EFFECT OF PROPOFOL CONCENTRATION ON MEAN ARTERIAL PRESSURE AND SUCCESS OF LARYNGEAL MASK AIRWAY INSERTION: A QUASI EXPERIMENTAL STUDY

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ABSTRACT

Background and Objective: Propofol effectively suppresses airway reflexes for supraglottic device insertion but can impact hemodynamic stability, particularly mean arterial pressure. In controlled infusions, Propofol provides good clinical outcomes with advantages of low dose requirement, short recovery time, and decreased incidence of adverse effects. This study aimed at comparing the frequency of successful attempts of Laryngeal Mask Airway (LMA) insertion and the effect on Mean Arterial Pressure (MAP) of two different target concentrations of propofol in blood given by TCI pump.

Methods: A total of 80 patients of both genders undergoing minor surgery were included in this quasi-experimental study, which was carried out in the operating rooms of the general surgery, at the department of anesthesia, Mayo Hospital, Lahore from June 2021 to January 2022. Patients in Group A received propofol to achieve a blood concentration of 6 µg/ml, while those in Group B received propofol to reach a blood concentration of 8 µg/ml. The number of successful attempts and mean arterial pressures were noted in the two defined groups.

Results: Mean arterial pressure was higher in Group A (96.98 ± 2.03 mmHg) compared to Group B (92.54 ± 1.79 mmHg) five minutes after achievement of target blood concentration of propofols, with a p-value of <0.0001, and with no significant difference in the number of successful attempts of LMA insertion between two groups.

Conclusion: A lower concentration of propofol administered via TCI is associated with a significantly lower drop in MAP compared to a higher concentration, without compromising the frequency of successful LMA insertion.

Key Words: Laryngeal mask airway, Mean arterial pressure, propofol, success of insertion, Target controlled infusion.

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Laryngeal Mask Airway (LMA) is a supraglottic device used to secure the airway of patients under general anaesthesia. It seals the laryngeal entrance, allowing for both spontaneous and controlled ventilation.[1] LMA is preferred over the endotracheal tube as it requires a lesser depth of anesthesia for insertion, may be inserted without the use of muscle relaxant, and causes less airway stimulation and fewer hemodynamic changes, provided its use is not contraindicated in any particular scenario.[2-4] Various agents are used to attain adequate depth of anesthesia

for the successful insertion of LMA. These agents include propofol, midazolam, opioids, and inhalational agents, e.g. sevoflurane. The most commonly used drug for LMA insertion is propofol.[5] However, its bolus administration is associated with either insufficient depth of anesthesia leading to laryngeal spasms or excess administration associated with cardiovascular depression.[6] Recent advances have permitted the use of target-controlled infusion pumps to obtain the correct depth of anesthesia for LMA placement, decreasing the hazards associated with over- or under-dosing. TCI pumps are used nowadays to set a target plasma or effective site concentration of a drug to achieve specific clinical results.[7] According to recent advances, propofol provides good clinical outcomes during controlled infusions in terms of dose requirement, recovery time, and incidences of adverse effects. The recommended induction dose of propofol for LMA insertion is 2-2.5mg/kg with blood concentration of 8-10 μ g/ml but it may cause side effects including hemodynamic instability.[8] Target control infusion is designed to achieve and maintain blood concentration steadily, avoiding the untoward effects of bolus doses.[9]

Propofol effect-site concentrations for maintaining adequate anesthesia show substantial variability, with 95% falling between 1.5 and 3.5 µg/mL.[10] The target blood concentration (TBC) of propofol for successful laryngeal mask airway (LMA) insertion further varies depending on patient factors and adjuvant medications. Kodaka's study suggests a target blood concentration (TBC) of 4.07 µg/mL is needed for successfully placing the LMA.[11] While Higuchi et al found that the plasma concentration of propofol necessary for successful LMA installation in 50% of patients was 8.7 µg/mL (EC50);[12] each result reflects different target concentrations and success thresholds. Despite these discrepancies, we were unable to find any recent data consolidating the optimal target blood concentration of propofol for successful LMA insertion. These discrepancies indicate that patient response to propofol may be influenced by factors such as individual physiology or population-specific characteristics. Consequently, further investigation is essential, especially in diverse populations, to establish an effective and hemodynamically safe concentration tailored to specific patient needs. Also, potential differences in patient demographics, baseline cardiovascular health, and healthcare practices in the local population can further contribute to different results as compared to the results of the studies described earlier. Region-specific data can optimize propofol dosing and enhance anesthetic safety and efficacy for the local population. We designed this study to assess the frequency of successful attempts of LMA insertion and the changes in mean arterial pressure (MAP) between two target blood concentrations of propofol given by the TCI pump.

