ORIGINAL ARTICLE

# A Comparison between Laryngeal Tube Suction II Airway™ and Proseal™ Laryngeal Mask Airway in Laparascopic Surgery

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**SUMMARY**

**This was a prospective randomized study comparing the ease of insertion, haemodynamic changes, quality of airway seal, oxygenation and ventilation parameters and complications between Laryngeal Tube Suction II™ (LTS II™) with Proseal™ Laryngeal Mask Airway (PLMA™), both are supraglottic airway incorporated with gastric passage. Fifty-four ASA I and II patients were randomly allocated to receive either LTS II™ or PLMA™. Both devices provided a secure airway even under conditions of elevated intra-abdominal pressure up to 17 mmHg. In this study, there were no differences concerning ease of insertion, haemodynamic changes, quality of airway seal, oxygenation and ventilation parameters and complications between LTS II™ and PLMA™.**

**KEY WORDS:**
*LTS, LMA, Laparoscopic, Airway seal, Haemodynamic, Oxygenation, ventilation*

## INTRODUCTION

The Laryngeal Tube Suction II™ (LTS II™) and the Proseal™ Laryngeal Mask Airway (PLMA™) are two popular supraglottic airway devices used for maintaining the airway during spontaneous and controlled ventilation during general anaesthesia[1,2]. The Laryngeal Tube Suction II™ (LTS II™) is a latex free, double lumen silicon tube (respiratory and alimentary passages) and was developed from the Laryngeal Tube Suction™. It is inserted blindly with the distal tip positioned in the hypopharynx or upper esophagus. The LTS II™ has two low-pressure cuffs (proximal and distal), and two main oval ventilation apertures placed between them. It has been advocated for prehospital emergency airway management and serves as a useful tool during failed intubations[3-5].

The PLMA™ was developed from the classic LMA (cLMA). In comparison to the cLMA, it has a gastric drainage tube, a deeper bowl and a posterior cuff which serves as a bypass channel for regurgitated fluid and allows gastric tube insertion to prevent gastric insufflations. The PLMA™ produces a higher-pressure seal within the pharynx than a cLMA. The PLMA™ has been used as a rescue device after failed intubations during rapid sequence induction. It is also widely utilised as an alternative airway device in laparoscopic surgery[1,6].

To date, there are few studies comparing the PLMA™ to the LTS II™. Cook *et al* and Gaitini *et al* have showed that both devices were safe and effective airway adjuncts in mechanically ventilated anaesthetised adult patients[7-,11]. Cook *et al* described LTS II™ performing better in controlled ventilation compared to spontaneous ventilation in general anaesthesia[7]. There was only one study by Roth *et al* that described both devices providing a similar secure airway in laparoscopic surgery[8]. Until now, there was no study assessing both devices in the Malaysian population for laparoscopic surgery.

The objective of the study was to compare the performance of LTS II™ and PLMA™ during laparoscopic surgery with regards to insertion, haemodynamic changes, and quality of airway seal, oxygenation and ventilation parameters and complications.

## MATERIALS AND METHODS

This was a prospective randomized, single blind study carried out in Universiti Kebangsaan Malaysia Medical Centre from April 2006 to August 2008 following the approval of the Dissertation Committee, Department of Anaesthesiology and Intensive Care and Research Ethics Committee, Faculty of Medicine, UKM. Informed consent was obtained from each patient. Fifty-four patients were enrolled and were randomly allocated into Group LTS II™ or Group PLMA™. Randomisation was achieved using sealed opaque envelopes containing the letters LTS II™ or PLMA™, one of which was opened by the author immediately before the induction of anaesthesia.

Those included in the study were ASA I and II patients, aged between 18 and 65 years undergoing elective general surgical or gynecological laparoscopic surgery in which the use of LTS II™ and PLMA™ were regarded as an acceptable alternative for airway management. Patients who were at risk of pulmonary aspiration, BMI >30kg/m$^2$ or a known or predicted difficult airway were excluded.

