Comparison of Inhalational Vital Capacity Induction with Sevoflurane to Intravenous Induction with Propofol for Insertion of Laryngeal Mask Airway in Adults: A Randomized Study

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Abstract

Background: Since the development of laryngeal mask airway (LMA) by Dr. Brain, it is extensively used for airway management; satisfactory insertion of LMA requires administration of an induction agent and suppression of airway reflexes. Among intravenous agents, propofol has been the drug of choice in view of better safety profile, relaxation and depression of upper airway reflexes. Sevoflurane on the other hand, with pleasant odor, nonirritating to the airways and with bronchodilator property are best among the volatile induction agents. While it is true both propofol and sevoflurane have their merits, still both have certain limitations. We aimed to compare the quality and ease of LMA insertion, hemodynamic changes, and complications with inhalation of 8% sevoflurane vital capacity breath and propofol. Materials and Methods: A prospective randomized study of 100 American Society of Anaesthesiologists’ Class I and II patients was conducted equal distribution among two groups with 50 each undergoing gynecological procedures under general anesthesia. Group P received injection propofol and Group S received sevoflurane. At the end point of induction, the LMA insertion was attempted. Scoring systems were used to grade the conditions for insertion of the LMA. Induction characteristics, hemodynamic changes, and complications were assessed. Results: Sevoflurane took a longer time for induction and jaw relaxation than propofol. There was no statistically significant difference between the two groups, with respect to LMA insertion time, and conditions. Apnea time was more in propofol group. Fall in heart rate and mean blood pressure was more in propofol. Conclusion: Propofol is associated with faster induction while sevoflurane is associated with good hemodynamic stability.

Keywords: Laryngeal mask airway, propofol, sevoflurane

INTRODUCTION

The laryngeal mask airway (LMA) has gained pervasive popularity and has become a valuable and important device for the airway management in anesthesia practice.[1] LMA is a supraglottic airway device; its design is such that it provides and maintains a seal around the larynx for spontaneous ventilation. It is also a safe device for controlled ventilation, where airway pressure is maintained at 15–20 cm of H2O.[2] LMA can be used safely in variety of age groups and in various surgical procedures.[2] It has the advantage of being minimally invasive, less traumatic, and having a relatively effortless insertion without muscle relaxants or laryngoscopy.[1] The ensuing airway stimulation is less, resulting in minimal hemodynamic changes, less coughing and agitation on awakening from anesthesia, and less severe postoperative sore throat.[3] This has, therefore, found increasing use in ambulatory and day care surgeries, along with the added advantage of emergency and difficult airway management.[4,5]

The insertion of LMA is preceded by the administration of induction agents to attain sufficient depth of anesthesia and suppression of airway reflexes. Intravenous agents such as thiopentone, propofol, and ketamine and inhalational agents such as halothane and sevoflurane have been tried with varying success.[6-9]

Among intravenous agents, propofol has been the drug of choice for LMA insertion in view of better safety profile, and effectiveness.

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relaxation, and depression of upper airway reflexes and mild bronchodilation.\[14-17\] However, the free use is limited by adverse effects such as pain on injection, thrombophlebitis, cardiovascular, and respiratory depression.\[9\]

Sevoflurane, on the other hand, is a halogenated volatile anesthetic agent with pleasant odor, nonirritating to the airways and with bronchodilator property is best among the volatile induction agents. These properties of sevoflurane, along with faster induction, relative hemodynamic stability, and satisfactory recovery characteristics, have made it an increasingly popular choice for LMA insertion.\[10\] Side effects associated with sevoflurane induction are breath holding, coughing, and laryngospasm.\[11,12\]

While it is true both propofol and sevoflurane have their merits, still both have certain limitations.

We performed a prospective, randomized study to compare the quality and ease of LMA insertion after induction with either inhalational sevoflurane (8%) by vital capacity breath and intravenous induction with injection propofol (2.5 mg.kg\(^{-1}\)). The primary objective of this study was to compare conditions for insertion of LMA. Secondary objectives assessed were induction times, jaw relaxation times, LMA insertion times between the drugs, along with the relative difference in success rate, apnea time, and hemodynamic changes between them.

