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Comparative Study of Propofol with Ketamine and Propofol with Butorphanol for Total Intravenous Anesthesia in Short Surgical Procedures

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ABSTRACT

Background: Because of its quick start, easy recovery, and lower risk of postoperative sequelae, total intravenous anesthesia (TIVA) is frequently used for brief surgical operations. Although propofol is commonly used for TIVA, its use is linked to respiratory suppression, cardiovascular depression, and injection discomfort. Propofol is frequently used with ketamine and butorphanol as adjuvants to enhance analgesia and anesthetic stability. Propofol–ketamine and propofol–butorphanol combinations for TIVA in brief surgical operations were compared in this study in terms of hemodynamic parameters, respiratory effects, injection pain, postoperative drowsiness, and postoperative nausea and vomiting. **Aim & Objectives:** To assess the effects of propofol-ketamine and propofol-butorphanol combinations for total intravenous anesthesia in short surgical procedures in terms of postoperative drowsiness, postoperative nausea and vomiting, respiratory effects, discomfort during propofol injection, and hemodynamic parameters. **Methodology:** 60 adult patients receiving brief surgical procedures lasting less than an hour under total intravenous anesthesia participated in this hospital-based interventional trial. Patients in ASA physical status I and II, ages 18 to 60, were split into two groups of 30 at random. Propofol and ketamine were given to Group A, and propofol and butorphanol were given to Group B. During the procedure, SpO_2, respiratory rate, and hemodynamic parameters were measured at predetermined intervals. Additionally evaluated were postoperative drowsiness, postoperative nausea and vomiting, and pain following propofol injection. SPSS version 30 was used to analyze the data, and $p<0.05$ was deemed statistically significant. **Results:** In terms of baseline clinical features and demographic profile, both groups were similar. Group A experienced considerably more pain after receiving a propofol injection (60%) than Group B (13.33%) ($p=0.0001$). During the intraoperative phase, Group B showed a higher decrease in heart rate, systolic and diastolic blood pressure, respiratory rate, and SpO_2 than Group A. At several time points, statistically significant variations in oxygen saturation, respiratory rate, and systolic and diastolic blood pressure were noted. The two groups experienced similar levels of postoperative drowsiness, nausea, and vomiting ($p>0.05$). **Conclusion:** For complete intravenous anesthesia during brief surgical operations, propofol–ketamine and propofol–butorphanol combination worked well. While propofol–butorphanol was more successful in lowering pain during propofol administration, propofol–ketamine offered superior hemodynamic and respiratory stability.

Keywords*: Total intravenous anaesthesia, Propofol, Ketamine, Butorphanol, Haemodynamic stability, Pain on injection, Short surgical procedures.*

INTRODUCTION

Due to its quick induction, easy maintenance, quick recovery, and decreased risk of postoperative nausea and vomiting, total intravenous anesthesia (TIVA) has grown in popularity for brief surgical operations. [1,2] TIVA avoids exposure to volatile anesthetic agents and offers greater control over anesthetic depth because it solely uses intravenous drugs for the induction and maintenance of anesthesia, in contrast to inhalational anesthesia. [2] The safety and acceptance of TIVA in contemporary anesthetic practice have been further enhanced by the creation of novel short-acting intravenous medications as well as improvements in infusion devices and monitoring methods. [3]

Rapid onset, sufficient hypnosis and analgesia, hemodynamic stability, minimal respiratory depression, and a smooth recovery with fewer side effects are all characteristics of the perfect intravenous anesthetic. [4,5] Due to its favorable pharmacokinetic profile, quick redistribution, quick recovery period, and antiemetic qualities, propofol has become one of the most popular drugs for TIVA. [6, 7] Gamma-aminobutyric acid (GABA) receptors are mostly modulated by it, which results in quick hypnosis with easy recovery. [8] Despite these benefits, propofol has no inherent analgesic qualities and is linked to intravenous injection discomfort, respiratory depression, and dose-dependent hypotension. [9, 10] Therefore, in order to produce balanced anesthesia and minimize its side effects, propofol is frequently used with adjunct analgesic medications. [11]

Ketamine is a dissociative anesthetic that primarily works by blocking N-methyl-D-aspartate (NMDA) receptors. [12] Ketamine effectively relieves pain at subanaesthetic dosages while maintaining spontaneous breathing and airway reflexes. [13] Unlike propofol, ketamine increases blood pressure and heart rate by stimulating the sympathetic nervous system, which may assist offset propofol's cardiovascular depressing effects. [14, 15] Due to these characteristics, the propofol–ketamine combination has been investigated more and more for TIVA, especially in brief surgical procedures when quick recovery and hemodynamic stability are desired. [16]

