Original Article

Airway Management During Diagnostic Laparoscopic Surgery: A Comparison of I-Gel and Proseal Laryngeal Mask Airway

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Abstract

Background: Supraglottic airway devices (SADs) may be used during laparoscopic procedures in place of the often utilised endotracheal tube. The Proseal laryngeal mask airway (PLMA) is designed with an inflatable cuff, which provides an excellent oropharyngeal seal, and the I-gel is a newer SAD designed with a softer and noninflatable cuff and sharing similar features with PLMA. **Aim and Objectives:** This study compared the ease of insertion, haemodynamic and ventilatory parameters as well as morbidities associated with these SADs when used for airway management during diagnostic laparoscopic procedures. **Patients and Methods:** Eighty American Society of Anaesthesiologist I and II patients aged 18–60 years undergoing diagnostic laparoscopic surgery under controlled ventilation had either I-gel or PLMA used for airway management. Anaesthesia was induced with standard dose of propofol, patient received atracurium, fentanyl and the SAD inserted. Pulse oximetry, capnography, noninvasive blood pressure, oropharyngeal leak pressure (OLP), and evidence of pharyngolaryngeal morbidity were assessed. Data were analysed using the Statistical Package for Social Sciences version 21.0. The quantitative variables were analysed using the Student's *t* test and the qualitative using the Chi-square test. A *P* value of less than 0.05 was considered significant. **Results:** The success rates at first insertion for I-gel and PLMA were 95% and 80%, respectively ($P = 0.04$). The mean changes in mean arterial pressure following insertion were 9.6 mmHg (±4.7) and 10.6 mmHg (±8) for I-gel and PLMA, respectively ($P = 0.02$). The OLP during insufflation was higher in the PLMA (35.8 cmH2O) than in the I-gel group (27.9 cmH2O) ($P = 0.57$). In the I-gel group, 12.5% of the patients had oropharyngeal morbidities compared with 37.5% in the PLMA group ($P = 0.009$). **Conclusion:** Both I-gel and PLMA provide optimal ventilation during abdominal insufflation, with PLMA providing a better oropharyngeal seal, whereas I-gel has a better haemodynamic profile.

Keywords: *I-gel, Proseal laryngeal mask airway, supraglottic airway device*

Introduction

Laparoscopic surgery has continued to evolve and has extended from minor gynaecological procedures and cholecystectomy to involve advanced gastrointestinal and urological procedures.[1] Both diagnostic and therapeutic procedures may be performed laparoscopically, because of the associated raised intra-abdominal pressure and increased risk of regurgitation and aspiration, maintaining a patent airway and adequate ventilation is often achieved with a cuffed endotracheal tube (ETT). The ETT is considered the gold standard for providing a safe glottic seal during laparoscopic procedures under general anaesthesia.[2] Endotracheal intubation, however, requires rigid laryngoscopy, which is associated with some changes such as concomitant haemodynamic responses and damage to oropharyngeal structures at insertion with reported incidents of sore throat, laryngeal oedema, hoarseness, and nerve injury leading to dysphonia.[3] Additionally, laparoscopic procedures are often performed on a daycase basis with patients returning home on the day of surgery, and thus, an invasive method of securing the airway such as ETT insertion is not preferred with its associated discomforts in the postoperative period.

Successful use of supraglottic airway devices (SADs) as an effective alternative to ETT in laparoscopic surgeries has been on the increase. These SADs include the laryngeal mask airway-classic (LMA-classic), Proseal LMA (PLMA), and I-gel. The PLMA and the I-gel have particularly been used

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as alternatives to ETT in different kinds of surgical procedures.[2] Such use of SADs was reported way back in the late 20th century when LMA-classic was reported to be used for ambulatory anaesthesia.[4] The clinical use of SADs, particularly PLMA and I-gel, extended to involve general anaesthesia with positive pressure ventilation and during cardiopulmonary resuscitation requiring airway management.[5] The PLMA is designed with a cuff that extends over the posterior surface of the mask as well as around its periphery, which pushes the mask anteriorly to provide a better seal around the glottic aperture and permits peak airway pressure of more than 30 cmH2O without leaks.[6] It possesses a drain tube, which opens at the tip of the cuff to lie at the upper oesophageal sphincter permitting drainage of passively regurgitated gastric fluid or passage of gastric drain tube. The I-gel is an anatomical device designed without an inflatable cuff. It is soft and made to fit the perilaryngeal and hypopharyngeal structures with its noninflatable thermoplastic mask.[6] As the noninflatable cuff fits onto the perilaryngeal framework, its tip lies in the proximal opening of the oesophagus, thus isolating the oropharyngeal opening from the laryngeal opening. It has been shown to be easier to insert with higher success rate at the first attempt and has significantly less associated haemodynamic changes immediately following insertion compared with the ETT.[7] I-gel offers a good seal during anaesthesia both in spontaneously breathing patients and in patients under controlled ventilation. The soft cuff avoids compression trauma and the tip bears a gastric access.[8]