**MATERIALS AND METHODS**

We performed this prospective, randomized study in the department of anesthesia of a tertiary care rural hospital in Central India, between September 2015 and September 2017.

After institutional ethics committee clearance and written informed consents, 100 patients posted for gynecological procedures under general anesthesia, having American Society of Anesthesiologist (ASA) Class I and II, Mallampatti Grade I and II, aged between 20 and 60 years and weighing anywhere between 40 and 70 kg were enrolled into the study. The patients were allocated randomly to two induction groups of 50 each using computer-generated random numbers [Figure 1].

- Group P: Induced with intravenous propofol (2.5 mg.kg\(^{-1}\))
- Group S: Induced with 8% sevoflurane, by vital capacity breath technique.

Higher ASA class or Mallampatti grades were excluded, along with anticipated difficult airway, comorbid conditions such as coronary artery disease, cerebrovascular disease, respiratory tract pathology, high risk of regurgitation and aspiration.

Each patient was examined for fitness the evening before surgery. On the day of surgery, after shifting the patients to operating room, standard monitors were attached to the patients and baseline hemodynamic parameters were recorded. 18-gauge intravenous cannula was secured in a large peripheral vein of the hand and Ringers lactate infusion was started at the rate of 80 ml.hr\(^{-1}\). All patients were premedicated with injection glycopyrrolate 0.2 mg, injection midazolam 0.05 mg.kg\(^{-1}\), injection fentanyl 1 ug.kg\(^{-1}\), and injection ondansetron 0.1 mg.kg\(^{-1}\) 5 min before induction. All patients were preoxygenated with 10 L.min\(^{-1}\) O\(_2\) through Hudson mask for 5 min. Patients were induced with either propofol or sevoflurane depending on the group into which they were randomized. The standard size of LMA classic was used according to weight of patient.

**In Group P**

Injection propofol 2.5 mg.kg\(^{-1}\) at the rate of 40 mg every 10s till the loss of eyelash reflex. Thereafter, adequacy of jaw relaxation was assessed by giving jaw thrust if not adequate propofol bolus of 0.5 mg.kg\(^{-1}\) repeated till acceptable jaw relaxation, then LMA insertion attempted.

**In Group S**

Eight percent sevoflurane by vital capacity breath technique. In this, patients were asked to exhale fully, inhale fully, and hold their breath as long as possible through an anatomical facemask attached to the Bain’s circuit, jaw relaxation was assessed, if inadequate, patients were allowed to continue spontaneous ventilation with oxygen and 8% sevoflurane, after reassessing jaw relaxation, LMA insertion was attempted.

LMA insertion was performed by same anesthesiologist having 3-year experience of LMA insertion by the conventional technique.\[13\] While inserting the LMA, the study parameters were noted and defined as follows:

- Induction time – the time interval from initiating drug delivery to loss of eyelash reflex.

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**Figure 1:** CONSORT flow diagram for patient allotment
Jaw relaxation time – the time interval from initiating drug delivery to attaining adequate jaw relaxation
LMA insertion time – time taken from jaw relaxation to successful insertion of LMA
Success rate – ability to insert LMA for oxygenation and ventilation in the first attempt
Apnea time – time taken for the return of spontaneous ventilation after insertion of LMA
LMA insertion conditions – graded by an observer on a three-point scale using six variables, that is, jaw relaxation, ease of insertion, patient response by movement, gagging, coughing, and laryngospasm [Table 1]. Scoring was done as excellent 18, satisfactory 16–17 and poor <16
Hemodynamic parameters – heart rate and mean blood pressure were recorded at the time of induction, insertion of LMA, and then at 1, 3, 5, and 10 min after insertion of LMA.