Butorphanol is a synthetic opioid agonist-antagonist with moderate agonistic and antagonistic activity at mu opioid receptors, mostly acting as a kappa receptor agonist. [17] Compared to traditional opioids, it offers efficient analgesia with a comparatively decreased risk of dependence and respiratory depression. [18] To improve perioperative analgesia and lessen injection pain, butorphanol has been used as an adjuvant to propofol. [19, 20] However, surgical recovery and hemodynamic parameters may be impacted by its sedative and respiratory depressive effects. [21]

Different medication combinations used for TIVA in brief surgical procedures have been compared in a number of studies. [22–25] According to earlier studies, the propofol–ketamine combination may improve hemodynamic stability, whereas the propofol–butorphanol combination may more successfully lessen pain following propofol injection. [22, 24] Nevertheless, there is currently a dearth of research on postoperative drowsiness, respiratory consequences, and postoperative nausea and vomiting.

With a focus on hemodynamic stability, respiratory parameters, injection pain, postoperative sedation, and postoperative nausea and vomiting, the current study was conducted to compare propofol combined with ketamine and propofol combined with butorphanol for total intravenous anesthesia in brief surgical procedures.

AIM & OBJECTIVES

1. To evaluate the respiratory and hemodynamic effects of propofol–ketamine and propofol–butorphanol combinations for complete intravenous anesthesia during brief surgical operations.
2. To compare the two groups' postoperative nausea and vomiting, postoperative sedation, and pain following propofol injection.

MATERIAL AND METHODS

In order to compare propofol–ketamine and propofol–butorphanol combinations for total intravenous anesthesia in brief surgical procedures, the current hospital-based interventional study was carried out over an 18-month period in the Department of Anaesthesiology and Critical Care at Muzaffarnagar Medical College and Hospital. 60 patients with ASA physical status I and II, aged 18 to 60, were enrolled in the study and divided into two groups at random (n = 30 each). Propofol and ketamine were given to Group A, and propofol and butorphanol were given to Group B.

Before surgery, every patient had a thorough pre-anesthetic assessment. All individuals provided written informed consent, and standard fasting requirements were adhered too. Electrocardiography, non-invasive blood pressure, pulse oximetry, heart rate, and breathing rate were all routinely monitored upon arrival in the operating room, and baseline values were noted. Prior to propofol induction, intravenous access was established, and patients were given the research medications in accordance with their assigned groups. Throughout the treatment, oxygen supplementation was used in conjunction with the whole intravenous anesthesia approach to maintain anesthesia.

Heart rate, systolic and diastolic blood pressure, respiration rate, and SpO_2 were among the hemodynamic parameters that were measured during the procedure at predetermined intervals. During induction, a clinical assessment of propofol injection pain was conducted. During the postoperative phase, postoperative drowsiness as well as postoperative nausea and vomiting were evaluated. SPSS version 30 was used to analyze the gathered data. Qualitative factors were expressed as frequency and percentage, whereas quantitative variables were expressed as mean ± standard deviation. Statistical analysis was conducted using the Student's t-test and Chi-square test; $p<0.05$ was deemed statistically significant.

Inclusion Criteria

Patients fulfilling the following criteria were included in the study:

- Age between 18 and 60 years
- Either gender
- ASA physical status I or II
- Patients undergoing short surgical procedures of less than one hour duration under general anaesthesia
- Patients willing to participate in the study and provide written informed consent

Exclusion Criteria

Patients were excluded from the study if they had:

- Refusal to participate
- Known allergy or hypersensitivity to study drugs
- Significant cardiovascular, respiratory, hepatic, renal, or neurological disease
- Psychiatric illness
- Pregnancy or lactation
- Anticipated difficult airway
- Patients receiving medications affecting haemodynamic parameters or CNS function
- Emergency surgical procedures

RESULTS

The demographics of both groups were similar in **Table 1**. Group A's mean age was 37.03 ± 12.35 years, but Group B's was 41.57 ± 11.94 years ($p=0.19$). The two groups' gender distribution, height, weight, and ASA physical status were all similar ($p>0.05$), suggesting that the study participants were well matched at baseline.

