Less perilaryngeal gas leakage with SLIPA™ than with LMA-ProSeal™ in paralyzed patients

Moins de fuites périlaryngées de gaz avec le SLIPA™ qu'avec le LMA-ProSeal™ chez les patients curarisés

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Abstract

Purpose The aim of this study was to compare the Streamlined Liner of the Pharynx Airway (SLIPA™) with the ProSeal Laryngeal Mask Airway (LMA-ProSeal™) in mechanically ventilated paralyzed patients undergoing laparoscopic gynecologic surgery.

Methods One hundred and one patients were allocated randomly to SLIPA ($n = 50$) or to LMA-ProSeal ($n = 51$) treatment groups. After induction of general anesthesia and insertion of the assigned supralaryngeal airway (SLA) device, we made note of the occurrence of any gastric insufflation and perilaryngeal leakage. We then evaluated the anatomical fit of the SLA device using a fiberoptic bronchoscope, and we assessed the airway sealing pressure and respiratory mechanics with change in head position and during peritoneal insufflation. After surgery, we evaluated the severity of postoperative sore throat and the presence of blood or regurgitated fluid on the SLA device.

Results The insertion success rate, gastric insufflation, perilaryngeal leakage, anatomical fit, airway sealing pressure, respiratory mechanics, severity of sore throat, and incidence of blood and regurgitated fluid on the device were similar between the two groups. The incidence of perilaryngeal leakage with changes in the patient's head position was lower with the SLIPA group than with the

LMA-ProSeal group (3/50 vs 11/51, respectively; $P = 0.026$). During peritoneal insufflation, perilaryngeal leakage did not occur with the SLIPA but occurred in four cases with the LMA-ProSeal ($P = 0.045$).

Conclusion Both the SLIPA and the LMA-ProSeal can be used effectively and without severe complications in paralyzed patients undergoing laparoscopic gynecological surgery. However, the SLIPA offers the advantage of less perilaryngeal gas leakage than the LMA-ProSeal with change in head position and during insufflation of the peritoneal cavity. This trial is registered with ANZCTR (ACTRN12609000914268).

Résumé

Objectif L'objectif de cette étude était de comparer le masque SLIPA™ (Streamlined Liner of the Pharynx Airway) et le masque LMA-ProSeal™ (ProSeal Laryngeal Mask Airway) chez des patientes curarisées recevant une ventilation mécanique et subissant une chirurgie gynécologique par laparoscopie.

Méthode Cent une patientes ont été aléatoirement réparties en deux groupes de traitement, soit SLIPA ($n = 50$) et LMA-ProSeal ($n = 51$). Après l'induction de l'anesthésie générale et l'insertion du masque supralaryngé attribué, nous avons noté la survenue de toute insufflation gastrique ou fuite périlaryngée. Nous avons ensuite évalué l'ajustement anatomique du masque supralaryngé à l'aide d'un bronchoscope à fibres optiques, la pression de fermeture des voies aériennes et la mécanique respiratoire suite à des changements de position de la tête et pendant l'insufflation péritonéale. Après la chirurgie, nous avons évalué la gravité des maux de gorge postopératoires et la présence de sang ou de liquides régurgités sur le masque supralaryngé.

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Résultats Le taux de réussite d'insertion, l'insufflation gastrique, les fuites périlaryngées, l'ajustement anatomique, la pression de fermeture des voies aériennes, la mécanique respiratoire, la gravité des maux de gorge et l'incidence de sang et de liquides régurgités sur le masque étaient similaires dans les deux groupes. L'incidence des fuites périlaryngées lors de changement de position de la tête de la patiente était plus basse dans le groupe SLIPA que dans le groupe LMA-ProSeal (3/50 vs 11/51, respectivement; $P = 0,026$). Pendant l'insufflation péritonéale, il n'y a pas eu de fuite périlaryngée avec le SLIPA; en revanche, quatre cas ont été observés avec le LMA-ProSeal ($P = 0,045$).

Conclusion Le SLIPA et le LMA-ProSeal peuvent tous deux être utilisés efficacement et sans provoquer de complication grave chez les patientes curarisées subissant une chirurgie gynécologique par laparoscopie. Le SLIPA offre cependant l'avantage de provoquer moins de fuite périlaryngée de gaz que le LMA-ProSeal lors du changement de position de la tête et pendant l'insufflation de la cavité péritonéale. Cette étude est enregistrée auprès de ANZCTR (ACTRN12609000914268).

