Section: Anaesthesia

Original Research Article

COMPARATIVE STUDY OF THE EFFICACY OF INTRAVENOUS ESMOLOL, DILTIAZEM, AND LIGNOCAINE IN ATTENUATING THE PRESSURE RESPONSE TO LARYNGOSCOPY AND TRACHEAL INTUBATION

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Abstract

Background: Laryngoscopy and tracheal intubation often lead to significant hemodynamic disturbances due to sympathetic nervous system activation. This study compares the efficacy of intravenous Esmolol, Diltiazem, and Lignocaine in reducing the pressor response to laryngoscopy and intubation. **Materials and Methods:** This randomized controlled trial included 90 ASA I and II adult patients scheduled for elective non-cardiac surgery under general anaesthesia. Patients were randomly allocated into three groups (n=30 each): Group EG (Esmolol 1 mg/kg IV), Group DG (Diltiazem 0.3 mg/kg IV), and Group LG (Lignocaine 1.5 mg/kg IV). Hemodynamic parameters—systolic arterial pressure (SAP), diastolic arterial pressure (DAP), heart rate (HR), and mean arterial pressure (MAP)—were recorded at baseline, immediately post-intubation (0 min), and at 1, 3, 5, and 10 minutes post-intubation. Adverse effects were also documented. **Result:** Diltiazem demonstrated the most effective control of SAP, DAP, and MAP at all time points ($p<0.05$). Esmolol was superior in controlling HR ($p<0.001$). Lignocaine exhibited the least impact on hemodynamic stability but effectively reduced airway reflexes. Side effects included mild bradycardia (10%) in Group EG, headache (6.7%) in Group DG, and injection site discomfort (13.3%) in Group LG. **Conclusion:** Diltiazem is recommended for patients at risk of hypertension, while Esmolol is preferred for tachycardia control. Lignocaine had limited hemodynamic benefits. Further studies are needed to establish optimal perioperative management strategies.

INTRODUCTION

In general anaesthesia, laryngoscopy and tracheal intubation are the key procedures which ensures adequate oxygenation and ventilation. However, these procedures are associated with significant hemodynamic changes and this is mostly due to sympathetic nervous system activation. The mechanical stimulation of the upper airway during laryngoscopy and endotracheal intubation initiates an acute sympathoadrenal response, which leads to the release of catecholamines such as epinephrine and norepinephrine. The physiological response expresses as transient hypertension, tachycardia, and, in some cases, arrhythmias posing potential risks, in patients with pre-existing cardiovascular comorbidities such as hypertension, ischemic heart disease, and cerebrovascular disorders.[1-3]

In order to lessen these pressor responses, a number of pharmacological agents have been considered, including beta-adrenergic blockers, calcium channel blockers, and local anaesthetics.

- The effectiveness of esmolol, a beta-1 adrenergic receptor antagonist with a quick onset and extremely short half-life, in reducing tachycardia and hypertensive reactions brought on by intubation has been extensively researched. Esmolol stabilises haemodynamic parameters by decreasing myocardial contractility and cardiac output through the inhibition of beta-adrenergic receptors.[4,5]
- Diltiazem, a calcium channel blocker, reduces myocardial oxygen demand, has adverse

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chronotropic effects, and causes systemic vasodilation by preventing calcium from entering cardiac cells and vascular smooth muscle. Diltiazem is a favourable drug in lowering the tachycardic and hypertensive components of the intubation response because of its pharmacological profile.[4 6]

- By lowering nerve excitability and stabilising neuronal membranes, lignocaine, a sodium channel blocker, acts as a local anaesthetic. Its inhibition of airway reflexes during laryngoscopy and its inhibitory effects on sympathetic nerve activity are responsible for its capacity to reduce the pressor response.[4,7]

Despite the widespread use of these drugs, there is no clear agreement on which one is the best for controlling blood pressure and heart rate changes during laryngoscopy and intubation. Differences in study designs, patient characteristics, and dosage make it difficult to compare results. More research is required to better understand the effectiveness and safety of these medications. This study explores and compare the effects of Esmolol, Diltiazem, and Lignocaine on blood pressure and heart rate at different time points after intubation. It also looks at any possible side effects these drugs may cause to determine their overall usefulness and safety during surgery.