Table 2 compares the two groups' postoperative results and pain following propofol infusion. Only 4 patients (13.33%) in Group B experienced injection-related pain, compared to 18 patients (60%) in Group A. This difference was determined to be highly statistically significant ($p=0.0001$). 63.33% of patients in Group A and 66.67% of patients in Group B experienced postoperative drowsiness; there was no statistically significant difference between the groups ($p=0.79$). Similarly, there was no statistically significant intergroup difference ($p>0.05$) in postoperative nausea and vomiting, which were similar in both groups.

The mean heart rates of Groups A and B at various time intervals are compared in **Table 3.** The two groups' baseline heart rates were similar ($p=0.79$). The mean heart rate decreased more in Group B after induction and during the intraoperative phase, although at most time periods, the intergroup differences were not statistically significant. In both groups, heart rate readings progressively got closer to baseline during the postoperative phase.

The mean systolic blood pressure (SBP) for Group A and Group B at various time intervals is compared in **Table 4-A.** The two groups' baseline SBPs were similar ($p=0.69$). At most intraoperative intervals, Group B's systolic blood pressure decreased more than Group A's after induction, and this difference was statistically significant. The early intraoperative period saw the biggest drop in SBP, following which both groups' values progressively returned to baseline.

Group A and Group B's mean diastolic blood pressure (DBP) at various time intervals is compared in **Table 4-B.** Baseline DBP values were similar for both groups ($p=0.94$). After induction, Group B's diastolic blood pressure decreased more than Group A's. At the majority of intraoperative intervals, statistically significant intergroup differences were found, suggesting that Group B experienced a more severe hypotensive impact throughout the anesthesia maintenance phase.

Peripheral oxygen saturation (SpO_2) and respiratory rate at various time intervals are compared between the two groups in **Table 5.** Group A and Group B had similar baseline respiratory rates and SpO_2 ($p>0.05$). During the intraoperative and postoperative phases, Group B showed a higher decrease in respiratory rate; statistically significant differences were seen at most intervals after five minutes. Similar to Group A, Group B's SpO_2 values decreased slightly but significantly across a number of intraoperative intervals, however both groups' oxygen saturation levels stayed within clinically acceptable bounds for the duration of the trial.

The distribution of patients based on the level of discomfort following propofol injection is depicted in **Figure 1.** Only 4 patients (13.33%) in Group B reported pain during injection, compared to 18 patients (60%) in Group A. Group B experienced a considerably lower incidence of injection-related pain than Group A (p=0.0001).

Table 1: Demographic profile of Study Participants: (N = 60)

	Group A	Group B	p value
Age (years)	**37.03 ± 12.35**	**41.57 ± 11.94**	0.19
Gender (M/F)	14/16	17/13	0.44
Height (cm)	167.5 ± 8.28	164.93 ± 8.08	0.22
Weight (kg)	60.82 ± 8.69	58.74 ± 8.15	0.28
ASA (I/II)	24/06	23/07	0.75

Table 2: Comparison of Pain on Injection and Postoperative Outcomes Between the Groups

Parameters	Group A	Group B	p value
Pain on Injection			
Yes	18 (60%)	4 (13.33%)	**0.0001**
No	12 (40%)	26 (86.67%)	
Postoperative Sedation			
Yes	19 (63.33%)	20 (66.67%)	0.79
No	11 (36.67%)	10 (33.33%)	
Postoperative Nausea			
Yes	7 (23.33%)	8 (26.67%)	0.76
No	23 (76.67%)	22 (73.33%)	
Postoperative Vomiting			
Yes	1 (3.33%)	1 (3.33%)	1.00
No	29 (96.67%)	29 (96.67%)	

Table 3: Comparison of Mean Heart Rate at Different Time Intervals Between the Groups

Heart Rate (beats/min)	Group A Mean ± SD	Group B Mean ± SD	p value
Pre-op	79.97 ± 7.05	80.53 ± 9.78	0.79
0 min	76.37 ± 6.00	72.77 ± 8.24	0.07
1 min	76.23 ± 5.74	72.27 ± 9.26	0.06
5 min	76.73 ± 8.05	73.50 ± 9.80	0.16
10 min	75.73 ± 7.69	72.37 ± 9.17	0.13
15 min	77.40 ± 7.70	72.80 ± 10.46	0.06
20 min	77.27 ± 7.76	72.47 ± 9.33	**0.05**
25 min	76.67 ± 7.85	74.03 ± 9.43	0.24
30 min	77.17 ± 7.84	73.00 ± 9.24	0.06
Post-op	77.67 ± 8.01	74.23 ± 9.95	0.15