The fact that the I-gel or PLMA is associated with minimal haemodynamic changes compared with ETT makes them suitable for patients with cardiovascular diseases such as hypertension and ischaemic heart disease. They are also suitable for patients with hyperactive airway such as asthma because they are known to be less irritating to the airway. They create a seal, with high airway leak pressure that is sufficient for both spontaneously breathing as well as paralysed patients, making it easier for the anaesthetist with less experience in airway management to use and monitor. A low rate of perilaryngeal morbidity translates to fewer postoperative complaints enhancing faster patient recovery, greater patient satisfaction, and expected quicker discharge from the hospital, especially following day-case laparoscopic procedures. This study compares the use of I-gel and PLMA for airway management in patients undergoing diagnostic laparoscopic procedures.

Materials and Methods

This was a prospective, single-blind, randomised study carried out at Aminu Kano Teaching Hospital, a tertiary institution in Northwest Nigeria. With institutional ethical committee approval obtained, 80 patients between 18 and 60 years old who belonged to the American Society of Anaesthesiologist physical status classification I and II and had given written consent were recruited into this study. These patients were scheduled for diagnostic laparoscopic procedures under general anaesthesia. Patients excluded from this study include: patients with anticipated difficult airway, patients with cervical spine disease, hypertensive, diabetic, and obese patients (with body mass index [BMI] >35 kg/m2); patients with respiratory disease such as asthma and preoperative sore throat, and patients with a high risk of regurgitation and aspiration.

Patients enrolled for the study were randomly allocated into either group I (I-gel) or P (Proseal LMA) comprising 40 patients each after picking one folded sheet of paper from a box containing uniformly folded pieces of paper labelled either I or P. The paper was handed over to the research assistant (a designated resident doctor) who was not blinded to the study group the patient belonged to and was not involved in data collection. The investigator was not notified of the group allocation of the patients. Preanaesthetic assessment was done in all selected patients and it included history taking, examination, and review of relevant investigations such as full blood count, urea, creatinine, and electrolytes. Airway assessment was also conducted to predict any difficulty. All selected patients were ensured to have fasted overnight. Patients' weights and heights were measured and documented. Patients were counselled on the procedure and on the options of airway management, and consent for the study was sought.

Each patient was premedicated with intravenous (IV) glycopyrrolate 5 ug/kg, IV metoclopramide 0.2 mg/kg, and IV ranitidine 1 mg/kg after securing an intravenous access. The anaesthetic machine and other equipment were checked to ensure their functionality. Resuscitation drugs were prepared and labelled. An hour after standard premedication, patient was transferred to the operating room. On arrival in the operating room, the patient was positioned supine on the operating table. Using a multiparameter monitor, baseline parameters of pulse rate (PR), blood pressure (systolic, diastolic, and mean arterial pressures [MAPs]), and peripheral oxygen saturation (SpO_2) were recorded. The patient was preoxygenated with 100% oxygen for 3–5 min. Anaesthesia was induced with propofol 2–2.5 mg/kg until loss of verbal contact. Neuromuscular blockade was achieved with atracurium 0.5 mg/kg to facilitate the placement of the airway device.