An increasing number of non-invasive supralaryngeal airway (SLA) devices are currently available and used widely for mechanical ventilation of patients during surgery. The ProSeal Laryngeal Mask Airway (LMA-ProSealTM; Laryngeal Mask Company, Henley-on-Thames, UK) has a distal cuff that is inflated when positioned in the patient's pharynx to achieve a seal and permit ventilation of the lungs.¹ The Streamlined Liner of the Pharynx Airway (SLIPATM; SLIPA Medical Ltd, London, UK) is a relatively new type of SLA device with a boot shape that resembles the anatomy of the pharynx.^{2,3} A recent study has shown that the LMA-ProSeal and the SLIPA have similar insertion characteristics⁴; however, that study was performed in non-paralyzed patients.

Unlike the LMA-ProSeal, the SLIPA does not have a cuff to seal off the pharynx, and it is made from more rigid plastic than the LMA-ProSeal cuff. Due to these physical characteristics, we hypothesized that the SLIPA could be inserted more easily and properly in paralyzed patients than in non-paralyzed patients and that relaxed pharyngeal muscle could facilitate the use of a larger-sized device. Consequently, the SLIPA could likely achieve a better fit, an improved airway sealing pressure, and a lower incidence of gastric insufflation in paralyzed patients. We presumed that these advantages would not be seen with the LMA-ProSeal, since it is a relatively small device with a cuff that seals the pharynx sufficiently in non-paralyzed patients but would likely be inadequate in paralyzed subjects.

The aim of this study was to compare the SLIPA with the LMA-ProSeal with respect to the incidence of gastric insufflation when used in paralyzed patients undergoing elective laparoscopic gynecologic surgery. We also compared the insertion success rate and perilaryngeal leakage after insertion. In addition, anatomical fit, airway sealing pressure, and respiratory mechanics were measured with change in head position and during peritoneal insufflation. Finally, both devices were compared for the presence of blood or regurgitated fluid and the severity of postoperative sore throat.

Methods

The study protocol was approved by the Institutional Review Board of Chung-Ang University School of Medicine, and the study was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12609000914268). This study was carried out according to the principles of the Declaration of Helsinki, 2000, and written informed consent was obtained from all participants before inclusion in the trial.

Women aged 18–65 yr and scheduled for laparoscopic gynecologic surgery under general anesthesia were considered eligible for the study. Exclusion criteria were 1) a history of diabetes mellitus; 2) obesity (body mass index > 30); 3) gastroesophageal reflux; 4) severe cardiopulmonary disease; 5) neurologic disease; or 6) cervical spine disease.

We randomized the patients into SLIPA and LMA-ProSeal treatment groups based on random numbers generated on Microsoft Excel software by a statistician who did not otherwise participate in this study. The numbers were held in a series of sealed envelopes and were not disclosed to the investigators and the patients. After each patient was admitted to the operating room, the appropriate numbered envelope was opened to reveal whether the patient was designated to the SLIPA or to the LMA-ProSeal group.

The patients did not receive premedication. After placement of standard monitoring systems (electrocardiography, noninvasive arterial blood pressure sensing, pulse oximetry), anesthesia was induced with fentanyl $2 \mu\text{g}\cdot\text{kg}^{-1}$, propofol $1.5\text{--}2 \text{ mg}\cdot\text{kg}^{-1}$, and rocuronium $0.6 \text{ mg}\cdot\text{kg}^{-1}$. Ventilation was controlled via a facemask with 50% N_2O in O_2 and 3% sevoflurane.

After jaw relaxation, the appropriate LMA-ProSeal or SLIPA was inserted according to the manufacturer's insertion guide.^{A,B} In the SLIPA group, we inserted the toe

^A http://slipa.com/index.php?option=com_content&task (accessed April 20th, 2010).

