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COMPARATIVE EVALUATION OF PROPOFOL-KETAMINE, PROPOFOL-FENTANYL, AND PROPOFOL-DEXMEDETOMIDINE FOR LARYNGEAL MASK AIRWAY INSERTION

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ABSTRACT

Background and Rationale: Airway management remains a critical component of anesthetic practice, with the Laryngeal Mask Airway (LMA) serving as a vital alternative to endotracheal intubation. While intubation is the gold standard, it often provokes significant hemodynamic responses and airway reflexes. The LMA offers a less invasive approach but requires the suppression of upper airway reflexes for successful placement. Propofol is the preferred induction agent for this purpose; however, its use is limited by dose-dependent cardiovascular depression, necessitating the use of adjuvant drugs to mitigate side effects and reduce dosage requirements. **Overview:** This prospective, randomized, double-blind study was conducted at Bharat Ratna Late Shri Atal Bihari Vajpayee Memorial Medical College & Hospital, Rajnandgaon from July 2023 to November 2024. The objective was to compare the efficacy of three specific drug combinations for LMA insertion during short surgical procedures: Propofol-Ketamine (PK), Propofol-Fentanyl (PF), and Propofol-Dexmedetomidine (PD). **Key Findings:** The study analyzed 75 patients (ASA I-II, aged 18-60) divided equally into three groups. The results demonstrated that the Propofol-Dexmedetomidine (PD) group had significantly lowest propofol dose requirement and highest rate of excellent insertion conditions (88%). Conversely, the Propofol-Ketamine (PK) group exhibited highest rate of adverse events (28%), including laryngospasm, and three cases required conversion to intubation. The study concluded that the PD combination provides superior insertion conditions with minimal adverse events, making it the preferred regimen for short surgical procedures.

KEYWORDS : Laryngeal Mask Airway, Propofol, Ketamine Dexmedetomidine, Fentanyl**INTRODUCTION**

Airway management is the cornerstone of anesthesia, ensuring the delivery of anesthetic gases and the maintenance of oxygenation. Traditionally, endotracheal intubation has been viewed as the definitive method for airway control because it secures the airway and prevents aspiration. However, the procedure requires laryngoscopy, a stimulus known to cause sympathetic nervous system activation, resulting in hemodynamic fluctuations and potential postoperative complications.

In 1983, Brain introduced Laryngeal Mask Airway (LMA), a supraglottic airway device designed to be simpler and less invasive than intubation¹. The primary advantage of LMA is that it avoids the need for laryngoscopy, thereby provoking fewer airway reflexes and sympathetic responses. Despite these benefits, the insertion of an LMA is not without challenges. It requires the suppression of active airway reflexes, such as gagging, coughing, and laryngospasm, particularly because these devices are often inserted without the use of muscle relaxants. Consequently, the selection of appropriate induction agents is critical to the procedure's success.

Pharmacological Considerations

Propofol is widely regarded as the drug of choice for LMA insertion due to its rapid onset, short duration of action, and potent ability to suppress airway reflexes. However, achieving adequate conditions with propofol alone often requires high doses, which can lead to significant cardiorespiratory depression. To address this, researchers have explored various adjuvants including opioids, ketamine, benzodiazepines, and alpha 2-agonists to reduce the necessary dose of propofol and improve insertion conditions.

The study focuses on three specific adjuvants:

- Fentanyl: A short-acting opioid that improves insertion conditions but carries the risk of exacerbating apnea, bradycardia, and hypotension.
- Ketamine: Known for its sympathomimetic and analgesic properties, ketamine helps counteract propofol-induced hypotension. However, it is associated with increased secretions and risk of emergence delirium.
- Dexmedetomidine: A selective alpha 2-adrenergic agonist that provides sedation, analgesia, and hemodynamic stability without significant respiratory depression, though it may cause bradycardia.

Given the need for optimal conditions involving jaw relaxation and

reflex suppression, and the limited comparative data among these specific combinations, this study aimed to evaluate PK, PF, and PD combinations comprehensively.

Review of Literature

The study is grounded in a body of research evaluating drug combinations for LMA insertion. Previous studies have primarily sought to identify agents that reduce propofol requirements while maintaining stability.

Goyagi et al. (2003): Demonstrated that fentanyl pretreatment significantly reduced the ED50 and ED95 propofol doses required for successful LMA insertion compared to controls².

