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Use of Supraglottic Airway Devices in the Prone Position

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Abstract

Supraglottic airway devices (SADs) have revolutionized airway management. These advanced devices incorporate specific features to protect against gastric regurgitation and aspiration and also create a high oropharyngeal seal pressure. These developments have broadened indications for SADs, and some anesthetists use SADs with the patient in the prone position. SADs are also used as rescue device in instances of unintentional tracheal extubation. In addition, there is the elective use of SADs in the prone position. However, the use of SADs in the prone position remains controversial. This review aims to examine the published evidence regarding the use of SADs in patients undergoing surgery in the prone position.

Keywords: Laryngeal mask airway; Prone position; Supraglottic airway device

Introduction

Supraglottic airway devices (SADs) have revolutionized airway management over the past 30 years [1]. They can be classified as first and second generation [2]. First-generation devices are simple airway tubes, whereas second-generation devices incorporate specific features to protect against gastric regurgitation and aspiration [3]. Second-generation SADs have a drain tube to separate the upper airway from the gastrointestinal tract, and they also create a higher oropharyngeal seal pressure compared to first-generation SADs [4-7]. These developments have broadened the indications for SADs. Some anesthetists use SADs with the patient in the prone position; however, this use is still controversial. The aim of this systematic review is to examine the published evidence regarding the use of second-generation SADs in patients undergoing surgery in the prone position.

Methods

We searched the PubMed database for the keywords "laryngeal mask airway," "supraglottic airway," and "prone position." We included all clinical studies, case reports, meta-analyses, randomized clinical trials (RCTs), and reviews published in English between January 2005 and May 2015, which described the use of SADs in the prone position. We also undertook a hand search of reference lists from retrieved articles to identify additional articles.

Results

The search identified a total of 38 articles. Articles including pediatric patients, as well as those using animal models, first-generation SADs, the lateral position, or alternative devices were excluded. Three pro-con debate reports were also excluded. A total of 12 articles [8-19] were deemed eligible for inclusion in the present review (Figure 1).

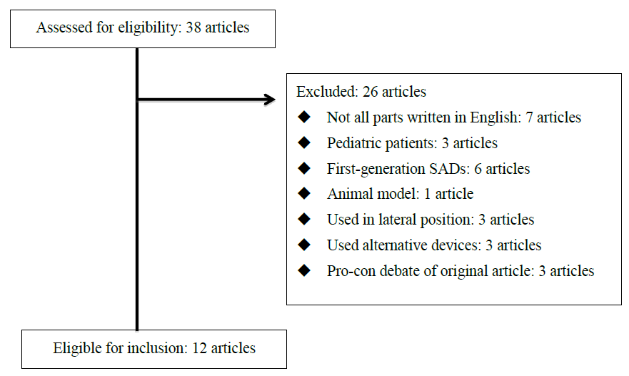

Figure 1: Overview of search results.

SADs as a rescue device for unintentional tracheal extubation

One review article suggested the utility of using SAD as a rescue device in the instance of unintentional extubation in the prone position [8], and one case of second-generation SAD use as a rescue device was reported [9]. In the report of unintentional extubation during spine surgery [9], the authors successfully inserted the ProSeal^{TM} laryngeal mask airway (PLMA) in the prone position. If this attempt had failed, there would have been no other solution but to turn the patient to the supine position, with substantial risk of neurologic complications.

A systematic review [8] examined 12 articles, including several prospective cohort and retrospective studies, as well as case reports, and concluded that in experienced hands, placement of SADs in the prone position was successful in 87.5% to 100% of cases at first attempt and 100% at second attempt.

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Elective use of second-generation SADs in the prone position

The remaining 10 articles [10-19] pertained to the elective use of second-generation SADs in patients in the prone position (Table 1). One study reported the successful use of PLMA by experienced users (not trainee anesthesiologists) in 245 patients in the prone position [10]. The LMA Supreme^{TM} (SLMA) has also been used successfully in the prone position, as reported in one case report [11] and two prospective studies [12,13]. In one prospective study [12], problems such as laryngospasm and regurgitation of gastric contents through the drain tube occurred during insertion; however, no patients had to be turned to the supine position to secure the airway. The authors concluded that SLMA may be used safely in the prone position by experienced users.