All patients were assessed in the ward one day prior to surgery. All patients were fasted from midnight and received oral midazolam 7.5mg as premedication prior to surgery. An 18G intravenous cannula was inserted and standard anaesthetic monitoring including electrocardiography, non-

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invasive arterial blood pressure, pulse oximetry, gas analyzer, spirometry (including P-V loop, tidal volume for inspiratory and expiratory, plateau and peak pressure and compliance) were attached, and baseline vital sign was recorded. All patients were induced with IV fentanyl 1-2µg/kg, propofol 2.5mg/kg, rocuronium 0.6mg/kg and anaesthesia was maintained with oxygen: air (50:50) with sevoflurane 2-3% to achieve a MAC of 1.3. All patients were manually ventilated for 2-3 minutes before insertion of the supraglottic airway. The technique of insertion of each airway is described below:

***LTS II™ placement***

The selection of the size was according to the patient's height. A size 4 was used if the height of patient >155 cm whereas a size 3 was used when the height is less than 155 cm. After lubrication with a water soluble lubricant, the LTS II™ was inserted with the subject's head in the 'sniffing' position. The device was introduced into the oropharynx against the hard palate and slid down until a resistance was felt or the second bold black line on the tube had passed between the upper and lower incisors. Both the cuffs were inflated with air using a pre-prepared syringe supplied by the manufacturer. The cuff's pressure was adjusted to 60 mmHg using a cuff pressure manometer.

***PLMA™ placement***

The size was determined according to the patient's weight and inserted according to the manufacture's recommendation with the use of an introducer. The cuff was inflated with air and the cuff's pressure was adjusted to 70 mmHg using a cuff pressure manometer.

Correct placement and effective airway for both devices was confirmed by ensuring:

- Good chest expansion and bilateral chest excursion on manual ventilation and auscultation over both lungs.
- A square wave capnography.
- No audible leak from the drain tube when peak airway pressure was kept at 20 cm $H_2O$. A leak below 20 cm H20 was taken as significant and suggests a malposition of the airway.
- The gel displacement test done by placing a blob of gel at the tip of the drain tube and ejection of the gel during ventilation was considered as a sign of incomplete separation of airway and alimentary tract.

The number of insertion attempts was recorded and the ease of insertion for both airways was assessed during the first attempt. The ease of insertion was graded as either easy, moderate or difficult. In the event of failure to establish an effective airway after 3 attempts of insertion, intubation with endotracheal tube was performed. An effective airway is defined as $SpO_2 \geq 95\%$, $ETCO_2 \leq 45$ mmHg and minimal air leak (the difference between inspiratory and expiratory tidal volume should be less than 15%). After successful insertion of the device, airway sealing pressure was immediately measured with the head in the neutral position with the adjustable pressure-limiting valve of the circle system closed at 40 cm $H_2O$ while maintaining a gas flow at 3 L/min. The airway sealing pressure at which the manometer reached equilibrium was recorded. The location of the gas leak was determined by listening for an audible sound of gas escaping with the ear close to the mouth, auscultation over the epigastrium (audible sound of gas escaping into esophagus) and watching for bubbling or movement of the lubricant gel placed on the proximal end of the drainage tube of the devices.

A gastric tube (size 14-16F), was then passed through the drain tube. The ease of placement of the gastric tube is recorded and its correct placement confirmed by gurgling sound during insufflations with air by epigastric auscultation.

The initial mode of ventilation was started using volume control with a starting tidal volume (VT) of 9ml/kg, RR of 12, I: E ratio of 1:2 and PEEP of 5. Below were parameters that were compared before and 20 minutes after the onset of capnoperitoneum:

- Heart rate, systolic, diastolic and mean blood pressures before induction, and at 1 and 5 min after the insertion of the device and after achieving capnoperitoneum/ insufflating carbon dioxide and then at every 5 min intervals.
- Oxygen saturation ($SpO_2$), end tidal $CO_2$ ($ETCO_2$) and tidal volume.
- Peak airway and plateau pressures were recorded before and after the insufflations of the abdomen which was kept between 11-17 mmHg. $SpO_2 > 95\%$ and $ETCO_2 \leq 45$ mmHg was maintained by adjusting the $FiO_2$, respiratory rate and tidal volume during capnoperitoneum.

Upon completion of surgery, muscle paralysis was reversed accordingly. The volatile anaesthetic was turned off and the patient ventilated with 100% oxygen. The airway device was removed when the patients was fully awake and able to respond to verbal commands. Tolerance during removal of the airway was assessed using a scale described by Gaitini et al as shown below[9]:

- Good : comfortable patients
- Moderate : minor sign of intolerance such as coughing, retching, hiccups or biting of the airway.
- Poor : major sign of intolerance such as vomiting or vagal reaction rendering it necessary to remove the airway immediately

Following removal of the airway devices, any traces of gastric fluid or blood on the airway devices were documented. Patients were subsequently admitted to the recovery bay and monitored for a minimum period of one hour. They were assessed for sore throat before discharge from the recovery bay.