Anaesthesia was induced with propofol 2–2.5 mg/kg until loss of verbal contact. Neuromuscular blockade was achieved with atracurium 0.5 mg/kg to facilitate the placement of the airway device. Analgesia was provided with fentanyl 1–2 mcg/kg. The airway device (PLMA or I-gel) of appropriate size was inserted by the primary investigator according to the patient's allocation. The patient's head was then made to assume the "sniffing the morning air position", and the SAD was inserted using the digital technique after lubricating the cuff with a water-based jelly. The cuff of the PLMA was inflated with the

recommended volume of air. The device was connected to the breathing circuit with capnographic monitoring and correct placement of the airway device was confirmed by observing adequate chest movement on manual ventilation, normal rectangular-shaped capnograph tracing, bilateral air entry on auscultation, absence of leak, and normal SpO_2 (>95%). The airway device was secured following confirmation of correct placement. An appropriately sized nasogastric tube was inserted. The ease of insertion of either PLMA or I-gel was assessed and recorded as either easy or difficult. Easy insertion was when there was no resistance to insertion in one attempt, and difficult was when insertion was associated with resistance or more than one attempt is required. The SAD that could not be inserted was termed as Impossible insertion, and the patient was excluded from the study. Anaesthesia was maintained with isoflurane 1%–2% in 50% oxygen in air, providing controlled ventilation with tidal volume of 8–10 mL/kg and frequency of 12–14 per min, keeping the inspiratory to expiratory ratio (I:E ratio) at 1:2. Intraoperative fluid therapy was maintained with 0.9% saline.

Patient monitoring continued throughout the surgery. PR, systolic blood pressure (SBP), diastolic blood pressure, MAP, and peripheral saturation of haemoglobin (SpO_2) were recorded before insertion of SAD, 1, 3, and 5 min after insertion. The end-tidal carbon dioxide ($ETCO_2$) was also recorded at 1, 3, and 5 min after insertion of the SAD, then after pneumoperitoneum, and finally 5 min after release of pneumoperitoneum. It was ensured that SpO_2 was kept above 95%, and values between 90% and 94% were considered suboptimal. Suboptimal SpO_2 was treated by adjusting the position of the device, checking for regurgitation, and ensuring that adequate tidal volume was delivered to the patient.

Airway sealing pressure was also recorded at the 1st, 3rd, and 5th min, after insufflation and after deflation of the peritoneum. It was determined by closing the expiratory valve of the circle system at a fixed gas flow rate of 3 L/m and recording the airway pressure shown on the machine, at which an audible leak was heard at the mouth or by an audible noise using a stethoscope placed just lateral to the thyroid cartilage. At the end of the surgery, the residual neuromuscular block was reversed with a combination of neostigmine 0.05 mg/kg and glycopyrrolate 0.04 mg/kg. After removal of the SAD, regurgitation as well as blood staining of the device, the tongue, or the lip were checked and recorded. Markers of pharyngolaryngeal morbidity such as hoarseness of the voice, sore throat, and dysphonia were also assessed, starting in the postanaesthetic care unit and extending up to the first 24 h after surgery. This assessment was done by following up the patient at 24 h postoperatively, in the ward for patients admitted in the hospital, or by telephone conversation with the patient or with a responsible adult caring for the patient, for those patients discharged before 24 h.

Data collected in this study were entered into a computer database and analysed using the statistical software Statistical Package for Social Sciences version 20 (Manufactured by IBM, Chicago, Illinois, USA). Values were expressed as numbers, means, and standard deviations (SDs), and the results were presented as tables, charts, and graphs. Hypothesis testing was done using the Student's *t* test and Chi-square test for continuous and discrete variables, respectively. A *P* value of less than 0.05 was considered significant.

Results

Patients' demographic profiles including age, sex, and BMI were comparable [Table 1].

Insertion of I-gel was easy in 38 (95%) patients and difficult in two patients, whereas the insertion of PLMA was easy in 32 (80%) patients and difficult in eight patients. There was a statistically significant difference between the two devices in terms of success rate at the first attempt ($P = 0.04$).

The baseline haemodynamic parameters were comparable in both groups. The heart rate (HR), SBP and diastolic blood pressure, and MAPs increased from baseline values following the insertion of SAD in both groups, with higher changes seen in the PLMA group [Figure 1], these changes were statistically significant. Mean (± SD) changes in HR, SBP, and MAP for I-gel group were 7.6 (±6.9), 10.6 (±9.3), and 9.6 (±4.6), respectively, whereas in the PLMA group, mean changes in HR, SBP, and MAP were 12.1 (±8.5), 12.7 (±9.8), and 10.6 (±7.9), respectively.

The mean baseline SBP and baseline MAP in the I-gel group were 119 (±9) mmHg and 88 mmHg, respectively, and the mean baseline SBP and MAP in the PLMA were 118 (±10) mmHg and 89 mmHg, respectively.