Author, Year	Type of Article	LMA Type (Number of Patients)	Outcomes / Complications
López et al. [14]	RCT	PLMA vs. SLMA (N=60 *vs.* N=60)	Successful first insertion: 98%-100%. Time to placement: 16-17 sec. Mean seal pressure (cmH_2O): PLMA 31 *vs.* SLMA 27 (P<0.01)
			Laryngospasm: N=7. Regurgitation through the drain tube: N=1. Blood on LMA: N=9. Sore throat: N=5
Kang et al. [16]		SLMA vs. I-gel (N=132 *vs.* N=131)	Insertion time: I-gel 16 sec; SLMA 15.6 sec. Number of attempts: I-gel first N=108, second N=23, third N=0 *vs.* SLMA first N=128, second N=2, third N=2. Insertion of I-gel was more difficult and required more assistance than SLMA (P<0.001).
			No desaturation. Low rate of sore throat, blood observation, and neck discomfort
Olsen et al. [18]		PLMA *vs.* tracheal tube (N=70 *vs.* N=70)	Time of anesthesia induction and positioning: PLMA 25 min *vs.* tracheal tube 30 min (P<0.001)
			Fewer cases of sore throat, hoarseness, and pain in muscles and joints in PLMA group at 3 hours postoperatively
Brimacombe et al. [10]	Observational study	PLMA (N=245)	Self-positioning followed by PLMA insertion: successful insertion first N=237, second N=8. Oropharyngeal leak pressure: 32 cm H_2O
			Blood on the surface of PLMA: N=4
Sharma et al. [12]		SLMA (N=205)	Successful insertion: first 92.5%, second 7.5%. Categorized depending on BMI → no increase of airway complications. No difference between positive pressure ventilation and spontaneous management
			Repositioning of SLMA: N=13, regurgitation of gastric contents through the drain tube: N=4, laryngospasm: N=1, size change of SLMA: N=6, more than two attempts at insertion: N=2
López et al. [13]		SLMA (N = 40)	First-attempt success rate: 92.5%
			Regurgitation of gastric contents through LMA drainage tube in four cases (no aspiration)
Sharma et al. [17]		PLMA (N=70)	Successful insertion: first 88.57%, second 91.42%. Manpower requirement: supine 5 people *vs.* prone 3 people (P<0.001). Surgical readiness time: supine 22.1 min *vs.* prone 5.9 min (P<0.001)
			Blood on PLMA: N=1, sore throat: N=1
Weksler et al. [19]		PLMA vs. tracheal tube (N=25 *vs.* N=25)	Manpower requirement for positioning: supine 6 people vs. prone 3 people (P<0.001); time to surgical readiness: supine 22.1 min *vs.* prone 5.9 min (P<0.001)
Thomas et al. [11]	Case report	SLMA (N=1)	Successful insertion during liposculpture operation
			Sore throat occurred postoperatively.
Taxak and Gopinath, [15]		I-gel (N=1)	Easy insertion at first attempt and no complications in flap repair operation for pilonidal sinus
BMI: Body Mass Index; LMA: Laryngeal Mask Aairway; PLMA: ProSeal Laryngeal Mask Airway; RCT: Randomized Controlled Trial, SLMA: LMA Supreme			

Table 1: Elective use of second-generation supraglottic airway devices in the prone position.

One RCT compared the use of PLMA and SLMA patients operated in the prone position [14]. Both LMAs were successfully placed in almost all patients at first attempt. There was no significant difference in times required for placement. The mean seal pressure was slightly greater with PLMA compared to SLMA (31 cmH_2O *vs.* 27 cmH_2O; P<0.01). Laryngospasm occurred in seven patients, but all were successfully treated by deepening the level of anesthesia or administering a neuromuscular blocking agent. Regurgitation of gastric contents through the drainage tube was noted in one patient, but aspiration into the lungs did not occur. Blood was noted on the LMA in 9 of 120 subjects, and the incidence of sore throat was 4.2 (5/120)% [14]. Based on the high rate of successful insertion, effective ventilation, and low incidence of complications, the authors recommended both PLMA and SLMA as suitable airway devices for selected patients anesthetized in the prone position [14].

In addition to PLMA and SLMA, there is one case report of successful use of the I-gel® in the prone position [15]. Comparing the I-gel® to SLMA, one RCT suggested that both were suitable for airway management in patients undergoing elective surgery in the prone position [16]. No differences were observed with regard to insertion time, but the I-gel® required more attempts and more assistance at insertion (P<0.001). The complication rate was low and was similar between groups. No episodes of laryngospasm or regurgitation were observed. Both devices provided high seal pressure and prevented regurgitation. Postoperatively, blood was occasionally found on the LMA at removal, but in most cases, this was not clinically significant. The incidence of sore throat or neck discomfort after surgery was low in both groups. The authors also suggested that the I-gel® may be superior to the SLMA as a conduit in fiberoptic tracheal intubation [16].

Comparison of patient's position at SAD insertion: supine *vs.* prone

Another topic is the comparison of position (supine *vs.* prone) at SAD insertion. One prospective study reported no differences between supine and prone groups with regard to efficacy and safety of the PLMA [17]. No patients developed hypoxemia or airway obstruction during induction and maintenance of anesthesia. No patients in the prone position required turning to the supine position for airway management. There were significant differences in manpower requirements for positioning (5 for supine *vs.* 3 for prone; P<0.001), and time to surgical readiness was significantly decreased in the prone position (5.9 min *vs.* 22.1 min; P<0.001). However, these results must be interpreted with caution because time to surgical readiness from induction was calculated differently [18]; in the prone group, it was measured after the patient was in the desired position, whereas in the supine group, it was measured starting at the beginning of anesthesia induction.

