



Effects of Propofol and Sevoflurane on Hemodynamics during Laryngeal Mask Airway Insertion –A Prospective Comparative Study

Authors

Dr Ushakumari.P.R¹, Dr Harikumar.C.K²

¹Additional Professor, Department of Anaesthesiology, Medical College Trivandrum

²Assistant Professor, Department of Anaesthesiology, Medical College, Trivandrum

Corresponding Author

Dr Ushakumari.P.R

Additional Professor, Department of Anaesthesiology, Medical College Trivandrum

Abstract

The Laryngeal mask airway insertion has become a very good alternative for face mask ventilation in paediatric patients for short surgical procedures. It can be used for both spontaneous and controlled ventilation and in all age groups from neonates to adults. Main advantages of LMA insertion are its minimal hemodynamic changes during insertion, Laryngoscopy can be avoided and muscle relaxants are not required for insertion. The LMA insertion after induction of Anaesthesia requires sufficient depth for suppression of airway reflexes. In this study we compare the hemodynamic changes during insertion of LMA after using propofol and sevoflurane. We conducted the study at SAT Hospital Medical college Trivandrum after getting ethical committee clearance. We selected 50 paediatric patients aged 3 to 12 years of ASA grade 1 and 2 undergoing lower abdominal and lower limb surgeries. Exclusion criteria were those at increased risk for aspiration, with history of convulsions or with difficult airway. We randomly selected 2 groups of patients with sample size of 25 each as propofol group and sevoflurane group. Haemodynamic parameters such as systolic BP, diastolic BP, mean arterial pressure, heart rate and arterial saturation were monitored in each group. The propofol and sevoflurane are excellent induction agents for LMA insertion in paediatric patients with minimum side effects. The heart rate and BP decreased more in propofol group but patients were hemodynamically stable in both groups. However sevoflurane has a long induction time than propofol, sevoflurane is associated with good haemodynamic stability and may prove useful in cases where propofol is to be avoided

Keywords: Propofol, sevoflurane, laryngeal mask airway, mean arterial pressure, heart rate, induction, anaesthesia

Introduction

Laryngeal mask airway has gained extensive popularity for airway management during short surgical procedures, after its initial introduction in 1989 by Dr Archie Brain¹². LMA is a supraglottic airway device successfully used for maintaining patent airway during spontaneous and controlled ventilation, both in pediatric and adult patients³. Earlier, it was very difficult to maintain pediatric airway with face mask for short surgical procedures³. The LMA is a small elliptical mask made up of siliconized rubber, and with an

aperture facing anteriorly overlying the laryngeal inlet. It has got a silicon cuff that fills the hypopharyngeal space, after inflation creating a seal⁴. A cuff pressure of up to 20cm of water pressure is allowed during mechanical ventilation. Laryngeal mask airways are available in different sizes and different types. Classic LMA is available from pediatric size 1 to adult size 6. The laryngeal mask airway insertion has got many advantages over the tracheal intubation. For the use of LMA muscle relaxant is not required,

laryngoscopy can be avoided and hemodynamic changes are minimal during insertion^{5,6}.

Adequate depth of anesthesia is required for Insertion of LMA, which will depress the airway reflexes. Both intravenous and inhalation agents have been used for insertion of LMA. These induction agents will produce unconsciousness, jaw relaxation, loss of upper airway reflexes and cardio vascular stability^{7,8}. Sevoflurane is the best volatile anaesthetic agent used for induction of anaesthesia. Propofol is the most commonly used intravenous anaesthetic drug that can be used safely for LMA insertion^{9,10}. Ideally, these drugs should have rapid and smooth induction, maintenance and smooth recovery.

