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Lidocaine, Esmolol, and Beyond: A Comprehensive Analysis of Hemodynamic Stress during Laryngoscopy and Intubation

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Abstract

Objective: To evaluate the haemodynamic stress response rin combination of lidocaine and esmolol versus lidocaine or esmolol alone during laryngoscopy and intubation.

Methods: This research comprised 60 patients who provided written permission and met the inclusion and exclusion criteria. Selected patients were randomly assigned to one of three groups based on a computer-generated random number: lignocaine 1.5 mg/kg (n = 40), esmolol 2 mg/kg (n = 40), or lignocaine 1 mg/kg and esmolol 1 mg/kg (n = 40). This research comprised patients aged 20 to 42 who had elective procedures under general anaesthetic and had ASA I and II. Patients with contraindications to beta blockers, such as bronchial asthma, COPD, a basal heart rate of 60 beats per minute, respiratory impairment, and documented reactions to local anaesthetics.

Results: There were no significant variations in age, preoperative heart rate, or blood pressure between the groups. Males and females were approximately equally dispersed throughout all groupings. Following the delivery of the test medicines, all three groups saw a substantial drop in heart rate (Group E 61.23 ± 3.64, Group L 73.25 ± 5.36, Group LE 72.23 ± 5.36) ($P < 0.001$). Four Group E patients developed bradycardia. (HR <60). Although both Group LE and Group L showed near baseline values, Group L showed near baseline values until the third minute, whereas Group LE showed a continuous reduction in heart rate rates. After 30 minutes, all three groups' heart rates were statistically insignificant. Following induction and administration of the test medicines, systolic, diastolic, and hence mean arterial blood pressure lowers gradually in all three groups ($P < 0.001$). (This is for systolic blood pressure.). Group E 97.36 ± 5.69, Group L 125.39 ± 6.36, Group LE 116.78 ± 4.78) Group E 60.034.69, Group L 82.935.36, Group LE 72.034.78) (Group E 72.10 ± 3.69, Group L 96.90 ± 3.85, Group LE 86.44 ± 2.87) Before intubation, patients in Group E experienced substantial decreases in systolic, diastolic, and mean arterial blood pressure (less than 20% of baseline). Following intubation, blood pressure levels in Group LE were near baseline until the 30th minute ($P < 0.001$). Group E had a consistent fall in all three blood pressure readings following intubation until the fifth minute. Group E's blood pressures were likewise around baseline at the 15th and 30th minutes. Until the 15th minute, Group L had a considerable rise in all three blood pressures.

Conclusion: As a result, esmolol and lidocaine together are a safe and effective strategy to minimise laryngoscopy responses to intubation and extubation, lowering myocardial oxygen consumption and the risk of myocardial ischemia under general anaesthesia.

Keywords: Haemodynamic stress, lidocaine, esmolol, laryngoscopy intubation

Introduction

Cardiovascular issues are one of the most common causes of anesthesia-related morbidity and mortality. Direct laryngoscopy and endotracheal intubation often result in a cardiovascular stress response characterised by hypertension and tachycardia because of reflex sympathetic simulation. Within 30 seconds of intubation, the patient begins to show signs of a response that lasts less than 10 minutes. Patients with hypertension, tachycardia, myocardial infarction, and other conditions, on the other hand, may have serious side effects if they take it.[1-3] Pharmacological therapies have been used to lower the pressure responses to laryngoscopy and tracheal intubation.[4]

African-Americans do not respond as well to beta adrenergic receptor blocking medications as whites do, therefore this must be taken into consideration prior to treatment.[5] Endotracheal intubation hemodynamic responses in normotense black patients were examined in the present research between lidocaine and esmolol. Preoperative myocardial infarction is a leading cause of postoperative morbidity and mortality because of hypertension and tachycardia.[1] Anaesthetic death rates in Africa are as high as 1:1900 in Zambia,[6] 1:500 for Malawi,[7] and 1:150 in Togo, according to African research. [8]

Anesthesia-related deaths may be prevented if myocardial ischemia-induced hemodynamic changes can be controlled. When ischemia occurs, the rate pressure product (RPP) is a measure of the heart's demand for oxygen,[9] and so, an evaluation of the effectiveness of lidocaine and esmolol in reducing hematopoietic cell death in the Indian population is needed. Efforts are being made in India to practise safe anaesthesia and reduce the risk of complications and mortality after surgery.