METHODS

This study was carried out in the operation theatres of general surgery, by department of anesthesia, Mayo Hospital Lahore, from June 2021 to January 2022, after getting approval from the ethical committee of King Edward Medical University/Mayo Hospital (1993/RC/KEMU). A sample of 80 patients was taken (40 in each group), estimated by using a 95% confidence level and 80% power of the test, with a predicted MAP of 100±8.75mmHg with 6µg/ml and 93.5±1.75mmHg with 8 µg/ml.[12] Sampling was done by a non-probability consecutive sampling technique. The study included both male and female patients aged 18 to 60 who were classified as class I or II by the American Society of Anaesthesiologists (ASA). Patients with Difficult airway (Mallampati class III and IV), Cervical spine injury, morbidly obese patients (BMI >3O), pregnant females, patients with Sleep apnea syndrome, having reactive airway diseases, respiratory tract infection, or those with chances of regurgitation and aspiration were excluded from the study.

After receiving an endorsement from the hospital ethical committee and obtaining informed consent, patients fulfilling the selection criteria were allocated to two groups by lottery method.

Name, gender, age, and weight of the patient were

noted. Upon patients' arrival in operation theatre (OT), an 18G venous cannula was inserted, and standard monitoring consistence of pulse oximetry, ECG, and non-invasive blood pressure was performed. Patients were premedicated with an intravenous dose of 0.1mg/kg nalbuphine and 0.1mg/kg dexamethasone. Pre-oxygenation was carried out for three minutes. The induction of anaesthesia began with the infusion of propofol by Marsh's plasma kinetic Model, which was designed to attain and sustain a targeted blood concentration for each patient group using Deprifusor. The time required to induce anesthesia was measured from when the target blood cell concentration was achieved until verbal contact was lost. Patients in group A received propofol with a TBC of 6ug/ml while those in group B got the target blood concentration of 8ug/ml. After achieving the target blood concentration of propofol, the attempt was made to place an appropriately sized LMA according to the weight of the patient. If the LMA was inserted within 3 minutes and was confirmed by the presence of bilateral equal air entry on auscultation, the attempt was labeled as successful.

If LMA had not been inserted at three minutes, no further attempt was made, and it was considered a failed attempt. When LMA insertion was not attained due to coughing or gagging, more efforts to place the LMA were made when plasma concentration went up from 6ug/ml to 8ug/ml; the patient was oxygenated via facemask throughout the interval, and the total number of attempts was noted. If the LMA could not be inserted even at 3 minutes, a change in anesthesia plan was made, and a bolus dose of propofol was given, and ETT was used to secure the airway, and the patient was excluded from the study.

MAP was measured at induction time taken as T0 (baseline) and T5 (5 minutes after the successful insertion of LMA). Final recordings of MAP were compared between two groups after the LMA was inserted successfully. The number of attempts for each group was also noted.

Data were entered in SPSS 26. Quantitative variables such as age and MAP were presented as mean ± SD (standard deviation). Qualitative variables, i.e. gender and number of successful attempts, were presented as frequencies and percentages. The t-test was used to compare the two groups, MAP, and the chi-square test was applied for the number of successful attempts. Data were stratified for gender, age, ASA classification status, and BMI. Post-stratification t-test and chi-square test were applied with a p-value of ≤ 0.05 taken as significant.

RESULTS

The patients in two groups were stratified in terms of age, gender, BMI, ASA status, and baseline MAP as shown in Table 1.

Table 1: *Demographics, ASA status and Mean Arterial Pressure (n=80)*

DEMOGRAPHICS	Group A		Group B		p-value
	n=40		n=40		
Age in years (Mean ± SD)	35.82± 9.31		37.45 ± 10.25		0.46
Gender	M	F	M	F	0.99
	32	8	31	9	
BMI	25.61 ± 5.79		27.82 ± 6.91		0.12
ASA status	I	II	I	II	0.59
	32	8	29	11	
Baseline MAP (mmHg) (Mean ± SD)	98.429±1.80		97.825±1.3		0.65
MAP $_{5\ min}$ (mmHg) (Mean ± SD)	96.98 ± 2.03 mmHg		92.54 ± 1.79 mmHg		0.0001

The number of attempts for the successful placement of LMA was not significantly different between the two groups (Table 2). However, the mean arterial pressure (MAP) was significantly higher in Group A compared to Group B, 5 minutes after the

Table 2: *The comparison of Successful attempts between two groups*

Successful Attempt		Group A	Group B	p-value
		n=40	n=40	
1	Yes	31 (77.5%)	37 (92.5%)	0.06
2	No	9 (22.5%)	3 (7.5%)	

achievement of the target blood concentration of propofol, as shown in figure-1. Except for the mild involuntary movements that occurred in four patients, no further adverse events were seen. There were no reports of soreness from the injection. These findings imply that establishing a target concentration of 8µg/ml would allow for successful LMA insertion in 92% of patients. MAP of both groups at base line and at 5 minutes are shown in figure 1.