Successful LMA insertion was confirmed by chest wall auscultation and capnography. Any failure of insertion after 3 attempts were excluded from the study. During apnea period, 100% oxygen was delivered through Bain’s circuit. If desaturation occurred (SpO₂ <95%), positive pressure ventilation was given. No controlled or assisted breaths were given until pulse oximetry reading went <95%. This study ended 10 min after successful insertion of LMA, and further, management of case was done according to the nature of surgery.

Statistical analysis
Before beginning this study, we performed a power calculation to determine the ideal sample size. A minimum of 50 patients in each group was required to detect a reduction from 23% to 13% in the induction time between sevoflurane and propofol induction with a power of 80% and a confidence interval of 95%.

The data collected were entered into MS Excel (version 10.0). Quantitative data were presented as mean and standard deviation. Comparison was done with the help of unpaired t-test as per the results of normality test. Qualitative data was presented with the help of percentage table. Association was assessed with Chi-square test. Softwares used in the analysis were SPSS Software (Statistical Package of Social Sciences) version 17.0 (SPSS Inc. Chicago, IL, USA) and GraphPad Prism version 6.0 (GraphPad Software, La Jolla, California USA; www.graphpad.com); P < 0.05 was considered statistically significant.

Results
There was no significant difference between the groups with respect to age, weight, ASA class, and Mallampatti grade distribution [Table 2]. The mean age in Group P was 42.04 ± 4.12, and in Group S, it was 40.82 ± 3.94. The mean weight in Group P was 52.82 ± 6.64, and in Group S, it was 54.03 ± 4.27. Similarly, there was no significant difference between the groups with respect to size of LMA required (P = 0.68).

Induction was more rapid with IV propofol [Table 3]. The mean time for induction in Group P was 38.64 ± 8.71, and in Group S, it was 44.38 ± 8.93 s (P = 0.016). Similarly, time required for jaw relaxation was more in Group S. The mean time (in seconds) required for jaw relaxation in Group P was 62.84 ± 10.83 s and in Group S, it was 92.76 ± 10.83 s (P = 0.00001).

There was no difference in the mean time to LMA insertion between the groups. The mean time (in seconds) for LMA insertion in Group P was 14.86 ± 2.79, and in Group S, it was 15.66 ± 2.01 s (P = 0.10).

Four patients in Group P and 6 patients in Group S required a second attempt for insertion of LMA. In remaining patients, LMA was successfully inserted in the first attempt. Analysis indicates that success rate of LMA insertion was similar in both the groups (P = 0.50).

Apnea time was more in Group P. The mean apnea time in Group P was 31.04 ± 11.21 s and in Group S, it was 24.90 ± 8.19 s (P = 0.0024).

Overall LMA insertion characteristics were comparable between Group P and Group S [Table 4]. Jaw relaxation was adequate in both groups with full relaxation achieved

| Criteria                      | Score | 3 | 2 | 1 |
|-------------------------------|-------|---|---|---|
| Introduction of LMA           |       | Full | Partial | Nil |
| Ease of insertion             |       | Easy | Difficult | Impossible |
| Patient response              |       | Nil | Minor | Severe |
| Coughing                      |       | Nil | Minor | Severe |
| Gagging                       |       | Nil | Moderate | Vigorous |
| Patient movements             |       | Nil | Partial | Total |
| Laryngospasm                  |       |     |   |
| Total score                   |       |     |   |

Priya *et al.*<sup>15</sup> Total score=18 - Excellent, 16-17 - Satisfactory, <16 - Poor. LMA=Laryngeal mask airway

| Patient factors | Group P (n=50) | Group S (n=50) | P |
|-----------------|----------------|----------------|---|
| Age (years)     | 42.04±4.12     | 40.82±3.94     | t=1.51, P=0.13, NS |
| Weight (kg)     | 52.82±6.64     | 54.03±4.27     | t=1.08, P=0.28, NS |
| ASA class I/II  | 28/22          | 22/27          | χ²=0.99, P=0.31, NS |
| Mallampatti class I/II | 23/27 | 24/26 | χ²=0.04, P=0.84, NS |
| LMA size 3/size 4 | 23/27 | 21/29 | χ²=0.16, P=0.68, NS |