^B <http://www.lmana.com/proseal.php> (accessed April 20th, 2010).

of the SLIPA after mouth opening and advanced it towards the posterior pharyngeal arch. At this point, while lifting the patient's jaw with the left hand, we pushed the device down until the heel lodged in the nasopharynx. Once the chamber was applied firmly against the back of the patient's throat, we pushed on the stem posteriorly until firm resistance was felt.^A In the LMA-ProSeal group, the cuff was fully deflated, held like a pen, and inserted while pressing against the palatopharyngeal curve using the index finger. The LMA-ProSeal was advanced into the hypopharynx until definite resistance was felt. After placement, the cuff was inflated to 60 cmH₂O using a calibrated aneroid manometer (cuff pressure gauge, VBM Medizintechnik GmbH, Sulz, Germany).^B The SLIPA size was selected according to the guidelines of Miller *et al.*,⁴ which involve matching the width across the thyroid cartilage with that of the widest transverse diameter of the SLIPA. The size of the LMA-ProSeal was chosen based on body weight and according to the manufacturer's recommendation (size 3 if the patient weighed < 50 kg, or size 4 if > 50 kg).^B

If the initial attempt at inserting the airway was unsuccessful, a supplementary dose of propofol (up to 1 mg·kg⁻¹) was administered and the patient's head was repositioned to allow one further attempt. If the second attempt was unsuccessful, it was recorded as an insertion failure. Five investigators were selected to insert the airways, all had more than six years' experience in clinical anesthesia and more than two years' experience with LMA-ProSeal insertion. Prior to the study, these investigators were trained with a minimum of 20 SLIPA insertions using a mannequin and 30 SLIPA insertions with patients.

After inserting the SLA device, mechanical ventilation was initiated using a volume-controlled ventilator (Datex-Ohmeda Aestiva/5 ventilator; GE Health Care, Madison, WI, USA). The ventilator settings were as follows: a tidal volume of 10 mL·kg⁻¹ of the patient's ideal body weight ($45.5 + 0.91 \times [\text{height in cm} - 152.4]$),⁵ a respiratory rate of 10 breaths·min⁻¹, and an inspiratory-to-expiratory ratio of 1:2. During the operation, the end-tidal concentration of sevoflurane was maintained at 1.5–2%, and rocuronium was administered as required to maintain adequate surgical relaxation.

Perilaryngeal leakage was defined as a > 10% difference between inspiratory and expiratory tidal volumes (as measured by spirometry) persisting for at least five mechanical breaths, or the development of an audible leak. Perilaryngeal leakage was checked at three different time points, i.e., after insertion of the SLA device, with head position change, and after peritoneal insufflation. We repositioned the SLA device when perilaryngeal leakage was noted after insertion. If repositioning had no effect, we

added 10 mL of air into the cuff of the LMA-ProSeal or we attempted to insert a larger-sized SLIPA.

Anatomical fit was determined using a flexible fiberoptic bronchoscope (Olympus BF-3C40; Olympus Optical, Tokyo, Japan) and was graded using a scale developed by Keller *et al.*⁶ (i.e., 4 = only vocal cords seen; 3 = cords plus posterior epiglottis seen; 2 = cords plus anterior epiglottis seen; and 1 = cords not seen but the function is adequate). Airway sealing pressure was then measured by closing the expiratory valve of the breathing circuit and noting the pressure at which a leak developed with a fresh gas flow of 3 L·min⁻¹.⁷ We then assessed perilaryngeal leakage with change in head position (15° flexion, 15° extension, turning the patient's head maximally to the left, and turning the patient's head maximally to the right).

A pneumoperitoneum was created using CO₂, and an intraperitoneal pressure of 10–15 mmHg was maintained. The angle of the head-down tilt was kept at 10–15°. Before and after creating pneumoperitoneum and changing position, we used a spirometry module (S/5TM Compact anesthesia monitor; Datex-Ohmeda, Tewksbury, MA, USA) to measure the respiratory mechanics, including the peak inspiratory pressure, the plateau pressure, the static compliance of the respiratory system, and the resistance of the airway. During the pneumoperitoneum, we monitored perilaryngeal leakage and gastric insufflation by using a stethoscope positioned over the patient's stomach and by visualizing the stomach directly through a laparoscope. The surgeon, who was blinded to the type of SLA device used, checked for gas in the patient's stomach at insertion of the laparoscope and at 20-min intervals thereafter.

