What happens to the hemodynamic responses for laryngeal mask airway insertion when we supplement propofol with butorphanol or fentanyl for induction of anesthesia: A comparative assessment and critical review

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ABSTRACT

Background: There is a delicate balance between respiratory tract anatomy, its physiology, physiological response to anesthetic agents, and airway management. The traditional gadgets to secure airway are face masks or endotracheal tubes. Recently, laryngeal mask airway (LMA) is gaining popularity. It does not require laryngoscopy thereby minimizing hemodynamic responses. For LMA placement, propofol is the induction agent of choice. Propofol, when used alone, requires large doses and leads to undesirable cardiorespiratory depression. To culminate its dose, various adjuncts are combined with it.

Aim: Comparison of hemodynamic response of LMA using either butorphanol or fentanyl (according to group allocated) in combination with propofol.

Methodology: Hundred patients scheduled for various surgical procedures were randomly selected and divided into two groups of 50 patients each, Group F (propofol and fentanyl) and Group B (propofol and butorphanol). One minute after giving intravenous (IV) opioids, induction was achieved with IV propofol 2.5 mg/kg. Depth of anesthesia was assessed, and LMA was inserted. Hemodynamic variables were measured before premedication, after premedication; 1, 3, and 5 min after insertion and after extubation of LMA.

Results: After insertion of LMA, statistically significant drop in mean heart rate, systolic blood pressure (BP), diastolic BP, and mean BP was noted in Group F as compared to Group B ($P<0.05$).

Conclusion: The use of propofol-butorphanol combination produces stable hemodynamics as compared to propofol-fentanyl combination.

Key Words: Butorphanol, fentanyl, hemodynamics, insertion conditions, laryngeal mask airway, propofol

INTRODUCTION

Successful airway management is the vital component of safe anesthesia. Failure to achieve this can lead to ventilation failure, hypoxia, neurological insufficiency, or death of the patient\(^1\). Endotracheal intubation is the gold standard for securing airway, but it requires clinical expertise\(^2\) and can lead to life-threatening stress response such as tachycardia, hypertension, and...
myocardial ischemia.\textsuperscript{3} Laryngeal mask airway (LMA), which is a supraglottic device can replace laryngoscopy and intubation thereby preventing these stress responses during airway management.\textsuperscript{4} Securing airway with supraglottic device minimizes the risks due to a lesser degree of invasion. LMA is a device with modified mask whose cuff when inflated forms a seal around the laryngeal inlet.\textsuperscript{5,6} It is less stimulating,\textsuperscript{7} and its insertion requires a lighter depth of anesthesia than endotracheal intubation.\textsuperscript{8}

Thiopentone and propofol are the standard induction agents for LMA placement. Propofol is better accepted as it provides sufficient depression of laryngeal reflexes leading to minimal coughing, gagging, and laryngospasm as compared to thiopentone.\textsuperscript{9} Propofol when used as a sole drug for LMA placement requires a large dose to achieve optimal insertion conditions. Larger induction doses lead to greater degree of cardiorespiratory depression manifesting as prolonged apnea and hypotension.

To reduce the dose of propofol and to prevent hypotension, various methods have been used such as preloading, prophylactic ephedrine, prophylactic metaraminol,\textsuperscript{10} and coinduction drugs such as opioids, lidocaine spray, midazolam, and low-dose atracurium have been introduced.\textsuperscript{11} In this study, we have used opioids as co-induction agent with propofol. The combination of propofol and butorphanol was compared with the combination of propofol and fentanyl for hemodynamic responses to LMA insertion.

**METHODOLOGY**

After the approval from the institutional ethical committee, we conducted a prospective, randomized study in the department of anesthesiology at AVBRH, JNMC, and DMIMSU Sawangi (Meghe), Wardha during the period of 2007–2009 comprising total 100 patients of ASA I and ASA II with Mallampati-II and III between the age of 18–60 years who were randomly selected and divided into two groups of 50 each, i.e., Group F (propofol and fentanyl) and Group B (propofol and butorphanol). Age <18 years and more 60 years, ASA III and IV, Mallampati-III and IV, pregnancy >14 weeks, morbid obesity, hiatal hernia/gastroesophageal reflux disease, delayed gastric emptying, patients who were not willing or having a history of allergy to opioids were excluded from the study.

