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RESEARCH ARTICLE

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Use of view-adjustable video laryngeal mask versus endotracheal intubation for airway management during anaesthesia for arthroscopic surgery: a randomized trial

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ABSTRACT

Introduction: The objective of this study was to compare the practicality and efficacy of utilizing a view-adjustable video laryngeal mask (SafeLM) versus endotracheal intubation (ETI) in the context of arthroscopic shoulder surgery.

Patients and Methods: A randomized controlled trial enrolled 100 patients undergoing arthroscopic shoulder surgery, randomly assigned to the SafeLM group (n = 50) or ETI group (n = 50). The primary outcome measure was hemodynamic parameters, while mechanical ventilation parameters, complications, and the quality of anaesthesia recovery were considered as secondary outcomes. These parameters were then compared between the two groups.

Results: During the intubation and extubation procedures, the SafeLM group demonstrated significantly lower mean arterial pressure and heart rate compared to the ETI group ($p<0.001$). Furthermore, the airway pressure at T_2 and T_3 was notably lower in the SafeLM group compared to the ETI group ($p<0.001$). However, there were no statistically significant differences in oxygen saturation observed between the two groups at any time point. Both groups were equally capable of quickly establishing a surgical airway when necessary. Notably, a smaller proportion of patients in the SafeLM group exhibited negative reactions during tube removal. Additionally, there was a statistically significant difference in the occurrence of post-operative sore throat, difficulty swallowing, choking, and coughing between the two groups ($p<0.001$).

Conclusions: The utilization of SafeLM may result in enhanced regulation of blood pressure and heart rate among patients who undergo arthroscopic surgery for the shoulder while in the side decubitus position.

HIGHLIGHTS

1. Compared with endotracheal intubation (ETI) group, view-adjustable video laryngeal mask (SafeLM) group had smaller changes in mean arterial pressure (MAP) and heart rate (HR) during the intubation and extubation phase ($p<0.001$).
2. In supine and lateral decubitus position, the airway pressure (AP) in the SafeLM group is significantly lower than in the ETI group ($p<0.001$).
3. There were no statistically significant differences in oxygen saturation (SPO_2) observed between the two groups at any time point during the surgical procedure ($p>0.050$).
4. During the extubation phase, cough choking was significantly lower in the SafeLM group than in the ETI group ($p<0.001$).
5. Compared with endotracheal intubation (ETI) group, the occurrence of post-operative sore throat, difficulty swallowing, choking, and coughing in the SafeLM group are significantly lower than in the ETI group ($p<0.001$).
6. Compared with endotracheal intubation (ETI) group, patients in the SafeLM group being more satisfied ($p<0.001$).

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Introduction

Arthroscopic shoulder surgery is a minimally invasive procedure that's become a standard approach for diagnosing and treating various shoulder joint issues. Compared with open surgery, shoulder arthroscopy has obvious advantages such as less trauma, high accuracy, strong pertinence, quick postoperative recovery, and short hospital stay [1]. Endotracheal intubation (ETT) is the gold standard for airway management. However, the intubation and extubation process can irritate the throat and vocal cords, causing fluctuations in blood pressure and heart rate [2]. Patients with heart conditions are more susceptible to these circulatory changes during surgery. Any event that destabilizes the cardiovascular system can have severe consequences. Therefore, anaesthesiologists should reduce these risks, especially during the induction and extubation phases.

In clinical practice, various techniques are utilized to alleviate or manage cardiovascular stress and airway responses during intubation and extubation procedures. These methods encompass the administration of vasoactive drugs, such as esmolol or labetalol, the utilization of topical anaesthesia on the throat and trachea, blockade of the superior laryngeal nerve, augmentation of anaesthetic dosages, deepening the anaesthesia level, or the selection of appropriate airway management devices, such as the laryngeal mask airway (LMA) [3].

LMA has established itself as an invaluable tool in the realm of anaesthesia management, demonstrating safety and effectiveness in ensuring both spontaneous and controlled ventilation across a variety of surgical disciplines, including endoscopic, orthopaedic, thyroid, and neurosurgery, as well as in procedures extending beyond two hours in duration. This broad application underscores the versatility and reliability of the LMA in diverse surgical settings [4–6]. The view-adjustable video laryngeal mask (SafeLM) disposable laryngeal mask represents a significant innovation in the field of anaesthesia management by integrating tracheal intubation, oesophageal drainage, adjustable viewing angles, and continuous visibility into a single device. This latest domestically produced visual laryngeal mask, with its unique design, offers doctors a more convenient and safer airway management solution during various surgeries.

Currently, there is no published literature on the use of the SafeLM for arthroscopic shoulder surgery in the lateral position. Therefore, the aim of this clinical trial was to comparatively investigate the feasibility and efficacy of SafeLM use with endotracheal intubation (ETI) during arthroscopic shoulder surgery in the lateral decubitus position.

Patients and methods

Study participants

The inclusion criteria were as follows: 1) American Society of Anaesthesiology (ASA) physical status I–II; 2) 18–65 years of age; 3) Mallampati I to II patients with normal cognitive status; 4) active cooperation; 5) general anaesthesia; and 6) scheduled for arthroscopic shoulder surgery in lateral position between May 2023 and September 2023. Exclusion criteria: patients with cardiac dysfunction, moderate to severe ventilation dysfunction, reflux, aspiration risk factors and other conjunctive laryngeal mask use, patients with a history of difficult airway, restricted mouth opening, and limited neck movement. The patients were randomized to the SafeLM or ETI groups based on a random number table generated by a computer. The flow diagram of the study selection process was shown in Figure 1.

Study design and anaesthetic management

This was a randomized, single-blind, controlled trial. Patients receiving arthroscopic shoulder surgery in lateral decubitus position by the same surgeons were enrolled blindly. Two seniors anaesthetists and one experienced resident performed all anaesthesia operations. Postoperative data were collected by blinded researchers.

Patients fasted 8 h and abstained from drinking 4 h before surgery. Venous access was established 30 min prior. All patients were treated with general anaesthesia combined with interscalene brachial plexus block, which can provide good intraoperative and postoperative analgesia, intraoperative blood pressure control, and reduce stress response. Brachial plexus nerve block was performed using an ultrasound-guided intramuscular groove approach with 20 ml of 0.25% ropivacaine. Electrocardiography (ECG), oxygen saturation (SPO_2), mean arterial pressure (MAP), heart rate (HR), and bispectral index (BIS) were monitored.

Anaesthesia was induced with intravenous infusion of sufentanil, etomidate, and propofol. After unconsciousness and BIS (BISx®, Aspect Medical Systems, Inc., Norwood, MA, USA) ≤60, cisatracurium was intravenously administered for tracheal intubation or SafeLM insertion. SafeLM or ETI was inserted by the anaesthesiologist. Mechanical ventilation parameters were set to maintain $PetCO_2$ at 35–40 mmHg. Propofol and remifentanil were injected intravenously during

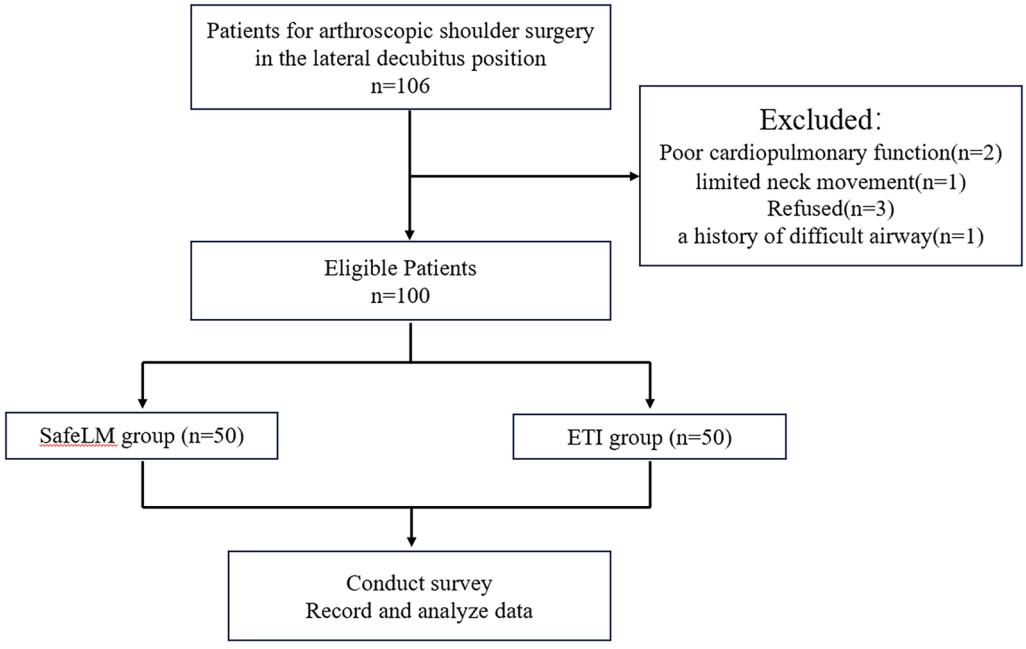

Figure 1. Flow diagram of the study selection process. SafeLM, view-adjustable video laryngeal mask; ETI, endotracheal intubation.

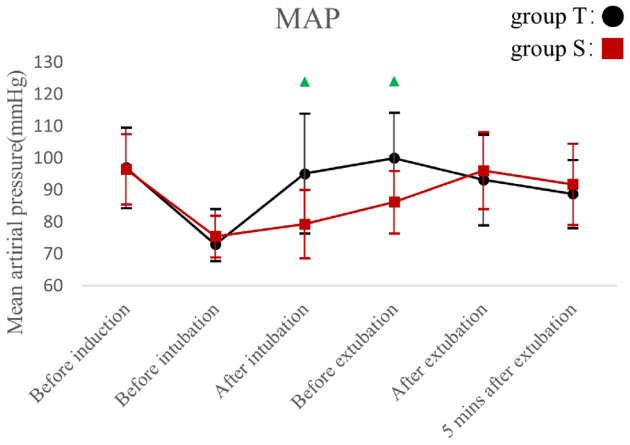

Figure 2. MAP at different time points in the SafeLM and ETI groups. ▲ $p < 0.001$ versus the ETI group. MAP, mean arterial pressure; SafeLM, view-adjustable video laryngeal mask; ETI, endotracheal intubation.

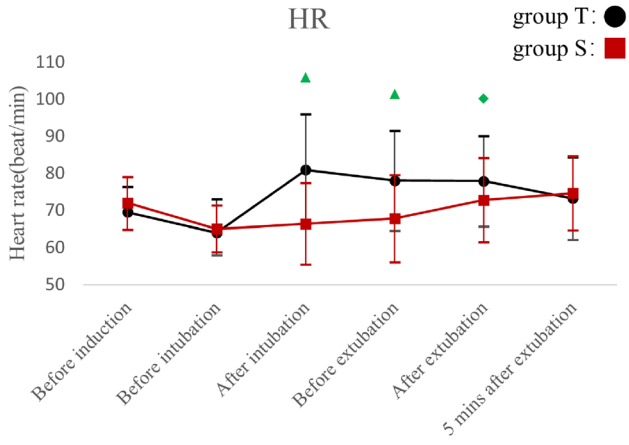

Figure 3. HR at different time points in the SafeLM and ETI groups. ▲ $p < 0.050$ and ▲ $p < 0.001$ versus the ETI group, respectively. HR, heart rate; SafeLM, view-adjustable video laryngeal mask; ETI, endotracheal intubation.

surgery, dosage adjusted to maintain BIS 40–60. If intraoperative HR ≤50 beats/min, atropine was injected intravenously. If MAP reduction exceeded 20% of baseline, phenylephrine hydrochloride was intravenously administered. Lactated Ringer's solution and hydroxyethyl starch 130/0.4 were intravenously infused to replace fluid and blood losses.