S=Significant, NS=Not significant, LMA=Laryngeal mask airway, ASA=American Society of Anesthesiologists

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in 94% of patients with propofol and 96% of patients with sevoflurane \( (P = 0.64) \). The subjective ease of insertion was also comparable between groups \( (P = 0.64) \). Patient movement in response to LMA insertion was similar in both groups, with marginally higher incidence of movement seen with sevoflurane \( (P = 0.30) \). No complications such as cough or laryngospasm were encountered in any patient of either group. One case of minor gagging was noted with sevoflurane, which was short-lived \( (P = 0.31) \). Overall summation of scores revealed excellent insertion characteristics in >90% of participants in Group P, which was insignificantly greater than those in Group S \( (86\%) \) \( (P = 0.34) \).

The two groups were comparable with respect to baseline mean heart rate \( (P = 0.40) \) [Figure 2]. There was a significant rise in mean HR during insertion of LMA in both the groups compared to baseline values. After insertion, there was a significant fall in mean HR compared to their baseline values in both the groups. There was a significant difference in the heart rate between two groups 1, 3, and 5 min after insertion of LMA. Statistical evaluation showed the fall in mean HR in Group P was more significant than in Group S \( (P < 0.0001) \).

Baseline values of mean MAP were comparable in both the groups \( (P = 0.52) \) [Figure 3]. In both the groups, there was a significant rise in mean MAP during insertion of LMA compared to baseline values. After insertion, there was a significant fall in mean MAP compared to their baseline values in both the groups. Intergroup statistical evaluation showed

### Table 3: Induction characteristics and laryngeal mask airway insertion data

| Induction characteristics and LMA insertion data | Group P \((n=50)\) | Group S \((n=50)\) | \(P\) |
|-------------------------------------------------|------------------|------------------|------|
| Induction time (s)                              | 38.64±8.71       | 44.38±8.93       | \(t=3.25, P=0.016, S\) |
| Jaw relaxation time (s)                         | 62.84±8.06       | 92.76±10.83      | \(t=15.67, P=0.00001, S\) |
| LMA insertion time (s)                          | 14.86±2.79       | 15.66±2.01       | \(t=1.64, P=0.10, NS\) |
| Success rate (insertion in 1st attempt)         | 46/50            | 44/50            | \(\chi^2=0.44, P=0.50, NS\) |
| Apnea time (s)                                  | 31.04±11.21      | 24.90±8.19       | \(t=3.12, P=0.0024, S\) |

**S=Significant, NS=Not significant, LMA=Laryngeal mask airway**

### Table 4: Laryngeal mask airway insertion conditions: Results of the scoring system

| Score | Description | Group P, \(n\) (%) | Group S, \(n\) (%) | \(\chi^2\) | \(P\) |
|-------|-------------|-------------------|-------------------|----------|------|
| Jaw relaxation | | | | | |
| 3 | Full | 47 (94) | 48 (96) | 0.21 | 0.64, NS |
| 2 | Partial | 3 (6) | 2 (4) | | |
| 1 | Nil | 0 | 0 | | |
| Ease of insertion | | | | | |
| 3 | Easy | 48 (96) | 47 (94) | 0.21 | 0.64, NS |
| 2 | Difficult | 1 (2) | 3 (6) | | |
| 1 | Impossible | 0 | 0 | | |
| Patient movement | | | | | |
| 3 | Nil | 49 (98) | 47 (94) | 1.03 | 0.30, NS |
| 2 | Moderate | 1 (2) | 3 (6) | | |
| 1 | Vigorous | 0 | 0 | | |
| Incidence of coughing | | | | | |
| 3 | Nil | 50 (100) | 50 (100) | - | - |
| 2 | Minor | 0 | 0 | | |
| 1 | Severe | 0 | 0 | | |
| Incidence of gagging | | | | | |
| 3 | Nil | 50 (100) | 49 (98) | 1.00 | 0.31, NS |
| 2 | Minor | 0 | 1 (2) | | |
| 1 | Severe | 0 | 0 | | |
| Incidence of laryngospasm | | | | | |
| 3 | Nil | 50 (100) | 50 (100) | - | - |
| 2 | Minor | 0 | 0 | | |
| 1 | Severe | 0 | 0 | | |
| Total scores after summation | | | | | |
| 18 | Excellent | 46 (92) | 43 (86) | 0.91 | 0.34, NS |
| 16-17 | Satisfactory | 4 (8) | 7 (14) | | |
| <16 | Poor | 0 | 0 | | |

