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**Original Research Article**

# Comparative evaluation of bispectral index and hemodynamic changes during induction of anaesthesia with propofol and thiopentone

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## ABSTRACT

**Background:** Induction requires sufficient anaesthetic depth to prevent patient awareness while maintaining hemodynamic stability. The research study used Bispectral index (BIS) measurements to test the effectiveness of thiopentone and propofol as general anaesthesia induction agents.
**Methods:** A randomised prospective trial with masked members of the study overcame the logistical issues of recruiting 60 ASA I patients of between18-65 years of age for consecutive first time surgical procedures, with all patients recruited on a non first case basis. The 60 patients were placed randomly into two groups for receiving either thiopentone 5 mg/kg (Group T) or propofol 2 mg/kg (Group P) as their induction agents. The study was conducted for 600 seconds with the first data collection point being at the start of the procedure (0) and at 24 seconds after induction, including BIS measurements along with heart rates and mean arterial pressure.
**Results:** BIS values were found to decrease following propofol use by a total of 33.7±7.43 while thiopentone was 44.8±10.61. The total duration of a BIS<60 was greater for propofol than thiopentone (190.13±91.0 seconds versus 70.53±41.3 seconds). At 240 seconds post administration, propofol BIS was 43.9±15.12 and thiopentone was 65±6.8. It was also determined that thiopentone provided better hemodynamic stability since it caused very little decrease in mean arterial pressure or heart rate.
**Conclusions:** Propofol was better than thiopentone in preserving sufficient hypnotic depth during induction and intubation, but thiopentone had better hemodynamic stability.

**Keywords:** Bispectral index, Propofol, Thiopentone, Induction of anaesthesia, Hemodynamic changes, Intubation, General anaesthesia

## INTRODUCTION

Bispectral index (BIS) systems have become an important new development for the application of anesthesia today since they provide an analysis of processed EEG evaluations that enable clinicians to determine the level of hypnosis. The processed EEG-based anesthesia system provides clinicians with the tools to evaluate how much anesthesia will be needed for patients. There is, however, limited documentation on the ability of the processed EEG-based anesthesia system to prevent the awareness of patients. This applies clinically when the patient is induced into the state of general anaesthesia, when consciousness is rapidly changing, and when cardiovascular instability often occurs, especially when intravenous agents are administered prior to the airway instrumentation.[1,2] Propofol is the most commonly used intravenous induction agent because of its rapid onset, smooth induction profile,

and good recovery properties. It is also linked to both dose-dependent hypotension and decreases in mean arterial pressure during the early peri-induction period. Dose-reduction strategies do not eliminate the potential for hemodynamically significant changes, suggesting that patient sensitivity is not always constant and that clinical effects cannot be used solely to define optimal hypnotic dosing. Individualisation of induction has been sought to be achieved by BIS-guided titration, to identify hypertonic hyperactivity, and possibly to restrain cardiovascular depression about overdose.[3] The general body of literature confirms the presence of BIS in the prevention of both under- and over-anaesthesia. A meta-analysis of randomised controlled trials published in 2024 found that BIS monitoring decreased the incidence of intraoperative awareness by approximately half, but this difference was not significant overall; it also showed smaller increases in extubation time, spontaneous eye opening, and sevoflurane consumption. Some perioperative effectiveness outcomes, such as recovery-related endpoints and anaesthetic use, were also found to be improved in the study. Discussion of anaesthesia depth monitoring also states that BIS and other processed EEG monitoring devices are still useful for estimating hypnotic state when used in a clinical setting and during anaesthetic procedures.[4] Notwithstanding these achievements, hemodynamic parameters such as heart rate and blood pressure remain limited, as they serve as surrogates for cerebral hypnotic depth. Processed EEG monitors can be variable with some anaesthetic regimens, but they can provide a more accurate estimate of brain effect than cardiovascular responses alone, which are dependent on nociception, autonomic tone, circulating volume, and vasoactive drugs. Such a difference is especially significant in situations where neuromuscular blockade is applied, as the absence of patient movement may conceal inadequate hypnosis unless objective monitoring of the brain itself is used.[5]