Each patient was kept nil by mouth overnight before surgery. All patients were preoxygenated with 100\% O\textsubscript{2} for 3 min before induction. For coinduction, Group B patients were given 30 µg/kg intravenous (IV) butorphanol, and Group F patients were given 1.5 µg/kg IV fentanyl. Induction was achieved with IV propofol 2.5 mg/kg over 60 s, and the depth of anesthesia of the patient was assessed by the loss of eyelash reflex. Disposable unique LMA of size 3 or 4 was inserted with standard technique according to the weight of the patients (30–50 kg or 50–70 kg, respectively) and cuff was inflated over 3–5 s with required amount of air, i.e., 20–30 ml without holding the LMA. The LMA was then connected to Bains circuit. If LMA placement was not successful in the first attempt within 15–20 s then second attempt was made. If it would fail then the patient was intubated. After proper placement and sufficient air inflation, the LMA was then connected to Bains circuit. Successful LMA placement was checked for using following criteria: Bilateral equal breath sounds on auscultation, normal chest movements, normal excursion of reservoir bag, positive end-tidal carbon dioxide (ETCO\textsubscript{2}), the absence of audible leak, and longitudinal black line of the tube in mid line facing upper lip.

Anesthesia was maintained with oxygen and nitrous oxide (50:50) and isoflurane 0.5–1\%. Gentle positive pressure ventilation was given until patient regained spontaneous ventilation.

Monitoring for pulse rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP), percentage saturation of oxygen (SPO\textsubscript{2}), and ETCO\textsubscript{2} concentration were done before premedication, 1 min after premedication, and 1, 3, and 5 min after induction. Incidence of hypotension, hypertension, or dysrhythmias was noted. Coughing/gagging, head and limb movements, and laryngospasm were noted and treated accordingly.

All results were compared, compiled, and statistically analyzed by computer software package “SPSS version 14.0 (IBM, Chicago, USA) for window to reach the conclusion. Observation table were made, and conclusions were drawn.

**RESULTS**

Patients in both the study groups were comparable with respect to age and weight (P value = 0.42 and 0.07, respectively) with nonsignificant difference for gender distribution (P value = 0.11) [Table 1].

In our study, all baseline hemodynamic variables including heart rate (HR), SBP, DBP, and MBP were comparable before premedication [Table 2]. After premedication, a transient rise in the mean HR (92.38 ± 16.00) (Z = 1.32; P = 0.188) and a significant rise in the mean SBP (125.86 ± 13.96) (Z = 2.77; P = 0.007) was observed in Group B. The MBP (92.75 ± 1.07) was significantly higher (Z-value = 2.15; P = 0.033) after premedication in Group B when compared to...
Group F [Table 3]. One minute after insertion of LMA, though the mean HR decreased in both the groups, it was statistically significant (Z-value = 2.05; P = 0.043) in Group F as compared to Group B. Similarly, the SBP, DBP, and MBP in both the groups were decreased in comparison to their baseline values, and this drop was statistically significant in Group F as compared to Group B [Table 4]. After 3 min of LMA insertion, hemodynamic parameters (HR, SBP, DBP, and MBP) showed a significant decrease in Group F [Table 5]. The HR reached to the lowest value at 5 min in both the groups. The values of mean SBP, DBP, and MBP were also lowest at 5 min of insertion of LMA with statistically significant decrease in Group F than in Group B [Table 6]. However, all the variations in vital parameters were within the acceptable physiological range without any abnormal electrocardiogram (ECG) findings or need of pharmacological intervention.

After extubation, all the vital parameters started returning to premedication values, however, the increase in the mean SBP and MBP after extubation was statistically significant in Group B (Z = 2.99; P = 0.003 and Z = 2.91; P = 0.004, respectively) as compared to Group F [Table 7].

SPO2 was maintained >96% in all the patients throughout the procedure.