**S=Significant, NS=Not significant**
that the fall in MAP observed in Group P was significantly more than Group S at the end of induction, 1, 3 and 5 min after insertion of LMA ($P < 0.0001$).

**DISCUSSION**

The LMA device developed by British Anesthesiologist Dr. Archi Brain has been in use since 1988 in airway management and nowadays is used extensively in different types of surgeries. Satisfactory insertion of LMA requires administration of an induction agent and suppression of airway reflexes. Depth of anesthesia should be as deep as required for the insertion of endotracheal tube. Although, insertion of LMA is associated with less hemodynamic changes than endotracheal intubation. Several intravenous, as well as inhalational agents, have been tried to facilitate LMA insertion. Intravenous thiopentone fails to suppress the residual intact airway reflexes and increases airway irritability hence is not a suitable choice for the LMA insertion. On the contrary, propofol has the advantages of inducing anesthesia rapidly if used more frequently. Similarly, halothane has a disadvantage of having strong odor, cardiovascular depression, and hepatic necrosis in high concentrations. Sevoflurane is the inhalational agent of choice for the insertion of LMA because of its pleasant, smooth, and rapid induction, hemodynamic stability and no hepatic toxicity.

In our study, we compared propofol and sevoflurane induction for insertion of LMA classic in patients undergoing gynecological procedures under general anesthesia. The dosage of intravenous injection propofol taken was 2.5 mg.kg$^{-1}$, which was optimal for induction, jaw relaxation and abolishing airway reflexes. While 8% sevoflurane by vital capacity breath technique was found to be comparable as the patient can be induced within 1–3 breaths.

The time for induction of anesthesia was taken as the time from the beginning of administration of agent to the loss of eyelash reflex. Various other studies have also used this event as end point of induction. In our study, induction with propofol was significantly more rapid than with sevoflurane; this coincides with the results of Thwaites et al., Hall et al., and Ti et al. In contradiction, Molloy et al. observed faster induction with sevoflurane, probably because they used sevoflurane in combination with nitrous oxide. Adequate jaw relaxation assessed by jaw thrust was taken as an ideal condition for the insertion of LMA as this implies cessation of airway reflexes. Time required for jaw relaxation was more in patients induced with inhalational sevoflurane, The mean required for jaw relaxation in propofol group was 62.84 ± 8.06, and in sevoflurane group, it was 92.76 ± 10.83 s ($P = 0.00001$). Sarkar et al. and Siddik-Sayyid et al. observed similar faster jaw relaxation with propofol than sevoflurane.

Successful insertion of LMA was confirmed by chest auscultation and capnography. In our study, mean time required for LMA insertion in propofol and sevoflurane group was not statistically significant. Similar results were reported by Priya et al. and Soomro et al. In the study by Sarkar et al., the mean LMA insertion time in both propofol and sevoflurane induction was prolonged, due to their study design of waiting for 1 min after loss of eyelash reflex before insertion and calculating insertion time from initiation of drug to insertion of LMA. Success rate for LMA insertion was the ability to insert in the first attempt and described by the number of attempts. This was similar for both groups, with no patient requiring >2 attempts for successful insertion of LMA. Paneerselvam and Nandakumar and Ti et al. obtained similar results wherein LMA insertion required fewer attempts with propofol than with sevoflurane.