Spontaneous ventilation was established before the end of surgery. When tidal volume reached 8 mL·kg⁻¹ and patients were able to obey commands, we removed the ventilation equipment SLA device and inspected its surface for any blood or regurgitated gastric fluid. The patients were then transferred to the postanesthesia care unit. Thirty minutes after arrival in the postanesthesia care unit, the patients were asked to score their throat pain on an 11-point numeric rating scale (NRS, 0–10). Intraoperative data were collected by three non-blinded investigators who were not involved in the insertion of the SLA device, and postoperative data were gathered by two blinded investigators.

The primary outcome measurement was the incidence of gastric insufflations. The sample size calculation was based on a pilot study of 40 patients with LMA-ProSeal and a previous study with SLIPA.⁸ In the pilot study, the incidence of gastric insufflation was 12.5% with LMA-ProSeal and 19% with SLIPA.⁸ We accepted a two-tailed α error of 5% and a β error of 20% to detect any significant difference in the incidence of gastric insufflation. Based on these calculations, the required study size per group was 46. Considering a patient refusal rate and an insertion failure

rate of 15% and 5%, respectively, we needed 116 patients for the study.

For continuous variables, the normal distribution of the collected data was first evaluated using the Kolmogorov–Smirnov test. As all the variables were normally distributed, the differences between study groups were compared using the unpaired Student's *t* test, and the differences from baseline within each group were compared using a paired Student's *t* test. The descriptive variables were analyzed by either Chi square analysis or Fisher's exact test, as appropriate. All the variables are expressed as mean values, with variability expressed as standard deviations or absolute number. $P < 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA).

Results

Among the 116 patients who were eligible for the study from December 2009 to January 2010, six patients refused to participate, and nine patients were excluded as they suffered from diabetes mellitus, obesity, gastroesophageal reflux, cardiac disease, pulmonary disease, neurologic disease, or cervical disease (Figure). Of the 101 patients, 51 patients were randomized to the LMA-ProSeal group and 50 patients to the SLIPA group (Table 1). There were no differences between the groups in terms of patient demographics and anesthetic time (Table 1).

One insertion failure (1%) occurred in the SLIPA group because the patient was too small for any available size; the situation was managed by endotracheal intubation. This patient was excluded from the analyses of the post-insertion variables. In the LMA-ProSeal group, four patients needed additional air, and the SLA devices in three patients in the SLIPA group needed replacement with a larger device (Table 2).

The anatomic fit, as determined fibreoptically, was similar between groups, and there was no significant difference in terms of airway sealing pressure ($P = 0.051$). The incidence of perilaryngeal leakage was lower in the SLIPA group than in the LMA-ProSeal group with change in head position as well as during the peritoneal insufflation ($P = 0.026$ and $P = 0.045$, respectively) (Table 2).

However, the incidence of gastric insufflation was similar between the two groups, and no regurgitation of gastric contents was observed. The incidence of blood traces and regurgitated fluid on the surface of the SLA devices and the scores for sore throat were similar between the two groups (Table 2).

There were no significant differences between the groups in terms of the respiratory variables. Peak inspiratory pressure increased in both groups, and compliance of

the respiratory system decreased after a pneumoperitoneum was created in the head-down tilt position (Table 3).

Discussion

This study compared the SLIPA with the LMA-ProSeal in paralyzed patients who underwent laparoscopic gynecologic surgery. Both the SLIPA and LMA-ProSeal were inserted easily with success rates of 92% and 94% after one attempt and 98% and 100% after one or two attempts, respectively. These results are in close agreement with the findings of other studies reporting an insertion success rate of 98% for the SLIPA and 100% for the LMA-ProSeal.^{4,8}

Unlike the LMA-ProSeal, which has a cuff filled with air to fit the patient's pharynx, the SLIPA has a preformed fixed shape, and, therefore, it is important to choose the correct size. However, the manufacturer's size rule, which involves gender and height, was imprecise, i.e., there was size overlap, and the recommended size was too large in many cases in our pilot study. Therefore, we selected the SLIPA size according to the guidelines of Miller *et al.*⁴

There was no significant difference with regard to airway sealing pressure. If anything, the pressure was slightly greater with the SLIPA device than with the LMA-ProSeal. Our results are different from those of previous reports⁴ in patients undergoing laparoscopic gynecological surgery. Those findings showed a slightly lower airway sealing pressure with the SLIPA than with the LMA-ProSeal. This difference may be due to our patients receiving a muscle relaxant prior to airway insertion. Relaxation of the pharyngeal muscles makes it easier to insert an SLA device and facilitates the use of a larger device (replacement with a larger-sized SLIPA was performed in three cases in our study); consequently, there is a closer fit within the pharynx. These advantages may be strengthened by using the SLIPA, which is composed of more rigid material and does not have an inflatable cuff. While the LMA-ProSeal cuff might provide an adequate seal, even if the device is relatively small compared with the surrounding pharynx, a more rigid device may be inserted in a paralyzed patient more easily than a soft device.