The score for glottic counterpoint in the SafeLM group was recorded in both supine and lateral positions, in accordance with the endoscopic view grading system (EVGS), which aligns with the Cormack and Lehane grading system for laryngoscopic view. Specifically, grade 1 represented a complete view of the glottis aperture, assigned a score of 4 points; grade 2 denoted a partial view of the glottis aperture, awarded 3 points; grade 3 corresponded to a view of the free edge or ventral face of the epiglottis, assigned 2 points; and grade 4 indicated an unrecognizable structure or whiteout screen, awarded 1 point [7].

The spontaneous breathing pattern of patients was used to measure oropharyngeal leakage pressure (OLP) in the SafeLM group. In manual ventilation mode, the APL valve was set to 40 cmH_2O and oxygen flow to 6 L/min. OLP was recorded when leakage

sound occurred. If OLP exceeded 40 cmH_2O without leakage, measurement stopped, and airway sealed pressure was noted as 40 cmH_2O [8]. After pressure measurement, intermittent positive-pressure ventilation was initiated with anaesthesia machine. SafeLM cuff was inflated with recommended air volumes (20, 30, 40 mL for sizes 3, 4, 5), and tracheal balloon inflated to 25–30 cmH_2O (measured by balloon manometer). Airway pressure (AP) was recorded again in both groups while in the lateral position.

Airway devices were removed from the operating room when consciousness, airway reflexes, muscle tension, and spontaneous respiration returned to normal ($PetCO_2$ 7 mL/kg). Patients were then transferred to the PACU for observation. No analgesics or tranquilizers were administered during recovery.

Measurements

Clinical variables included hemodynamic parameters (MAP as primary outcome, HR as secondary), ventilation parameters, insertion parameters, surgical parameters, and postoperative reactions. Hemodynamic parameters were monitored continuously using an anaesthesia monitor (Bene View T8). Parameters were recorded at multiple time points: before anaesthesia induction (T0), before intubation (T1), after intubation (T2), spontaneous breathing recovery (T3), after extubation (T4), and 10 min later (T5). Vasoactive drug use was recorded, with intravenous infusions used to treat hypertension or tachycardia.

Ventilation parameters, including minute ventilation and AP, were recorded after intubation and lateral positioning. Insertion parameters encompassed success rates (first, adjusted first, and second), OLP and glottic counterpoint scores in supine and lateral position for the SafeLM group. Anaesthesia recovery quality was assessed by extubation time, coughing grade during extubation, post-surgical sore throat cases, and visual analog scale (VAS) scores 2 h post-surgery. Postoperative reactions were evaluated based on nausea/vomiting cases, intraoperative awareness, hypoxia, and pulmonary atelectasis.

Statistical analysis

The group sample size was calculated as 42 per group (42 in the SafeLM group and 42 in the ETI group because it would provide 80% power to reject the null hypothesis of equal means when the mean difference is −8 (83–91) with standard deviations of 13 for SafeLM group and 13 for the ETI group at a two-sided alpha of 0.05. With an anticipated dropout rate of 15%, the total sample size required was 100 (50 in the SafeLM group; 50 in the ETI group).

Statistical analysis was conducted using SPSS 21.0. Measurement data with normal distribution were represented by mean ± standard deviation and analyzed by ANOVA (surgical, insertion, and postoperative recovery times). Discrete data were analyzed using $\chi 2$ test or Fisher's exact probability test (sex, success rates, and complications). A significant *p*-value was set at <0.050.

Results

Demographic and anaesthesia data

One hundred patients were randomized into the SafeLM or ETI group ($n = 50$ per group). Patients in both groups were successfully intubated once. Table 1 presents the demographic data, including sex, age, and body mass index (BMI), as well as surgical details. There was no statistically significant difference in the basic data between the two groups.

Intraoperative fluctuations of MAP and HR

MAP and HR were significantly different between the two groups at T_2 and T_4 (all $p < 0.001$). HR was also significantly different between the two groups at T_5 ($p < 0.050$). At the remaining time points observed, MAP and HR were not statistically different between the groups (Figures 2 and 3). Three patients received esmolol and four received nicardipine during anaesthesia induction in ETI group. One patient received nicardipine during anaesthesia induction in SafeLM group. One patient received esmolol and one received nicardipine during anaesthesia recovery in ETI group. (Table 1).

Insertion related parameters

There was a significant difference between the two groups in the time from the start of general anaesthesia induction to the successful establishment of the airway($p < 0.001$). It is used for a shorter time in the SafeLM group(Table 1). The success rate of the first insertion between the two groups was not statistically significant, with both groups achieving a rate of 100%. Furthermore, in the SafeLM group, there was no difference in the glottic counterpoint score and OLP between the supine and lateral positions (Table 2).

Intraoperative ventilation parameters

At T_2 and T_3, there was a statistically significant difference in AP between the two groups ($p < 0.050$). Specifically, when compared to the ETI group, the AP levels in the SafeLM group were marginally lower. SPO_2 levels in both groups remained consistent and did not exhibit any noteworthy variations between the groups at any given time point ($p > 0.050$). The detailed numerical data are presented in Table 3.

Table 1. Demographic data and surgery details in the SafeLM and ETI groups.

	SafeLM group ($n = 50$)	ETI group ($n = 50$)	$T/\chi^2/F$	p-value
Age (years)	50.9 ± 9.9	49.7 ± 9.4	−0.621	0.536
Sex (M/F)	24/26	23/27	0.040	0.841
BMI (kg/m^2)	24.7 ± 3.5	25.1 ± 3.3	0.662	0.509
ASA grade				
I ~ II	50 (100.0%)	49 (98.0%)	0.364	1.233
III	0 (0.0)	1 (2.0%)	--	--
Medical History				
Hypertension	8 (16.0%)	9 (18.0%)	0.878	0.568
Diabetes	6 (12.0%)	4 (8.0%)	0.996	0.449
Ventricular premature beats	0 (0.0)	1 (2.0%)	--	--
Application of vasoactive drug (cases) (esmolol/nicardipine)	0/1	4/5	/	/
Airway establishment time	3 (3, 4)	3 (2, 3)	/	0.000
Duration of anesthesia (minutes)	110.8 ± 23.8	103.3 ± 23.4	−1.585	0.116
Duration of operation (minutes)	67.5 ± 22.5	67.3 ± 22.0	−0.045	0.964

SafeLM: View-adjustable video laryngeal mask; ETI: endotracheal intubation; BMI: body mass index.

Table 2. Comparison of position change of view-adjustable laryngeal mask in SafeLM group.

	Glottic counterpoint score (median (Q1, Q3))	OLP (median (Q1, Q3), (cmH_2O))
Supine position	4 (3.75, 4)	30 (26.75, 34)
Lateral position	4 (3, 4)	28 (25, 32.25)
P-value	0.865	0.064

SafeLM, view-adjustable video laryngeal mask; OLP, oropharyngeal leakage pressure.

Anaesthesia and postoperative recovery

Compared with the SafeLM group, the ETI group had a higher probability of coughing during extubating ($p < 0.001$). The number of patients with sore throat when swallowing ($n = 32$) was significantly higher in the ETI group ($p < 0.001$) than in the SafeLM group ($n = 14$). After a surgical procedure, it was observed that the VAS score for throat discomfort upon swallowing was notably elevated in the ETI group compared to the SafeLM group, reaching statistical significance at the 2-hour mark ($p < 0.001$). Additionally, during the removal of the tracheal catheter, bloody discharge was noted around the capsule in four patients belonging to the ETI group and in one patient from the SafeLM group. The incidences of other adverse reactions, such as nausea and vomiting, intraoperative awareness, dysphagia, and hypoxaemia, were no significant difference between the two groups. There was also a difference in patient satisfaction between the two groups, with patients in the SafeLM group being more satisfied ($p < 0.001$; Table 4).

Discussion

Our findings suggest that there were statistically significant differences in MAP and HR between patients in SafeLM group at critical moments of intubation and extubation compared with those in ETI group ($p < 0.001$). This means that SafeLM has less of an impact on the patient's circulation than ETI. The process of intubation and extubation is prone to irritation of the pharynx and voice valves, leading to fluctuations in blood pressure and HR [9]. The LMA serves as a compensation for the constraints related to tracheal intubation. Its design, tailored to the anatomy of the human pharynx, ensures that the glottis remains shielded, minimizing irritation during both insertion and removal. Its widespread utilization in surgical procedures is attributed to its user-friendly operation, robust reliability, and minimal irritation to the pharynx [10–12]. Numerous studies have consistently affirmed the safety and efficacy of LMA usage [4,6]. Some

Table 3. Comparison of the ventilation parameters between the SafeLM and ETI groups.

	AP (median (Q_1, Q_3), (cmH_2O))		SpO_2(median (Q1, Q3), %)					
	Supine position	Lateral position	T_0	T_1	T_2	T_3	T_4	T_5
ETI group ($n = 50$)	15 (14, 17)	17 (16, 19)	98 (97, 99)	100 (99, 100)	100 (99, 100)	100 (99, 100)	100 (99, 100)	97 (96, 100)
SafeLM group ($n = 50$)	14 (12, 15.25)	15 (14, 17)	98 (96, 99)	100 (99, 100)	100 (99, 100)	100 (99, 100)	99 (98, 100)	98 (96, 99.25)
P-value	<0.001	<0.001	0.553	0.158	0.791	0.472	0.061	0.609

SafeLM, view-adjustable video laryngeal mask; ETI, endotracheal intubation; AP, air pressure; T_0: before anaesthesia induction; T_1: before intubation; T_2: after intubation; T_3: spontaneous breathing recovery; T_4: after extubating; T_5: 10 min after extubating.

Table 4. Comparison of the quality of anaesthesia and postoperative recovery between the SafeLM and ETI groups.

	Coughing grade during resuscitation				Number of cases of sore throat 2 h after surgery(cases)	Pain score for pharyngeal swallowing 2 h after surgery (mean (Q1, Q3))	Dysphagia (cases)	Bloody globular discharge (cases)	Hoarse (cases)	Nausea and vomiting (cases)	Patient satisfaction score (mean (Q1, Q3))
	I	II	III	IV							
ETI group ($n=50$)	5	13	28	4	32	1.5(0,3)	0	4	0	0	9(8,10)
SafeLM group ($n=50$)	46	4	0	0	14	0(0,1.25)	0	1	0	0	10(9,10)
χ^2	/				13.04	/	/	/	/	/	/
P-value	<0.001				<0.001	0.001	<0.001	0.362	<0.001	<0.001	<0.001

SafeLM, view-adjustable video laryngeal mask; ETI, endotracheal intubation.

studies have shown that the use of laryngeal masks had a lower effect on postoperative complications in elderly patients than the use of tracheal catheters [13,14]. The results of these studies on LMA are consistent with the results of our studies on SafeLM.