Methods and Materials

After receiving ethical approval from the institution, this double blinded prospective randomised trial was carried out at the department of Anesthesia.

The patients were divided into three groups. The patients who took part in the trial provided written informed consent. This research comprised 60 patients who provided written concent taken and met the inclusion and exclusion criteria. Selected patients were randomly assigned to one of three groups based on a computer-generated random number: lignocaine 1.5 mg/kg, esmolol 2 mg/kg, or lignocaine 1 mg/kg and esmolol 1 mg/kg (n = 40). This research comprised patients aged 20 to 42 who had elective procedures under general anaesthetic and had ASA I and II. Patients with

contraindications to beta blockers, such as bronchial asthma, COPD, a basal heart rate of 60 beats per minute, respiratory impairment, and documented reactions to local anaesthetics.

Methodology

60 patients were randomly allocated to one of three groups: esmolol group (group E), lidocaine group (group L), and combination group (group LE). All of the patients in the operating room were secured with 18 G IV lines and began on intravenous fluids. There were standard monitors connected. Continuous measurements of pulse rate, blood pressure, and SpO2 were taken. Premedication included injections of 0.2 mg glycopyrolate and 2 mg/kg fentanyl. Injection Thiopentone sodium 5 mg/kg was used for induction, while injection Vecuronium 0.5 mg/kg was used for paralysis. Group E received 5 ml of normal saline 3 minutes before intubation and 10 ml of esmolol 2 mg/kg 90 seconds before intubation. Group L got lidocaine 1.5 mg/kg in 5 ml 3 minutes before intubation and normal saline 10 ml 90 seconds before intubation.

Group LE got lidocaine 1 mg/kg in 5 ml 3 minutes before intubation and esmolol 1 mg/kg in 10ml 90 seconds before intubation. All patients were intubated by a third-year MD postgraduate. Anaesthesia was maintained with 1 MAC sevoflurane and 50% nitrous oxide after 15 minutes of intubation, and a skin incision was done 5 minutes later. The following variables were investigated: mean heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and rate pressure product index.

Statistical Evaluation

It was necessary to create a Master Chart to keep track of all of the data that had been acquired. SPSS 25.0 was used to analyse the data on a computer. A one-way ANOVA and chi-square test were used to examine the significance of differences across variables for the consolidated data.

Results

There were no significant variations in age (Table 1), preoperative heart rate (Table 2), or blood pressure (Tables 3, 4, and 5) between the groups. Males and females were approximately equally dispersed throughout all groupings (Table 6). Following the delivery of the test medicines, all three groups saw a substantial drop in heart rate (Group E 61.23 ± 3.64, Group L 73.25 ± 5.36, Group LE 72.23 ± 5.36) ($P < 0.001$) (Table 2).

Table 1. **Age distribution**

Age	Esmolol group	Lignocaine group	Esmolol + Lignocaine group	*P* value
below 25	10	9	12	
25–35	25	24	22	0.55
above 35	5	7	6	
Mean	35.48 ± 3.69	36.74 ± 4.23	34.96 ± 3.98	

Table 2. **Heart rate**

Heart rate	Esmolol group Mean ± Sd	Lignocaine group Mean ± Sd	Esmolol + Lignocaine group Mean ± Sd	*P* value
Baseline	83.21 ± 4.52	83.25 ± 5.56	81.69 ± 4.63	Non significant
Before Laryngoscopy	61.23 ± 3.64	73.25 ± 5.36	72.23 ± 5.36	significant
After Intubation	65.74 ± 3.88	79.22 ± 5.47	75.36 ± 3.66	significant
1	65.98 ± 4.21	81.12 ± 6.35	74.88 ± 4.52	significant
3	67.74 ± 3.36	85.36 ± 4.32	77.22 ± 4.39	significant
5	69.64 ± 3.87	87.19 ± 4.69	82.88 ± 5.63	significant
15	72.98 ± 4.52	87.89 ± 4.12	82.99 ± 5.66	significant
30	85.96 ± 6.36	83.16 ± 3.96	83.22 ± 4.36	Non significant