Aim and Objectives

1. To compare the effect of three drugs (Esmolol, Diltiazem, and Lignocaine) on Systolic arterial pressure (SAP), Diastolic arterial pressure (DAP), Mean arterial pressure (MAP) before and after the induction of anaesthesia and at 0, 1, 3, 5, and 10 minutes following tracheal intubation.
2. To compare the three groups' heart rates (HR) before and after tracheal intubation at 0, 1, 3, 5, and 10 minutes following the induction of anaesthesia.
3. To determine the frequency of adverse events related to the administration of lignocaine, diltiazem, and esmolol during the study period.

MATERIALS AND METHODS

This prospective, randomized controlled study was conducted on ninety adult patients classified as ASA Grade I or II, aged 18–60 years, scheduled for elective non-cardiac surgery under general anaesthesia, after ethical committee approval. All patients underwent a thorough preanesthetic evaluation, which included a detailed medical history, comprehensive physical examination, and standard laboratory investigations such as haemoglobin estimation, TLC, DLC, blood glucose levels, renal function tests (blood urea, serum creatinine), serum electrolytes, routine urine examination, chest X-ray, and electrocardiogram (ECG).

Patients were excluded if they were graded as ASA III or IV, age less than 18 years or more than 60 years, patients with history of hypertension, receiving beta adrenergic blocking drugs, SBP <100 mm Hg or DBP less than 50 mm Hg, COPD, asthma or bronchospasm, pregnancy, known hypersensitivity to Esmolol, Diltiazem or Lignocaine, severe hepatic or renal impairment or had anticipated difficult intubation.

After obtaining informed consent, patients were randomly allocated into three equal groups (n=30 each) using a computer-generated randomization sequence.

- Group EG received Esmolol (1 mg/kg IV),90 seconds prior to laryngoscopy and intubation.
- Group DG received Diltiazem (0.3 mg/kg IV), 90 seconds prior to laryngoscopy and intubation
- Group LG received Lignocaine (1.5 mg/kg IV) 90 seconds prior to laryngoscopy and intubation

The anaesthesiologist administering the drugs and the observer recording the hemodynamic parameters were blinded to the group allocation.

All patients received T.Alprazolam 0.25 mg and T.Ranitidine 150 mg on the evening before surgery and one hour before surgery. General anaesthesia was induced with intravenous Propofol (2 mg/kg), Midazolam (0.02mg/kg), Fentanyl (2 µg/kg). The selected one of the three drugs under study was given 90 seconds before laryngoscopy. Muscle relaxation was achieved with Inj.Vecuronium(0.1mg/kg), after confirming correct endotracheal tube placement, anaesthesia maintained with Oxygen, Nitrous oxide and Isoflurane (0.5 -1%) under controlled ventilation. Standard monitoring included Electrocardiography (ECG), Non-invasive blood pressure (NIBP) and Pulse Oximetry (SpO2).

Hemodynamic parameters, including SAP, DAP, HR, and MAP, were recorded at baseline, immediately post-intubation (0 min), and at 1, 3, 5, and 10 minutes post-intubation. Any adverse events, such as hypotension, bradycardia, or injection site discomfort, were documented throughout the study. The primary outcomes assessed were changes in SAP, DAP, HR, and MAP at predefined time intervals. Secondary outcomes included the incidence of side effects such as bradycardia, hypotension, and injection site reactions. Data were analyzed using SPSS version [V 29]. Continuous variables were expressed as mean ± standard deviation (SD) and analyzed using ANOVA with post-hoc tests. A p-value <0.05 was considered statistically significant.

RESULTS

The study included 90 patients with even distribution into three groups: Group EG (Esmolol), Group DG (Diltiazem), and Group LG (Lignocaine).

Socio-Demographic Characteristics

The baseline demographic parameters including age, weight, sex distribution, and ASA classification, were comparable across the groups as shown in [Table 1]

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- **Age:** The mean age was similar across groups—40.53 ± 10.51 years (EG), 39.63 ± 9.17 years (DG), and 41.2 ± 8.96 years (LG)—ensuring greater comparison
- **Weight:** Mean weight was 61.45 ± 4.16 kg (EG), 62.2 ± 4.65 kg (DG), and 62.9 ± 6.3 kg (LG), minimizing weight-related variation
- **Sex Distribution:** Gender distribution was properly balanced, with 15 males and 15 females in EG, 16 males and 14 females in DG, and 15 males and 15 females in LG.
- **ASA Classification:** Most patients were ASA Grade I (24 in EG, 25 in DG, 24 in LG), with a smaller proportion in ASA Grade II (6 in EG, 5 in DG, 6 in LG).