The scoring system used to grade insertion characteristics was a six-variable three-point system, which graded overall conditions as excellent, satisfactory, and poor. Similar grading system was also used by Priya et al. and Sivalingam et al. The ease of LMA insertion between study groups was comparable since we waited for adequate jaw relaxation before attempting insertion. This corroborates the results obtained by Chavan et al. and Patel et al. Patient movement was another parameter where no difference was found between groups. Movement during insertion of LMA
may indicate light plane of anesthesia and can lead to various complications and make insertion of LMA difficult. Similar concurrent result was noted by Priya et al.\textsuperscript{[14]} and Paneeselvam and Nandakumar.\textsuperscript{[24]}

None of the patients in our study had any incidence of coughing. Coughing indicates inadequate depth of anesthesia and suppression of airway reflexes. This can lead to complications such as trauma, aspiration, and desaturation. Our finding concurs with the study done by Prakash and Sreedevi\textsuperscript{[26]} and Tbolia et al.\textsuperscript{[27]} Similarly, there was no incidence of laryngospasm in either of our study groups. Laryngospasm is a life-threatening situation, usually indicating an inadequate depth of anesthesia. Dwivedi et al.\textsuperscript{[17]} also had similar findings in this respect. The overall insertion characteristic score was excellent in 92% of patients induced with propofol and 86% of patients induced with sevoflurane; this was statistically insignificant and hence comparable in both the groups ($P = 0.34$). Our result was concurrent with the findings of Soomro et al.\textsuperscript{[23]} and Prakash et al.\textsuperscript{[26]}. On the contrary, in the study by Priya et al.,\textsuperscript{[14]} insertion characteristics were statistically significant, with excellent in only 64% of patients with propofol and 32% of patients with sevoflurane.

The hemodynamic changes observed in two groups were in accordance with the pharmacological effects of either drug, propofol which inhibits the baroreceptor reflexes decreases the heart rate, while sevoflurane has no effect on the baroreceptor reflex. The two groups were comparable with respect to baseline mean heart rate and mean of mean blood pressure. There was a significant difference in the heart rate and mean blood pressure between two groups after insertion of LMA at 1, 3, and 5 min significant fall of heart rate and mean blood pressure in patients induced with propofol than sevoflurane. This indicates patients induced with sevoflurane were more hemodynamically stable than induced with propofol. Similar inference was drawn by Priya et al.,\textsuperscript{[14]} Thwaites et al.,\textsuperscript{[7]} and Jellish et al.\textsuperscript{[12]}

On the whole, when parameters such as LMA insertion conditions and ease of insertion are considered, propofol can be used for the insertion of LMA. Sevoflurane should be kept reserved for patients where a better hemodynamic stability is required such as patients with valvular disease or reduced ejection fraction. This study can be representative of the population since the study participants were homogenous and representative between the two groups. The limitation of this study was the inability to have a double-blinded design structure. Furthermore, the exact monitoring of depth of anesthesia with Bispectral index system was not applied and the inability to uniformly evaluate the satisfactory placement of LMA through fibre optic bronchoscope examination.

Future research possibilities include randomized double-blind control study designs with incorporation of depth of anesthesia monitoring and fiber-optic confirmation of placement of LMA. Furthermore, an exhaustive meta-analysis or systematic review is warranted.

**Conclusion**

Propofol (2.5 mg kg$^{-1}$) was superior to sevoflurane (8%) for insertion of the LMA, using loss of eyelash reflex as the end point for induction. Mean times for induction of anesthesia and jaw relaxation were shorter with propofol. The overall LMA insertion conditions and time required for insertion were comparable in propofol and sevoflurane groups. Sevoflurane provided an equivalent LMA insertion condition while maximizing hemodynamic stability and minimizing apnea.

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**Conflicts of interest**

There are no conflicts of interest.

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