Table 3. **Systolic blood presure**

Systolic bp	Esmolol group Mean ± Sd	Lignocaine group Mean ± Sd	Esmolol + Lignocaine group Mean ± Sd	*P* value
Baseline	129.11 ± 5.85	128.02 ± 5.74	128.11 ± 5.12	Non significant
Before Laryngoscopy	97.36 ± 5.69	125.39 ± 6.36	116.78 ± 478	significant
After Intubation	104.69 ± 5.51	151.36 ± 6.31	119.67 ± 4.66	significant
1	101.87 ± 5.21	156.69 ± 6.12	121.36 ± 6.32	significant
3	104.71 ± 6.36	152.31 ± 5.69	121.66 ± 4.36	significant
5	109.69 ± 4.69	141.58 ± 5.85	123.98 ± 4.74	significant
15	126.33 ± 6.31	136.31 ± 5.88	128.14 ± 5.69	significant
30	130.02 ± 7.61	130.00 ± 4.78	128.31 ± 5.87	significant

Table 4. **Diastolic blood pressure**

Diastolic bp	Esmolol group Mean ± Sd	Lignocaine group Mean ± Sd	Esmolol + Lignocaine group Mean ± Sd	*P* value
Baseline	84.33 ± 5.89	84.67 ± 5.12	84.20 ± 5.33	Non significant
Before Laryngoscopy	60.03 ± 4.69	82.93 ± 5.36	72.03 ± 4.78	significant
After Intubation	65.27 ± 4.12	104.90 ± 5.11	80.83 ± 5.17	significant
1	62.03 ± 5.32	100.40 ± 4.78	80.70 ± 5.63	significant
3	66.37 ± 6.32	94.80 ± 6.35	82.20 ± 6.10	significant
5	67.93 ± 5.41	90.07 ± 5.85	83.13 ± 5.93	significant
15	80.27 ± 6.12	87.23 ± 5.26	83.17 ± 4.55	significant
30	87.03 ± 4.63	87.23 ± 4.98	82.90 ± 4.87	significant

Table 5. **Mean arterial pressure**

Map	Esmolol group Mean ± Sd	Lignocaine group Mean ± Sd	Esmolol + Lignocaine group Mean ± Sd	*P* value
Baseline	99.51 ± 3.65	99.09 ± 3.74	98.58 ± 2.69	Non significant
Before Laryngoscopy	72.10 ± 3.69	96.90 ± 3.85	86.44 ± 2.87	significant
After Intubation	77.91 ± 3.48	120.03 ± 4.22	93.23 ± 2.74	significant
1	74.74 ± 4.23	118.70 ± 3.69	93.82 ± 2.69	significant
3	78.83 ± 3.66	113.14 ± 4.52	94.92 ± 2.62	significant
5	81.31 ± 4.11	106.76 ± 3.33	96.19 ± 3.14	significant
15	95.23 ± 3.14	103.19 ± 2.58	97.90 ± 2.78	significant
30	101.37 ± 4.55	101.69 ± 3.11	97.64 ± 2.96	significant

Table 6. **Gender**

Gender	Esmolol group	Lignocaine group	Esmolol + Lignocaine group	*P* value
Male	26	25	22	0.77
Female	14	15	18	

Four Group E patients developed bradycardia. (HR <60). Although both Group LE and Group L showed near baseline values, Group L showed near baseline values until the third minute, whereas Group LE showed a continuous reduction in heart rate rates. After 30 minutes, all three groups' heart rates were statistically insignificant.

Following induction and administration of the test medicines, systolic, diastolic, and hence mean arterial blood pressure lowers gradually in all three groups ($P < 0.001$). (This is for systolic blood pressure.). Group E 97.36 ± 5.69, Group L 125.39 ± 6.36, Group LE 116.78 ± 4.78) Group E 60.034.69, Group L 82.935.36, Group LE 72.034.78) (Group E 72.10 ± 3.69, Group L 96.90 ± 3.85, Group LE 86.44 ± 2.87). Before intubation, patients in Group E experienced substantial decreases in systolic, diastolic, and mean arterial blood pressure (less than 20% of baseline). Following intubation, blood pressure levels in Group LE were near baseline until the 30th minute ($P < 0.001$). Group E had a consistent fall in all three blood pressure readings following intubation until the fifth minute. Group E's blood pressures were likewise around baseline at the 15th and 30th minutes. Until the 15th minute, Group L had a considerable rise in all three blood pressures (Tables 3, 4, and 5).

After 30 minutes, systolic blood pressure was statistically insignificant in all three groups, although diastolic blood pressure and mean arterial blood pressure were significant.

