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Retrospective Comparative Study Of Haemodynamic Changes With Propofol And Ketofol As Induction Agents In Laparoscopic Surgeries Under General Anaesthesia

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Abstract
Background and Aims
Laparoscopic surgery is increasingly performed due to its advantages, though pneumoperitoneum can induce significant physiological changes. Propofol is widely used for induction but is limited by dose-dependent hypotension and myocardial depression. Combining propofol with ketamine (ketofol) may improve haemodynamic stability. This study aimed to retrospectively compare haemodynamic changes in patients undergoing laparoscopic surgery under general anaesthesia, using propofol or ketofol as induction agents.
Materials and Methods
This retrospective observational study reviewed medical records of 80 ASA I/II patients who underwent elective laparoscopic procedures under general anaesthesia. Patients were divided into two groups based on the induction agent administered:
- ***Group A (Ketofol):*** *Propofol 1 mg/kg + Ketamine 1 mg/kg, diluted to 20 ml with saline.*
- ***Group B (Propofol):*** *Propofol 2 mg/kg, diluted to 20 ml with saline.*

Haemodynamic parameters (HR, SBP, DBP, MAP) were extracted from anaesthesia charts at predefined intervals until pneumoperitoneum. Postoperative recovery times and complications were also recorded. Data were compiled in MS Excel and analyzed using SPSS v20.0. Statistical tests included repeated measures ANOVA and Chi-square to assess significance.
Results
Demographic characteristics and surgical duration were comparable between groups. Significant differences ($P < 0.05$) were observed in SBP, DBP, MAP, and HR, with Group A (ketofol) showing superior haemodynamic stability. Recovery time was longer in the ketofol group (4.95 min) compared to the propofol group (1.8 min). Postoperative nausea and vomiting were more frequent in the ketofol group ($P = 0.004$).
Conclusion
Ketofol provided better haemodynamic stability than propofol alone during induction for laparoscopic surgery. However, recovery was prolonged and postoperative nausea/vomiting were more common in the ketofol group. No major complications were noted in either group.

Keywords: *Pneumoperitoneum, haemodynamic stability, ketofol, laparoscopy, propofol*

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I. Introduction

Laparoscopic surgery, also referred to as minimally invasive surgery (MIS) or keyhole surgery, is a modern technique that has largely replaced many open procedures across the world. Its adoption has transformed surgical practice by reducing morbidity, mortality, and hospital stay, while still achieving effective therapeutic outcomes.[1] By minimizing tissue trauma, laparoscopy offers significant advantages over conventional approaches. Traditionally, these procedures are performed under general anaesthesia after establishing an artificial pneumoperitoneum with carbon dioxide insufflation, which provides adequate visualization of intra-abdominal structures.[2,3]

The creation of pneumoperitoneum, however, induces notable physiological alterations across multiple organ systems. Increased intra-abdominal pressure and the release of neurohumeral mediators contribute to significant haemodynamic changes.[3,4,5]

Propofol, a substituted isopropyl phenol (2,6-di-isopropylphenol), is chemically distinct from other induction agents.[6] It is a non-opioid, non-barbiturate, sedative-hypnotic drug characterized by rapid onset and short duration of action due to its lipid solubility. Acting through facilitation of GABA-mediated inhibitory neurotransmission, propofol reliably produces sedation, amnesia, and anaesthesia. Despite its effectiveness, its use is limited by dose-dependent hypotension and respiratory depression.[7,8]

Ketamine, a phencyclidine derivative, produces "dissociative anaesthesia," resembling a cataleptic state with open eyes and slow nystagmus. It functions as a non-competitive NMDA receptor antagonist with additional opioid receptor activity. Ketamine provides analgesia with minimal respiratory or cardiovascular depression, making it valuable for postoperative pain control.[9,10,11] However, its use as a sole induction agent is restricted by psychomimetic and sympathomimetic side effects.[12]

Combining propofol and ketamine (ketofol) has been proposed to counterbalance their individual haemodynamic drawbacks, thereby offering a more stable cardiovascular profile during induction. This combination may also reduce postoperative nausea, vomiting, and shivering.[13,14]

Accordingly, the present study was designed to retrospectively compare the haemodynamic responses of patients undergoing laparoscopic surgery under general anaesthesia when induced with either propofol or ketofol.