Systolic Arterial Pressure (SAP) [Table 2, Figure 1, 2]

The reduction of SAP post-intubation varied across the groups, with Group DG (Diltiazem) demonstrating the most effective control at all time points compared to Groups EG (Esmolol) and LG (Lignocaine). Group LG consistently showed the least reduction in SAP, with statistically significant differences ($p<0.05$).

- **Key findings:** At 1 minute post-intubation, Group DG recorded a mean SAP of 109.27 ± 19.94 mmHg, significantly lower than Group EG (117.10 ± 15.76 mmHg) and Group LG (150.47 ± 14.53 mmHg) ($p < 0.001$). By 10 minutes, Group EG maintained the lowest SAP (111.97 ± 14.43 mmHg), followed by Group DG (117.87 ± 13.77 mmHg) and Group LG (136.57 ± 12.18 mmHg).

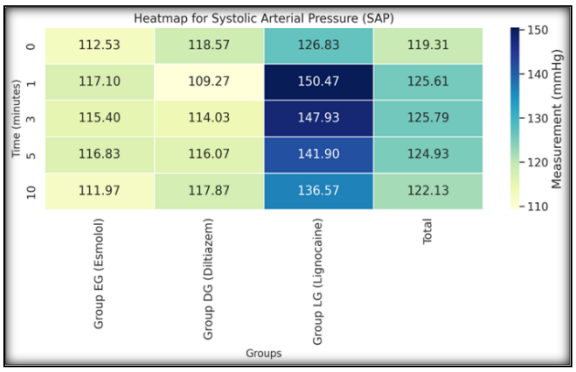

Figure 1: Heatmap for Systolic Arterial Pressure (SAP)

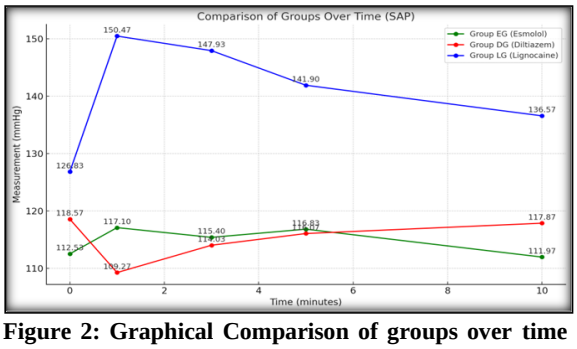

Figure 2: Graphical Comparison of groups over time (SAP)

Diastolic Arterial Pressure (DAP) [Table 3, Figure 3 and 4]

Group DG demonstrated superior control of DAP at 3 and 5 minutes, with significantly lower values compared to Groups EG and LG ($p<0.05$). In contrast, Group LG consistently showed the highest DAP at all time points.

- **Key findings:** At 3 minutes, the mean DAP in Group DG was 69.73 ± 12.25 mmHg, significantly lower than Group EG (74.20 ± 14.15 mmHg) and Group LG (95.90 ± 9.65 mmHg) ($p < 0.001$). At 10 minutes, Group LG exhibited the highest DAP (87.57 ± 10.10 mmHg).

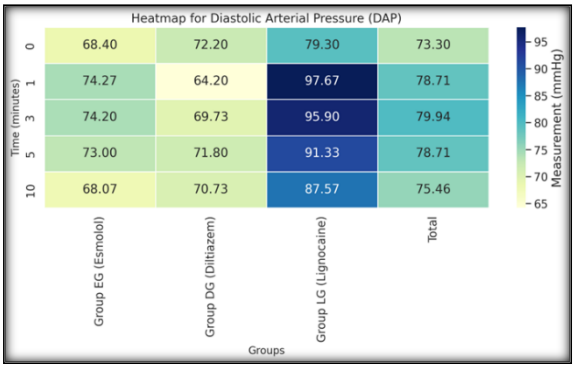

Figure 3: Heatmap for Diastolic Arterial Pressure (DAP)

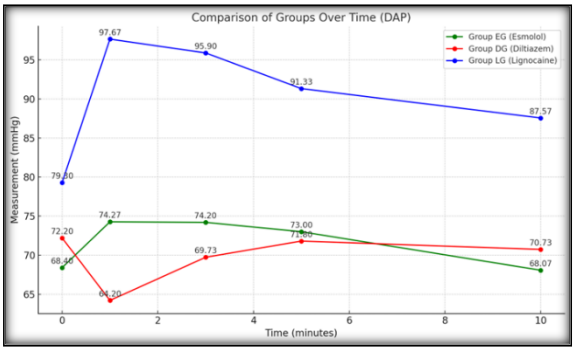

Figure 4: Graphical Comparison of groups over time (DAP)

Comparison of Mean Arterial Pressure (MAP) [Table 4, Figure 5 and 6]

Group DG was the most effective in stabilizing MAP values throughout the study period, with statistically significant differences observed between groups ($p<0.05$).