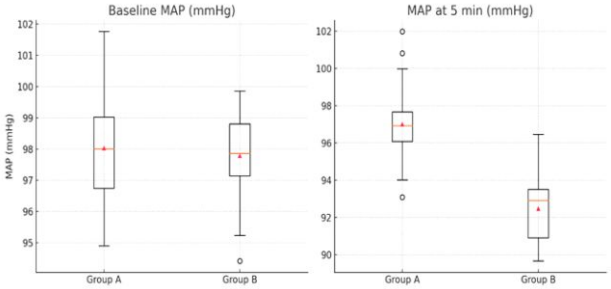

Figure-1: *The comparison of MAP between group A and B.*

Discussion

It is the aim of every physician to give any drug to the patient in the concentration which produces the desired effects while at the same time avoiding any unwanted effects. Target-controlled infusion devices are made to achieve this aim.[13,14]

Cardiovascular and respiratory issues associated with anesthesia induction seen with the bolus doses of propofol may result from the higher peak blood concentrations attained.[15] The concentration of propofol at the point of loss of consciousness is approximately 3.36 µg/mL; this is due to the lag time in attaining the equilibrium between the injection and the target site.[16] The patients in whom the blood concentration of propofol of 6 µg/mL was achieved to induce satisfactory levels of anesthesia for LMA insertion would likely be overdosed if 2.5 mg/kg of propofol was given as a bolus dose at induction. This may lead to more intense cardiac and respiratory depression.[17]

Sahu et al. found that the ease on insertion of LMA was comparable in groups getting propofol by TCI or by manual infusion.[18] Hur et al investigated LMA insertion at two different effect-site concentrations (3.0 µg/mL and 3.5 µg/mL in Group 1 in Group 2, respectively) using TCI propofol, finding no significant differences between the groups in either LMA insertion conditions or hemodynamic responses ($p>0.05$).[19] While the referenced study reported no significant hemodynamic changes between the groups. Our study found a significant drop in MAP in Group B (higher concentration) compared to Group A (lower concentration). This highlights that while both studies agree on comparable success rates for LMA insertion across groups, the hemodynamic impact of higher propofol concentrations may vary by increasing dose as doses in our study were higher, emphasizing the need for careful monitoring and individualized dosing.

The results of the study done by Hijazi et al. indicate that no significant differences were seen in the success rates of laryngeal mask airway (LMA) insertion between children receiving propofol at doses of 2.5 mg/kg and 3.5 mg/kg. The results bear similarity to our study, where two different target blood concentrations showed equal success rate for LMA insertion. However, the referenced study used bolus administration of propofol in contrast to our study, where we used a target-controlled infusion system for propofol administration.[20]

Although recent literature shows that the addition of adjuvants to propofol significantly reduces the target blood concentration of propofol for the successful placement of LMA,[21] we were unable to find any recent data consolidating the optimal target blood concentration of propofol when used alone for successful LMA insertion.

The differences in the results of the studies discussed above and the results of our study can be attributed to differences in methodology or patient demographics. These findings emphasize the necessity of further research to establish region-specific protocols, ensuring a balance between efficacy and safety, particularly in populations with differing baseline health characteristics. The aim should be the development of Optimal TCI dosing strategies with minimum hemodynamic compromise while maintaining high success rates for LMA insertion, thus enhancing patient safety and procedural efficiency in anesthesia practice.

This study was conducted at a single center with a relatively small sample size, which may limit

the generalizability of the findings. Additionally, other hemodynamic parameters such as heart rate and cardiac output were not evaluated, which could provide a more comprehensive understanding of cardiovascular stability. Further multicenter studies with larger and more diverse patient populations are needed to validate these findings.

CONCLUSION

While higher propofol concentrations administered via TCI improve the success rate of LMA insertion, the difference was not statistically significant between groups. However, a significantly greater drop in MAP was observed in the higher concentration group, indicating a hemodynamic compromise. These findings highlight the importance of balancing anesthetic effectiveness with cardiovascular stability and underscore the need for careful titration of propofol concentration to individual patient needs for safe and effective airway management during induction of general anesthesia.

Ethical Approval:

The ethical approval was obtained vide letter no. 1993/RC/KEMU.

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Author's Contribution

Conceptualization study design	MA, LRB
Data Acquisition	MA, MZ, MA
Data Analysis/ interpretation	MA, MA, MOA, SK
Manuscript drafting	MA, LRB, MZ, MA, MOA, SK
Manuscript review	MA, LRB, MZ, MA, MOA, SK

All authors read and approved the final draft.

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