Most commonly used IV anaesthetic agent for induction is propofol. It is one of the groups of alkyl phenols (2-6-diisopropylphenol) have hypnotic properties and available as 1% emulsion, which is highly lipid soluble. Propofol has rapid onset and offset properties. The requirement of propofol for induction in Paediatric patients when compared to adult patients is high on milligram per kg body weight. This is due to the high drug clearance rate and larger volume of distribution. After the induction dose of propofol, the blood level decreases rapidly as a result of redistribution and elimination of the drug. Propofol has the distribution $\frac{1}{2}$ life of 2-8 minutes and elimination $\frac{1}{2}$ life of 4-7 hours. The time of peak effect is at 90 to 100 seconds. Propofol exert its sedative hypnotic effects through a GABA receptor activity¹¹. Propofol is rapidly metabolized in the liver by conjugation to glucuronide and sulphate. The metabolic products are inactive and eliminated through the kidneys. Pain on injection and myoclonus are the side effects of propofol. Hemodynamic changes are produced by decrease in systemic vascular resistance and changes in cardiac output¹².

Sevoflurane is an inhalation agent of choice for LMA insertion in pediatric patients. Sevoflurane is a fluorinated methyl isopropyl ether. It is non pungent, not irritating to airway, colorless and clear liquid with a low blood solubility. Alveolar concentration rises rapidly after inhalation and

produce bronchodilation. It has a boiling point of 58.5 degree c. Sevoflurane is degraded by soda lime into compound A and produce nephro toxicity in low flow techniques. Sevoflurane produces hemodynamic stability, minimal or no increase in heart rate and fall in systemic vascular resistance¹³.

Materials and methods

This is a prospective comparative study conducted at SAT Hospital, Medical College, Thiruvananthapuram after getting clearance from the hospital ethics committee. Before conducting the study written informed consent were obtained from parents for surgery and inclusion in this study. All phases of the study were conducted in accordance with the declaration of the Helsinki.

Participants in this study included pediatric patients of ASA grade, I and II during the study period. We included children between the age group of 3 and 12yrs, for surgery under GA or regional anesthesia, such as herniotomy, circumcision, urethroplasty and lower limb surgeries. However, we excluded children with increased risk of aspiration and difficulty airway from this study. Moreover, Children with history of seizures and ISL were also not included in this study. We followed a random sampling strategy to enroll the patients. A prior sample size calculation showed required sample size as 25 each in both groups.

Children were seen pre-operatively by the investigator. Detailed history with reference to history of congenital heart disease, drug allergy, aspiration chance, GERD, bronchial asthma, previous history of anesthesia, respiratory infection, obesity and difficult airway were taken. Clinical examination was done by the investigator. Routine blood results were examined and done to all children. Children with any of the diseases noted were excluded. There were two groups. Group 1 received propofol for induction and group 2 received Sevoflurane for induction.

Atropine (0.02 mg/kg body weight) and Midazolam (0.02 mg/kg body weight) was given intravenously before induction.

Prior to the induction of anesthesia, patients in both groups had a face mask placed over their face and was breathing spontaneously.

Group 1 (Propofol group) received intravenous Propofol (1.5 to 2.5 mg/kg body weight) with 100% oxygen and N₂O via the face mask.

Group 2 (Sevoflurane group) children were induced with Sevoflurane 8% in N₂O and Oxygen. Jackson's rees circuit was primed with Sevoflurane 8% N₂O and oxygen.

Loss of eyelash reflex was considered as the end point of induction in both groups. After the end point of induction, classical LMA insertion was attempted with appropriate size LMA.

Ease of introduction of classical LMA in each group was scored and graded as described in the literature {Priya, 2002 #2320}. Scores below 16 were considered as poor, 16 to 17 were considered as satisfactory and 18 as excellent. The parameters noted were jaw opening, ease for LMA insertion, coughing, gagging, laryngospasm and patient movement. All children were observed and scores were allotted by the investigator. Principal investigator collected basic demographic and other relevant variables in a pre structured and pretested case report form.

Statistical analysis was done in R software. Categorical data was summarized as frequencies and numerical data and percentages as mean and standard deviation. The student t-test and chi-square test were used for analysis of association

between numerical variables and categorical variables. Statistically significant value was taken when p value was less than 0.05.