DISCUSSION

LMA insertion has been revolutionized with the development of induction agents such as propofol which depresses pharyngeal and laryngeal reflexes. To overcome propofol’s adverse cardiovascular depressive effects, a number of co-induction drugs such as low dose atracurium, midazolam, remifentanil, or alfentanil were introduced which significantly improves the ease and success of insertion of LMA compared with propofol alone.[12-15] Opioids depress upper airway reflexes and thereby potentiate the effect of propofol. They also permit rapid titration to the effect and produce residual if not complete postoperative analgesia with minimal side effects. Butorphanol is a synthetic, nonnarcotic analgesic having intrinsic agonist activity at the μ-opioid receptor and antagonist activity at the κ-receptor. The side effects of butorphanol are sedation and produces limited respiratory depression.[16,17]

Because of safer respiratory profile, hemodynamic stability, analgesia, sedation, and in view of lesser side effects; in this study, we used butorphanol in combination

### Table 1: Distribution of patients according to demographic characteristics

| Variables       | Group F (n = 50) | Group B (n = 50) | Z-value | P value |
|-----------------|-----------------|-----------------|---------|---------|
| Age in years    | 33.48 ± 11.15   | 31.84 ± 11.49   | 0.72    | 0.42 NS, P > 0.05 |
| Weight in kg    | 47.66 ± 7.51    | 50.42 ± 7.65    | 1.81    | 0.07 NS, P > 0.05 |
| Gender (M/F)    | 6/44            | 12/38           | k2 value = 2.43 | 0.11 NS, P > 0.05 |

M/F: Male/Female, NS: Not significant

### Table 2: Haemodynamic changes before premedication

| Variables       | Group F          | Group B          | Z-value | P value |
|-----------------|------------------|------------------|---------|---------|
| HR              | 92.48 ± 17.01    | 86.50 ± 14.36    | 1.89    | 0.061 NS, P > 0.05 |
| SBP             | 121.50 ± 11.27   | 120.48 ± 13.13   | 0.41    | 0.678 NS, P > 0.05 |
| DBP             | 75.76 ± 8.45     | 75.62 ± 10.49    | 0.07    | 0.942 NS, P > 0.05 |
| MBP             | 89.88 ± 8.91     | 90.57 ± 10.55    | 0.35    | 0.726 NS, P > 0.05 |

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, NS: Not significant

### Table 3: Haemodynamic changes one min after Pre-medication

| Variables       | Group F          | Group B          | Z-value | P value |
|-----------------|------------------|------------------|---------|---------|
| HR              | 88.12 ± 16.13    | 92.38 ± 16.00    | 1.32    | 0.188 NS, P > 0.05 |
| SBP             | 118.82 ± 11.21   | 125.86 ± 13.96   | 2.77    | 0.007 S, P < 0.05 |
| DBP             | 74.16 ± 9.85     | 76.20 ± 11.22    | 0.96    | 0.337 NS, P > 0.05 |
| MBP             | 88.38 ± 9.20     | 92.75 ± 1.07     | 2.15    | 0.033 S, P < 0.05 |

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, NS: Not significant, S: Significant

### Table 4: Haemodynamic changes one min after insertion of LMA

| Variables       | Group F          | Group B          | Z-value | P value |
|-----------------|------------------|------------------|---------|---------|
| HR              | 73.66 ± 12.06    | 79.12 ± 14.40    | 2.05    | 0.043 S, P < 0.05 |
| SBP             | 100.90 ± 10.49   | 108.10 ± 13.56   | 2.96    | 0.004 S, P < 0.05 |
| DBP             | 61.72 ± 10.63    | 66.64 ± 11.53    | 2.17    | 0.032 S, P < 0.05 |
| MBP             | 74.82 ± 9.80     | 80.39 ± 11.59    | 2.59    | 0.011 S, P < 0.05 |

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, S: Significant, LMA: Laryngeal mask airway

### Table 5: Haemodynamic changes after three min of insertion of LMA

| Variables       | Group F          | Group B          | Z-value | P value |
|-----------------|------------------|------------------|---------|---------|
| HR              | 67.12 ± 11.09    | 71.82 ± 12.43    | 1.99    | 0.049 S, P < 0.05 |
| SBP             | 93.02 ± 8.19     | 99.00 ± 13.80    | 2.73    | 0.008 S, P < 0.05 |
| DBP             | 55.90 ± 8.61     | 59.74 ± 9.25     | 2.14    | 0.034 S, P < 0.05 |
| MBP             | 68.27 ± 7.61     | 72.82 ± 10.00    | 2.56    | 0.012 S, P < 0.05 |

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, S: Significant, LMA: Laryngeal mask airway

