0375-9393.17.12112-7
34. Kluger MT, Culwick MD, Moore MR, Merry AF. Aspiration during anaesthesia in the first 4000 incidents reported to webAIRS. *Anaesth Intensive Care*. 2019;47(5):442-451. doi:10.1177/0310057X19854456
35. Patel S, Wali A. Airway Management of the Obstetric Patient. *Curr Anesthesiol Rep*. 2020;(10):350-360. doi:10.1007/s40140-020-00422-5/Published
36. Hammer M, Santer P, Schaefer MS, et al. Supraglottic airway device versus tracheal intubation and the risk of emergent postoperative intubation after general anaesthesia in adults: a retrospective cohort study. *Br J Anaesth*. 2021;126(3):738-745. doi:10.1016/j.bja.2020.10.040
37. Lucas DN, Yentis SM, Kinsella SM, et al. Urgency of caesarean section: A new classification. *J R Soc Med*. 2000;93(7):346-350. doi:10.1177/014107680009300703
38. Gibbs NM, Culwick M, Merry AF. A Cross-sectional Overview of the First 4,000 Incidents Reported to webAIRS, a De-identified Web-based Anaesthesia Incident Reporting System in Australia and New Zealand. *Anaesth Intensive Care*. 2017;45(1):28-35. doi:10.1177/0310057X1704500105