Results

Out of the 50 patients, there were 31(62%) males. Median age from the data was 4(3-5) years. The mean (\pm) heart rate was 104(3.88) per minute. Most of the patients belonged to ASA, I category. Other characteristics of the patients are given in table1.

Table 1: Baseline characteristics of the study population.

| | [ALL] N=50 |
|---------------------|------------------|
| Age | 4.00 [3.00;5.00] |
| Sex: | |
| Female | 19 (38.0%) |
| Male | 31 (62.0%) |
| Heart rate | 104 (3.88) |
| Mean Blood Pressure | 110 [108;110] |
| SPO ₂ | 50 (100%) |
| Weight | 4.00 [3.25;6.00] |
| ASA: | |
| 1 | 39 (78.0%) |
| 2 | 11 (22.0%) |
| Diagnosis: | |
| Circumcision | 15 (30.0%) |
| Inguinal hernia | 16 (32.0%) |
| SSG leg | 6 (12.0%) |
| Umbilical hernia | 7 (14.0%) |
| Urethroplasty | 6 (12.0%) |

There were 25 patients each in propofol and sevoflurane group. Basic demographic characteristics were comparable across the two groups (table2).

Table 2: Baseline comparison between the Propofol and sevoflurane groups

| | [ALL] N=50 | propofol N=25 | servoflurane N=25 | p.overall |
|---------------------|------------------|------------------|-------------------|-----------|
| Age | 4.00 [3.00;5.00] | 4.00 [3.00;6.00] | 4.00 [3.00;5.00] | 0.216 |
| Sex: | | | | 0.560 |
| Female | 19 (38.0%) | 11 (44.0%) | 8 (32.0%) | |
| Male | 31 (62.0%) | 14 (56.0%) | 17 (68.0%) | |
| Heart rate | 104 (3.88) | 102 (3.77) | 106 (2.87) | <0.001 |
| Mean Blood Pressure | 110 [108;110] | 110 [104;110] | 110 [108;110] | 0.602 |
| Weight | 4.00 [3.25;6.00] | 5.00 [4.00;7.00] | 4.00 [2.00;6.00] | 0.093 |
| ASA: | | | | 0.495 |
| 1 | 39 (78.0%) | 18 (72.0%) | 21 (84.0%) | |
| 2 | 11 (22.0%) | 7 (28.0%) | 4 (16.0%) | |
| Diagnosis: | | | | 0.925 |
| Circumcision | 15 (30.0%) | 8 (32.0%) | 7 (28.0%) | |
| Inguinal hernia | 16 (32.0%) | 9 (36.0%) | 7 (28.0%) | |
| SSG leg | 6 (12.0%) | 3 (12.0%) | 3 (12.0%) | |
| Umbilical hernia | 7 (14.0%) | 3 (12.0%) | 4 (16.0%) | |
| Urethroplasty | 6 (12.0%) | 2 (8.00%) | 4 (16.0%) | |
| Duration | 40.0 [30.0;50.0] | 40.0 [30.0;45.0] | 40.0 [30.0;60.0] | 0.914 |

Analysis shows statistically significant difference between propofol group and sevoflurane group with regards to the total scores for intubating conditions (P value <0.001). There was

statistically significant difference in hemodynamic parameters, the mean arterial pressure and heart rate (table 3 and 4)

Table 3: comparison of heart rate between the Propofol and sevoflurane groups at different time points

| | [ALL] N=50 | Propofol N=25 | Sevoflurane N=25 | P value |
|------------------------|---------------|---------------|------------------|---------|
| Heart rate at baseline | 104 [102;108] | 102 [100;104] | 108 [104;108] | 0.001 |
| Heart rate 5 minutes | 102 (3.53) | 100 (3.16) | 104 (3.06) | <0.001 |
| Heart rate 10 minutes | 102 (3.71) | 101 (3.51) | 103 (3.60) | 0.025 |
| Heart rate 15 minutes | 103 (3.82) | 102 (3.45) | 105 (3.52) | 0.002 |
| Heart rate 20 minutes | 103 [100;106] | 100 [100;106] | 106 [102;108] | 0.015 |
| Heart rate 25 minutes | 104 [100;106] | 102 [100;106] | 106 [102;108] | 0.070 |
| Heart rate 30 minutes | 104 (4.26) | 103 (4.33) | 106 (3.78) | 0.019 |