- Gupta A et al. (2011): Compared ketamine, fentanyl, and butorphanol. While butorphanol provided the best jaw relaxation, ketamine preserved hemodynamic stability effectively, though it offered less ideal insertion conditions⁸.
- Gamal T. Yousef et al. (2013): Found that "Ketofol" (propofol-ketamine) in children provided faster induction and better jaw relaxation than propofol alone⁹.
- Mohan Kumar RM et al. (2017): Reported that while ketamine-propofol and fentanyl-propofol provided similar insertion conditions, ketamine was superior for hemodynamic stability¹⁰.
- Uzumcugil et al. (2008): Compared dexmedetomidine-propofol against fentanyl-propofol. Both were effective, but fentanyl caused longer durations of apnea, whereas dexmedetomidine preserved respiration³.
- Sowmya Jayaram et al. (2014) & Ramaswamy AH et al. (2015): Both studies confirmed that while fentanyl and dexmedetomidine provided comparable insertion scores, the fentanyl groups experienced more frequent and prolonged apnea⁷.
- SS Nellore et al. (2016): Highlighted that dexmedetomidine significantly reduced propofol requirements while providing excellent conditions⁵.
- J.Y. Yoo et al. (2017): Specifically quantified that dexmedetomidine pretreatment reduced the ED50 of propofol by 38% for smooth LMA insertion⁵.

Literature suggests that while propofol alone causes depression, and fentanyl risks apnea, dexmedetomidine offers a unique profile of sedation and stability with minimal respiratory impact.

MATERIALS AND METHODS**Study Design and Setting**

This was a hospital-based, prospective, randomized, double-blind

interventional study. It was conducted at the Department of Anaesthesiology, B.R.L.S.A.B.V.M. Medical College & Hospital, Rajnandgaon, Chhattisgarh, spanning from July 2023 to November 2024. The study was registered under CTRI/2024/06/069611 and received ethical clearance prior to commencement.

Study Population

The sample size consisted of 75 patients, divided into three groups of 25.

- Inclusion Criteria: Patients belonging to ASA grade I-II, aged between 18 and 60 years, and scheduled for elective short surgical procedures lasting less than one hour.
- Exclusion Criteria: Patients were excluded if they were ASA grade III or higher, had anticipated difficult airways, known hypersensitivity to study drugs, severe systemic illnesses (cardiac, pulmonary, hepatic, renal), or were pregnant/lactating or Refusal to participate.

Preoperative and Randomization Protocols

All patients underwent a detailed history, clinical examination, and routine laboratory investigations. A strict "Nil per oral" status was ensured. Randomization was achieved using a computer-generated method to allocate patients into Group PK, Group PF, or Group PD. To ensure double-blinding, study drugs were prepared by an independent anesthesiologist not involved in patient management, meaning both the patient and the anesthesiologist performing the LMA insertion were unaware of the specific drug administered.

Drug Protocols

- Group PK: Received Ketamine 1mg/kg IV 1 min before induction + Propofol 1.5-2.5 mg/kg IV.
- Group PF: Received Fentanyl 1mcg/kg IV 1 min before induction + Propofol 1.5-2.5 mg/kg IV.
- Group PD: Received Dexmedetomidine 1mcg/kg IV over 10 minutes + Propofol 1.5-2.5 mg/kg IV.

Anesthesia Technique

Upon arrival at the operating table, baseline vital parameters were recorded. All patients received premedication consisting of Injection Glycopyrrolate (0.2mg IV), Midazolam (1mg IV), and Ondansetron (4mg IV). Following preoxygenation with 100% Oxygen for 3 minutes, induction was carried out with the allocated study drug and Propofol (1.5-2.5 mg/kg), after which LMA insertion was attempted. Anesthesia was maintained using Oxygen + Nitrous Oxide (50:50) with Sevoflurane, with patients maintaining spontaneous ventilation.

Monitoring and Scoring

Standard ASA monitoring was utilized, including ECG, SpO₂, Non-invasive blood pressure, and End-tidal CO₂. Hypotension and bradycardia were managed with Ephedrine and Atropine, respectively.

LMA Insertion Scoring:

Variables	Scoring		
	1	2	3
Mouth opening	Nil	Partial	Full
Ease of insertion	Impossible	Difficult	Easy
Patient's Response			
Swallowing	Gross	Slight	Nil
Coughing/Gagging	Severe	Mild	Nil
Patient Movement	Vigorous	Moderate	Nil
Laryngospasm	Severe	Mild	Nil

- Total score of 18 is considered as excellent, 16–17 as satisfactory, and <16 as poor.

RESULTS

Demographics and Propofol Requirements

The demographic profiles regarding age, sex, BMI, and ASA grading were comparable across all three groups, with no statistically significant differences ($p>0.05$). However, significant differences were observed in propofol dose requirements. The Propofol-Dexmedetomidine (PD) group demonstrated the lowest mean propofol requirement.