During laryngoscopy and intubation, the rate pressure product, which is an indication of myocardial oxygen consumption, did not exceed the baseline value in Group LE. In contrast, rate pressure exists in Group E. Because of the decrease in heart rate and blood pressure, the product was much lower than the baseline. In group L, the rate pressure product was considerably higher than baseline, resulting in increased myocardial oxygen demand (Table 7).

Discussion

Ethnic differences in pathophysiology and therapy are particularly important for the Afro-Caribbean population. Beta-blockers are less effective in black hypertensives due to a propensity to low renin levels and increased peripheral resistance. Higher beta-blocker doses are often required when treating people of colour.[10,11] Esmolol is a good medication for inhibiting the cardiovascular response due to its many properties. It is not only a cardio-specific medication, but it also has an extremely short half-life (9 min) Finally, no serious drug interactions with commonly used anaesthetics have been reported.[12] According to Korpinen et al., an esmolol bolus of 2 mg kg^{-1} IV 2 minutes before

Table 7. **Rate pressure product**

Rate pressure product	Esmolol group	Lignocaine group	Esmolol + Lignocaine group	*P* value
	Mean ± Sd	Mean ± Sd	Mean ± Sd	
Baseline	8208.76 ± 714.58	8134.78 ± 455.98	7950.72 ± 522.69	Non significant
Before Laryngoscopy	4345.26 ± 622.39	7019.74 ± 633.78	6154.49 ± 547.19	significant
After Intubation	5037.26 ± 522.87	9379.01 ± 639.85	6904.09 ± 611.52	significant
1	4855.68 ± 741.96	9508.87 ± 699.77	6905.82 ± 637.59	significant
3	5255.03 ± 852.63	9549.92 ± 598.88	7218.78 ± 689.22	significant
5	5557.14 ± 569.74	9175.78 ± 566.67	7853.43 ± 698.66	significant
15	6879.17 ± 598.98	8973.52 ± 633.55	8007.12 ± 577.61	significant
30	8584.93 ± 563.77	8339.90 ± 644.19	7996.86 ± 633.77	significant

laryngoscopy and intubation reduced heart rate rather than blood pressure (1998).[13]

Bostana and Eroglu demonstrated the efficacy of 1 mg kg^{-1} IV esmolol given prior to intubation (2012).[14] Esmolol 2 mg kg^{-1} has also been shown to be safe and effective in Asian populations, with no reports of unexpected hypotension or bradycardia. However, no one has agreed on the best dose or timing for administration.[15] Lidocaine, when given, inhibits or lowers the normal decrease in potassium ion permeability that occurs during phase 4 depolarization. Lidocaine's ability to attenuate the haemodynamic stress response is explained by its ability to diminish the rate of spontaneous phase 4 depolarization. When esmolol is delivered at 2 mg/kg, the heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and the rate pressure product all go below the baseline. In this group, hypotension and bradycardia were more common.[16]

Although 1.5 mg/kg lignocaine reduces heart rate, it has no impact on blood pressure, diastolic and mean arterial pressure, or rate product. Only the drug combination of lignocaine 1 mg/kg and esmolol 1 mg/kg maintained hemodynamic values close to baseline during laryngoscopy. First, third, and fifth minutes after intubation. While lignocaine had no effect on heart rate, the combination group was consistently advantageous in reducing the reactivity to tracheal intubation, as shown by the authors' findings. The Bp reaction was unaffected by lidocaine or esmolol. Only esmolol and lidocaine can lower systolic blood pressure. Harbhej Singh et al.[17] discovered that Lidocaine and acetaminophen are efficient anaesthetics.

Nitroglycerin was shown to be ineffective in controlling the initial hemodynamic response during laryngoscopy and intubation. When compared to esmolol, lidocaine or nitroglycerin had no effect on the HR response to laryngoscopy or intubation. There was a significant difference in MAP M decrease between lidocaine and Esmolol. According to Andrew Levitt et al.[18] Lidocaine and Esmolol had equal effectiveness in attenuating moderate hemodynamic response to intubation in persons with isolated head trauma. Sanjeev Singh et al.[19] discovered that esmolol prophylactic therapy was more effective and safe than lidocaine in lowering cardiovascular reactivity to laryngoscopy and tracheal intubation in a study in a black population.

Conclusion

Esmolol and lidocaine together are a safe and effective strategy to minimise laryngoscopy responses to intubation and extubation, lowering myocardial oxygen consumption and the risk of myocardial ischemia under general anaesthesia.

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