Hemodynamic fluctuations generated by the use of different ventilation tools might be clinically significant in patients who have concomitant cardiovascular or cerebrovascular diseases [2]. However, this study did not involve such populations, and further exploration of the application value for these patients and critically ill patients requires additional randomized controlled trials (RCTs). Nevertheless, this study suggests that for patients with ASA grades I to II, the use of vasopressor drugs was relatively lower in the SafeLMA group compared to the ETI group. This might indicate a greater advantage in using the SafeLM for such patients.

Main factors affecting respiratory parameters during surgery are age, respiratory diseases, surgical method, surgical position, and ventilation method [15–19]. To minimize confounding factors, we used data from patients aged 18–65 with surgical duration <4h, no respiratory complications, and no excessive twisting of the head or neck. In our study, the first intubation attempt was successful in both groups due to experienced anaesthesiologists performing the procedures.

An oropharyngeal leak pressure (OLP) of ≥20 cmH_2O related to the use of Laryngeal Mask Airway (LMA) is considered safe and effective for mechanical ventilation in most patients [20]. In our study, the average OLP of the SafeLM group exceeded 20 cmH_2O, indicating its reliability. The stability of the LMA's position is crucial for safe ventilation, as changes in the surgical position can easily alter the LMA's placement. However, some studies have shown that ventilation through the laryngeal mask remains safe even when switching from a supine to a lateral position [21,22]. In our research, there was no difference in the glottic alignment scores and OLP between the supine and lateral positions within the SafeLM group. Moreover, at the same body position, the airway pressure (AP) in the SafeLM group at time T_3 was significantly lower than in the Endotracheal Intubation (ETI) group, showcasing a clear clinical application advantage. Notably, the SafeLM group experienced no incidents of transient leakage throughout the surgery.

The SafeLM group had lower cough incidence and VAS score for postoperative sore throat compared to the ETI group. Sore throat is a significant adverse reaction after general anaesthesia, affecting recovery, satisfaction, and medical disputes [23]. In this study, the SafeLM group had significantly lower sore throat incidence during swallowing compared to the ETI group, consistent with previous studies. The ETI group had a higher coughing probability during extubation and lower patient satisfaction scores.

The advent of the SafeLM, a Chinese-engineered device, marks a significant leap in medical technology, particularly in the realm of airway management. Unlike traditional LMAs, the SafeLM is visibility during the laryngeal mask placement process. The video guidance feature allows operators to accurately position the laryngeal mask, thereby minimizing potential damage and irritation to the epiglottis, larynx, and adjacent soft tissues. Additionally, the device's adjustable viewing angle broadens the scope of observation, reducing the likelihood of air leakage and airway obstruction by confirming proper mask positioning and averting blockages from the epiglottis and other tissues. Moreover, the SafeLM facilitates the early detection and management of secretions, thereby diminishing the risk of aspiration. Its adaptability proves advantageous in emergencies or instances of difficult intubation, allowing for an initial insertion of the laryngeal mask followed by visual-guided intubation without compromising patient oxygenation. The device's operational prowess is further augmented by automatic video storage and wireless connectivity to computers, streamlining the process for educational purposes. Overall, the SafeLM stands out as a more convenient,

safe, and reliable alternative to traditional LMAs, heralding a new era in airway management.

Despite the promising capabilities of the SafeLM, its application in surgeries conducted in the lateral decubitus position remains undocumented. To address this gap, an investigation into its efficacy and feasibility during arthroscopic shoulder surgery can provide valuable insights.

This study has the following limitations: first, this study only confirmed the application of SafeLM in low-risk adult patients, but the ventilation effect of shoulder arthroscopic surgery in patients with difficult airway still needs to be verified, and the results of this study cannot be extruded to children. Second, this study was only single-blind, and the anaesthesiologist responsible for laryngeal mask placement knew the laryngeal mask type, which might cause observer bias. Finally, SafeLM is intubated laryngeal mask, this study only compared its ventilation function, and its function of guiding tracheal intubation needs further study. In addition, before the study, we calculated the sample size to be 40 per group based on relevant research results. After the study started, we recalculated the sample size to 50 per group based on the collected data. Therefore, we are here to explain why the sample size in the manuscript is not exactly consistent with the sample size in the clinical registration.

Conclusion

In summary, the findings of this study indicate that SafeLM is capable of maintaining hemodynamic stability in ASA I~II patients undergoing shoulder arthroscopy in the lateral position. Therefore, from the perspectives of patient safety and comfort, SafeLM can serve as an alternative to tracheal intubation for this population.

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Study design: Hong Zeng, Chun-Jing Geng, Guang-Lei Su.

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Data analysis: Ying Deng, Zhukai Cong.

Data interpretation: Hong Zeng, Chun-Jing Geng, Guang-Lei Su.

Drafting of article: Chun-Jing Geng, Guang-Lei Su.

Review & editing: Hong Zeng.

All authors have read and approved the final work.

Ethical approval

This study was approved by the Institutional Review Board and Ethics Committee of Peking University Third Hospital (LM2022760). The study adheres to the Declaration of Helsinki. Written informed consent was obtained from all patients. The trial was registered at https://www.chictr.org.cn/ (ChiCTR2300071058).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The data that support the results of this study is available from the authors upon reasonable request and with permission of Peking University Third Hospital.

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Supraglottic Airway Devices (SADs) and Laparoscopic Surgery

by Shauna Schwartz, DO, and Yong G. Peng, MD, PhD, FASE, FASA

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Supraglottic airway devices (SADs) continue to gain popularity and are increasingly used in anesthetic practices. However, the efficacy and safety of SADs for laparoscopic surgery are disputed. Although not traditionally used in laparoscopic surgery, SADs offer several benefits for appropriately selected patients.

EVOLUTION OF THE SAD

Since the invention of the first SAD, the device has undergone several design advancements that improve its safety profile.[1] The classic laryngeal mask airway developed by Teleflex (Wayne, PA) was one of the first SADs.[1] It had a relatively simple design, but it revolutionized the concept of airway management as it allows for a hands-free approach to ventilation and bypasses upper airway obstruction relative to the facemask.[1] Innovation has led to the creation of second-generation SADs, which allow for higher oropharyngeal leak pressures.[1] This improvement allows for better protection against regurgitated gastric contents and reduces aspiration risk.[1-3] In addition, it allows for the delivery of more successful positive pressure ventilation.[1,2]

SUPRAGLOTTIC AIRWAY AND HEMODYNAMICS

One potential benefit of SADs in laparoscopic surgery is improved hemodynamic stability.[3-5] In a study that assessed hemodynamics and catecholamine levels in obese patients undergoing laparoscopic gastric banding, patients randomized to receive an endotracheal tube (ETT) rather than a SAD had higher blood pressure and higher circulating catecholamine levels throughout the procedure than those in the SAD group.[4] High catecholamine levels can increase a patient's heart rate, which may impair myocardial oxygen delivery.[4] They also lead to a prothrombotic state.[4] The increase of catecholamines can exacerbate perioperative complications; therefore, SADs are an appealing alternative in certain high-risk populations. Placement of the SAD leads to less sympathetic stimulation and has the potential to require less anesthesia, avoiding reductions in systemic vascular resistance and myocardial depression.[5-7] The combination of a catecholamine surge and increased anesthetic requirements for ETTs can further lead to hemodynamic alterations that may not be well tolerated in certain patient populations.

COMPARING SAD VS. ETT OUTCOMES

Another potential benefit of SADs over ETTs is that SADs may be associated with less airway morbidity than the ETT.[5,6,8,9] The incidence of sore throat in the ambulatory surgical setting was found to be 45.5% in patients with an ETT compared to 17.5% in patients with an SAD.[9] In a meta-analysis of randomized controlled trials comparing the SAD and ETT in patients undergoing elective laparoscopic surgery, there was a higher incidence of laryngospasm, dysphagia, dysphonia, sore throat, and hoarseness in the ETT group.[8] Similarly, pediatric patients undergoing anesthesia with recent upper respiratory infections are at an increased risk for respiratory complications, such as bronchospasm and laryngospasm with an ETT vs. a SAD.[6,10] When pediatric patients, aged 3 months to 16 years, with a recent upper respiratory infection were randomized to receive a SAD vs. ETT for their anesthetic for a variety of elective surgical procedures, the patients who had an ETT had an increased incidence of bronchospasm and desaturation, defined as SpO_2 <90% during airway management as compared to those patients who had a SAD.[6] There is a reduced rate of laryngospasm, cough, and desaturation in pediatric patients undergoing laparoscopic hernia repair with SAD placement when compared to ETT placement.[11] Data suggests that SAD may reduce the risk of perioperative respiratory complications, even in a high risk group for bronchospasm, laryngospasm, and desaturation.[6,11] Furthermore, studies mentioned above suggest reduced patient airway complaints associated with SADs as well as a reduction in airway complications.

The reductions in airway morbidity and fewer hemodynamic disturbances may contribute to earlier discharge times in patients who undergo airway management with SADs.[4] In a randomized controlled trial that assessed postanesthesia care unit (PACU) and hospital length of stay, patients who received a SAD during their anesthetic for laparoscopic gastric banding met PACU discharge criteria 17 minutes earlier than those patients who received an ETT for their anesthetic.[4]

SAD AND VENTILATION DURING PNEUMOPERITONEUM

One of the challenging aspects of laparoscopic surgery is pneumoperitoneum. The physiological changes associated with a pneu-

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moperitoneum may lead to increased abdominal pressure, reduced diaphragmatic excursion, and ultimately reduced respiratory compliance, which hinders the efficacy of ventilation and increases the likelihood of gastric regurgitation and the risk of aspiration.[3,12,13] However, newer SADs are designed to allow higher oropharyngeal leak pressure.[1,3,8] This is advantageous because it allows for improved ventilation, particularly when implementing positive pressure ventilation.[8,14] In a meta-analysis of randomized controlled trials comparing ETT to SAD in patients undergoing laparoscopic surgery, the studies found no difference in the incidence of oropharyngeal leak pressure or desaturation.[8] This suggests that effective ventilation is possible with SADs during pneumoperitoneum.[3,7,8,14-16] In another meta-analysis comparing randomized controlled trials, case-series, and large prospective observational studies, ventilation was found to be effective in 99.5% of patients with a SAD.[14] The only concerning subgroup of patients were those patients with BMI > 30 as they more likely to require ETT placement due to respiratory obstruction or an air leak.[14] These studies support the idea that adequate ventilation and oxygenation can be achieved while using a SAD for laparoscopic surgery in nonobese patients.