II. Materials And Methods

Following approval from the Institutional Ethics Committee, medical records of 80 patients with American Society of Anesthesiologists (ASA) physical status I or II, aged 18–50 years, who underwent laparoscopic surgery under general anaesthesia with endotracheal intubation, were reviewed. Patients of either sex were included. Exclusion criteria noted in records were uncontrolled hypertension or diabetes mellitus, psychiatric illness, pregnancy, BMI >30 kg/m², and documented allergy to study drugs. The sample size was calculated based on a previous study,[15]

Based on anaesthesia charts, patients were categorized into two groups according to the induction agent administered:

- **Group A (Ketofol):** Propofol 1 mg/kg combined with ketamine 1 mg/kg (10 mg/ml dilution), diluted to 20 ml with saline.
- **Group B (Propofol):** Propofol 2 mg/kg diluted to 20 ml with saline.

All patients had been kept fasting for 8 hours and received standard premedication (Ranitidine 150 mg, Metoclopramide 10 mg, Lorazepam 1 mg orally the night before surgery). Intraoperative records confirmed use of standard ASA monitoring (NIBP, pulse oximetry, ECG, ETCO). Baseline haemodynamic parameters (SBP, DBP, MAP, HR, SpO) were documented prior to induction.

Anaesthesia records indicated that patients were pre-oxygenated with 100% oxygen for 3 minutes, followed by administration of glycopyrrolate (0.2 mg), midazolam (0.02 mg/kg), and fentanyl (2 mcg/kg) intravenously before induction. After IV induction, mask ventilation was assessed, and vecuronium (0.1 mg/kg) was administered for neuromuscular blockade. Endotracheal intubation was performed, confirmed by capnography and bilateral air entry, and the tube was secured. Anaesthesia was maintained with O :N O (50:50), sevoflurane (1–1.5%), and intermittent vecuronium doses. Paracetamol 1 g and ondansetron 4 mg IV were administered approximately 30 minutes before completion of surgery.

Extubation records showed that at the end of surgery, inhalational agents were discontinued, patients were ventilated with 100% oxygen until spontaneous respiration resumed, and residual neuromuscular blockade was reversed with neostigmine (50 mcg/kg) and glycopyrrolate (10 mcg/kg). Extubation was performed once patients demonstrated adequate spontaneous breathing and responsiveness.

Haemodynamic parameters (SBP, DBP, MAP, HR, SpO) were extracted from charts at predefined intervals: before induction, 1 minute after induction, 1 minute after intubation, and every 5 minutes until pneumoperitoneum was established. Postoperative recovery notes were reviewed for nausea, vomiting, and shivering, which were graded using a four-point scale.

Table 1.
Postoperative Nausea and Vomiting grading

Grade	Features
Grade 0	No nausea/vomiting
Grade 1	Nausea alone
Grade 2	Vomiting alone
Grade 3	Vomiting 2 times or more in 30 minutes interval

Table 2.
Postoperative shivering grading

Grade	Features
Grade 0	No shivering
Grade 1	Mild - shivering localized to neck/thorax seen as artifact in ECG or felt by palpation
Grade 2	Moderate – intermittent involving of upper extremity ± thorax
Grade 3	Severe – generalized shivering / sustained upper extremity and lower limb shivering.

Dexamethasone 8 mg and Tramadol 25 mg IV were given as rescue drugs for vomiting and shivering with grade >2. All postoperative parameters were recorded every 15 min till 2 h in the postoperative recovery room and ward.

Statistical Analysis

Patient demographic details and clinical parameters were extracted from anaesthesia records and entered into Microsoft Excel for analysis. Continuous variables were summarized as mean ± standard deviation (SD), and their distribution was assessed for normality using the Kolmogorov–Smirnov test. Haemodynamic parameters (SBP, DBP, MAP, SpO , HR) documented at different time intervals were compared between groups using repeated measures ANOVA. Categorical variables such as the incidence of postoperative nausea and vomiting (PONV), pain, and shivering were expressed as percentages and analysed using the Chi-square test. All statistical evaluations were performed at a 5% level of significance, with a p-value <0.05 considered statistically significant. Data analysis was conducted using SPSS software version 20.0.