Current clinical research still relies on BIS as a useful endpoint in induction research. To illustrate, a 2024 study in older adults compared ciprofol with propofol during BIS-monitored induction and measured time to BIS 60 and the incidence of hypotension as major outcomes, demonstrating the continued relevance of BIS-based comparisons in gauging the quality and safety of induction.[6]

On a like note, modern propofol induction trials present hypotension and hypnotic adequacy as similar but separate issues, and provide the rationale for monitoring BIS trends and hemodynamic responses jointly, rather than in isolation.[7]

It is against this backdrop that the current study was planned to compare thiopentone and propofol in cases involving induction of anaesthesia, with BIS as the main parameter for measuring hypnotic depth, and, at the same time, to note changes in mean arterial pressure and heart rate.

## METHODS

### *Study design*

A prospective research study was performed in the Department of Anesthesia at Sri Venkateswara Institute of Medical Sciences, to evaluate the effect of propofol and Thiopentone on the BIS during the induction of General Anaesthesia (GA), while monitoring heart rate (HR) and mean arterial pressure (MAP). The design of the study was a two-group double-blind randomised design.

### *Study population*

Sixty patients of both sexes aged between 18 and 65 years, with an ASA physical status of I, and the need to have elective surgeries under general anaesthesia with the necessity to undergo endotracheal intubation were included.

### *Inclusion and exclusion criteria*

The patient with ASA grade I who was aged 18-65 and consented were also included. The study excluded participants who met one or more of these criteria: complicated airway requirements (Mallampati III/IV) or pregnancy or study drug allergies or neurological diseases or drug or alcohol dependence or BMI above 30 kg/m$^2$ or cranial surgery or failure to comply with study requirements.

### *Ethical considerations*

The ethics committee of the institution approved, and written informed consent was obtained from all patients.

### *Randomization and blinding*

The random numbers were generated using a computer-generated random number table and the sealed-envelope method to create two groups from which 30 patients were assigned. Group T received thiopentone sodium at a dose of 5 mg per kilogram through intravenous injection while group P received propofol at a dose of 2 mg per kilogram through intravenous injection. The anesthesiologist responsible for induction had no involvement in data collection while the observer remained unaware of the applied drug type.

### *Preoperative preparation*

There was no premedication to interfere with BIS values. These patients were to be starved for 6 and 12 hours, respectively, of solid and clear liquid. The Allen test was done before cannulating the arteries.

### *Monitoring and instrumentation*

Pulse oximetry monitoring and ECG (Lead II) were implemented in the operating room. An IV cannula of 18G

was inserted, and Ringer's lactate infusion commenced. An invasive blood pressure catheter was a 20-G radial arterial catheter that was inserted in the non-dominant hand. The Philips IntelliVue MP60 monitor was used for BIS monitoring.

### *BIS sensor application*

The forehead was wiped with surgical swab, and the BIS sensor was placed diagonally. The valid readings were signal quality index of greater than 50 and electromyographic activity less than 50 dB. Baseline HR, BIS, $SpO_2$, Systolic and diastolic blood pressure and MAP.

### *Anesthetic protocol*

Patients were preoxygenated using 100 per cent oxygen. Fentanyl 1 µg/kg was then injected IV in 12 seconds, followed after 24 seconds by either thiopentone sodium 5 mg/kg in group T or propofol 2 mg/kg in group P. To facilitate intubation, Vecuronium 0.15 mg/kg was administered. Inhalational agent-free mask ventilation with 100% oxygen was continued. It was intubated after 3 minutes and 48 seconds and confirmed by checking the chest.

### *Data collection*

HR, systolic blood pressure, diastolic blood pressure, MAP, $SpO_2$, and BIS were measured at baseline and every 24 seconds up to 600 seconds (10 minutes). BIS 60 time, BIS returning 60 time, and BIS duration below 60 time were recorded. Sevoflurane 2% was initiated when BIS went back to 60.