Table 4: comparison of mean arterial pressure between the Propofol and sevoflurane groups at different time points.

| | [ALL] N=50 | Propofol N=25 | Sevoflurane N=25 | p.overall |
|-------------------|---------------|---------------|------------------|-----------|
| MBP at baseline | 110 [106;110] | 108 [100;110] | 110 [108;110] | 0.173 |
| MBP at 5 minutes | 110 [104;112] | 108 [102;110] | 110 [106;112] | 0.192 |
| MBP at 10 minutes | 110 [104;112] | 108 [102;112] | 110 [106;114] | 0.137 |
| MBP at 15 minutes | 108 [106;114] | 106 [100;114] | 110 [108;114] | 0.109 |
| MBP at 20 minutes | 108 (4.99) | 107 (5.63) | 110 (3.97) | 0.070 |
| MBP at 25 minutes | 110 [104;112] | 108 [102;112] | 112 [108;112] | 0.031 |
| MBP at 30 minutes | 110 [106;112] | 108 [102;112] | 110 [108;114] | 0.081 |

Serial measurement of mean arterial pressures at different time points showed lowest mean arterial pressure at 15 minutes for propofol and at 5 and 10 minutes for sevoflurane. In addition, Propofol exhibited a consistently low mean arterial pressure compared to sevoflurane. Statistically significant

differences between the two groups were measured with ANOVA when serial measurement in heart rate and mean arterial pressures at different time periods were compared (figure 1 and 2 and table 3 and 4).

Figure 1: comparison of trend in heart rate at different time points across two groups