The absence of an inflatable cuff in the SLIPA can result in an increased risk of gastric insufflations.⁸ This risk is exaggerated in laparoscopic gynecologic surgery because of the increased airway pressure and the decreased compliance. However, the incidence of gastric insufflations (6%) in our study was less than that of another study (19%).⁸ This might be due to the use of a muscle relaxant in our study. Muscle relaxants suppress unwanted reflexes, such as coughing and retching associated with SLA device insertion. We can expect early recovery and a shorter operating time by avoiding muscle relaxants when an SLA

Figure A recruitment flow diagram **Table 1** Demographics and anesthetic time

	LMA-ProSeal group (n = 51)	SLIPA group (n = 50)
Age (yr)	43.1 ± 19.3	46.6 ± 17.0
Height (cm)	161.0 ± 7.4	159.5 ± 5.5
Weight (kg)	59.7 ± 8.3	60.6 ± 7.9
BMI (kg·m ⁻²)	23.0 ± 2.6	23.8 ± 2.7
ASA PS 1/2/3 (n)	30/15/6	28/14/8
Mallampati class 1/2/3 (n)	35/13/3	31/14/5
LMA-ProSeal size 3/4 (n)	33/18	–
SLIPA size 47/49/51/53 (n)	–	3/8/27/12
Anesthetic time (min)	131.1 ± 66.4	141.8 ± 85.0

Values are expressed as mean ± standard deviation, or absolute number

There are no significant differences between the groups

LMA-ProSeal = ProSeal Laryngeal Mask Airway; SLIPA = Streamlined Liner of the Pharynx Airway; BMI = body mass index; ASA PS = American Society of Anesthesiologists physical status

is used.⁴ This advantage may be lost in circumstances that require muscle relaxants or long surgery.

Although the SLIPA is made of a more rigid material than the LMA-ProSeal and we are less experienced with its use, it appears to be similarly traumatic to the pharynx, as judged by the similar NRS scores for sore throat and the

incidence of blood on the surface of the airways. We suggest that the pressure-induced trauma caused by the inflatable cuff of the LMA-ProSeal was greater than expected. Reduction of LMA intracuff pressure lowers the incidence of postoperative pharyngolaryngeal complications.⁹ When we inserted a LMA-ProSeal, the cuff pressure

Table 2 Airway observations

	LMA-ProSeal group (<i>n</i> = 51)	SLIPA group (<i>n</i> = 49)	<i>P</i> value
During induction			
Number of attempts 1/2/fail (<i>n</i>)	48/3/0	45/4/1*	0.541
Perilaryngeal leakage after insertion of SLA (<i>n</i>)	4	4*	0.736
Anatomical fit 1/2/3/4	2/13/11/25	1/12/8/28	0.855
Airway sealing pressure (cmH ₂ O)	24.7 ± 7.8	27.3 ± 5.6	0.051
Perilaryngeal leakage with change in head position (<i>n</i>)	11	3	0.026†
During pneumoperitoneum			
Perilaryngeal leakage during operation (<i>n</i>)	4	0	0.045†
Gastric insufflation (<i>n</i>)	4	3	1.000
After operation			
Blood on SLA (<i>n</i>)	8	8	0.930
Regurgitant on SLA (<i>n</i>)	0	0	1.000
NRSs of sore throat	1.2 ± 1.9	1.4 ± 1.9	0.729

Values are expressed as mean ± standard deviation or absolute number

* Number of patients in SLIPA group is 50 because one failed insertion is included in the analysis. † *P* < 0.05 between groups. LMA-ProSeal = ProSeal Laryngeal Mask Airway, SLIPA = Streamlined Liner of the Pharynx Airway; NRSs = numeric rating scale score (0–10), SLA = supra-laryngeal airway