### *Statistical analysis*

The results were presented as the mean and standard deviation.

Student's t test was used for continuous variables, the chi-square test for categorical variables, and ANOVA with paired t tests for intragroup comparisons. A statistically significant $p<0.05$.

## RESULTS

A sample of 60 patients was used in the study, 30 patients in the thiopentone (Group T) and 30 in the propofol (Group P). All patients were aged 18-65 years and ASA I. The groups had similar baseline demographic statistics. Group T mean age was 35.232±11.46 years, and group P mean age was 40.0328.25 years (p=0.096 and p=0.290). Group T mean body weight was 55.37210.29 kg, and group P mean body weight was 52.828.25 kg (p=0.290). There was also a similar sex distribution (14/16 vs 13/17 males/females; p=1.000). There is no significant difference in age distribution among predetermined age groups (p=0.280).

There were no differences in baseline BIS values between groups (94.57±2.8 vs 93.9±2.9; p=0.18). At the initial stages of observation (24,72 s), BIS values were similar. Significant differences emerged after 96 seconds. Propofol induced greater and more prolonged BIS suppression than thiopentone. Compared to group T (intubation 65±6.8), BIS was significantly lower in group P (43.9±15.1; p=0.001) and was more efficiently hypnotised on propofol.

The further analysis revealed that the lowest BIS was observed with propofol (33.7±7.43) compared with thiopentone (44.8±10.61; p=0.0001). Though BIS decreased to 60 somewhat sooner in the presence of thiopentone, propofol sustained BIS at 60 or less significantly longer (190.13±91.0 s vs 70.53±41.3 s; p=0.0001). BIS did not drop to 60 in any of the 3 patients (10% in the thiopentone group).

The baseline heart rate was the same (86=18.6 vs 78.6=20.1 bpm; p=0.07). Group T had higher heart rates than group P at several time points following induction. As an example, the HR in group T and P at 120 seconds was 92.3 vs 74.4, with a difference of 15.4 (p=0.001). These results show that propofol leads to a greater decrease in heart rate.

Baseline MAP did not differ (95.73+10.9 vs 95.1+9.1 mmHg; p=0.40). After induction, MAP decreased significantly in the propofol group. MAP of group T was 87.56 14.8 mmHg at 168 seconds, and group P was 67.23 11.2 mmHg at 168 seconds (p=0.0001). These results show more hypotension using propofol.

Correlation analysis revealed very little correlation between BIS and heart rate in group T (R=-0.05) and a weak positive correlation in group P (R=0.30). The BIS was also moderately related to MAP in both groups (R=0.54 in group T and R=0.57 in group P). These results indicate that hemodynamic variables are not good predictors of the depth of hypnosis.

**Table 1: Baseline demographic characteristics of patients in the thiopentone and propofol groups.**

| Variables | Group T, (n=30) | Group P, (n=30) | P value |
|---|---|---|---|
| **Age (in years)** | 35.23±11.46 | 40.03±10.48 | 0.096 |
| **Weight (kg)** | 55.37±10.29 | 52.8±8.25 | 0.290 |
| **Gender** | | | |
| Male | 14 | 13 | 1.000 |
| Female | 16 | 17 | |

**Table 2: Age-wise distribution of patients in both study groups.**

| Age group (in years) | Group T | Group P | Total |
|---|---|---|---|
| **18-30** | 10 | 5 | 15 |
| **31-40** | 11 | 9 | 20 |
| **41-50** | 6 | 11 | 17 |
| **51-65** | 3 | 5 | 8 |
| **Total** | 30 | 30 | 60 |

*P=0.280.