The increase in HR was maximum at the 1st min after insertion of the device in both groups of patients with higher increases seen in the PLMA group [Figure 2], the difference between the two groups was not significant ($P = 0.60$). An increase in SBP and MAP was also observed to be maximum at 1 min after insertion. The differences

Table 1: Patients' demographic characteristics

Parameter	I-gel group ($n = 40$) (Mean ± SD)	PLMA group ($n = 40$) (Mean ± SD)	*P* value
Age	32.3 ± 6.2	31.3 ± 4.7	0.17
BMI	28.9 ± 2.8	28.9 ± 2.8	0.29
Sex (M: F)	3: 37	2: 38	0.64
Type of surgery			
Gynae	36	35	
Gen Surgery	3	2	
Urology	1	3	

PLMA: Proseal laryngeal mask airway, SD: standard deviation

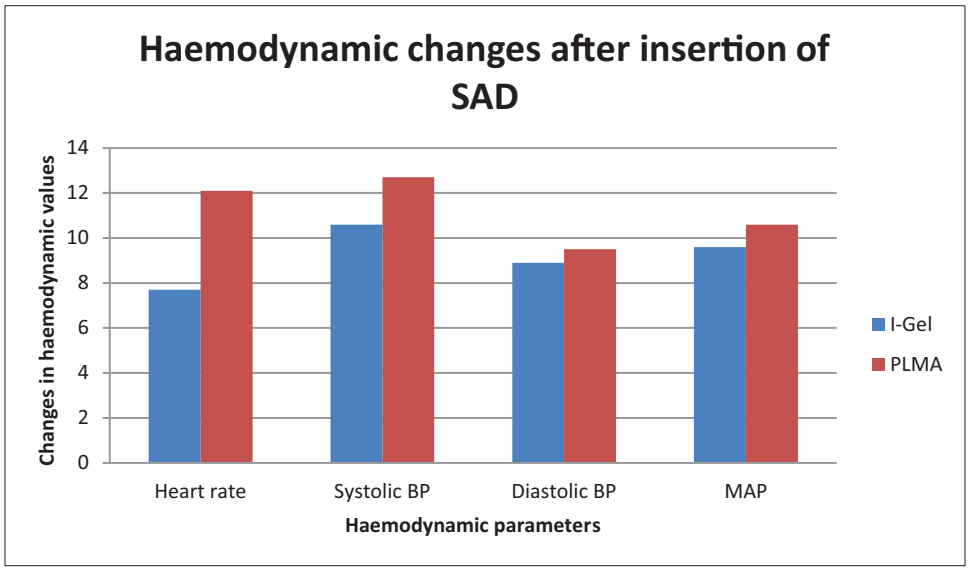

Figure 1: Comparison of haemodynamic changes after insertion of SAD. SAD: supraglottic airway device

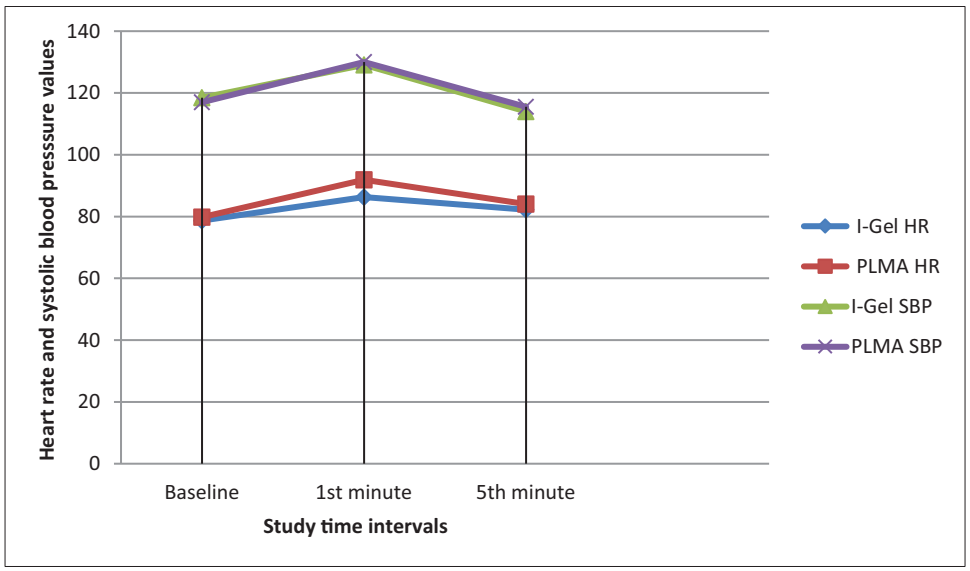

Figure 2: Haemodynamic changes at different time intervals

between the two groups in terms of change in SBP and DBP were not significant ($P = 0.72$ for SBP and $P = 0.07$ for DBP), whereas the difference in terms of MAP was significant ($P = 0.02$).