All data were analyzed using independent Student's t-test and Chi-square test where appropriate. Paired t-test was used for comparison of repeated measurements. *A $p < 0.05$* was taken as statistically significant.

## RESULTS

A total of 54 patients were recruited into this study. Table I shows the demographic data of the patients in both groups. There were no statistical differences in both groups with respect to age, gender, weight, height, BMI and type of procedure performed.

**Table I: Patients' demographic data and clinical characteristics. Values are expressed as mean + SD, number and percentage in parenthesis where appropriate.**

| | LTS II™ (n=27) | PLMA™ (n=27) |
|---|---|---|
| Age (years) | 38.1 ± 9.4 | 40.4 ± 8.6 |
| ASA I / II | 27 /0 | 25 / 2 |
| Gender : Female | 23 (85) | 24 (89) |
| Male | 4 (15) | 3 (11) |
| Race : Chinese | 11 (40.7) | 7 (25.9) |
| Indian | 1 (3.7) | 1 (3.7) |
| Malay | 15 (55.6) | 18 (66.7) |
| Other | 0 (0) | 1 (3.7) |
| Weight (kg) | 59.8 ± 5.6 | 62.5 ± 8.5 |
| Height (cm) | 156.3 ± 5.5 | 155.6 ± 6.3 |
| BMI (kg/m$^2$) | 24.5 ± 1.0 | 25.8 ± 1.3 |
| Laparoscopic Procedures | | |
| BTL | 10 (37.1) | 11 (40.7) |
| Cholecyctectomy | 7 (25.9) | 3 (11.1) |
| Gynecology | 7 (25.9) | 8 (29.6) |
| Hernia | 3 (11.1) | 5 (18.5) |

**Table II: Airway assessment. Values are expressed as number and percentage in parenthesis**

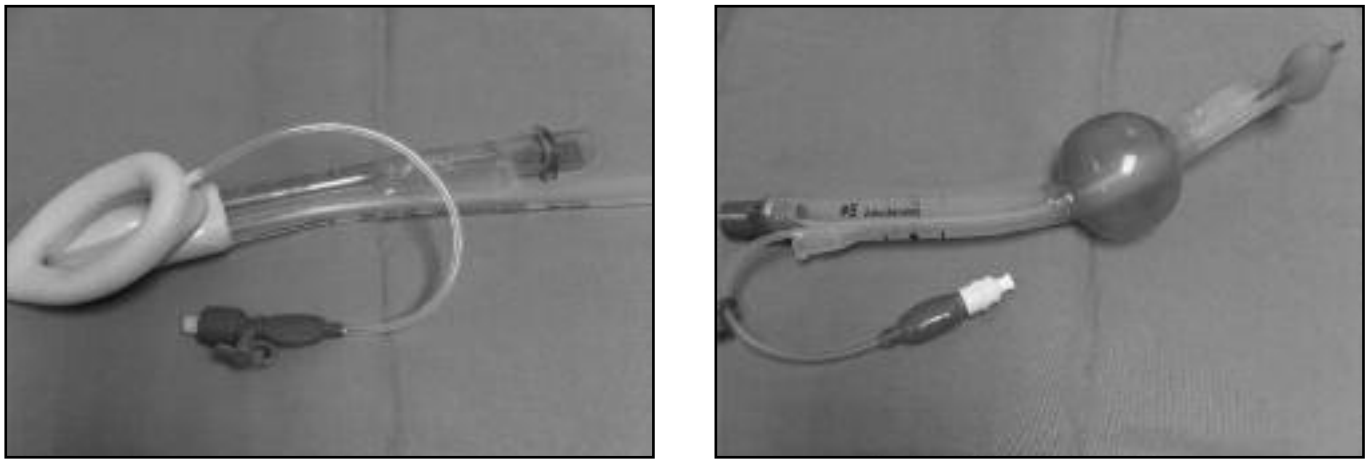
| | LTS IITM (n = 27) | PLMATM (n = 27) |
|---|---|---|
| Mallampati score I : II | 22 : 5 | 20 : 7 |
| Airway size (3 : 4) | 14 : 13* | 4 : 23* |
| Attempt (1/2/3) | 24/1/2 | 26/1/0 |
| Ease of insertion (Easy : Difficult) | 24 : 3 | 26 : 1 |
| Rescue device | 2 | 0 |

