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Comparison of Propofol–Ketamine versus Propofol–Fentanyl for Laryngeal Mask Airway Insertion: A Randomized Controlled Study Assessing Hemodynamic Stability and Induction Characteristics.

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Abstract

Background: Laryngeal mask airway (LMA) insertion requires adequate depth of anesthesia to suppress airway reflexes while maintaining hemodynamic stability. Propofol is widely used for induction due to rapid onset and smooth recovery profile; however, it is associated with dose dependent hypotension, respiratory depression and requirement of higher doses to achieve adequate jaw relaxation. Co-induction agents such as ketamine and fentanyl are commonly combined with propofol to improve insertion conditions and reduce adverse hemodynamic effects. Ketamine has sympathomimetic properties that help maintain cardiovascular stability, whereas fentanyl effectively suppresses airway reflexes and reduces anesthetic requirement. ***Objectives:*** To compare propofol–ketamine and propofol–fentanyl combinations for LMA insertion with respect to hemodynamic stability and induction characteristics including requirement of additional propofol. ***Methods:*** A prospective randomized controlled study was conducted among 100 patients undergoing elective surgical procedures under general anesthesia. Patients were randomly allocated into two groups of 50 each. Group PK received ketamine 0.5 mg/kg intravenously prior to propofol induction and Group PF received fentanyl 1 mcg/kg intravenously prior to propofol induction. Hemodynamic parameters including heart rate and mean arterial pressure were recorded at baseline, 1, 3, 5 and 10 minutes after LMA insertion. Requirement of additional propofol dose was also recorded. Statistical analysis was performed using independent t test and chi-square test. ***Results:*** Baseline characteristics were comparable between both groups ($p>0.05$). Requirement of additional propofol was significantly higher in ketamine group (24%) compared to fentanyl group (8%) ($p=0.02$). Heart rate was significantly higher in ketamine group at 1, 3, 5 and 10 minutes after LMA insertion ($p<0.05$). Mean arterial pressure was significantly higher in ketamine group at all time intervals ($p<0.001$), indicating better hemodynamic stability. ***Conclusion:*** Propofol–ketamine combination provides superior hemodynamic stability compared to propofol–fentanyl combination for LMA insertion. Propofol–fentanyl combination provides better insertion conditions with lower propofol requirement. Choice of co-induction agent should be individualized based on patient characteristics and clinical requirements.

Keywords: Propofol; Ketamine; Fentanyl; Laryngeal Mask Airway; Co-induction agents; Hemodynamic stability; Heart rate; Randomized controlled trial.

INTRODUCTION

Airway management is a critical component of safe anesthesia practice and plays a vital role in maintaining adequate oxygenation and ventilation during surgical procedures. Over the years, various airway devices have been developed to ensure patency of airway and minimize complications associated with anesthesia. Endotracheal intubation has traditionally been considered the gold standard for airway management; however, it is associated with significant sympathetic stimulation and hemodynamic responses including tachycardia, hypertension and arrhythmias which may be detrimental in susceptible patients (1).

Supraglottic airway devices have emerged as useful alternatives to endotracheal intubation in elective surgical procedures. Among these, the laryngeal mask airway (LMA), developed by Archie Brain, has gained widespread popularity due to ease of insertion, minimal airway trauma and reduced hemodynamic stress response (2). LMA occupies an intermediate position between facemask ventilation and endotracheal tube placement in terms of invasiveness and effectiveness. Compared to endotracheal intubation, LMA insertion produces less sympathetic stimulation and is associated with greater hemodynamic stability (3).

Successful insertion of LMA requires adequate depth of anesthesia to suppress airway reflexes such as gagging, coughing and laryngospasm along with adequate jaw relaxation. Several intravenous induction agents have been used to facilitate LMA insertion including thiopentone, etomidate, midazolam and propofol (4). Among these agents, propofol is considered the most suitable drug because of rapid onset, short duration of action and ability to effectively suppress airway reflexes (5). Propofol provides smoother induction and faster recovery compared to other induction agents and is associated with lower incidence of postoperative nausea and vomiting (6).

Despite its advantages, propofol is associated with several adverse effects including hypotension, bradycardia and respiratory depression (7). Propofol produces dose dependent cardiovascular depression by reducing systemic vascular resistance and myocardial contractility. Rapid administration of propofol may lead to significant fall in blood pressure and apnea which may compromise patient safety, especially in elderly patients and those with cardiovascular disease (8).

To overcome these limitations, co-induction agents are frequently used along with propofol. Co-induction refers to administration of a second drug to reduce dose requirement of primary induction agent and minimize adverse effects (9). Opioids such as fentanyl are commonly used as co-induction agents due to potent analgesic properties and ability to suppress airway reflexes (10). Fentanyl acts on μ opioid receptors in central nervous system producing analgesia and sedation. When combined with propofol, fentanyl improves insertion conditions by reducing coughing, gagging and patient movement during LMA insertion (11).