III. Results

In the retrospective review, 39 patients in Group A (ketofol) were included in the final analysis; one case was excluded as the procedure was converted to open surgery. In Group B (propofol), 38 patients were analyzed; two cases were excluded—one due to conversion to open surgery and another because additional pharmacological intervention was required to stabilize haemodynamics.

The demographic characteristics of patients in both groups were comparable, with no statistically significant differences observed [Table 3]. Haemodynamic parameters were extracted from anaesthesia records and analysed at predefined time points: baseline (T1), one minute after induction (T2), one minute following intubation (T3), five minutes post-intubation (T4), and after creation of pneumoperitoneum (T5).

Table 3.
Demographic Characterstics

Variable	Group A (n = 39)	Group B (n = 38)
Age (years), mean ± SD	33.95 ± 7.84	33.47 ± 8.97
Sex (M/F)	1 / 38	6 / 32

BMI (kg/m²), mean ± SD	22.72 ± 3.94	22.99 ± 3.94
ASA physical status (I/II)	35 / 4	36 / 2

SD - Standard deviation, BMI - Body mass index

Group A had consistently higher systolic blood pressure (SBP) than Group B at all postinduction and postintubation time points, and the betweengroup differences were statistically significant ($P < 0.05$). This indicates better attenuation of hypertensive response to laryngoscopy and intubation in Group B.
[Table 4].

Table 4.
Systolic Blood pressure

Time point	Group A SBP (mm Hg) mean ± SD	Group B SBP (mm Hg) mean ± SD	Significance
T2 – 1 min after induction	108.44 ± 14.10	90.84 ± 13.03	P < 0.05 (significant)
T3 – 1 min after intubation	117.64 ± 17.19	104.00 ± 17.80	P < 0.05 (significant)
T4 – 5 min after intubation	110.49 ± 15.06	102.42 ± 13.96	P < 0.05 (significant)

Group A had slightly higher DBP than Group B at all time points, but the difference reached statistical significance only at T2 ($P < 0.05$). [Table 5].

Table 5.
Diastolic Blood pressure

Time point	Group A DBP (mm Hg) mean ± SD	Group B DBP (mm Hg) mean ± SD	Significance
T2 – 1 min after induction	65.69 ± 8.60	61.29 ± 8.74	P < 0.05 (significant)
T3 – 1 min after intubation	73.51 ± 11.46	68.53 ± 11.43	Not significant (P > 0.05)
T4 – 5 min after intubation	70.62 ± 12.53	67.47 ± 10.21	Not significant (P > 0.05)

Mean arterial pressure [Table 6], heart rate [Table 7], and recovery times [Table 8] all favoured Group B, with significantly lower MAP at all time points, higher HR only at T2, and much faster recovery (eye opening and obeying commands).

Table 6.
Mean Arterial Pressure (MAP)

Time point	Group A MAP (mm Hg) mean ± SD	Group B MAP (mm Hg) mean ± SD	Significance
T2 – 1 min after induction	79.92 ± 9.34	72.58 ± 10.03	P < 0.05 (significant)
T3 – 1 min after intubation	89.44 ± 12.12	80.26 ± 13.44	P < 0.05 (significant)
T4 – 5 min after intubation	83.15 ± 10.95	78.95 ± 9.61	P < 0.05 (significant)