*p < 0.05

**Table III: Perioperative haemodynamic, airway pressure, oxygenation and ventilation parameters. Values are expressed as mean + SD**

| | LTS II™ (n = 27) | PLMA™ (n = 27) | p-value |
|---|---|---|---|
| **Sealing pressure (cmH20)** | 33.6 ± 3.6 | 35.7 ± 5.1 | 0.092 |
| **Capnoperitoneum pressure (cmH20)** | 13.8 ± 1.6 | 13.9 ± 1.5 | 0.835 |
| **Systolic NIBP (mmHg)** | | | |
| Pre-induction | 118.1 ± 10.6 | 120.0 ± 11.4 | 0.547 |
| Post-induction | 111.0 ± 9.1 | 111.5 ± 9.1 | 0.836 |
| Capnoperitoneum | 124.6 ± 8.2 | 126.5 ± 7.2 | 0.366 |
| **Diastolic BP (mmHg)** | | | |
| Pre-induction | 72.8 ± 7.8 | 75.0 ± 8.3 | 0.327 |
| Post-induction | 65.7 ± 8.2 | 68.6 ± 8.2 | 0.219 |
| Capnoperitoneum | 77.8 ± 8.2 | 77.6 ± 7.9 | 0.954 |
| **Heart rate (beat/minute)** | | | |
| Pre-induction | 76.0 ± 6.0 | 77.0 ± 7.0 | 0.460 |
| Post-induction | 78.0 ± 5.0 | 75.0 ± 5.0 | 0.088 |
| Capnoperitoneum | 80.0 ± 6.0 | 77.0 ± 8.0 | 0.169 |
| **Peak airway pressure (cmH20)** | | | |
| Post-induction | *12.1 ± 2.2 | **12.4 ± 2.5 | 0.662 |
| Capnoperitoneum | *20.6 ± 2.5 | **22.0 ± 3.6 | 0.088 |
| **Plateau airway pressure (cmH20)** | | | |
| Post-induction | *11.3 ± 2.3 | **11.7 ± 2.3 | 0.591 |
| Capnoperitoneum | *19.5 ± 2.2 | **20.8 ± 3.1 | 0.086 |
| **SpO2 (%)** | | | |
| Pre-induction | 98.8 ± 0.8 | 98.5 ± 1.1 | 0.275 |
| Post-induction | 99.8 ± 0.4 | 99.8 ± 0.5 | 0.905 |
| Capnoperitoneum | 99.6 ± 0.8 | 99.6 ± 0.9 | 0.714 |
| **ETCO2 (mmHg)** | | | |
| Post-induction | 32.9 ± 1.2 | 33.3 ± 1.2 | 0.310 |
| Capnoperitoneum | 39.4 ± 2.4 | 38.7 ± 2.5 | 0.307 |
| **Inspiratory TV (ml)** | | | |
| Post-induction | 486 ± 40 | 492 ± 55 | 0.618 |
| Capnoperitoneum | 420 ± 30 | 436 ± 55 | 0.177 |
| **Expiratory TV (ml)** | | | |
| Post-induction | 476 ± 37 | 474 ± 54 | 0.882 |
| Capnoperitoneum | 406 ± 24 | 417 ± 55 | 0.352 |

*and** show p < 0.001



**Appendix:** Proseal ( left) and LTMA (right).

Table II shows airway assessment and the type of procedure performed. There was a significant difference between the airway size selected for patients in the LTS II™ and PLMA™ group. Both PLMA™ and LTS II™ had an equal high success rate of insertion in the first attempt (96% vs. 89%), a second attempt was necessary in one patient in each group. There were two cases of failed insertion which required a rescue device in the LTS II™ Group

Table III shows hemodynamic parameters (NIBP and HR) for both devices before induction, post induction and after capnoperitoneum. There were no statistical differences between both groups. The airway sealing and capnoperitoneum pressures were comparable for both devices. There was a significant increase in the peak and plateau pressures after the induction of capnoperitoneum when compared to the baseline values in both groups ($p < 0.001$). Otherwise, both devices showed comparable peak and plateau pressures ($p > 0.05$) before and after capnoperitoneum. Oxygenation was not impaired and considered optimal ($SpO_2 > 95\%$) in all patients of both groups before and after capnoperitoneum. There was an increase of $ETCO_2$ after capnoperitoneum as expected due to $CO_2$ insufflations but there were no significant differences in both groups. Although there were reductions in tidal volumes and an increase in $ETCO_2$, ventilation was adequate and optimum.