Another commonly cited disadvantage of SADs is gastric insufflation resulting from an insufficient adhesive seal.[5] With gastric insufflation there is a risk of aspiration,[5] which is one of the most cited contraindications for SAD placement, particularly in patients who are at increased risk (Table 1).[17] In patients with a high risk of aspiration, such as unfasted patients and those with a bowel obstruction, it is prudent to continue with ETT intubation. However, there are many studies with successful use of second-generation SADs in laparoscopic surgery without evidence of gastric insufflation or aspiration.[7,8,14] One of the greatest determinants of leak and gastric insufflation is the seal and positioning of the SAD.[3,5,18] When evaluated after gastric insufflation by a fiberoptic bronchoscope, 44% of first-generation SADs were found to be malpositioned.[18] However, properly positioned first-generation SADs showed only a 3% incidence of gastric insufflation.[18] Second-generation SADs were designed to reduce the risk of gastric insufflation by allowing for better seals and higher oropharyngeal leak pressures.[1,3,18] Thus, second-generation SADs reduce the potential risk of gastric reflux and aspiration when compared to first-generation SADs.[2,8,19] In addition, second-generation SADs are equipped with a gastric port that can drain gastric contents from the airway and serve as a conduit for gastric tube placement.[1,2] SADs have been successfully used without evidence of aspiration in appropriately selected patients undergoing laparoscopic surgery.[15]

Table 1: Patient Characteristics Indicating SAD Use[14,17,20]

Beneficial for:	Controversial for:	Contraindicated for:
• Fasted patients	• Patients with morbid obesity	• Unfasted patients
• Patients with a BMI <30	• Patients with a BMI >40	• Patients at high aspiration risk

BMI, body mass index; SAD, supraglottic airway device.

Table 2: Potential Benefits of SADs[1,2,4,6,9,17]

Potential Benefits	Added Potential Benefits of Second-generation SADs
• Reduced airway morbidity: sore throat, dysphagia, hoarseness	• Improved oropharyngeal leak pressure
• Improved hemodynamic stability	• Ability to provide PPV
• Reduced PACU and hospital stay	• Gastric drainage port
• Fewer respiratory complications	• Ability to pass orogastric tube

PACU, postanesthesia care unit; PPV, positive pressure ventilation; SAD, supraglottic airway device.

CONCLUSION

Second-generation SADs are a safe alternative for laparoscopic surgeries in appropriately selected patients. They are better than the first-generation SADs at protecting against gastric insufflation and aspiration. They also have improved ventilation that is effective even with pneumoperitoneum (Table 2). Anesthesia professionals may need to discontinue the use of first-generation devices in laparoscopic surgery due to the lower oropharyngeal leak pressures and increased incidence of gastric insufflation if improperly sealed. Otherwise, SADs may offer a variety of benefits over ETTs in laparoscopic surgery including improved hemodynamic stability, a reduced risk of perioperative respiratory complications, reduced airway morbidity, and they may even contribute to earlier hospital discharge. Second-generation SADs have many benefits that warrant their use in laparoscopic surgery.

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META-ANALYSIS

CME

Second-Generation Supraglottic Airway Devices Versus Endotracheal Intubation in Adults Undergoing Abdominopelvic Surgery: A Systematic Review and Meta-Analysis

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BACKGROUND: Second-generation supraglottic airway (SGA) devices are widely used, but thought to have inferior safety performance to endotracheal tubes (ETTs), but might be equally efficacious while improving patient-centered outcomes. We compared second-generation SGAs with ETTs for perioperative safety, efficacy, and quality of recovery in adults undergoing abdominopelvic surgery under general anesthesia. Our primary objective was to assess safety in the form of major airway complications. Secondary objectives were other safety, efficacy, and quality of recovery outcomes.
METHODS: We searched 4 databases for randomized controlled trials of adult patients having abdominopelvic surgery comparing second-generation SGAs and ETTs. After 2-person screening and data extraction, pairwise meta-analysis was conducted and the grading of recommendations, assessment, development, and evaluation (GRADE) approach was applied to assess the certainty of evidence.
RESULTS: A total of 51 studies, randomizing 5110 patients, were included. Second-generation SGAs significantly reduced the risk of major perioperative airway complications (risk ratio [RR], 0.41; 95% confidence interval [CI], 0.23–0.71; $P = .007$; low certainty), with no clear clinically relevant difference in regurgitation or pulmonary aspiration (low certainty). SGAs significantly increased the risk of inadequate ventilation (RR, 3.36; 95% CI, 1.43–7.89; $P = .011$; very low certainty); however, postoperative sore throat (RR, 0.52; 95% CI, 0.38–0.70; $P < .001$; moderate certainty), hoarseness (RR, 0.32; 95% CI, 0.231–0.48; $P < .001$; low certainty), coughing at the emergence of anesthesia (RR, 0.17; 95% CI, 0.08–0.36; $P < .001$; low certainty), and postoperative nausea and vomiting (RR, 0.64; 95% CI, 0.42–0.98; $P = .042$; very low certainty) were all less frequent with SGAs. No other clinically relevant differences were observed for other remaining outcomes.
CONCLUSIONS: Second-generation SGAs reduce the risk of major airway complications compared with ETTs in adults undergoing abdominopelvic procedures under general anesthesia, with no reported clinically relevant differences in the risk of regurgitation or pulmonary aspiration. Additionally, they improve the quality of postoperative recovery with lower risk of sore throat, hoarseness, and postoperative nausea and vomiting. These data provide an opportunity for clinicians to reassess the implications of conservative airway management, and potentially expand the role of second-generation SGAs in routine clinical practice. (Anesth Analg 2025;140:265–75)

KEY POINTS

- **Question:** Are second-generation supraglottic airway devices safer than endotracheal tubes for adults undergoing abdominopelvic procedures under general anesthesia?
- **Findings:** Second-generation supraglottic airway devices reduced the risk of major perioperative airway complications and improved quality of postoperative recovery in comparison with endotracheal tubes in adults undergoing elective abdominopelvic surgery under general anesthesia; although at the expense of an increased risk of inadequate ventilation.
- **Meaning:** Clinicians should consider second-generation supraglottic airway devices over endotracheal tubes for adult patients without risk factors for regurgitation or difficult airways undergoing abdominopelvic procedures under general anesthesia, when possible inadequate ventilation might be easily managed.

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Supraglottic airway (SGA) devices may reduce airway trauma, are easier to insert, and reduce the risks associated with tracheal intubation, potentially improving both efficacy of airway management and quality of postoperative recovery.[1–6] However, concerns have been raised regarding the risk of complications, such as laryngospasm, bronchospasm, hypoxemia, and pulmonary aspiration with such devices. Second generation of SGAs encompasses a set of devices designed to increase oropharyngeal seal and reduce the risk of gastroesophageal regurgitation as well as pulmonary aspiration.[7,8] A recent systematic review with network meta-analyses comparing different SGAs demonstrated differential performance between the devices with some second-generation SGAs increasing oropharyngeal seal in comparison with the LMA® Classic.[8] This increased oropharyngeal seal might therefore reduce the risk of regurgitation and pulmonary aspiration in comparison with first-generation SGAs and hence make the second-generation devices comparable to endotracheal tubes (ETTs) for efficacy of mechanical ventilation and risk of aspiration in patients undergoing general anesthesia.

These considerations have particular implications to patients having abdominopelvic surgery. This cohort is thought to be of higher risk of pulmonary aspiration, intraoperative abdominal manipulation could potentially impact efficacy of ventilation, yet simultaneously, both SGAs and ETT may be suitable in this setting. Clinicians may conservatively opt for ETTs, primarily citing comparative safety, as well as efficacy and patient-centered, quality of recovery outcomes.

To date, there has been no robust synthesis of data comparing second-generation SGAs with ETTs in the setting of abdominopelvic surgery. Therefore, we performed a systematic review and meta-analysis comparing these 2 types of device categories in adults undergoing general anesthesia for abdominopelvic surgery. We hypothesized that the second generation of SGAs might improve safety, efficacy, and quality of postoperative recovery compared with ETTs.

METHODS

Protocol and Registration

We adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, and the study protocol was prospectively published in INPLASY on September 8, 2022 (INPLASY202290041). No data were extracted or analyzed before protocol publication.

Eligibility Criteria

Inclusion criteria were as follows: randomized controlled trials; human patients aged ≥16 years undergoing abdominopelvic surgery under general anesthesia from any population (eg, general population, pregnant women, obese patients); data available on any outcome related to efficacy, safety, or patient outcomes. Safety outcomes were major airway complications (eg, laryngospasm, bronchospasm, and hypoxemia); risk of regurgitation (eg, gastric insufflation, regurgitation); and pulmonary aspiration. Efficacy outcomes sought included insertion performance (eg, first attempt success, failed insertion, and time to insertion) and ventilation efficacy (eg, leak pressure, leak fraction, and ventilation inadequacy). Patient-centered, quality of postoperative recovery outcomes included postoperative sore throat, hoarseness, and postoperative nausea and vomiting (PONV). We excluded studies where the data were not interpretable due to language restrictions; outcomes with no objective data presented (ie, effect sizes, measures of dispersion, frequency, etc); and studies with contradictory data.

Search Strategies

We searched PubMed, Embase, Web of Science, and Cochrane Central Register of Controlled Trials (CENTRAL) on June 30, 2022. We used keywords, Medical Subject Headings terms, and Boolean operators in various permutations seeking randomized controlled trials comparing second-generation SGAs and ETTs in patients having abdominopelvic surgery (see Supplemental Digital Content 1, Supplemental Appendix 1, http://links.lww.com/AA/E782).

Selection Process

References retrieved were imported to EPPI Reviewer Web (Beta)[9] for deduplication, title and abstract, and then full-text screening. Eligibility criteria were applied to select the studies to be included. Two reviewers independently performed title and abstract screening, full-text screening, risk of bias (RoB) assessment, and data extraction. An automated process was used for initial deduplication and a semiautomated process (manual screening supported by a machine learning algorithm)[10] used for the title and abstract screening, and full-text screening was manually performed. The results were compared, and disagreements were resolved by discussion and consensus reached between the reviewers. In the case of no consensus, another independent reviewer adjudicated. Authors were contacted 2 times over a month in cases of unclear or missing information. In the event of no response, then the missing outcomes or the study were excluded from analyses. Data were recorded in a Microsoft Excel spreadsheet (Microsoft, Inc). The form was piloted first in 5 of the included studies and then adjusted as required.

Data Collection

We collected data on author name; year of publication; country of origin; study population; patients' risk of regurgitation and aspiration; risk of difficult airway; type of surgery; nature of the procedure (elective versus urgent); interventions used; operator experience with the intervention; cuff pressures applied; tube size; tidal volume administered; and hypnotics, opioids, and neuromuscular blocking agents (NMBAs) used. A high risk of regurgitation was considered for patients with obesity and pregnant women. Operators were considered experienced with the device when they had used it more than 20 times or when stated as experienced by the study authors.

Outcomes

The primary outcome was a safety outcome, comprised of major airway complications, defined as laryngospasm, bronchospasm, or hypoxemia.

Secondary outcomes included efficacy, safety, and quality of postoperative recovery. Efficacy outcomes were related to insertion performance (eg, failed first attempt, failed insertion, and time to insertion) and ventilation efficacy (eg, leak pressure, leak fraction, and ventilation inadequacy). Secondary safety outcomes were risk of regurgitation and aspiration (eg, gastric insufflation, regurgitation, and aspiration). Outcome definitions were those used in each study. Quality of postoperative recovery was assessed through postoperative sore throat; hoarseness; dysphagia; tissue damage; PONV within 24 hours of the end of anesthesia; and abdominopelvic pain within 2 hours of the end of anesthesia.

Risk of Bias Within Studies

The RoB of each outcome from all studies was assessed according to the Cochrane RoB 2 tool.[11] Five domains are assessed through this tool: randomization process; deviation from intended intervention; missing outcome data; measurement of the outcome; and selection of reported results. This was performed for each included outcome, as well as an overall RoB assessment.