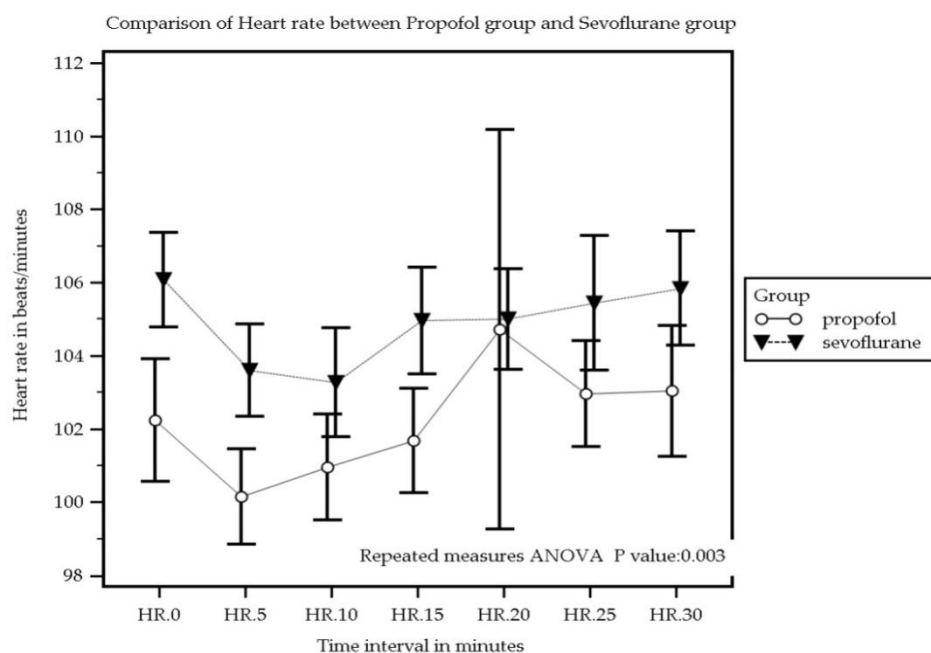
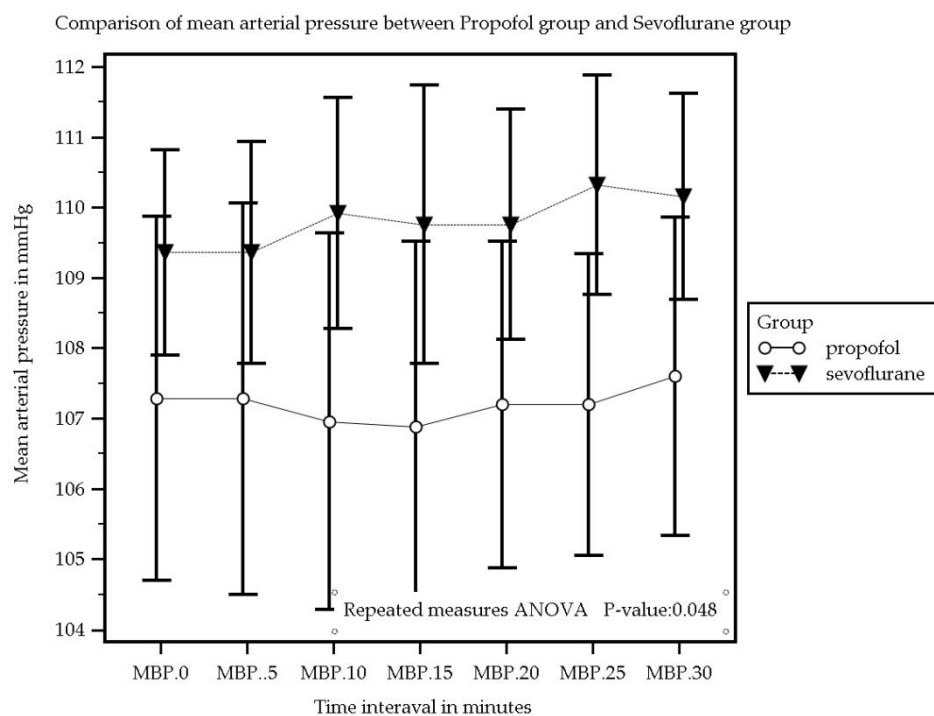


Figure 2: comparison of trend in mean arterial pressure at different time points.

Discussion

In this study, a part of another bigger study, we intended to compare the hemodynamic changes during induction of anesthesia with propofol and sevoflurane. Our study has shown that compared to sevoflurane, propofol is associated with consistent reduction in mean arterial pressure and heart rate at all time points from the time of induction of anesthesia. Propofol is known to cause a reduction in arterial blood pressure. In addition to the direct action on myocardium and arteries, propofol depresses the sympathetic firing in the brain stem¹⁴. Reduction in sympathetic activity caused by propofol is the cause for its vasodilatory effect. Propofol either reset or inhibit the baroreflex thus reduce heart rate in hypotension.

In our study, heart rate after propofol infusion reduces and maximum at 5 minutes after induction. There was an increase in the heart rate at twenty minutes after induction. These results are in consistent with other studies in the literature^{15,16}. However, there are some contradictory reports as well^{17,18}. The transient increase in the heart rate at 20 minutes corresponds to the maximal reduction in mean

arterial pressure. This could possibly explain the episode of tachycardia at 20 minutes in the propofol group. The differences in the hemodynamic changes were statistically significant between the two groups over the multiple time points.

One of the limitations of our study was the observational nature of the design. Another potential issue is the limited sample size and heterogenous nature of the sample population. Future studies need to address these issues.

Though there was a statistically significant difference in the hemodynamic changes in the propofol and sevoflurane groups, the difference was not clinically relevant. A difference of maximum 4 units during multiple measurements in heart rate and mean arterial pressure is not clinically important in most of the patients unless in a compromised state. The selection of propofol or sevoflurane as an induction agent in pediatric patients are not to be based on the hemodynamic changes as the endpoints. Sevoflurane is also associated with good hemodynamic stability and hence useful in cases where propofol to be avoided.