Comparison of SADs and tracheal tube

One RCT compared patients in whom PLMA was inserted in the prone position and patients in whom a tracheal tube was placed in the supine position and the patients were turned to the prone position [19]. The authors concluded that the PLMA method was 5 min faster than tracheal intubation (P<0.001), and patients' self-positioning in the prone position before induction saved manpower as well. There was nothing to indicate that PLMA method was unsafe. The other prospective study also suggested time savings and less manpower requirements with the prone position and additionally showed less hemodynamic changes in the prone position [20].

In one RCT, neurologic injury of the peripheral nerves and cervical spine, a major complication associated with the prone position, was discussed [18]. In one study, the incidence of neurologic injury, including reversible and irreversible symptoms, was 2% to 7% in the upper extremities and up to 24% in the lower extremities [21]. In another study, at 3 h postoperatively, fewer complications associated with the position on the operating table (pain in muscles and joints) were found in the PLMA group compared to the tracheal intubation group [18]. The authors suggested that a sufficiently powered study would be necessary to investigate if self-positioning before induction of anesthesia can reduce the number of injuries to the shoulders, elbows, nerves, and muscles.

Indications for use of second-generation SADs in the prone position

Second-generation SADs can be used safely in some patients in the prone position. However, it is not clear when the use of SADs in the prone position should be contraindicated. In a prospective audit [12], patients were categorized by body mass index (BMI). A total of 79 patients were classified as obese (BMI ≥ 30 kg/m^2); 53 in obese class I (30<BMI<35 kg/m^2), 20 in obese class II (35<BMI<40 kg/m^2), and 6 with BMI>40 kg/m^2. The results showed that SLMA could be inserted in obese patients without an increase in airway complications and also suggested that use of positive pressure ventilation and neuromuscular blocking drugs are not contraindicated for use of SLMA in the prone position. The duration of surgery also did not affect the results; however, the longest surgery in that study was 5 h.

Discussion

In this review article, we focused on the use of second-generation SADs in the patients in the prone position. In the prone position, the tongue falls forward due to gravity, and the posterior oropharyngeal space opens naturally, which may help accommodate SAD [22]. In addition, the advantage of greater oropharyngeal seal pressure as well as easy drainage of gastric contents and efficacy for positive pressure ventilation supports the use of second-generation SADs in the prone position.

Accidental extubation of the trachea during surgery in the nonsupine position is potentially life-threatening. The use of SADs as rescue devices after unintentional extubation appears reasonable, and two attempts at insertion by experienced practitioners may be acceptable, according to a case report [9] and systematic review [8]. Fortunately, unintentional extubation is a rare event, and thus RCTs to evaluate SADs under these urgent circumstances will perhaps never be performed.

There was some evidence to suggest safety and utility of second-generation SADs in patients undergoing elective surgery in the prone position [10-19]. The incidences of successful insertion, ventilation, and complications were not significantly different between PLMA, SLMA, and I-gel® in hands of experienced users. The reduced manpower and time savings to surgical readiness support the use of second-generation SADs in the prone position. However, the indications and contraindications for use of second-generation SADs in the prone position are still unclear and need more consideration. Only one prospective study [12] discussed contraindications of SAD use in the prone position. The longest surgery in that study was 5 h, and the safety of SAD use in the prone position for much longer procedures must be evaluated in a large cohort study. Further studies are needed to clarify indications and contraindications for these devices.

The use of second-generation SADs in the prone position may reduce the rate of complications associated with positioning on the operating table. Patients can find comfortable placement for each part of the body themselves before induction and placement of the SAD; however, the evidence to support this benefit is still insufficient, and further RCTs should be conducted.

The utility of elective use of PLMA, SLMA, and I-gel® in patients in the prone position has been evaluated in RCTs, but other types of second-generation SADs, including the Ambu LMA suction™ and the Air-Q, have not been adequately examined. Future multicenter RCTs should be conducted before broadening indications for the use of various types of second-generation SAD.

Conclusion

Based on the high rates of successful insertion and effective ventilation and the low incidence of complications [14], second-generation SADs can be used in the prone position and may be an alternative airway device to tracheal intubation; however, most of the evidence derives from single-center RCTs, several prospective cohort studies, retrospective studies, and case reports, and therefore the evidence remains insufficient to confidently recommend the technique as safe and superior to tracheal intubation in the prone position. Though it would be difficult to conduct RCTs on the emergency placement of SADs, future multicenter RCTs on the elective use of second-generation SADs in the prone position should be conducted before the technique is broadly recommended. Future studies should clarify in what type of patients the insertion of second-generation SADs in the prone position is indicated. For patient safety, indications should be selected carefully and practitioners should prepare for quick turnback to the supine position should airway management fail.

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