Data Synthesis

We collected means or medians, standard deviations or interquartile intervals or range, and total number of participants in each arm for the quantitative outcomes as well as the total number of participants and number of events in each arm for the qualitative outcomes. Medians (interquartile range, IQR [range]) were converted to mean (SD).[12,13]

Pairwise meta-analyses were conducted using the package "meta" from R software tools version 2023.06.2+561 (R Foundation for Statistical Computing). Data were summarized if there were at least 2 studies available. The dataset was published at Mendeley Data (https://data.mendeley.com/datasets/zxrjyvh66b/1). Per-protocol raw outcome data (ie, not precalculated effect sizes) were extracted or calculated from studies and summarized. Effect sizes, standard errors, and 95% confidence interval (CI) were estimated for each study. Forest plots of relative risk or mean difference were created for every outcome. Pooled effects were calculated from random-effects models (Sidik-Jonkman method with Hartung-Knapp adjustment) as there was qualitative heterogeneity among the included studies. The Peto's odds ratio (OR) method was also applied for a sensitivity analysis of low-incidence outcomes. Random-effects meta-analyses were conducted using a generalized linear mixed model to estimate event frequencies. A level of significance of 5% was considered to reject the null hypothesis of equivalence between the devices. Heterogeneity was also evaluated quantitatively by Cochran's Q test and I^2. Influence analyses were performed to assess the influence of each study on the pooled effects and the heterogeneity between studies as well as to evaluate the influence of outliers on the summarized results.[14]

We performed sensitivity analyses through meta-regression models accounting for operator experience with the second-generation SGA; study population; use of NMBA; RoB within the studies; and presence of outliers. Meta-regressions were conducted first using the metareg function from the meta package only if ≥10 studies were available and, when a significant influence was found, a subgroup meta-analysis was also performed to estimate the effect size, 95% CI and *P*-value when sufficient data were available.

Publication Bias

The small sample bias method was used to assess the risk of publication bias when 10 or more studies were available. Funnel plots were created and Egger's test of asymmetry was performed. The threshold of significance was set at $P < .1$ for this method as this test has low power. Duval and Tweedie's trim-and-fill procedure was applied to estimate bias-corrected effects.

Certainty of Evidence

We applied the grading of recommendations, assessment, development, and evaluation (GRADE) approach to assess the certainty of evidence for all outcomes.[15–17] This approach accounts for RoB in individual studies, heterogeneity between studies, indirectness of evidence, imprecision, and risk of publication bias.

RESULTS

Study Selection

Our initial search identified 28,827 articles. After deduplication, title, abstract, and full-text screening, we included 51 studies with 5110 patients for analysis (Figure 1). The full list of included studies is presented in Supplemental Digital Content 2, Supplemental Appendix 2, http://links.lww.com/AA/E783.

Study Characteristics

The studies involved adults from a general surgical population (30 studies; 2434 patients) undergoing mostly laparoscopic surgery; women undergoing gynecological procedures (14 studies; 1291 patients); pregnant women undergoing cesarean delivery (4 studies; 1140 patients); men undergoing laparoscopic radical prostatectomy (1 study; 50 patients); obese patients undergoing laparoscopic gastric banding (1 study; 75 patients); and elderly patients undergoing laparoscopic cholecystectomy (1 study; 120 patients). Forty-one studies included patients undergoing laparoscopic procedures; 4, laparotomies; 1, laparoscopy and laparotomy; 2, upper gastrointestinal endoscopy; and 3 studies did not provide enough information to allow classification. All studies included only elective procedures. Diverse anesthesia techniques were applied with different combinations of hypnotics, opioids, and NMBAs. Forty-one studies administered NMBAs for patients with second-generation SGAs; 5 did not use NMBAs; and 5 did not mention whether NMBAs were administered for these patients. Forty-seven studies administered NMBAs for patients with ETTs; 1 did not use

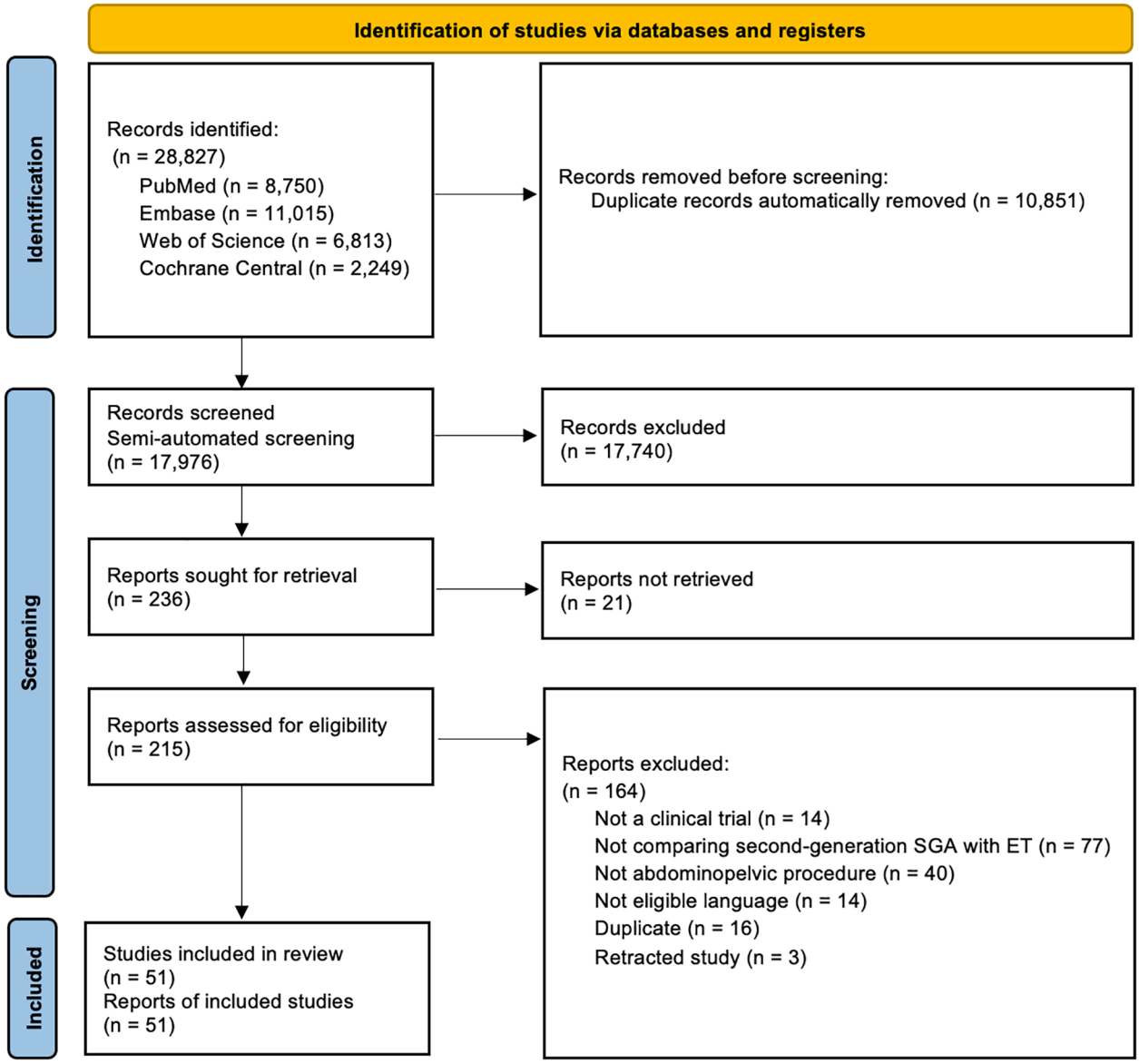

Figure 1. Review flow diagram. ET indicates endotracheal tube; SGA, supraglottic airway.

NMBAs for these patients; and 3 studies did not report whether using NMBAs. Only 3 studies provided information on comparative NMBA consumption, with 1 study showing significantly reduced use of NMBAs with the LMA® Proseal, while 2 studies did not find significant differences. Many studies did not provide data on use of drugs to reverse neuromuscular blockade. For those reporting (n = 19 studies), seventeen administered the same dose of neostigmine, sugammadex or pyridostigmine in both groups; 1 administered neostigmine only for intubated patients; and in 1 report it was unclear whether patients with SGAs also received neostigmine. Eleven different second-generation SGA devices were evaluated: Ambu Auragain; Baska Mask; Combitube; EasyTube; i-gel; Laryngeal Tube Suction II (LTS II); LMA Proseal; LMA Protector; streamlined liner of the pharynx airway (SLIPA); LMA Supreme, and Gastro-laryngeal Tube. Studies usually chose the SGA size based on manufacturer's recommendations and limited cuff pressure to 60 cmH_2O (maximum cuff pressure reported), whereas some studies have not reported this information. ETTs' internal sizes varied between 6.5 and 8.5 mm and their cuff pressure was usually limited to 20 to 30 cmH_2O. Tidal volumes applied varied between 6 and 10 mL/kg. Overall, studies planned to crossover the devices in case of failed insertion or inadequate ventilation. Nine studies reported need for tracheal intubation in patients assigned to SGAs (n = 35 patients). Two studies reported crossover from ETTs to SGAs (n = 2 patients). When cross-overs were due to fails, patients were included in the analyses of failed insertion; when cross-overs were due to inadequate ventilation, patients were included in the analyses of ventilation inadequacy. Most studies excluded patients with a history of gastroesophageal reflux, hiatus hernia, upper gastrointestinal surgeries, lack of adequate fasting time, and predictors of difficult airways. Twenty-five studies reported placement of gastric catheters and gastric suction in patients with SGAs, whereas 15 reported gastric catheters and gastric suction in patients with ETTs.

Risk of Bias

We assessed the RoB at the outcome level. A total of 366 outcome judgments were performed, with 71 (19.4%) regarded as high risk; 261 (71.3%) as having some concerns; and 34 (9.3%) as low risk of overall bias according to the RoB 2 tool. The major concerns were related to the randomization process, measurement of the outcome, and selection of reported results. Many reports were missing information on allocation concealment and prospectively published trial protocols. Others reported outcomes not presented in their protocols. A considerable number of outcomes had their data collected by unblinded assessors. A summary of RoB judgments is presented in Figure 2.