**Table 3: Comparison of mean BIS values at selected time points during the 600-second observation period.**

| Time point | Group T BIS | Group P BIS | P value |
|---|---|---|---|
| **Baseline** | 94.57±2.8 | 93.9±2.9 | 0.18 |
| **96 sec** | 77.63±18.0 | 85.1±9.8 | 0.025 |
| **120 sec** | 50.03±14.8 | 45.6±11.6 | 0.09 |
| **144 sec** | 50.0±13.0 | 40.5±8.2 | 0.001 |
| **168 sec** | 57.33±10.0 | 42.2±12.4 | 0.001 |
| **192 sec** | 60.63±9.0 | 42.9±13.1 | 0.001 |
| **216 sec** | 63.6±5.6 | 43.3±14.5 | 0.001 |
| **240 sec** | 65.0±6.8 | 43.9±15.1 | 0.001 |
| **360 sec** | 63.13±5.4 | 58.6±5.8 | 0.0015 |
| **432 sec** | 54.5±8.0 | 59.2±4.8 | 0.005 |
| **600 sec** | 44.9±9.0 | 54.2±6.4 | 0.001 |

**Table 4: Comparison of BIS after induction and during intubation in both groups.**

| Outcome measure | Group T | Group P | P value |
|---|---|---|---|
| **Lowest BIS value reached after induction** | 44.8±10.61 | 33.7±7.43 | 0.0001 |
| **Time when BIS fell to 60 (sec)** | 96.3±35.10 | 109.13±16.84 | 0.03 |
| **Time when BIS rose to 60 (sec)** | 166.8±65.25 | 299.93±95.84 | 0.0001 |
| **Duration of BIS below 60 (sec)** | 70.53±41.3 | 190.13±91.0 | 0.0001 |
| **BIS value during intubation at 240 sec** | 65.0±6.8 | 43.9±15.12 | 0.0001 |

**Table 5: Comparison of mean heart rate at selected time points during the 600-second observation period.**

| Time point | Group T HR (beats/min) | Group P HR (beats/min) | P value |
|---|---|---|---|
| **Baseline** | 86.0±18.6 | 78.6±20.1 | 0.07 |
| **72 sec** | 93.9±18.0 | 81.2±21.0 | 0.007 |
| **96 sec** | 95.7±13.6 | 85.0±13.7 | 0.01 |
| **120 sec** | 92.3±15.0 | 74.4±16.4 | 0.001 |
| **168 sec** | 87.4±14.0 | 72.2±16.7 | 0.001 |
| **240 sec** | 87.6±15.0 | 74.4±18.8 | 0.002 |
| **360 sec** | 98.7±14.0 | 84.6±18.7 | 0.001 |
| **600 sec** | 86.6±19.0 | 75.1±17.7 | 0.009 |

**Table 6: Comparison of mean arterial pressure at selected time points during the 600-second observation period.**

| Time point | Group T MAP (mmHg) | Group P MAP (mmHg) | P value |
|---|---|---|---|
| **Baseline** | 95.73±10.9 | 95.1±9.1 | 0.40 |
| **72 sec** | 94.6±14.4 | 86.4±9.9 | 0.006 |
| **96 sec** | 87.83±14.2 | 73.87±10.3 | 0.0001 |
| **168 sec** | 87.56±14.8 | 67.23±11.2 | 0.0001 |
| **240 sec** | 84.93±17.2 | 68.73±18.2 | 0.0004 |
| **360 sec** | 100.9±20.7 | 84.2±22.1 | 0.0019 |
| **600 sec** | 74.97±9.7 | 69.33±9.9 | 0.015 |

**Table 7: Correlation between BIS and hemodynamic parameters in the thiopentone and propofol groups.**

| Correlation tested | Group T (R value) | Group P (R value) |
|---|---|---|
| **BIS vs heart rate** | -0.05 | 0.30 |
| **BIS vs mean arterial pressure** | 0.54 | 0.57 |