### Table 6: Haemodynamic changes after five min of insertion of LMA

| Variables       | Group F          | Group B          | Z-value | P value |
|-----------------|------------------|------------------|---------|---------|
| HR              | 65.12 ± 11.18    | 68.84 ± 12.77    | 1.59    | 0.115 NS, P > 0.05 |
| SBP             | 90.14 ± 7.54     | 96.42 ± 11.54    | 3.22    | 0.002 S, P < 0.05 |
| DBP             | 54.04 ± 7.37     | 58.22 ± 8.50     | 2.62    | 0.010 S, P < 0.05 |
| MBP             | 66.10 ± 6.53     | 70.78 ± 9.01     | 2.96    | 0.004 S, P < 0.05 |

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, S: Significant, NS: Not significant, LMA: Laryngeal mask airway

### Table 7: Haemodynamic changes after Extubation

| Variables       | Group F          | Group B          | Z-value | P value |
|-----------------|------------------|------------------|---------|---------|
| HR              | 73.46 ± 13.99    | 78.98 ± 14.48    | 1.93    | 0.055 NS, P > 0.05 |
| SBP             | 101.54 ± 13.24   | 109.70 ± 13.95   | 2.99    | 0.003 S, P < 0.05 |
| DBP             | 62.82 ± 12.82    | 67.68 ± 12.00    | 1.95    | 0.053 NS, P < 0.05 |
| MBP             | 75.28 ± 9.83     | 81.68 ± 12.05    | 2.91    | 0.004 S, P < 0.05 |

HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, S: Significant, NS: Not significant, LMA: Laryngeal mask airway
with propofol to assess hemodynamic response to LMA insertion and compare this to the fentanyl–propofol combination.

All baseline hemodynamic variables including HR, SBP, DBP, MBP, SPO$_2$ and ETCO$_2$ in our study were comparable before premedication. After premedication, a transient, nonsignificant rise in the mean HR ($P = 0.188$), and a significant rise in the mean SBP ($P = 0.007$) was observed in Group B. The MBP ($92.75 \pm 1.07$) was although comparable to its baseline value, but it was significantly higher ($Z$-value $= 2.15$; $P = 0.033$) after premedication in Group B. One minute after insertion of LMA, the mean HR was decreased significantly ($P = 0.043$) in Group F. Similarly, the SBP, DBP, and MBP in both the groups were decreased in comparison to their baseline values and this drop was statistically significant in Group F when compared to Group B. After 3 min of LMA insertion, hemodynamic parameters showed a significant decrease in Group F. Hui et al. also found the similar results where the SBP and DBP decreased following induction, but the decreases in BP were greater in those patients receiving alfentanil ($P < 0.05$). The values of mean SBP, DBP, and MBP in our study were lowest at 5 min of insertion of LMA with statistically significant decrease in Group F than in Group B. These results correlate well with the study of AL-Qattan, et al.[15] However, all the variations in vital parameters were within the acceptable physiological range without any abnormal ECG findings or need of pharmacological intervention. Similar findings were also observed by Leong and Ong, when LMA insertion with inhaled desflurane was compared to IV propofol. Significant decreases in the mean arterial pressure in the propofol group over the first 5 min of induction were found. Mean arterial pressure, HR, and SPO$_2$ remained stable during the same period in the desflurane group.[19] Smith, et al. compared hemodynamic responses of sevoflurane-N$_2$O versus propofol/isoflurane-N$_2$O using the LMA in adults. HR was lower 5 and 10 min after LMA insertion in the sevoflurane-N$_2$O group ($P < 0.05$) as compared to control group.[20] Mishra et al. noted a significant fall in HR following midazolam and butorphanol.[21]

After extubation, all the vital parameters started returning to premedication values, the increase in the HR in both the groups was statistically not significant ($P = 0.055$), however, the increase in the mean SBP and MBP after extubation was significantly greater in Group B ($P = 0.003$ and $P = 0.004$, respectively) as compared to Group F. Fuji, et al. 1998 found that LMA removal elicited less hemodynamic change than tracheal extubation.[22]

CONCLUSION

Though the fentanyl is more hemodynamically stable as compared to butorphanol, the opposing effects of butorphanol-propofol on arterial BP and HR counter each other and result in an improved cardiovascular stability as compared to the combination of propofol and fentanyl.

Thus, from this study, we conclude that as coinduction agent with propofol 2.5 mg/kg, butorphanol 30 µg/kg is a better alternative to fentanyl 1.5 mg/kg as far as hemodynamic stability is concerned. Bradycardia caused by propofol is taken care of by the release of catecholamines due to butorphanol leading to stable hemodynamics.

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Conflicts of interest
There are no conflicts of interest.

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