Safety

We have included 20 studies reporting data on major airway complications. Twelve studies found zero events in all arms and therefore were not included in the meta-analysis to estimate the risk ratio (RR). Second-generation SGAs significantly reduced the risk of major airway complications in comparison

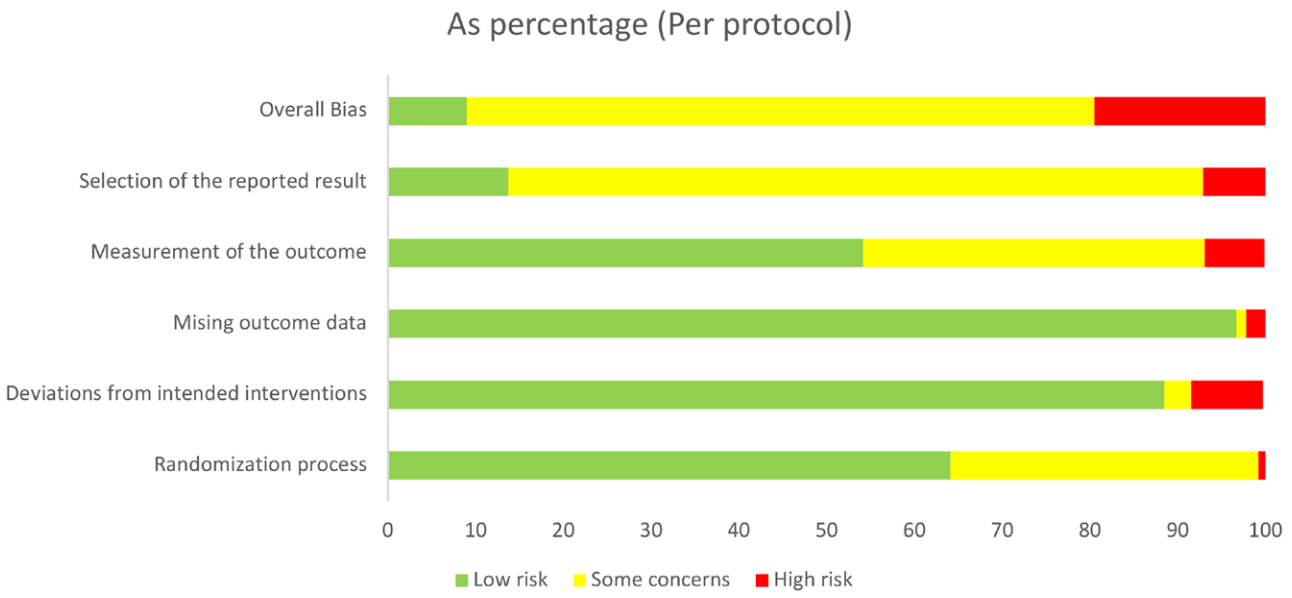

Figure 2. Risk of bias at study level according to Risk of Bias 2 tool: summary of judgments about each domain, presented as percentage across included studies.

with ETTs, with an RR of 0.41 (95% CI, 0.23–0.71 ; *P* = .007; 8 studies; 620 participants; I^2 = 0.0%; chi^2 - *P* = .942; GRADE = low certainty; Figure 3). The prediction interval (0.14–1.23) suggests the potential for future studies to lean towards favoring ETTs for major airway complications. Considering the concurrent low certainty of evidence, caution is advised in interpreting our results, acknowledging the inherent uncertainty in both our findings and inferences. The pooled probability (95% CI) of major airway complications with ETTs was 0.66% (0.15%–2.84%).

No statistically significant differences were observed between second-generation SGAs and ETTs for regurgitation or pulmonary aspiration (Table 1 and Figure 4). Twenty-four studies including 2591 participants presented data on regurgitation with zero events in both arms in 22 studies. One study reported 1 episode of regurgitation with second-generation SGAs and 2 with ETTs.[18] The remaining study injected 5 milliliters of methylene blue in the stomach and assessed regurgitation through bluish staining in the oropharynx, making it difficult to infer how clinically important the regurgitation episodes would have been.[19] This study reported 35 episodes of regurgitation with second-generation SGAs and 36 with ETTs. Of note, none of the included studies reported gastric content egression through the SGA's gastric access ports. Twenty-five studies including 2518 participants provided data on pulmonary aspiration with not a single event reported in any study, which hence prevented the performance of meta-analyses.

There was no statistically significant difference in gastric insufflation between second-generation SGAs and ETTs (RR, 2.06 [95% CI, 0.91–4.67]; *P* = .072; 6 studies; 490 participants; I^2 = 0.0%; *chi*2 - *P* = .675; GRADE = very low certainty). The pooled probability (95% CI) of gastric insufflation with ETTs was 0.13% (0.00%–4.56%) (Table 2).

Efficacy

There was no significant difference between second-generation SGAs and ETTs for failed first insertion attempt or failed insertion (Table 1 and Figure 4). However, second-generation SGAs had a statistically significant shorter time to insertion, though this difference was clinically unimportant (Table 1 and Supplemental Digital Content 3, Supplemental Figure 1, http://links.lww.com/AA/E784).

There was no significant difference in leak pressures or fractions (Table 1), but second-generation SGAs had an increased risk of inadequate ventilation compared with ETTs (RR, 3.36 [95% CI, 1.43–7.89]; *P* = .011). It was not possible to estimate the probability of inadequate ventilation with ETTs due to the scarcity of events. The pooled probability (95% CI) of inadequate ventilation with second-generation SGAs was 0.33% (0.06%–1.72%).

Patient-Centered Quality of Recovery Outcomes

Second-generation SGAs significantly reduced the risk of sore throat in comparison with ETTs (RR, 0.52 [95% CI, 0.38–0.70]; *P* < .001); hoarseness (RR, 0.32 [95% CI, 0.21–0.48]; *P* < .001); and PONV (RR, 0.64 [95% CI, 0.42–0.98]; *P* = .042). Coughing at emergence of anesthesia was also significantly reduced in patients receiving SGAs than ETT (RR, 0.17 [95% CI, 0.08–0.36]; *P* < .001). However, there was no statistically significant difference between them for dysphagia or mucosal and soft tissue damage (Table 1 and Figure 4).

Sensitivity and Subgroup Analyses

The results for sore throat were sensitive only to population, with pregnant women benefiting further in relation to the overall results (RR, 0.22 [95% CI, 0.05–0.97]; *P* = .012) and a single study showing that males have a higher risk of sore throat with

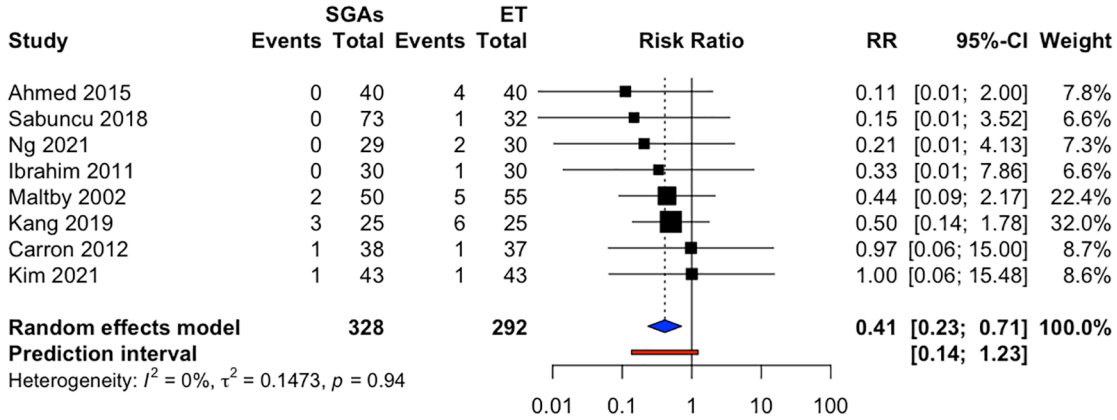

Figure 3. Forest plot with the results of the individual studies and their summarization comparing second-generation SGA devices with endotracheal tubes for major airway complications in adults aged ≥16 y undergoing abdominopelvic procedures under general anesthesia. 95% CI indicates 95% confidence interval; ETTs, endotracheal tubes; RR, risk ratio; SGAs, supraglottic airway.

Table 1. Summary of Findings of the Pairwise Analyses Comparing Second-Generation Supraglottic Airways and Endotracheal Tubes for 19 Outcomes in Adults Aged ≥16 y Undergoing General Anesthesia for Abdominopelvic Surgeries

Estimates of effects, CIs, and certainty of evidence
Patient or population: Adults
Interventions: Second-generation supraglottic airway devices
Comparator (reference): Endotracheal tubes
Setting: Operating theater

Outcomes	Effect size (95% CI)	*P*-value	Certainty of evidence
Major airway complications (8 RCT; 620 participants)	RR 0.41 (0.23–0.71)	.007	⊕⊕◯◯ Low Due to within-study bias and publication bias
Regurgitation (24 RCT; 2591 participants)	RR 0.96 (0.26–3.56)	.741	⊕⊕◯◯ Low Due to within-study bias and imprecision
Aspiration (25 RCT; 2518 participants)	No event	No event	No event
Gastric insufflation (6 RCT; 490 participants)	RR 2.06 (0.91–4.67)	.072	⊕◯◯◯ Very low Due to within-study bias, imprecision, and publication bias
Failed first attempt (28 RCT; 3344 participants)	RR 1.19 (0.77–1.86)	.421	⊕⊕◯◯ Low Due to within-study bias and imprecision
Failed insertion (11 RCT; 1065 participants)	RR 2.02 (0.82–5.03)	.115	⊕⊕◯◯ Low Due to within-study bias and imprecision
Leak pressure, cmH_2O (2 RCT; 1120 participants)	MD 0.00 (-1.76 to 1.75)	.997	⊕⊕◯◯ Low Due to within-study bias and publication bias
Leak fraction, % (4 RCT; 235 participants)	MD 2.18 (-0.24 to 4.60)	.077	⊕⊕◯◯ Low Due to within-study bias and publication bias
Inadequate ventilation (9 RCT; 706 participants)	RR 3.36 (1.43–7.89)	.011	⊕◯◯◯ Very low Due to within-study bias, heterogeneity, and imprecision
Sore throat (34 RCT; 3719 participants)	RR 0.52 (0.38–0.70)	<.001	⊕⊕⊕◯ Moderate Due to heterogeneity
Hoarseness (18 RCT; 1710 participants)	RR 0.32 (0.21–0.48)	<.001	⊕⊕◯◯ Low Due to heterogeneity and publication bias
PONV within 24 h (13 RCT; 1060 participants)	RR 0.64 (0.42–0.98)	.042	⊕◯◯◯ Very low Due to heterogeneity, imprecision, and publication bias
Cough at emergence of anesthesia (10 RCT; 769 participants)	RR 0.17 (0.08–0.36)	<.001	⊕⊕◯◯ Low Due to within-study bias and heterogeneity
Dysphagia (12 RCT; 1224 participants)	RR 0.81 (0.39–1.69)	.544	⊕◯◯◯ Very low Due to within-study bias, heterogeneity, and imprecision
Tissue damage (23 RCT; 2666 participants)	RR 1.06 (0.68–1.65)	.792	⊕⊕◯◯ Low Due to within-study bias and imprecision
Abdominopelvic pain within 2 h (6 RCT; 520 participants)	MD -0.34 (-0.86 to 0.17)	.193	⊕⊕⊕◯ Moderate Due to heterogeneity
Time to insertion (22 RCT; 2925 participants)	MD -12.78 (-17.53 to -8.03)	<.001	⊕⊕◯◯ Low Due to within-study bias and heterogeneity
Heart rate within 1 min from device insertion, bpm (14 RCT; 1148 participants)	MD -8.66 (-14.25 to -3.08)	.002	⊕◯◯◯ Very low Due to within-study bias, heterogeneity, and imprecision
Mean arterial pressure within 1 min from device insertion; mm Hg (8 RCT; 537 participants)	MD -2.49 (-7.43 to 2.44)	.322	⊕◯◯◯ Very low Due to within-study bias, heterogeneity, and imprecision

Certainty of evidence was judged based on GRADE approach. Abdominopelvic pain was measured in a 0–10 scale. It was not possible to perform meta-analysis for aspiration as there was no event reported.
Abbreviations: CI, confidence interval; GRADE, grading of recommendations, assessment, development, and evaluation; MD, mean difference; PONV, postoperative nausea and vomiting; RCT, randomized controlled trial; RR, risk ratio.