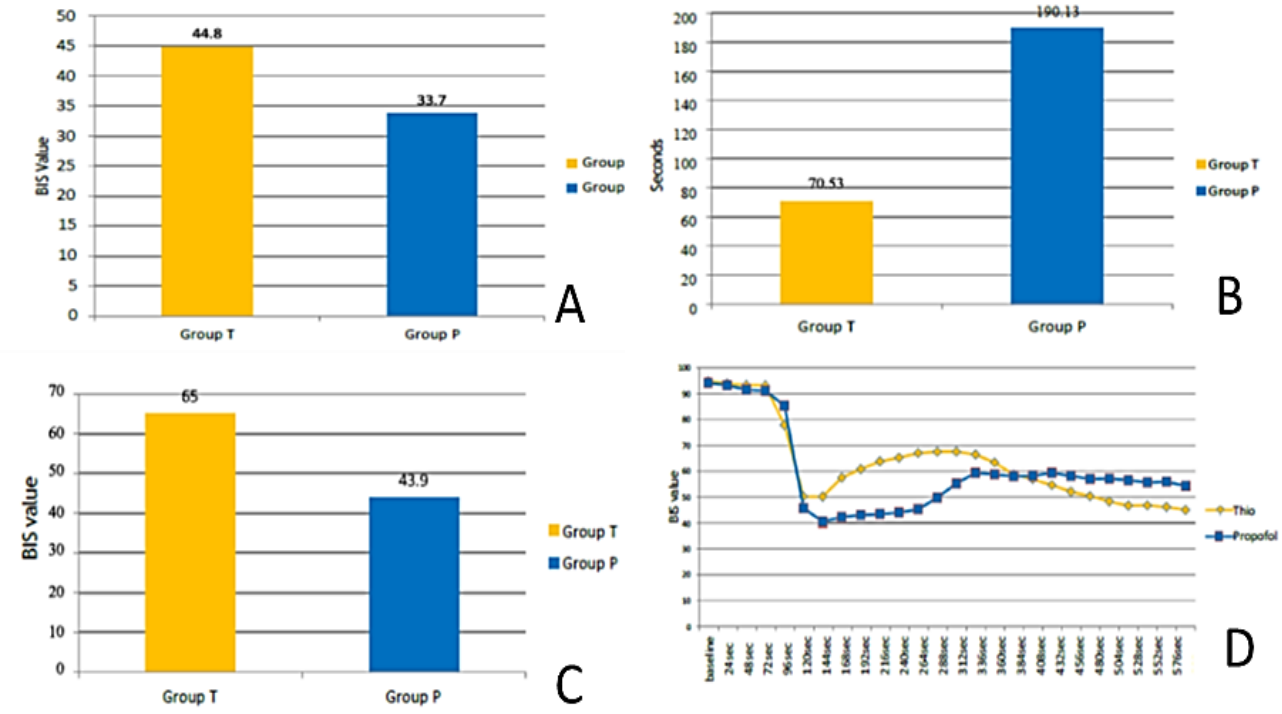


**Figure 1 (A-C): (A) Comparison of the lowest BIS value between group T and P, (B) Duration (seconds) of BIS value below 60, (C) BIS value during incubation (at 240th sec), (D) Comparison of mean BIS values between Group T and P.**