Four patients in the I-gel group (10%) and three patients in the PLMA group (7.5%) had baseline HRs of greater than 100 (tachycardia).

All patients had baseline SpO_2 above 95%. One patient (2.5%) in the I-gel group had SpO_2 of 94% and one patient (2.5%) in the PLMA group had SpO_2 of 95% in the 1st min after insertion. No incidence of SpO_2 less than 95% was recorded in both groups intraoperatively. The mean SpO_2 during abdominal insufflation was 99.5% (±0.7) in the I-gel group and 99.6% (±0.8) in the PLMA group; there was no statistically significant difference between the two groups ($P = 0.36$).

Table 2 shows that the mean $ETCO_2$ after insufflation in the I-gel group was 35.9 mmHg (±4.1), whereas in the PLMA group was 36.6 mmHg (±3.4), the difference between the two was not statistically significant ($P = 0.70$). Nineteen patients (47.25%) in the I-gel group and twenty patients (50%) in the PLMA group had $ETCO_2$ between 33 and 38 mmHg following the insufflation of CO2. Twenty-six patients (65%) in each group had $ETCO_2$ of 35 mmHg and above.

In the 1st and 5th min, the mean oropharyngeal leak pressures (OLP) recorded in the I-gel group were 24.1 and 24.6 cmH2O, respectively, as shown in Table 3, whereas the mean OLPs in the PLMA group were 30.5 and 31.2, respectively; the differences between the two groups were not statistically significant ($P = 0.47$ in the 1st min and $P = 0.21$ in the 5th min). The highest mean OLPs were observed after insufflation in both groups; 27.9 cmH2O (±3.9) and

Table 2: Mean end-tidal CO_2 concentrations (mmHg)

Time	I-GEL (±SD) $n = 40$	PLMA (±SD) $n = 40$	*P* value
1st min	33.3 (±2.7)	34.2 (±2.8)	0.19
3rd min	33.5 (±2.7)	35.3 (±3.3)	0.9
5th min	33.6 (±2.8)	34.0 (±2.3)	0.8
After insufflation	35.9 (±4.1)	36.6 (±3.4)	0.7
After deflation	33.6 (±3.5)	33.5 (±3.0)	0.2

PLMA: Proseal laryngeal mask airway

Table 3: Mean oropharyngeal leak pressures (cmH_2O)

Time	I-gel Mean ± SD	PLMA Mean ± SD	*P* value
1st min	24.1 ± 3.3	30.5 ± 3.3	0.47
5th min	24.6 ± 3.2	31.2 ± 3.3	0.21
After insufflation	27.9 ± 3.9	35.8 ± 3.6	0.57
After deflation	25.1 ± 3.6	31.3 ± 3.3	0.51

Proseal laryngeal mask airway, SD: standard deviation

35.8 cmH2O (±3.6) for I-gel and PLMA groups, respectively ($P = 0.57$). Following deflation of the pneumoperitoneum, the mean OLPs recorded in the two groups were 25.1 in the I-gel group and 31.3 in the PLMA group ($P = 0.51$).

Pharyngolaryngeal morbidities were recorded in a total of five patients (12.5%) in the I-gel group and 15 patients (37.5%) in the PLMA group ($P = 0.009$). The commonest morbidity was blood staining of the airway device, which was recorded in three patients (7.5%) in the I-gel group and eight patients (20%) in the PLMA group. Laryngospasm was recorded in one (2.5%) patient in the I-gel group and two (5%) patients in the PLMA group. The incidence of sore throat was found to be 2.5% (one patient) in the I-gel group and 5% (two patients) in the PLMA group. No dysphonia was recorded in the I-gel group, whereas one patient (2.5%) had dysphonia in the PLMA group.