Table 4-A: Comparison of Mean Systolic Blood Pressure at Different Time Intervals Between the Groups

SBP (mm Hg)	Group A Mean ± SD	Group B Mean ± SD	p value
Pre-op	118.77 ± 9.20	117.83 ± 8.99	0.69
0 min	113.63 ± 10.51	101.13 ± 11.44	**0.002**
1 min	113.17 ± 10.77	103.53 ± 10.04	**0.006**
5 min	114.13 ± 10.33z	101.27 ± 8.30	**0.001**
10 min	112.87 ± 10.73	102.07 ± 10.16	**0.002**
15 min	113.27 ± 9.92	103.67 ± 10.17	**0.004**
20 min	114.70 ± 9.82	102.73 ± 10.66	**0.001**
25 min	112.57 ± 10.46	102.07 ± 8.61	**0.002**
30 min	113.20 ± 12.76	105.43 ± 9.90	**0.02**
Post-op	111.77 ± 10.43	104.60 ± 11.43	**0.03**

Table 4-B: Comparison of Mean Diastolic Blood Pressure at Different Time Intervals Between the Groups

DBP (mm Hg)	Group A Mean ± SD	Group B Mean ± SD	p value
Pre-op	74.43 ± 8.17	74.57 ± 7.26	0.94
0 min	70.83 ± 9.32	64.53 ± 8.02	**0.007**
1 min	70.43 ± 9.95	67.07 ± 8.29	0.14
5 min	71.87 ± 9.04	66.50 ± 7.70	**0.02**

10 min	71.40 ± 8.14	65.77 ± 6.94	**0.01**
15 min	71.00 ± 9.34	65.07 ± 8.33	**0.01**
20 min	71.20 ± 9.44	66.80 ± 6.72	**0.03**
25 min	71.17 ± 8.89	66.40 ± 7.98	**0.03**
30 min	69.27 ± 8.52	67.20 ± 7.26	0.29
Post-op	72.00 ± 8.84	67.80 ± 6.94	**0.04**

Table 5: Comparison of Respiratory Rate and SpO_2 at Different Time Intervals Between the Groups

Time Interval	Respiratory Rate (breaths/min) Group A	Group B	p value	SpO_2 (%) Group A	Group B	p value
Pre-op	13.57 ± 2.21	13.47 ± 1.83	0.87	99.13 ± 0.78	99.07 ± 0.83	0.72
0 min	13.43 ± 2.40	12.53 ± 1.93	0.09	99.03 ± 0.81	97.97 ± 1.25	**0.001**
1 min	13.37 ± 2.57	13.00 ± 1.84	0.56	99.00 ± 0.74	97.93 ± 1.14	**0.001**
5 min	13.87 ± 2.26	12.53 ± 1.96	**0.03**	99.10 ± 0.71	98.37 ± 1.03	**0.004**
10 min	13.43 ± 2.34	12.53 ± 1.91	**0.05**	99.07 ± 0.69	98.17 ± 1.15	**0.001**
15 min	13.80 ± 2.17	12.67 ± 1.92	**0.04**	99.13 ± 0.73	97.90 ± 1.21	**0.001**
20 min	13.80 ± 2.52	12.67 ± 1.71	**0.04**	99.07 ± 0.74	97.93 ± 0.94	**0.001**
25 min	13.47 ± 2.29	12.40 ± 2.06	**0.05**	99.10 ± 0.71	98.33 ± 0.92	**0.002**
30 min	13.77 ± 2.64	12.47 ± 1.89	**0.03**	99.03 ± 0.76	98.03 ± 1.10	**0.001**
Post-op	13.77 ± 2.57	12.33 ± 1.71	**0.02**	99.00 ± 0.79	97.97 ± 1.38	**0.002**