Table 3 The changes of respiratory variables

		LMA-ProSeal group (<i>n</i> = 51)	SLIPA group (<i>n</i> = 49)
PIP (cmH ₂ O)	Before	14.2 ± 4.2	14.5 ± 4.3
	After	18.8 ± 4.2*	19.1 ± 4.3*
Pplat (cmH ₂ O)	Before	12.4 ± 2.2	12.6 ± 2.4
	After	15.6 ± 2.3*	16.8 ± 4.3*
Raw (cmH ₂ O·L ⁻¹ ·min ⁻¹)	Before	8.0 ± 5.8	8.4 ± 6.1
	After	10.7 ± 5.8*	10.9 ± 6.1*
Comp (mL·cmH ₂ O ⁻¹)	Before	52.9 ± 14.3	53.2 ± 15.1
	After	38.2 ± 14.5*	38.4 ± 15.4*

Values are expressed as mean ± standard deviation

* *P* < 0.05 compared with Before. LMA-ProSeal = ProSeal Laryngeal Mask Airway; SLIPA = Streamlined Liner of the Pharynx Airway; PIP = peak inspiratory pressure; Pplat = plateau pressure; Comp = static compliance of the respiratory system; RAW = resistance of the airway; Before = before pneumoperitoneum and change of position; After = after pneumoperitoneum and head-down tilt position

was set at 60 cmH₂O, which is higher than the pressure of a previous study.⁹ Had we reduced the LMA-ProSeal cuff pressure or adjusted it during the operation, the NRS scores for sore throat and incidence of blood on the surface of the device could have been lower. In addition, when N₂O is used to maintain anesthesia, its diffusion into the cuff of the LMA-ProSeal increases the intracuff pressure over time.¹⁰ Of course, the LMA-ProSeal exerts pressure on the pharyngeal structures similar to other inflatable airway devices.^{11,12}

Several studies have reported the association of using an LMA-ProSeal with injuries to the lingual and recurrent laryngeal nerves.^{13,14} The four cases of perilaryngeal leakage during pneumoperitoneum in the LMA-ProSeal group could be explained by displacement of the LMA-

ProSeal caused by diffusion of N₂O into the cuff. This occurrence is in contrast to the absence of leaks with the SLIPA, which has no cuff. The perilaryngeal gas leakage and gastric insufflation were stopped by simple manipulation; therefore, further gastric insufflations did not occur. However, pulmonary aspiration of gastric contents remains a major concern when using SLA devices,^{15,16} and this occurrence is considered more prevalent during laparoscopic surgery in gynecology patients.¹⁷ We should be all the more attentive to perilaryngeal leaks, consequent gastric insufflations, and pulmonary aspiration when using an SLA fitted with a cuff.

Head and neck movements change the shape of the pharynx,¹⁸ and this can displace the SLA device¹⁹; the SLIPA is not recommended when changing the head

position during surgery.³ In our study, the perilaryngeal leakage with change in head position was lower in the SLIPA group than in the LMA-ProSeal group. We believe that the stability of the SLIPA is primarily due to its shape, which is similar to that of the pharynx.

Our study had some limitations. First, it was impossible to blind the investigator who inserted the SLA device, and this may have introduced a possible source of bias. Second, the anesthesiologists placing the devices had much greater experience with the LMA-ProSeal than with the SLIPA. Third, N₂O might have affected the compliance of the LMA-ProSeal cuff by increasing the cuff volume, and, consequently, this could have increased the incidence of perilaryngeal leakage during the operation and the severity of any sore throat. Fourth, the sample size may be insufficient to detect a difference for variables other than the primary outcome. In this study, there were no differences with regard to respiratory mechanics, anatomical fit, airway sealing pressure, and the severity of sore throat. In these parameters, the possibility of type II error cannot be ruled out. Lastly, patients with comorbidity were excluded from this study; therefore, the results cannot be extrapolated to all patients, nor can rare complications be ruled out completely.

In conclusion, both the SLIPA and LMA-ProSeal can be used effectively and without severe complications in paralyzed anesthetized adult patients who are undergoing laparoscopic gynecological procedures. Although the two devices share similar insertion and functional characteristics, the SLIPA offers an advantage over the LMA-ProSeal in terms of less perilaryngeal gas leakage with change in head position and during pneumoperitoneum.