- **Key findings:** At 1 minute post-intubation, Group DG recorded a MAP of 78.30 ± 13.91 mmHg, significantly lower than Group EG (87.77 ± 13.77 mmHg) and Group LG (119.40 ± 18.14 mmHg) ($p < 0.001$). At 10 minutes, Group DG maintained stable MAP values (86.00 ± 11.25 mmHg), whereas Group LG recorded the highest MAP (107.43 ± 15.24 mmHg).

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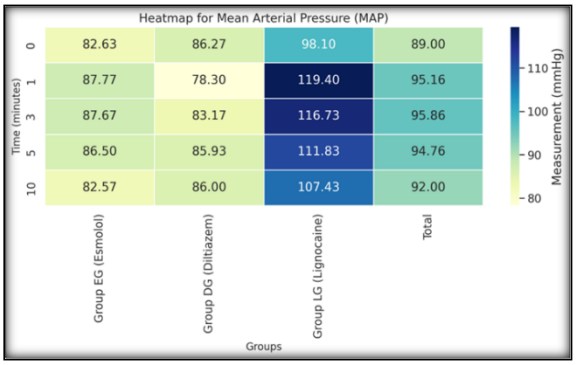

Figure 5: Heatmap for Mean Arterial Pressure (MAP)

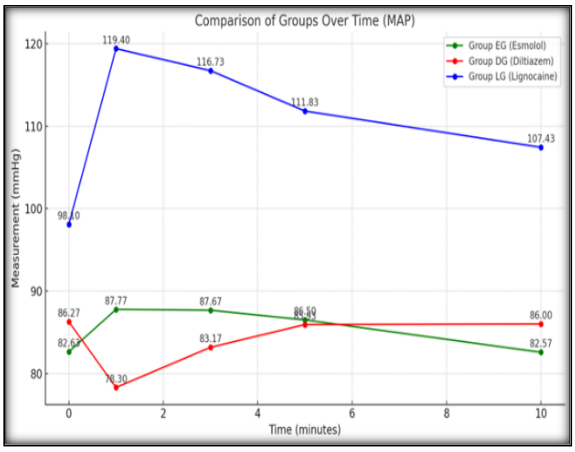

Figure 6: Graphical Comparison of groups over time (MAP)

Comparison of Heart Rate (HR) [Table 5, Figure 7 and 8]

Group EG achieved the most effective reduction in HR across all intervals, with statistically significant differences compared to Groups DG and LG ($p<0.05$). Group L exhibited the least control over HR.

- **Key findings:** At 1 minute post-intubation, Group EG had a mean HR of 82.63 ± 12.10 bpm, while Group DG had 82.47 ± 13.11 bpm, and Group LG had the highest HR at 101.30 ± 18.58 bpm ($p<0.001$).
- This trend persisted at 10 minutes, with Group EG maintaining the lowest HR of 83.67 ± 15.26 bpm.

Side Effects

The incidence of side effects varied between groups, with mild bradycardia noted in Group EG, headache in Group DG, and injection site discomfort in Group LG.

- **Group EG (Esmolol):** Mild bradycardia occurred in 10% of patients.
- **Group DG (Diltiazem):** Headache was reported in 6.7% of patients.
- **Group LG (Lignocaine):** Injection site discomfort was observed in 13.3% of patients.

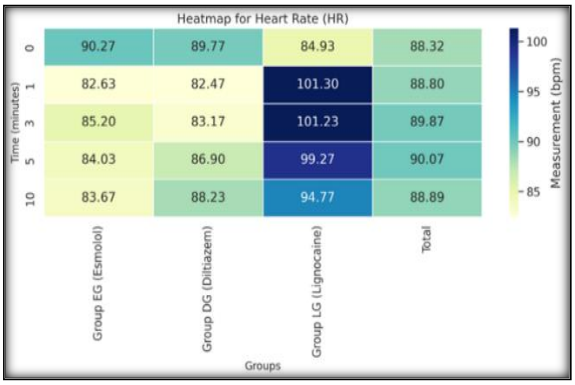

Figure 7: Heatmap for Heart Rate (HR)