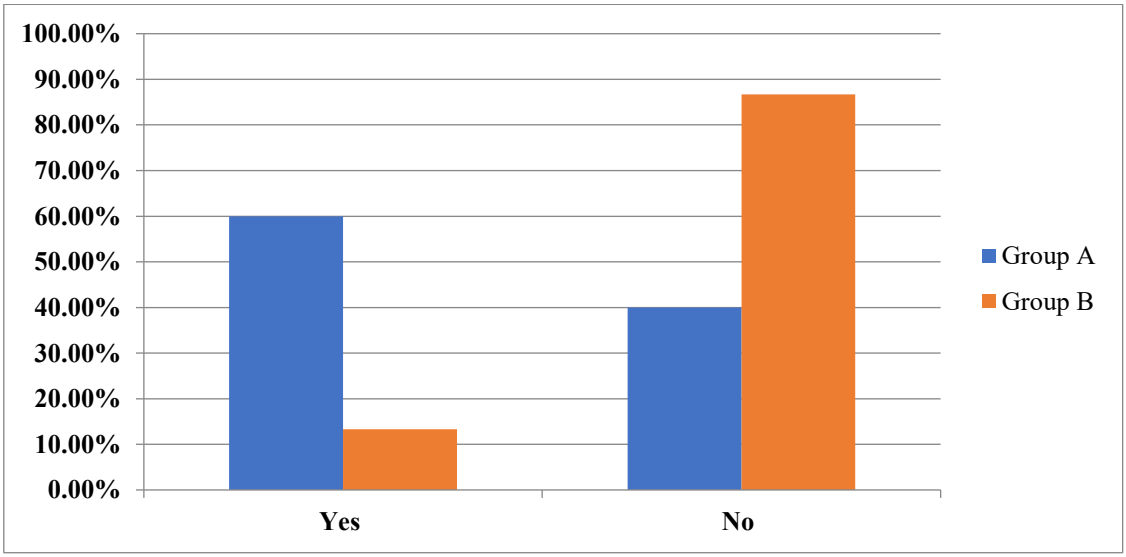

Figure 1: Distribution of Patients According to Pain on Injection

DISCUSSION

Both groups in the current study had similar baseline clinical features and demographic profiles. The two groups did not substantially differ in terms of mean age, gender distribution, height, weight, or ASA physical status ($p>0.05$), suggesting proper baseline matching. **Regmi NK et al. (2014)**, **Kulkarni KR et al. (2014)**, **and Gupta S et al. (2022)** have observed similar demographic comparability between the propofol–ketamine and propofol–butorphanol groups. [22, 26, 25] Group A experienced much more pain after receiving a propofol injection than Group B. In the current trial, only 13.33% of patients in the propofol–butorphanol group reported discomfort during injection, compared to 60% of patients in the propofol–ketamine group ($p=0.0001$). These results are similar to those of **Gupta S et al. (2022)** and **Regmi NK et al. (2014)**, who similarly found that butorphanol improved the attenuation of propofol injection pain. [22, 25] This action could

be explained by butorphanol's hypnotic and analgesic qualities. The two groups' postoperative sedation, nausea, and vomiting were identical, indicating equivalent initial postoperative recovery profiles.

Throughout the course of the trial, both groups' heart rates stayed comparatively constant, however Group B's decreased more after induction and during anesthesia maintenance. At most intervals, nevertheless, the intergroup differences were not statistically significant. The sympathomimetic activity of ketamine, which offsets the circulatory depressive effects of propofol, may be responsible for Group A's relatively greater hemodynamic stability. **Kulkarni KR et al. (2014)** and **Gupta S et al. (2022)** have observed similar findings. [26, 25]

Group B's systolic and diastolic blood pressure decreased more and more steadily than Group A's. At various intraoperative intervals, statistically significant intergroup variations were noted. These results imply that while ketamine aids in maintaining circulatory stability during TIVA, the propofol–butorphanol combination has stronger hypotensive effects. **Regmi NK et al. (2014)**, **Gupta S et al. (2022)**, and **Gaddam GNSR et al. (2024)** found improved hemodynamic stability with propofol–ketamine combos. [22, 26, 27]

Throughout the course of the trial, both groups' respiratory rates and SpO_2 stayed within clinically acceptable ranges. In contrast to Group A, Group B showed a slight decrease in oxygen saturation and a larger decrease in respiratory rate at various intervals. The limited respiratory depressive impact of ketamine may be the reason for Group A's comparatively intact respiratory parameters. **Kulkarni KR et al. (2014)** and **Gupta S et al. (2022)** have obtained similar results. [26, 25]

For complete intravenous anesthesia during brief surgical operations, propofol–ketamine and propofol–butorphanol combinations were generally successful. Propofol-ketamine, on the other hand, improved respiratory and hemodynamic stability, whereas propofol-butorphanol was more successful in lowering discomfort during propofol injection.

CONCLUSION

According to the current study, propofol–ketamine and propofol–butorphanol combinations work well for total intravenous anesthesia during brief surgical operations. While propofol-butorphanol was linked to noticeably decreased pain during propofol administration, propofol-ketamine offered superior hemodynamic and respiratory stability.

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