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Conflict of interest None declared.

References

1. Brimacombe J, Keller C. The ProSeal laryngeal mask airway: a randomized, crossover study with the standard laryngeal mask airway in paralyzed, anesthetized patients. *Anesthesiology* 2000; 93: 104-9.
2. Miller DM, Light D. Laboratory and clinical comparisons of the Streamlined Liner of the Pharynx Airway (SLIPA) with the laryngeal mask airway. *Anaesthesia* 2003; 58: 136-42.
3. Hooshangi H, Wond DT. Brief review: the Cobra Perilaryngeal Airway (Cobra PLA) and the Streamlined Liner of Pharyngeal Airway (SLIPA) supraglottic airways. *Can J Anesth* 2008; 55: 177-85.
4. Miller DM, Camporota L. Advantages of ProSeal and SLIPA airways over tracheal tubes for gynecological laparoscopies. *Can J Anesth* 2006; 53: 188-93.
5. Anonymous. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. The Acute Respiratory Distress Syndrome Network. *N Engl J Med* 2000; 342: 1301-8.
6. Brimacombe J, Berry A. A proposed fiber-optic scoring system to standardize the assessment of laryngeal mask airway position. *Anesth Analg* 1993; 76: 457.
7. Keller C, Brimacombe JR, Keller K, Morris R. Comparison of four methods for assessing airway sealing pressure with the laryngeal mask airway in adult patients. *Br J Anaesth* 1999; 82: 286-7.
8. Lange M, Smul T, Zimmermann P, Kohlenberger R, Roewer N, Kehl F. The effectiveness and patient comfort of the novel streamlined pharynx airway liner (SLIPA) compared with the conventional laryngeal mask airway in ophthalmic surgery. *Anesth Analg* 2007; 104: 431-4.
9. Seet E, Yousaf F, Gupta S, Subramanyam R, Wong DT, Chung F. Use of manometry for laryngeal mask airway reduces postoperative pharyngolaryngeal adverse events: a prospective, randomized trial. *Anesthesiology* 2010; 112: 652-7.
10. Tekin M, Kati I, Tomak Y, Yuca K. Comparison of the effects of room air and N₂O + O₂ used for ProSeal LMA cuff inflation on cuff pressure and oropharyngeal structure. *J Anesth* 2008; 22: 467-70.
11. Joh S, Matsuura H, Kotani Y, et al. Change in tracheal blood flow during endotracheal intubation. *Acta Anaesthesiol Scand* 1987; 31: 300-4.
12. Nott MR, Noble PD, Parmar M. Reducing the incidence of sore throat with the laryngeal mask airway. *Eur J Anaesthesiol* 1998; 15: 153-7.
13. Brimacombe J, Clarke G, Keller C. Lingual nerve injury associated with the ProSeal laryngeal mask airway: a case report and review of the literature. *Br J Anaesth* 2005; 95: 420-3.
14. Kawauchi Y, Nakazawa K, Ishibashi S, Kaneko Y, Ishikawa S, Makita K. Unilateral recurrent laryngeal nerve neuropraxia following placement of a ProSeal laryngeal mask airway in a patient with CREST syndrome. *Acta Anaesthesiol Scand* 2005; 49: 576-8.
15. Keller C, Brimacombe J, Bittersohl J, Lirk P, von Goedecke A. Aspiration and the laryngeal mask airway: three cases and a review of the literature. *Br J Anaesth* 2004; 93: 579-82.
16. Putzke C, Max M, Geldner G, Wulf H. Severe ARDS following perioperative aspiration of gastric content associated with the use of a "ProSeal" laryngeal mask airway (German). *Anesthesiol Intensivmed Notfallmed Schmerzther* 2005; 40: 487-9.
17. Duffy BL. Regurgitation during pelvic laparoscopy. *Br J Anaesth* 1979; 51: 1089-90.
18. Nandi PR, Charlesworth CH, Taylor SJ, Nunn JF, Dore CJ. Effect of general anaesthesia on the pharynx. *Br J Anaesth* 1991; 66: 157-62.
19. Ravalia A, Kumar N, Ravalia D. Rotation of reinforced laryngeal mask airway. *Anaesthesia* 1994; 49: 541-2.