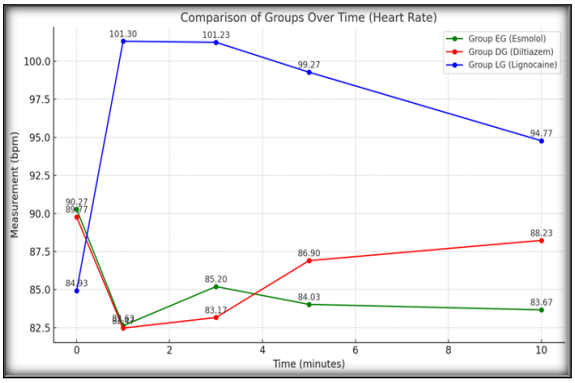

Figure 8: Graphical Comparison of groups over time (HR)

Table 1: Distribution of patients in three study groups

Variable	Group EG	Group DG	Group LG
Age (Mean ± SD)	40.53 ± 10.51	39.63 ± 9.17	41.2 ± 8.96
Weight (Mean ± SD)	61.45 ± 4.16	62.2 ± 4.65	62.9 ± 6.3
Sex (Male)	15	16	15
Sex (Female)	15	14	15
ASA Grade I	24	25	24
ASA Grade II	6	5	6

Table 2: Mean of Systolic Arterial Pressure (SAP in mmHg) at different Time points

Time (minutes)	Group EG (Esmolol)	Group DG (Diltiazem)	Group LG (Lignocaine)	Total	p-value (ANOVA)
0	112.53 ± 18.01	118.57 ± 20.14	126.83 ± 15.26	119.31 ± 18.67	<0.01
1	117.10 ± 15.76	109.27 ± 19.94	150.47 ± 14.53	125.61 ± 24.53	<0.001
3	115.40 ± 14.45	114.03 ± 16.02	147.93 ± 14.25	125.79 ± 21.59	<0.001
5	116.83 ± 14.07	116.07 ± 13.04	141.90 ± 11.58	124.93 ± 17.58	<0.001
10	111.97 ± 14.43	117.87 ± 13.77	136.57 ± 12.18	122.13 ± 17.01	<0.001

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Table 3: Mean of Diastolic Arterial Pressure (DAP in mmHg) at different Time points

Time (minutes)	Group EG (Esmolol)	Group DG (Diltiazem)	Group LG (Lignocaine)	Total	p-value (ANOVA)
0	68.40 ± 13.84	72.20 ± 12.62	79.30 ± 9.94	73.30 ± 12.93	<0.01
1	74.27 ± 14.71	64.20 ± 12.64	97.67 ± 12.05	78.71 ± 19.20	<0.003
3	74.20 ± 14.15	69.73 ± 12.25	95.90 ± 9.65	79.94 ± 16.63	<0.001
5	73.00± 14.30	71.80 ± 10.94	91.33 ± 10.20	78.71 ± 14.84	<0.001
10	68.07 ± 12.89	70.73 ± 10.97	87.57 ± 10.10	75.46 ± 14.21	<0.001

Table 4: Mean of Mean Arterial Pressure (MAP in mmHg) at different Time points

Time (minutes)	Group EG (Esmolol)	Group DG (Diltiazem)	Group LG (Lignocaine)	Total	p-value (ANOVA)
0	82.63 ± 14.04	86.27 ± 13.97	98.10 ± 15.07	89.00 ± 15.68	<0.001
1	87.77 ± 13.77	78.30 ± 13.91	119.40 ± 18.14	95.16 ± 23.33	<0.001
3	87.67 ± 13.36	83.17 ± 12.73	116.73 ± 16.95	95.86 ± 20.70	<0.001
5	86.50 ± 14.08	85.93 ± 10.33	111.83 ± 15.74	94.76 ± 18.10	<0.001
10	82.57 ± 12.42	86.00 ± 11.25	107.43 ± 15.24	92.00 ± 17.02	<0.001

Table 5: Mean Heart Rate (beats per minute)

Time (minutes)	Group EG (Esmolol)	Group DG (Diltiazem)	Group LG (Lignocaine)	Total	p-value (ANOVA)
0	90.27 ± 15.69	89.77 ± 12.90	84.93 ± 13.50	88.32 ± 14.17	<0.275
1	82.63 ± 12.10	82.47 ± 13.11	101.30 ± 18.58	88.80 ± 17.18	<0.001
3	85.20 ± 13.23	83.17 ± 12.23	101.23 ± 13.67	89.87 ± 15.25	<0.001
5	84.03 ± 13.73	86.90 ± 12.39	99.27 ± 11.31	90.07 ± 14.05	<0.001
10	83.67 ± 15.26	88.23 ± 13.46	94.77 ± 11.26	88.89 ± 14.04	<0.001