Drug Propofol	Group PD (n=25)	Group PK (n=25)	Group PF (n=25)	P value
Total Amount of Propofol administered per Kg body weight (mg/kg)	2.20 ± 0.48	3.02 ± 0.56	2.58 ± 0.49	<0.001

LMA Insertion Conditions

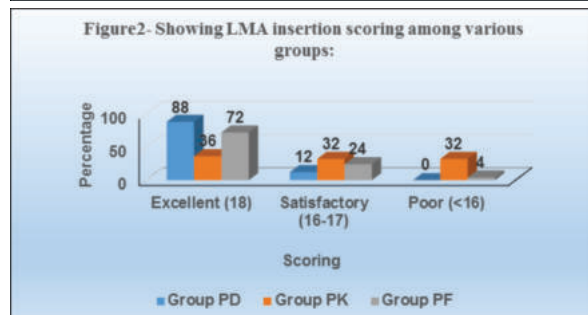
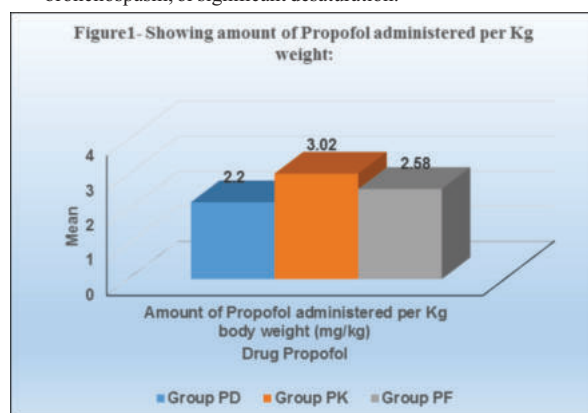
- Group PD: achieved "Excellent" conditions (score of 18) in 88% (22/25) of patients.
- Group PF: achieved "Excellent" conditions in 72% (18/25) of patients.
- Group PK: achieved "Excellent" conditions in only 36% (9/25) of patients.

Conversely, "Poor" insertion conditions (score <16) were highest in PK group at 32% (8/25), compared to 4% in the PF group and 0% in the PD group. The difference between PD and PK was statistically significant ($p=0.003$), as was the difference between PF and PK ($p=0.001$).

Adverse Events

The incidence of adverse events followed a distinct pattern: PK > PF > PD.

- Group PK: 28% incidence of adverse events. This group had significantly higher rates of laryngospasm and bronchospasm compared to the others. Additionally, three cases in the PK group failed LMA insertion and required conversion to endotracheal intubation.
- Group PF: 8% incidence of adverse events. While PF group experienced a higher frequency of apnea (>30 seconds) due to respiratory depression.
- Group PD: There were no recorded instances of laryngospasm, bronchospasm, or significant desaturation.



DISCUSSION

The study reinforces that airway management during short surgical procedures requires a delicate balance between suppressing reflexes and maintaining hemodynamic stability. While Propofol is the standard induction agent, its dose-dependent side effects necessitate adjuvants.

Ketamine is theoretically advantageous for its sympathomimetic properties which counteract hypotension. However, in this study, the PK combination performed poorly. It required the highest doses of propofol and was associated with inferior insertion conditions and high rates of adverse airway events, including laryngospasm. This aligns with findings by Mohan Kumar RM et al. (2017), who noted that while ketamine provides hemodynamic stability, it often yields poorer insertion conditions¹⁰. The study indicates that ketamine compromises insertion conditions and increases airway complications.

Fentanyl works synergistically with propofol to suppress airway reflexes. This study found that PF provided satisfactory insertion conditions in 72% of patients. However, the primary drawback was the exaggeration of propofol's respiratory depressant effects, leading to a

higher incidence of apnea and bradycardia. These results act as a confirmation of previous studies by Sowmya Jayaram et al. (2014)⁷ and Nellore SS et al. (2016)⁴.

Dexmedetomidine proved to be the superior adjuvant. As a highly selective alpha₂-adrenergic agonist, it provided sedation and analgesia while sparing respiratory function. The PD group required the lowest propofol dose and achieved excellent insertion conditions in 88% of cases with zero airway-related complications. These findings validate previous research by Ramaswamy AH et al. (2015)⁶ and Yoo JY et al. (2017)⁵, confirming that dexmedetomidine enhances insertion success while reducing propofol requirements.

Clinical Significance

The data clearly indicates that dexmedetomidine minimizes propofol requirements, ensures smooth insertion, and maintains stable intraoperative conditions. While fentanyl is a useful adjunct, its safety profile is limited by the risk of apnea, and ketamine is less suitable due to airway complications.

Limitations

- Sample Size: A total of 75 patients may be insufficient to generalize findings to larger populations.
- Single-Centre study was conducted, limiting external validity.
- Only ASA I-II patients were studied, excluding paediatric, geriatric and higher-risk populations.

CONCLUSION

This randomized, double-blind study provided a comparative analysis of Propofol-Ketamine (PK), Propofol-Fentanyl (PF), and Propofol-Dexmedetomidine (PD) for LMA insertion in short surgical procedures.

- Propofol-Dexmedetomidine (PD) demonstrated the best results, characterized by superior insertion conditions, the lowest propofol requirement, and absence of adverse airway complications.
- Propofol-Fentanyl (PF) offered satisfactory conditions but carried a distinct risk of respiratory depression and apnea.
- Propofol-Ketamine (PK) yielded the least favorable outcomes, with high failure rates, poor insertion conditions, and significant incidence of laryngospasm.

Propofol-Dexmedetomidine emerges as the most effective and safe adjuvant combination for smooth and successful LMA insertion. It offers an optimal balance of patient comfort and minimal adverse effects.

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