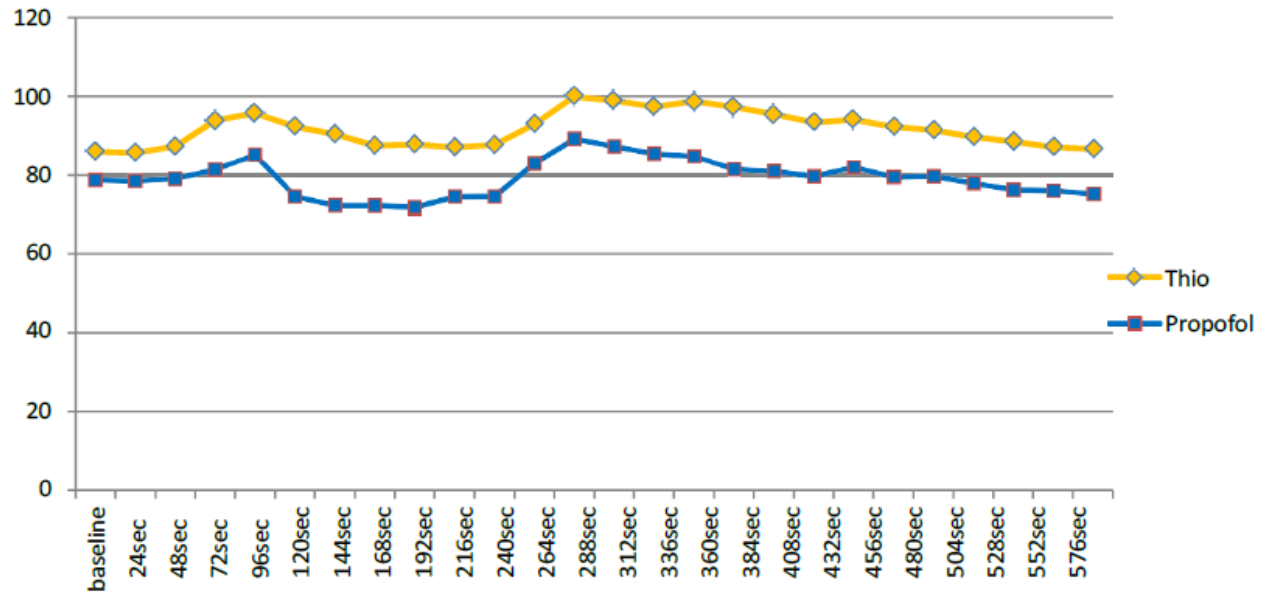


**Figure 2: Serial changes in mean heart rate in group T and P over the 600-second study period.**

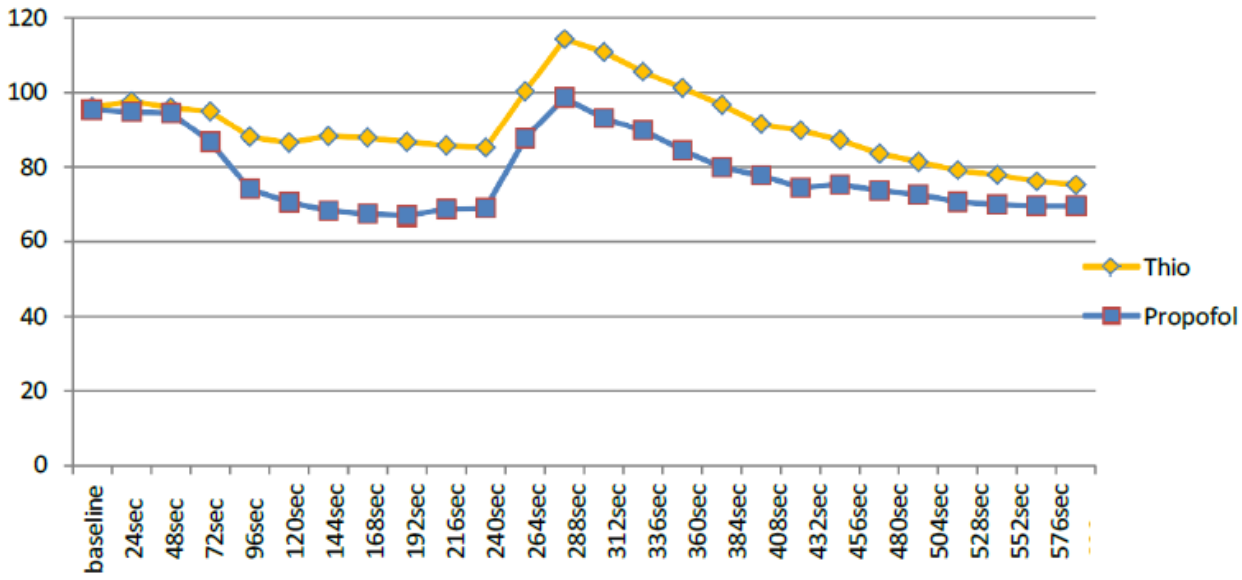


**Figure 3: Serial changes in mean arterial pressure in group T and P during the 600-second study period.**

## DISCUSSION

The current research shows that propofol induced more profound and sustained hypnosis as compared to thiopentone, which is indicated by a lower nadir BIS, longer BIS below 60 and lower intubation BIS. Conversely, thiopentone was more hemodynamically stable. This observation is consistent with the recent data that suggests that propofol induces a quick loss of consciousness and is usually linked with large decreases in blood pressure immediately after induction. Comparative studies of propofol administration technologies also document that bolus induction results in lower mean arterial pressure and greater variation in the depth of hypnotic state compared with controlled delivery schemes, suggesting that hypnotic adequacy and cardiovascular stability may not coexist.[8,9] The overall conclusion of this research is that propofol is better at maintaining BIS values within an acceptable range to achieve sufficient hypnosis during airway instrumentation. This is clinically significant, as recent reviews have stressed that processed EEG monitoring can provide information on anaesthetic depth that cannot be reliably assessed using conventional clinical signs under rapidly changing anaesthetic conditions. New studies on EEG-based depth monitoring also indicate the limitations of using physiological parameters such as blood pressure, movement, or heart rate alone, especially in patients with paralysis. The latest machine-learning solutions also imply that the future of anaesthesia monitoring will still be based on metrics obtained from EEG monitoring, as it captures the activity of the central nervous system more accurately than peripheral responses.[10,11] Meanwhile, hemodynamic outcomes support a compromise between hypnotic depth and cardiovascular stability. Various articles indicate that post-induction hypotension is one of the most serious concerns about the use of propofol, regardless of dose modifications or supplementary medications. Comparison of various agents, such as remimazolam, has revealed that non-propofol agents have lower rates of hypotension, and this observation is supported by the fact that propofol can impair hemodynamic stability compared with other intravenous agents. Recent data also find hypotension in the early post-induction period as a major clinical problem, as evidenced by the clear recovery of MAP in the propofol group in this study.