Ventilation was possible throughout all procedures with both devices without signs of gastric insufflation and regurgitation during the removal of the supraglottic airway. No adverse events occurred in either group. Before discharge from the recovery, sore throat was reported in 2 (7%) patients in the PLMA™ group and 4 (16%) in the LTS II™ group which was not statistically significant.

## DISCUSSION

The use of supraglottic airway devices under conditions of elevated intra abdominal pressure requires an excellent airway seal to divide the respiratory and alimentary tracts in a reliable manner due to the potential risk of regurgitation[6, 8].

Previously until recently, most anesthetists' regard endotracheal intubation as the gold standard in managing the airway during laparoscopic surgery. Current practice have shown an increased usage of supraglottic airway in low risk elective laparoscopic surgery in view of less airway trauma, better haemodynamic changes during insertion and increased tolerance during its removal. Most of the studies showed PLMA™ was superior when compared with other airway devices such as the cLMA and laryngeal tubes in laparoscopic surgery[1, 6, 7, and 8,13,14,15]. This is due to the ability of the PLMA™ to separate the alimentary tract from the respiratory tract with the presence of the drainage tube, which other devices lack.

Roth *et al* described the successful use of both PLMA™ and LTS II™ in providing secure airway in laparoscopic gynaecology surgery[8]. Their study showed similar performances between the PLMA™ and the newly developed LTS II™ during laparoscopic surgery in respect to handling, effective airway sealing, ventilation and complications[8]. Our study compared the same airway devices during laparoscopic surgery and found they had similar clinical performances, haemodynamic changes, and quality of airway seal, oxygenation and ventilation parameters and complications.

This study also showed a significant difference between the airway size selected for the patients in the LTS II™ and the PLMA™ group with $p < 0.01$. This was probably due the different methods of size selection based on height and weight respectively.

The success rate in obtaining a patent airway in this study was comparable (PLMA™ 100% vs. LTS II™ 93%) with the trend of a higher failure rate in the LTS II™ group. There were two failed attempts, which required endotracheal intubation in LTS II™. This was not related to the difficulty with insertion, but rather failure to form an effective airway. This was probably due to inappropriate device size despite adhering strictly to manufacturer's recommendation. An adjustment of the size of LTS II™ may be needed for the Malaysian population as the recommendation is based on the Caucasian population[2].

The haemodynamic parameters were comparable for both devices during perioperative period. Any changes noted during capnoperitoneum were within acceptable range of physiological changes that occurred during laparoscopic surgery.

The quality of airway seal as indicated by the airway sealing pressures was excellent for both devices (PLMA™ 35.7 $cmH_2O$ vs LTS II™ 33.6 $cmH_2O$) as this was required during laparoscopic surgery whereby higher peak and plateau airway pressures were needed in order to provide effective ventilation. A sealing pressure less than 40$cmH_2O$ provide lung protection against barotrauma. Peak and plateau airway pressures were significantly increased with capnoperitoneum in both groups but showed no differences. Our study also showed that the mean difference between airway sealing pressure and peak airway pressure during capnoperitoneum was more than 13 $cmH_2O$, which may be an estimate for the safety margin offered by these supraglottic airway devices. This is lower than the Roth *et al* study (mean> 23 cmH2O) which used peak airway pressure of 50 $cmH_2O$ as maximum airway sealing pressure limit[8].

Capnoperitoneum leads to a decrease in lung compliance and increase in $CO_2$ load. However, this study showed oxygenation and ventilation was optimum in both groups. Carbon dioxide removal was adequate in both groups despite an increased load. This was made possible by increasing minute ventilation by 15-20%, increasing $FiO_2$ and decreasing the tidal volume to minimise airway pressure. Leak was minimal in both devices reflecting good airway sealing pressure.

There were no major airway incidences or complications in this study. Sore throat was noted in 16% in the LTS II™ group compared to 7% in the PLMA™ group (p=0.1353), which was comparable. Postoperative sore throat was caused by the combination of trauma on insertion and the pressure exerted by the cuff against the pharyngeal mucosa. It is usually temporary and mild. Generally, the incidences of sore throat with both devices were much lower compared with endotracheal tube. The incidence of sore throat for endotracheal tube, Laryngeal Mask Airway and the face mask was 45.4%, 17.5% and 3.3% respectively[16] .

This study showed that the clinical performance of the LTS II™ and the PLMA™ was comparable during laparoscopic surgery with respect to ease of insertion, airway sealing, oxygenation, ventilation and complication.

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