Table 6: Incidence of Side Effects

Side Effect	Group E (Esmolol)	Group D (Diltiazem)	Group L (Lignocaine)
Bradycardia	10%	3.3%	0%
Headache	0%	6.7%	3.3%
Injection Site Discomfort	3.3%	0%	13.3%

DISCUSSION

The hemodynamic responses observed in the present study align with previous research studies evaluating the efficacy of Esmolol, Diltiazem, and Lignocaine in mitigating the pressor response to laryngoscopy and tracheal intubation. Several studies have highlighted the superiority of beta-blockers and calcium channel blockers in controlling blood pressure and heart rate fluctuations during intubation.[8,9]

Group EG (Esmolol)

Esmolol, had better heart rate (HR) control than Diltiazem and Lignocaine. The reduction of tachycardia at all time points was noticeable, being especially helpful for patients at high risk of excessive sympathetic stimulation. These findings align with the results of Rastogi et al. (2017), who concluded that Esmolol is effective in blunting tachycardic intubation responses because of its beta-1 blocking properties. Regarding systolic arterial pressure (SAP) and mean arterial pressure (MAP), Esmolol demonstrated modest blunting. However, its effects were inferior to Diltiazem, especially at the 1 and 3-minute marks. This may be due to the predominant action of Esmolol, on cardiac rate rather than vascular resistance. A mild incidence of bradycardia (10% of patients) was noted, a known side effect reported by Mulimani et al. (2019), suggesting prudent use in patients with baseline bradycardia.[9]

Group DG (Diltiazem)

Diltiazem, was the most potent agent in controlling SAP, diastolic arterial pressure (DAP), and MAP at each time points. This was better at the suppression of hypertensive responses compared to Esmolol and Lignocaine. These results were in accordance with Chauhan et al. (2020), who reported that Diltiazem reduces hypertensive surges due to its vasodilatory effects on systemic circulation. Diltiazem did have moderate control over HR, performing better than Lignocaine but was not as effectively as Esmolol. This finding is consistent with the study by Rastogi et al. (2017), which highlighted that though Diltiazem reduces HR, but its main action is on vascular resistance and not chronotropic modulation. Group had few side effects, headache was the most frequently occurring side effect (6.7% of patients) which is comparable with past research

Group LG (Lignocaine)

Local anesthetic, class 1b antiarrhythmic lignocaine, was the least effective in minimising both blood pressure and heart rate responses elicited by laryngoscopy and intubation. The results of the study show Lignocaine to be less efficacious in controls of airway reflexes with significantly lesser effects on SAP, DAP, MAP and HR when compared to Esmolol and Diltiazem. This result is similar to the findings of Muralidharan et al. (2021), who found that Lignocaine can only offer a modest hemodynamic stabilization; mostly acting in calming airway irritability. One of the major drawbacks of Lignocaine was the high incidence of

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injection site discomfort (13.3%), making it the least well-tolerated agent. These results are in accordance with Swapna et al. (2023), who found a higher incidence of local irritation and transient pain at the injection site.

Comparison Across Groups

1. **Control of SAP, DAP, and MAP:**

- Group DG showed the most significant reduction in all arterial pressure parameters compared to Groups EG and LG.
- Group EG, showed less sustained control of MAP.
- Group LG had the least control of arterial pressures across all time intervals.

2. **Control of HR:**

- Group EG showed the most significant reduction in HR, significantly outperforming both Groups DG and LG.
- Group DG showed moderate HR control, while Group LG had minimal impact on HR.

3. **Side Effects:**

- Group DG reported mild headache in a few participants.
- Group EG caused mild bradycardia
- Group LG caused discomfort at the injection site.

CONCLUSION

This study aimed to compare hemodynamic stability during laryngoscopy and intubation induced by Esmolol, Diltiazem, and Lignocaine on. The most potent antihypertensive effect was performed by diltiazem and Esmolol was the best controlling heart rate. Lignocaine not very effective in controlling the hemodynamic response, and was also linked with highest incidence of pain due to injection site.

In accordance to the findings, Diltiazem is recommended for patients at risk of hypertension, while Esmolol is preferred for those requiring heart rate control. Further research is needed to validate these results.

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