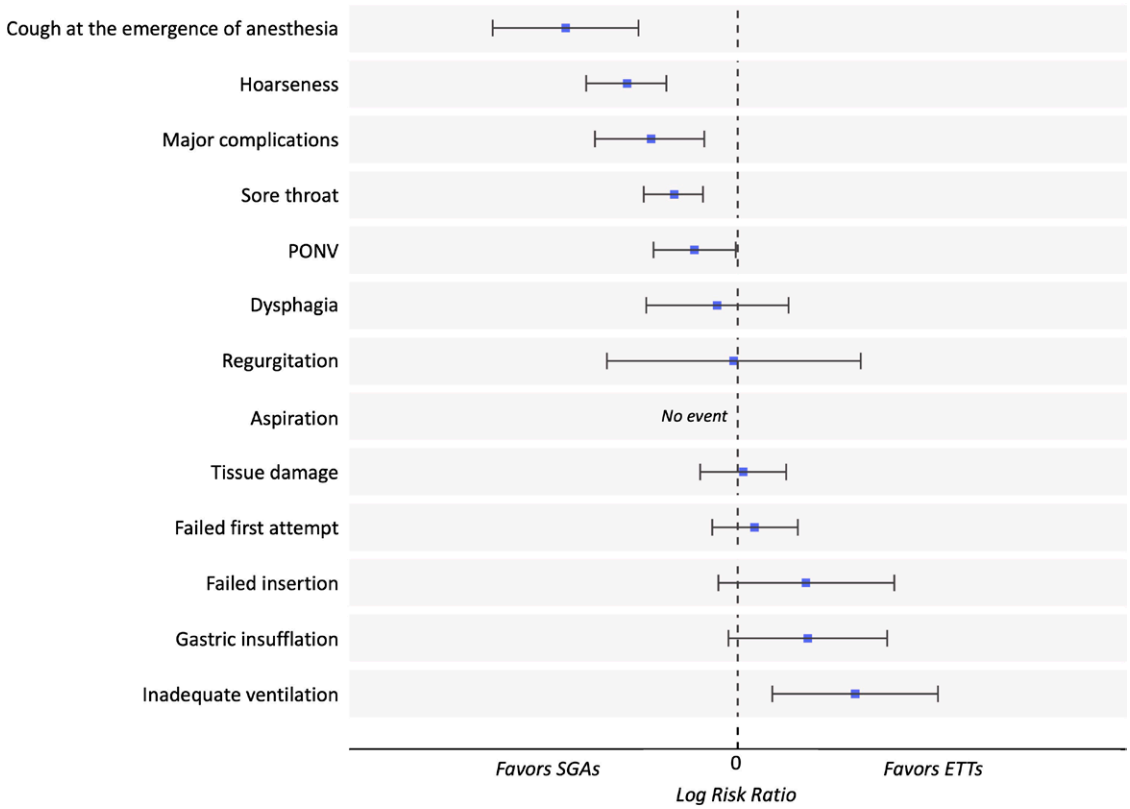

Figure 4. Forest plot with the summarized risk ratios (95% CI) from the pairwise analyses comparing second-generation supraglottic airway devices with endotracheal tubes for 9 outcomes in adults aged ≥16 y undergoing abdominopelvic procedures under general anesthesia. It was not possible to perform meta-analysis for pulmonary aspiration as there was no event available. CI indicates confidence interval.

second-generation SGAs compared with ETT (RR, 4.32 [95% CI, 1.07–17.51]; P = .040). The results for dysphagia were sensitive to population and administration of NMBAs, with increased risk of dysphagia with second-generation SGAs in the general population (RR, 2.98 [95% CI, 1.06–8.42]; P = .044) and reduced risk of dysphagia in patients not receiving NMBAs (RR, 0.06 [95% CI, 0.01–0.45]; P = .006). The results for tissue damage were sensitive only to population with a single study presenting significant reduction in risk of tissue damage with second-generation SGAs when used in obese patients (RR, 0.05 [95% CI, 0.00–0.78]; P = .033). The results for ventilation inadequacy were sensitive only to population. The results for leak fraction were sensitive only to the administration of NMBAs. The results for time to insertion were sensitive to population and administration of NMBAs, but the results of the remaining outcomes were not sensitive to the evaluated characteristics. No result was sensitive to the presence of outliers. Of note, the odds of gastric insufflation with second-generation SGAs was statistically significantly increased in comparison with ETTs when the Peto's OR method was applied (OR, 2.71; 95% CI, 1.07–6.90; P = .040). The Peto's OR analysis for major complications showed a reduced risk of these events with second-generation SGAs (OR, 0.32; 95% CI, 0.15–0.69; P = .010). A post hoc subgroup analysis of ventilation inadequacy including only studies explicitly reporting patients in the Trendelenburg position did not show a significant difference between both types of devices (RR, 3.24 [0.00–29.36 × 10^7]; P = .565).

Publication Bias

Egger's test for funnel plot asymmetry showed statistically significant asymmetry for sore throat (P = .096); hoarseness (P < .001); PONV (P = .015); and heart rate (P < .001). There was not statistically significant asymmetry for dysphagia (P = .950); tissue damage (P = .950); failed first insertion attempt (P = .769); failed insertion (P = .414); cough (P = .557); and time to insertion (P = .278). The following outcomes with less than 10 studies available were not submitted to Egger's test: abdominopelvic pain; regurgitation; pulmonary aspiration; major airway complications; leak pressure; leak fraction; gastric insufflation; ventilation inadequacy; and mean arterial pressure.

The bias-corrected effects from the Duval and Tweedie's trim-and-fill procedure for those outcomes with significant asymmetry were as follows: sore throat (RR, 0.71; 95% CI, 0.50–1.01; P = .054); hoarseness (RR, 0.60; 95% CI, 0.33–1.07; P = .079); PONV

Table 2. Pooled Probabilities (95% CI) and Mean (95% CI) of Outcomes for Both Second-Generation Supraglottic Airways and Endotracheal Tubes for Adults Undergoing Abdominopelvic Surgeries Under General Anesthesia

Outcomes	SGAs	ETs
Gastric insufflation, %	1.18 (0.23–5.81)	0.13 (0.00–4.56)
Failed first attempt, %	5.76 (3.59–9.11)	5.34 (3.71–7.63)
Leak fraction, %	7.35 (2.22–12.48)	4.52 (0.00–9.43)
Sore throat, %	12.92 (8.63–18.90)	30.02 (20.96–40.97)
Hoarseness, %	2.23 (0.77–6.28)	12.87 (5.59–26.92)
PONV, %	6.97 (2.47–18.14)	13.15 (5.29–29.09)
Dysphagia, %	4.29 (1.48–11.84)	6.37 (2.42–15.75)
Tissue damage, %	6.06 (3.58–10.09)	6.89 (4.79–9.81)
Abdominopelvic pain, 0–10 scale	3.21 (2.59–3.83)	3.64 (2.58–4.70)
Time for insertion, s	25.19 (14.61–37.78)	42.80 (15.55–70.06)
Heart rate within 1 min from device insertion, bpm	79.08 (75.32–82.85)	87.84 (82.26–93.42)
Mean arterial pressure within 1 min from device insertion, mm Hg	90.27 (79.25–101.28)	92.29 (83.21–101.37)

Only outcomes regarded to present results with sufficient precision are presented. Abdominopelvic pain was evaluated within 2 hours from the end of anesthesia. Cough was evaluated at emergence of anesthesia.

Abbreviations: CI, confidence interval; ETs, endotracheal tubes; PONV, postoperative nausea and vomiting; RCT, randomized controlled trial; SGA, second-generation supraglottic airway.

(RR, 0.78; 95% CI, 0.46–1.35; $P = .356$); heart rate (mean difference, 1.04; 95% CI, - 4.59–6.67; $P = .717$).

Certainty of Evidence Assessment

The certainty of evidence for each outcome is presented in Table 1.

DISCUSSION

This systematic review and meta-analysis showed a reduced risk of major airway complications with second-generation SGAs in comparison with ETTs in adults, with no clinically relevant increased risk of regurgitation or pulmonary aspiration, but a low certainty of evidence. Although the risk of inadequate ventilation was increased, there were more favorable patient-centered outcomes after surgery. These results suggest that, in the elective setting, the conservative approach clinicians may take by using ETTs might not be warranted, and indeed may be associated with less favorable outcomes than second-generation SGAs. This could underpin a substantial change in routine practice and education in the future.

Previous studies have compared first and second-generation SGAs together against ETTs in the perioperative setting.[1,3,20,21] These studies have been limited by a lack of quantitative synthesis,[20] comparing both first and second-generation SGAs with ETT,[20,21] focus on an individual outcome,[2] or assess outcomes in the obstetric setting only.[1] However, previous studies highlight the benefit of SGAs in terms of improved quality of postoperative recovery[1–3] and reduced risk of desaturation and laryngospasm,[2] although others presented inconclusive results.[22,23] Prospective and retrospective observational data also suggest a reduction in major airway complications.[24] Thus, this current robust systematic review addresses this uncertainty, presenting an important synthesis of data emphasizing the comparative safety of second-generation SGAs than ETTs.

There is biological plausibility to the evidence reported herein. First, the use of ETTs may be more traumatic than SGAs. Laryngoscopy and insertion of an ETT through to vocal cords and into the trachea may lead to soft tissue and mucosal injury that may not be seen with SGAs. Second, as laryngeal morbidity is reduced, the protective functions of the larynx are more preserved with SGAs and therefore mitigate microaspiration associated with pulmonary complications. Third, the position of an ETT through the larynx and within the trachea can be particularly stimulating, potentially triggering laryngospasm on extubation or bronchospasm with carinal irritation. Finally, the process of emergence of anesthesia is more controlled with SGAs as they are more readily tolerated in light planes of anesthesia than ETTs. Thus, the safety evidence we have found has a physiological and anatomical basis. However, given the low certainty in our synthesis, further data are still required to confirm these theories.

Of note, a key concern with SGAs is the risk of pulmonary aspiration. We did not find evidence for this increased risk, even in a population of patients with raised intraabdominal pressures and potential visceral manipulation. This, too, may have a biological plausibility, given that second-generation devices have greater seal pressures than first-generation SGAs, have gastric suction ports to allow egress of gastric content, are less likely to be associated with nausea and vomiting on emergence of anesthesia, and have a reduced requirement for neuromuscular blocking drugs than ETTs. Although our data are underpowered to draw definitive conclusions about relative risk of pulmonary aspiration, it is unlikely that second-generation SGAs themselves relevantly increase, from a clinical perspective, risk of aspiration in low-risk patients since they presented equivalent leak pressures and leak fractions when compared with ETTs and very low incidence of regurgitation with no events of aspiration in a total sample of 2518 patients (1295 with SGAs)—including obese patients, pregnant women and laparoscopic surgery in the Trendelenburg position. Other reports have also presented an extremely low incidence of pulmonary aspiration even with first-generation SGAs.[20,21] Notably,

the results of a large recently published trial including 2751 patients also suggested that pulmonary aspiration is not likely with the use of SGAs.[25] Overall, the theoretical risk of aspiration is not borne out in the data, and might not outweigh the other benefits of second-generation SGAs.