Discussion

In this study, insertion of the SAD was successful in all the 80 patients with no failed insertion recorded. Sizes 3 and 4 of both I-gel and PLMA were used in this study and were appropriate for both male and female populations. Both I-gel and PLMA were inserted with high success rates at the first attempt of 95% and 80%, respectively. Najeeb *et al.*[8] also studied I-gel and PLMA alongside ETT in patients undergoing laparoscopic surgeries and found similarly high success rates at the first attempt of insertion for I-gel and PLMA with success rates of 92.5% and 85%, respectively. Although Jadhav *et al.*[9] in their study did not include laparoscopic surgeries, they also compared I-gel and PLMA and discovered I-gel to be significantly easier to insert when compared with PLMA with success rates of 96.6% and 80%, respectively ($P < 0.05$), which is comparable to rates found in this study, their study had similar methodologies and dosages of induction agents as ours.

This study also measured the OLP, which is the pressure at which a gas leak occurs around an SAD. The OLP serves as an indicator of the degree of airway protection and helps evaluate; whether the successful placement of SAD has occurred and whether positive pressure can be provided.[10] The cuff of the I-gel has been made to fit the perilaryngeal and hypopharyngeal anatomy producing a seal without inflation.[11] For this reason, the I-gel provides a better seal and higher leak pressures than LMA-Unique and, thus, a better alternative for mechanical ventilation.[12] The PLMA is also designed to improve airway protection. Cook *et al.*[13] demonstrated that the PLMA offered significant benefits over classic LMA and tracheal tube in some circumstances including laparoscopic gynaecologic surgery. In the present study, OLPs were slightly less in the I-gel group than in the PLMA group during abdominal insufflation suggesting that the I-gel is a slightly less effective ventilatory device compared with the PLMA during pneumoperitoneum. We also saw a mean maximum OLP for the PLMA to be 7.9 cmH2O greater than that of I-gel, suggesting that PLMA provided a better seal, and, consequently, is a more effective ventilatory device. It may be argued that the noninflatable cuff and the gel-like material of the I-gel theoretically render it more susceptible to air leaks if the inappropriate size is used and the anatomical fit is imperfect.

A study by Uppal *et al.*,[14] however, showed remarkable efficacy of the I-gel when they compared it with cuffed ETT during pressure-controlled ventilation, their I-gel group had no significant difference in the gas leak compared with patients that had cuffed ETT utilised for ventilating at moderate pressures of 15–20 cmH2O.

In this study, I-gel produced the least changes in HR, blood pressures, and MAPs, even though the difference between the two was not significant. This implies that the devices can be used in selected elective cases where stress response may be undesirable and better avoided. The minimal pressor response observed with I-gel in this study might be attributed to lower pressures exerted by the I-gel on the soft tissues of the palate, and the adaptive nature of its mask permits further conformity. The findings in this study agree with the results of a previous study by Ismail *et al.*,[15] which showed that the insertion of I-gel evoked less cardiovascular response than classic LMA. It was observed in this study that both I-gel and PLMA provided effective pulmonary ventilation with normal and identical oxygen saturation and end-tidal carbon dioxide concentrations in the two devices.

The use of SAD may be associated with injury to the periglottic mucosa, which is recognised by blood on the SAD after removal. Devices with inflatable cuff have the potential to cause tissue distortion, venous compression, and nerve injury.[16] In this study, the incidence of pharyngolaryngeal morbidity was significantly higher with the PLMA than the I-gel, and the commonest morbidity was blood staining of the device. Blood staining of the device was seen in three

patients (7.5%) and eight patients (20%) in the I-gel and PLMA groups, respectively, similar number of patients had difficulties with the insertion of SAD in the study groups and, therefore, could have been responsible for this morbidity encountered. The Proseal LMA was designed so that its larger, wedge-shaped cuff would plug gaps in the proximal pharynx and the flat dorsal cuff would push the ventral cuff more firmly into the periglottic tissues.[13] This high incidence of side effects may, however, be attributed to the limited experience of the anaesthetists with the use of PLMA. Previous studies had reported a similarly low rate of blood staining while using I-gel.[17,18] Keller and Brimacombe[19] demonstrated that mucosal perfusion progressively decreased with increasing mucosal pressure caused by the inflated cuff of the PLMA.

Conclusion

We conclude that the SADs I-gel and PLMA are comparably effective and safe for airway management in patients undergoing diagnostic laparoscopic surgery. The two airway devices have comparable ventilatory efficacy and improved haemodynamic stability. Their use is associated with reduced incidence of postoperative adverse events; I-gel has significantly less postoperative adverse effects than PLMA.

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Conflict of interest

There are no conflicts of interest.

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