[12,13] Correlation analysis in the current study depicted a weak association between BIS and mean arterial pressure and an insignificant association between BIS and heart rate. This corroborates existing research showing that hemodynamic indicators are also dependent on non-hypnotic variables and cannot serve as accurate measures of anaesthetic depth. Some of the benefits reported in meta-analyses of EEG-guided anaesthesia include reduced anaesthetic exposure, reduced vasopressor requirements, and improved neurocognitive outcomes in selected groups. Suggestions of contemporary pooled evidence in the elderly suggest that EEG-guided anaesthesia can help prevent postoperative delirium and cognitive dysfunction by preventing excessive anaesthetic depth. Other comparable analyses have achieved better cognitive outcomes by applying BIS-guided strategies to avoid unnecessary deep anaesthesia.[14] Overall, the results indicate that propofol is better than thiopentone for achieving sufficient hypnotic depth during delayed intubation, and the latter may be preferable when greater cardiovascular stability is needed.

## CONCLUSION

The current research shows that, relative to thiopentone, propofol is more effective in inducing general anaesthesia, with lower BIS values after induction, a longer duration with BIS values less than 60, and a much lower BIS value during intubation. The evidence shows that propofol

performs better in ensuring a satisfactory hypnotic state during the delayed intubation in case vecuronium is administered. Conversely, thiopentone exhibited a relatively superior maintenance of heart rate and mean arterial pressure, indicating a higher degree of hemodynamic stability during the induction period. The relationship between BIS and hemodynamic parameters was weak to moderate, suggesting that heart rate and blood pressure cannot be used reliably to assess anaesthetic depth. Hence, BIS monitoring is much more direct and clinically beneficial in evaluating hypnosis during induction. All in all, propofol might be a better choice when the main issue is a sufficient hypnotic effect, but thiopentone might be preferred when cardiovascular stability is the priority.

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