Interestingly, the use of second-generation SGAs was associated with an increased risk of inadequate ventilation when compared with ETTs. Although this risk is low, with an incidence of 0.33% (0.06%–1.72%), it remains a valid concern. However, what this finding serves to highlight is that SGAs have a failure rate, and when they are inadequate, they should be either adjusted, changed or an alternative ventilation strategy used. Despite the relatively low risk of failure, if potential difficulty in airway management or difficulty with SGA ventilation is anticipated before induction of anesthesia, it might be advisable to consider ETT rather than SGAs. Finally, the risk-benefit should consider all outcomes, including safety outcomes, which might favor SGAs.

Beyond safety and efficacy, important patient-centered quality of recovery outcomes in airway management have traditionally been underreported and inconsistent.[26] When synthesizing these data, we found that hoarseness and postoperative sore throat were significantly reduced when second-generation SGAs were compared with ETTs. This reflects previously recognized evidence for hoarseness[27] and sore throat,[3] and is likely related to the more traumatic placement of ETTs. For example, up to 4% of patients who receive an ETT have a vocal fold hematoma, and cord edema is seen anywhere between 9% and 84% of patients.[27] These are likely to be substantially less frequent, and therefore the sequelae less common, in patients who receive second-generation SGAs. The finding of a lower incidence of PONV after SGA than ETT may have previously been thought to be somewhat surprising given that there is a theoretical risk of increased gastric insufflation. However, the data we present shows that this is an unfounded supposition with second-generation devices, and perhaps may be due to a reduced time of facemask ventilation and, therefore, a reduction in gastric insufflation. Moreover, the presence of an ETT within the oropharynx may stimulate gag receptors and trigger an increased risk of nausea. That said, the certainty of evidence is very low for this outcome, and there is mechanistic uncertainty, and thus further, high-quality data, are required to confirm these results.

This study has some limitations. Few studies evaluated obese patients and pregnant women as well as patients at higher risk of pulmonary aspiration and therefore care must be exercised when translating the present results to these populations. Moreover, our aim was to determine safety, efficacy, and patient-centered outcomes in the setting of abdominopelvic surgery, so generalizing beyond this cohort or these outcomes is inappropriate. Most results are based on evidence of low or very low certainty. We pooled airway complications to a composite of major complications, although this was a pragmatic decision aiming to summarize overall benefits. A range of devices with different features were clustered as second-generation SGAs (eg, cuffed or uncuffed laryngeal masks; devices with polyvinyl chloride or silicone cuffs; and different laryngeal tubes). These features may have influenced the performance of the devices and possibly affected our results. Tracheal intubation can be performed with a number of devices, ranging from direct laryngoscopy, videolaryngoscopy with different blades, and flexible bronchoscopy. Therefore the heterogeneity in performance has the potential to influence our results. The RoB of included studies was highly variable, and many trials include modest numbers of patients. A total of 19 outcomes were analyzed and readers should be mindful that some significant differences might have arisen by chance. Finally, data from published randomized controlled trials may have uncertain data veracity,[28] which we have been unable to control for.

Further well-designed, large randomized controlled trials are indicated to improve precision, clarify the evidence, and enhance certainty. Recent studies with large sample sizes have been conducted comparing SGA and ETT. However, they are hampered by heterogeneity in devices (both first and second-generation SGAs), include a cohort of low-risk patients, and need to be reproduced in different countries and settings.[25]

In conclusion, we found that second-generation SGAs reduce the risk of major airway complications compared with ETTs in adult patients undergoing elective abdominopelvic procedures under general anesthesia, with no reported clinically relevant differences in the risk of pulmonary aspiration and regurgitation. The certainty of evidence was low. Although efficacy is more variable in a small cohort of patients, SGAs also improve the quality of postoperative recovery by reducing the risk of sore throat, hoarseness, and PONV. These data provide an opportunity for clinicians to reassess the implications of conservative airway management, and potentially expand the role of second-generation SGAs in routine clinical practice. ■

DISCLOSURES

Name: Clístenes Crístian de Carvalho, PhD.
Contribution: This author helped conceive and design the study; screen the references; collect, analyze, and interpret the data; and draft, review, and approve the article.
Name: Ioannis Kapsokalyvas, MSc.

Contribution: This author helped screen the references; collect and interpret the data; review drafts for intellectual content; and approve the final article.
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Contribution: This author helped design the study; interpret the data; review drafts for intellectual content; and approve the article.
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The clinical economic value of SafeLM® Video Laryngeal Mask System

I. The SafeLM® Video Laryngeal Mask System shortens operating room time and improves operating room efficiency

Operating Room efficiency is crucial to hospital operations, and Operation Room Time (ORT) is a common indicator for evaluating operating room efficiency. Operating room time is defined as the period of time from anesthesia induction to the end of extubation.[1,2] Compared with tracheal intubation. there is no need to wait for the muscle relaxant to take effect to relax the vocal cords when the laryngeal mask is inserted. It shortens the anesthesia induction time. And the laryngeal mask can also use less or no muscle relaxant, which shortens the postoperative extubation time.[1] found that in 139 pediatric patients who underwent adenoidectomy, the laryngeal mask group reduced ORT by 20 minutes (Laryngeal Mask vs ETT: 29.5 minutes vs 49.5 minutes, $P< 0.001$), which validated laryngeal mask's ability to shorten operating room time. And the another study found that a 38.3% reduction in preoperative preparation time (from anesthesia induction to surgery starting) could increase the daily number of surgeries by 1.6 cases per operating room.[3] In addition, the average cost of the extra time in the operating room is $45-60 per minute.[4,5] So, laryngeal mask also saves about $900-1,200 per case in operating room costs. In summary, laryngeal mask can shortens operating room time by about 20 minutes to improve operating room efficiency and average daily surgical number, and laryngeal mask also save about $900-1,200 per case in operating room costs.

II. The SafeLM® Video Laryngeal Mask System accelerates postoperative recovery and shortens hospital stay

Compared with ETT, laryngeal mask can reduce the stress of E'T'T on the respiratory and circulatory systems.[6] And laryngeal mask can also accelerate postoperative recovery and shorten hospital stay by reducing the incidence of postoperative complications such as cough and sore throat.[7,8] Jia et al.[7] through a study on laryngeal mask versus ETT in gynecological laparoscopic surgery found that the incidence of cough and sore throat in the laryngeal mask group decreased by 10% and 5%(Cough: 9.3% vs 19.9%, Sore throat: 14.4% vs 20.9%, $P<0.001$). In addition, another study which use laryngeal mask for airway management in thoracic surgery have found that laryngeal mask for airway management in thoracic surgery can shorten the hospital stay by about 3 days(Laryngeal Mask vs ETT: 3.7±0.5 days vs 6.7±1.3 days, $P<0.001$).[8] These research verified that laryngeal mask can reduce the incidence of postoperative complications and shorten the hospital stay. Therefore, laryngeal mask can accelerate the postoperative recovery and it shorten the hospital stay by approximately 3 days which save about $2000- $5000 per day hospitalization costs.

III. The SafeLM® Video Laryngeal Mask System increases the proportion of day surgery in elective surgery

The proportion of day surgery in elective surgery is an important indicator for evaluating the operating management of hospitals. Therefore, how to reduce perioperative injuries of patients and transform inpatient surgery into day surgery is crucial for increasing the proportion of day surgeries. laryngeal mask as an important airway management in day surgery can reduce the airway injury caused by ETT, and reduce the use of muscle relaxants during the surgery. It accelerate the recovery efficiency of patients which enable patients to reach the criteria of discharge more quickly. Meanwhile, laryngeal mask promotes ERAS, and transform inpatient surgery into day surgery. It will expand the application range of day surgery, and improve the turnover efficiency of bed to further increasing the proportion of day surgery in elective surgery.

IV. The SafeLM® Video Laryngeal Mask System avoids side effects related to muscle relaxants/antagonists, which reduce the risk of significant economic claims caused by side effects of muscle relaxants/antagonists and drug costs

Perioperative anaphylaxis refers to the sudden and life-threatening systemic hypersensitivity reaction after exposure to allergens during surgery, with an incidence of about 1/18600-1/3539.[9] Studies have reported that 60% of

perioperative allergic reactions are caused by muscle relaxants,[10] and it may lead to 20% of the patients experienced morbidity, including renal failure , cardiovascular complications, and neurological complications.[11] In addition, muscle relaxant residual effects such as respiratory muscle weakness, throat muscle weakness, and obstruction of the upper respiratory tract may also occur after surgery due to incomplete metabolism of muscle relaxants. Even if Sugammadex is used for antagonism during the recovery period, it may still trigger allergic reactions. The incidence of allergic reactions to Sugammadex was found to be 0.33%.[12] And, Muscle relaxant antagonists can be expensive. The most commonly used drug, Sugammadex, can cost between USD50(generic drugs)-150 per vial, which approximately 1 vial would be used for a 50kg patient. Some countries may have generic versions which can be less expensive. Therefore, compared with ETT, laryngeal masks can avoid or reduce the use of muscle relaxants during anesthesia induction and maintenance, lower the occurrence of side effects related to muscle relaxants/antagonists, and thereby avoid or reduce the risk of significant economic claims caused by side effects of muscle relaxants/antagonists and drug cost.

V. The SafeLM® Video Laryngeal Mask System enhances the safety of laryngeal mask and expands its application range and usage ratio

At present, 50-80% of blind insertion of laryngeal masks in clinical practice is misplace.[13] It may lead to anesthesia risks such as displacement and air leakage of the laryngeal mask, regurgitation and aspiration of gastric contents, thereby limiting the application range of laryngeal mask. Blind laryngeal masks are generally only used for short surgeries in the supine position. The SafeLM® Video Laryngeal Mask System adds video function on the basis of traditional laryngeal masks which achieves the visualization of laryngeal masks. Moreover, the SafeLM® Video Laryngeal Mask System has obtained an international invention patent, and it is the world's first and only true visual laryngeal masks. The camera observation range is > 180°, which can fully expose the glottis to ensure the correct insertion of laryngeal masks and a tight fit between laryngeal masks and the larynx. The SafeLM® Video Laryngeal Mask System improve the Oropharyngeal Leak Pressure (OLP) and the sealing property of the laryngeal mask, with the maximum sealing pressure reaching 35-40 cmH2O. It can effectively prevent the incidence of anesthesia risks such as air leak and aspiration. In addition, the SafeLM® Video Laryngeal Mask System that has the higher OLP and the ability to observe the regurgitation and aspiration of gastric contents under visual conditions, can be applied to laparoscopic surgeries, long-term surgeries, and surgeries related to traditional laryngeal mask contraindications such as lateral or prone positions. Meanwhile, the SafeLM® Video Laryngeal Mask System can also be used for airway management in tubeless thoracic anesthesia, which reduce airway injury caused by tracheal intubation and promote the clinical application of tubeless anesthesia and ERAS. It expand the application range and usage proportion of laryngeal masks. For emergency and patients with difficult airways such as obesity and pharyngeal stenosis, the SafeLM® Video Laryngeal Mask System can also guide tracheal intubation under visual guidance while ensuring good ventilation for the patient,and it further expand the indications and the usage ratio of the laryngeal mask. In summary, the SafeLM® Video Laryngeal Mask System ensures accurate insertion of the laryngeal mask to avoid potential airway security issue such as air leakage, regurgitation and aspiration. And it will eliminate the relative contraindications of traditional laryngeal masks, which promote tubeless anesthesia for expanding the application range and usage ratio of laryngeal masks.

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