However, fentanyl may also produce respiratory depression, bradycardia and hypotension due to suppression of sympathetic tone (11). These effects may be undesirable in patients with limited cardiovascular reserve. Ketamine is another co-induction agent which provides dissociative anesthesia and analgesia. It acts by blocking N-methyl-D-aspartate (NMDA) receptors and produces sympathomimetic effects resulting in increased heart rate and blood pressure (12).

Unlike propofol and opioids, ketamine maintains airway reflexes and spontaneous respiration. When combined with propofol, ketamine counteracts cardiovascular depression caused by propofol and helps maintain hemodynamic stability (13). Combination of ketamine and propofol, commonly known as ketofol, combines advantages of both drugs including rapid onset of action, adequate analgesia and stable cardiovascular profile (14).

Previous studies comparing ketamine and fentanyl as co-induction agents for LMA insertion have reported variable findings. Some studies have shown better insertion conditions with fentanyl due to suppression of airway reflexes, whereas others have reported improved hemodynamic stability with ketamine (15,16). Selection of appropriate co-induction agent is important to ensure safe anesthesia and favorable patient outcomes.

The present study was conducted to compare propofol-ketamine and propofol-fentanyl combinations for LMA insertion with respect to hemodynamic stability and induction characteristics including requirement of additional propofol dose. The results of this study may help anesthesiologists select appropriate co-induction agent based on patient condition and clinical requirement.

MATERIALS AND METHODS

A prospective randomized controlled study was conducted in the Department of Anaesthesiology, Government Coimbatore Medical College Hospital over a period of one year from January 2023 to January 2024. The study included 100 patients aged between 20 and 70 years undergoing elective surgical procedures under general anesthesia. Patients willing to participate were included, while patients with anticipated difficult airway, restricted mouth opening less than 2 cm, upper airway obstruction, pregnancy, risk of aspiration, psychiatric illness or severe systemic illness were excluded. Sample size was calculated using previous study parameters with 95% confidence level and 80% power and 100 patients were included with 50 patients in each group.

Randomization was performed using computer generated random numbers. Patients were divided into two groups: propofol-ketamine group (PK group) and propofol-fentanyl group (PF group). All patients received glycopyrrolate 0.2 mg and midazolam 0.02 mg/kg intravenously as premedication. PK group received ketamine 0.5 mg/kg intravenously 4 minutes before induction and PF group received fentanyl 1 mcg/kg intravenously 1 minute before induction. Induction of anesthesia was performed using propofol 1 mg/kg intravenously. Jaw thrust maneuver was performed after loss of verbal response and additional propofol 0.5 mg/kg was given if jaw relaxation was inadequate. LMA insertion was performed and placement confirmed clinically and by ETCO2 tracing. Hemodynamic parameters including heart rate and mean arterial pressure were recorded at baseline, 1, 3, 5 and 10 minutes after LMA insertion. Requirement of additional propofol was also recorded. Data were analyzed using SPSS version 25. Independent t test and chi square test were applied. P value less than 0.05 was considered statistically significant.

RESULTS

A total of 100 patients were included with 50 patients in each group. Baseline demographic characteristics including age, weight, gender distribution and ASA grading were comparable between both groups indicating homogeneity of study population. Requirement of additional propofol was significantly higher in ketamine group compared to fentanyl group indicating relatively better insertion conditions with fentanyl combination. Heart rate and mean arterial pressure were significantly higher in ketamine group at all time intervals after LMA insertion demonstrating better hemodynamic stability compared to fentanyl group. No clinically significant desaturation was observed in either group.

TABLE 1. Baseline characteristics in a study on comparison of Propofol–Ketamine versus Propofol–Fentanyl for Laryngeal Mask Airway Insertion in a tertiary care Hospital, Tamil Nadu.

Variable	Propofol–Ketamine	Propofol–Fentanyl	p value
Age (years)	32.40 ± 8.34	33.44 ± 7.36	0.51
Weight (kg)	52.78 ± 4.99	52.86 ± 6.02	0.94
Female n (%)	46 (92%)	48 (96%)	0.40
ASA I n (%)	23 (46%)	22 (44%)	0.57

Both groups were comparable with respect to demographic characteristics. No statistically significant difference was observed between groups for age, weight, gender distribution or ASA grading ($p>0.05$). This indicates appropriate randomization and comparability of study population.

TABLE 2 Requirement of additional propofol in a study on comparison of Propofol–Ketamine versus Propofol–Fentanyl for Laryngeal Mask Airway Insertion in a tertiary care Hospital, Tamil Nadu.

Additional propofol	Propofol–Ketamine	Propofol–Fentanyl	p value
Yes	12 (24%)	4 (8%)	0.02*
No	38 (76%)	46 (92%)	

Requirement of additional propofol was significantly higher in propofol-ketamine group compared to propofol-fentanyl group ($p=0.02$). This indicates that fentanyl provided better jaw relaxation and insertion conditions compared to ketamine.