Table 7.
Heart Rate

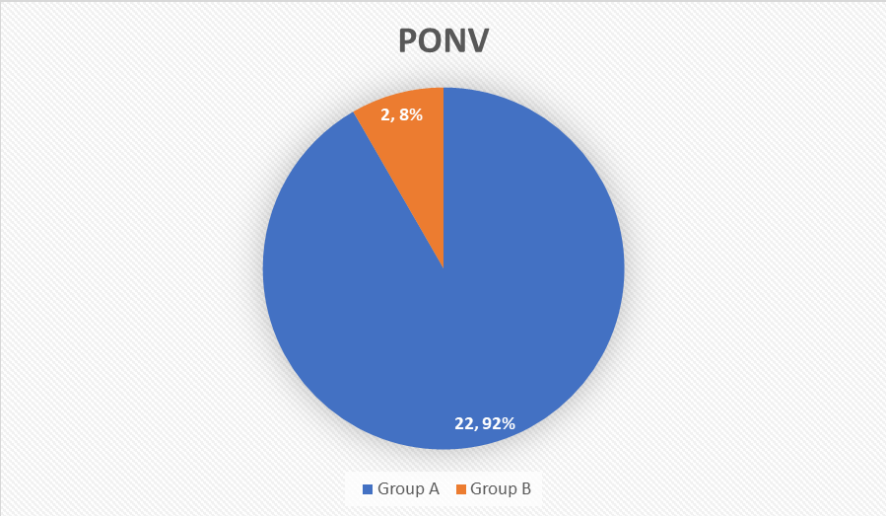
Time point	Group A HR (bpm) mean ± SD	Group B HR (bpm) mean ± SD	Significance
T2 – 1 min after induction	90.13 ± 10.11	96.89 ± 16.78	P < 0.05 (significant)
T3 – 1 min after intubation	88.87 ± 11.22	87.05 ± 19.69	Not significant (P > 0.05)
T4 – 5 min after intubation	85.59 ± 9.90	90.05 ± 13.65	Not significant (P > 0.05)

Table 8.
Recovery Time

Parameter	Group A mean ± SD (min)	Group B mean ± SD (min)	Significance
Time to spontaneous eye opening	4.95 ± 1.82	1.82 ± 1.39	P < 0.001 (significant)
Time to obeying commands	6.79 ± 2.33	3.16 ± 1.48	P < 0.001 (significant)

In group A, 22 patients had postoperative vomiting and in group B, 2 patients had postoperative vomiting with $P < 0.004$ which was statistically significant [Figure 1]. No patients in either group had postoperative shivering.

Figure 1.
Incidence of PONV



IV. Discussion

Laparoscopic surgery has transformed surgical practice by offering reduced morbidity, faster recovery, smaller incisions, and less postoperative discomfort and wound-related complications. Despite these advantages, the procedure carries specific risks, particularly those related to the physiological alterations induced by pneumoperitoneum. In anaesthetic practice, the combined use of ketamine and propofol has been well established. Both agents are characterized by rapid onset and effectiveness in sedation and analgesia for

minimally invasive procedures. [16,17] When mixed as ketofol, they remain physically compatible for up to one hour at room temperature and can be prepared in varying concentrations depending on surgical requirements. [18,19]

In this retrospective analysis, patients induced with ketofol demonstrated superior haemodynamic stability compared to those induced with propofol alone. Heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were more consistently maintained at one minute after induction, one minute after intubation, and following pneumoperitoneum in the ketofol group, with statistically significant differences noted.

These findings align with prior studies. Kayalha et al.[20] reported similar results in patients undergoing laparotomy, where ketofol maintained haemodynamic parameters more effectively than propofol. Likewise, Atashkhoyi et al.[15] observed reduced heart rate and mean arterial pressure in patients receiving propofol compared to those receiving ketamine-propofol combinations during gynaecological laparoscopy. Ramakrishna et al.[21] also demonstrated that ketofol attenuated the fall in blood pressure compared to propofol alone, though recovery times were longer with ketofol.

In the present study, recovery was faster in the propofol group, with shorter times to eye opening and response to verbal commands compared to ketofol. This delay in recovery with ketofol is consistent with earlier reports. The haemodynamic stability observed with ketofol may be attributed to attenuation of sympathetic overactivity, which often contributes to instability during induction and intubation. The need for additional pharmacological support in one patient from the propofol group further highlights this difference.

Postoperative nausea and vomiting (PONV) was more frequent in the ketofol group. This may reflect the combined emetogenic potential of laparoscopic surgery and ketamine. Similar findings were reported by Aboeldahab et al.[13], who noted higher PONV rates with ketamine compared to propofol or ketofol. In our cohort, however, no patients in either group experienced postoperative shivering or delirium.

V. Conclusion

In this retrospective analysis comparing haemodynamic responses to propofol and ketofol during induction for laparoscopic surgeries under general anaesthesia, ketofol was associated with greater haemodynamic stability across key parameters without major adverse effects. However, recovery times—specifically for eye opening and response to verbal commands—were prolonged in the ketofol group compared to propofol. Additionally, the incidence of postoperative vomiting was higher among patients receiving ketofol.

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Conflicts of interest: No conflicts of interest were reported.

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