Reference

1. Finucane BT, Tsui BC, Santora AH. The difficult airway. *Principles of airway management*: Springer; 2010: 361-414.
2. Baskett P, Bossaert L, Carli P, et al. Guidelines for the advanced management of the airway and ventilation during resuscitation: a statement by the Airway and Ventilation Management Working Group of the European Resuscitation Council. *Resuscitation* 1996; 31(3): 201-30.
3. Harless J, Ramaiah R, Bhananker SM. Pediatric airway management. *International journal of critical illness and injury science* 2014; 4(1): 65.
4. Barash PG. *Clinical anesthesia*: Lippincott Williams & Wilkins; 2009.
5. Jamil SN, Alam M, Usmani H, Khan M. A study of the use of laryngeal mask airway (LMA) in children and its comparison with endotracheal intubation. *Indian journal of anaesthesia* 2009; 53(2): 174.
6. Chen B-z, Tan L, Zhang L, Shang Y-c. Is muscle relaxant necessary in patients undergoing laparoscopic gynecological surgery with a ProSeal LMA TM? *Journal of clinical anesthesia* 2013; 25(1): 32-5.
7. Kuczkowski KM, Reisner LS, Benumof JL. Airway problems and new solutions for the obstetric patient. *Journal of clinical anesthesia* 2003; 15(7): 552-63.
8. Smith CE, Walls R, Lockey D, Kuhnigk H. Advanced airway management and use of anesthetic drugs. *Prehospital trauma care* 2001: 203-53.
9. Ghatge S, Lee J, Smith I. Sevoflurane: an ideal agent for adult day-case anesthesia? *Acta Anaesthesiologica Scandinavica* 2003; 47(8): 917-31.
10. Eger EI. Characteristics of anesthetic agents used for induction and maintenance of general anesthesia. *American Journal of Health-System Pharmacy* 2004; 61(suppl 4): S3-S10.
11. Billard V. Pharmacokinetic-pharmacodynamic relationship of anesthetic drugs: from modeling to clinical use. *F1000 Research* 2015; 4.
12. Simons P, Cockshott I, Douglas E, Gordon E, Hopkins K, Rowland M. Blood-concentrations, metabolism and elimination after a sub-anesthetic intravenous dose of C-14 propofol (Diprivan) to male-volunteers. *Postgraduate Medical Journal*; 1985: British Med Journal Publ Group British Med Assoc House, Tavistock Square, London, England WC1H 9JR; 1985. p. 64-.
13. Delgado-Herrera L, Ostroff RD, Rogers SA. Sevoflurane: Approaching the Ideal Inhalational Anesthetic A Pharmacologic, Pharmacoeconomic, and Clinical Review. *CNS Drug Reviews* 2001; 7(1): 48-120.
14. Krassioukov AV, Gelb AW, Weaver LC. Action of propofol on central sympathetic mechanisms controlling blood pressure. *Can J Anaesth* 1993; 40(8): 761-9.
15. Kanaya MDPDN, Hirata MDN, Kurosawa MDS, Nakayama MDPDM, Namiki MDPDA. Differential Effects of Propofol and Sevoflurane on Heart Rate Variability. *Anesthesiology* 2003; 98(1): 34-40.
16. Gamlin F, Vucevic M, Winslow L, Berridge J. The haemodynamic effects of propofol in combination with ephedrine. *Anaesthesia* 1996; 51(5): 488-91.
17. Dewhurst E, Lancaster C, Tobias JD. Hemodynamic changes following the administration of propofol to facilitate endotracheal intubation during sevoflurane anesthesia. *Int J Clin Exp Med* 2013; 6(1): 26-9.
18. Coursange F, Aubert M. [Effect of the rate of injection of propofol on blood pressure and heart rate]. *Ann Fr Anesth Reanim* 1987; 6(4): 258-60.