TABLE 3: Heart rate comparison (beats/min) in a study on comparison of Propofol–Ketamine versus Propofol–Fentanyl for Laryngeal Mask Airway Insertion in a tertiary care Hospital, Tamil Nadu.

Time	Propofol–Ketamine	Propofol–Fentanyl	p value
Baseline	74.82 ± 9.58	75.76 ± 9.22	0.44
1 min	75.96 ± 10.51	73.72 ± 4.25	0.04*
3 min	74.50 ± 9.38	71.30 ± 5.85	0.03*
5 min	73.62 ± 7.57	70.34 ± 4.92	0.01*
10 min	73.86 ± 5.48	70.32 ± 4.88	0.001*

Heart rate was significantly higher in ketamine group at all time intervals after LMA insertion ($p<0.05$). This demonstrates sympathomimetic effect of ketamine which helps maintain cardiovascular stability.

TABLE 4: Mean arterial pressure comparison (mmHg) in a study on comparison of Propofol–Ketamine versus Propofol–Fentanyl for Laryngeal Mask Airway Insertion in a tertiary care Hospital, Tamil Nadu.

Time	Propofol–Ketamine	Propofol–Fentanyl	p value
Baseline	88.49 ± 8.74	89.42 ± 6.81	0.55
1 min	90.10 ± 7.68	79.88 ± 5.18	<0.001*
3 min	88.80 ± 6.15	76.64 ± 5.85	<0.001*
5 min	87.37 ± 8.42	78.50 ± 5.55	<0.001*
10 min	83.66 ± 7.08	78.36 ± 5.59	<0.001*

Mean arterial pressure was significantly higher in ketamine group compared to fentanyl group at all time intervals ($p<0.001$). This indicates that ketamine provides better hemodynamic stability and prevents hypotension associated with propofol induction.

DISCUSSION

The present study compared ketamine and fentanyl as co-induction agents with propofol for LMA insertion focusing on hemodynamic stability and induction characteristics. Adequate depth of anesthesia is essential for successful LMA

insertion to suppress airway reflexes and provide adequate jaw relaxation (3). Propofol is widely used because it effectively suppresses airway reflexes; however, it produces dose dependent cardiovascular depression (7).
Baseline demographic characteristics were comparable between both groups indicating successful randomization and uniform study population. Requirement of additional propofol was significantly higher in ketamine group compared to fentanyl group. This finding suggests that fentanyl improves insertion conditions due to suppression of airway reflexes and improved jaw relaxation (11). Fentanyl acts on μ opioid receptors reducing sympathetic response to airway manipulation and thereby facilitates smooth insertion (10).

Heart rate was significantly higher in ketamine group compared to fentanyl group at all time intervals after LMA insertion. Ketamine stimulates sympathetic nervous system leading to increased release of catecholamines which increases heart rate and blood pressure (12). This sympathomimetic property counteracts cardiovascular depression caused by propofol (8).
Mean arterial pressure was also significantly higher in ketamine group compared to fentanyl group. Propofol produces vasodilation and reduces systemic vascular resistance leading to hypotension (7). Fentanyl may further reduce blood pressure by decreasing sympathetic tone (11). Ketamine maintains blood pressure by increasing cardiac output and systemic vascular resistance (12).

Maintenance of stable hemodynamic parameters during induction of anesthesia is important to prevent organ hypoperfusion and complications. Hypotension during induction may result in myocardial ischemia, cerebral hypoperfusion and postoperative complications (1). Therefore, ketamine may be beneficial in patients with cardiovascular compromise or risk of hypotension.

Fentanyl demonstrated lower requirement of additional propofol indicating improved insertion conditions. Adequate jaw relaxation and suppression of airway reflexes reduce patient movement and facilitate smooth insertion of LMA. Similar findings have been reported in previous studies comparing ketamine and fentanyl combinations (15,16).

The results of this study suggest that ketamine provides better hemodynamic stability whereas fentanyl provides better insertion conditions. Selection of co-induction agent should be individualized based on patient characteristics. In patients with hypotension risk, ketamine may be preferred due to cardiovascular stability (13). In patients where smooth insertion conditions are desired, fentanyl may be preferred (15).

Overall findings suggest that both combinations are safe and effective for LMA insertion. Combination of propofol with ketamine balances hypnotic and sympathomimetic effects whereas combination of propofol with fentanyl improves insertion characteristics.

STRENGTHS AND LIMITATIONS

Randomized controlled design and adequate sample size improved validity of study findings. Standardized drug dosage and uniform methodology improved comparability between groups. However, study was conducted in single centre and blinding was not performed. Postoperative recovery characteristics and complications were not evaluated.

CONCLUSION

Propofol-ketamine combination provides superior hemodynamic stability compared to propofol-fentanyl combination for LMA insertion. Propofol-fentanyl combination provides better insertion conditions with lower propofol requirement. Choice of co-induction agent should be individualized based on patient condition. Future studies with larger sample size and multicentric design are recommended.

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