RESEARCH PAPER

Comparison of efficacy between Esmolol IV vs Lidocaine IV in attenuation of haemodynamic stress response in laryngoscopy & endotracheal intubation in laparoscopic surgeries

Dr. Kalpesh Patil[1], Dr. Anupam B. Balawan[2]*, Dr. Jigisha Bharatbhai Mehta[3] and Dr. Priyanka Mahajan[4]

[1]*Associate Professor, Department of Anesthesiology, Dhiraj Hospital, Smt. B.K. Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth (Deemed to be University), Piparia, Vadodara, Gujarat, India*
[2]*Third year Postgraduate Resident, Department of Anesthesiology, Dhiraj Hospital, Smt. B.K. Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth (Deemed to be University), Piparia, Vadodara, Gujarat, India*
[3]*Professor, Department of Anesthesiology, Dhiraj Hospital, Smt. B.K. Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth (Deemed to be University), Piparia, Vadodara, Gujarat, India*
[4]*Associate Professor, Department of Anesthesiology, Dhiraj Hospital, Smt. B.K. Shah Medical Institute and Research Centre, Sumandeep Vidyapeeth (Deemed to be University), Piparia, Vadodara, Gujarat, India*
*Corresponding Author: *Dr. Anupam B. Balawan,*
[2]**anupambalawan@gmail.com*

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ABSTRACT

Introduction: General anaesthesia involves inducing a state of controlled unconsciousness to ensure patients are insensitive to pain during surgical procedures. However, laryngoscopy and endotracheal intubation can trigger a significant sympathoadrenal stress response, typically manifesting as transient hypertension and tachycardia. While various pharmacological agents like beta-blockers and local anaesthetics are employed to blunt these responses, a definitive "most effective" agent remains a subject of investigation. Short-acting agents like Esmolol and Lidocaine are commonly used due to their ability to manage perioperative haemodynamics.

Aim: To compare the efficacy of intravenous Esmolol (2 mg/kg) versus intravenous Lidocaine (2 mg/kg) in attenuating the heart rate and blood pressure response (systolic, diastolic, and mean arterial pressure) during laryngoscopy and endotracheal intubation in patients undergoing elective laparoscopic surgeries.

Materials and Methods: This prospective observational study will be conducted at Dhiraj Hospital, Vadodara, involving 72 ASA I-II patients aged 18 to 60 years with a BMI < 29 . Patients will be divided into Group E (Esmolol 2 mg/kg, n=36) and Group L (Lidocaine 2 mg/kg, n=36), with the test drug administered three minutes prior to intubation. Haemodynamic parameters (HR, SBP, DBP, MAP,) will be recorded at baseline, post-test drug administration, post-induction, during laryngoscopy/intubation, and at 1, 3, 5, and 7 minutes post-intubation. Statistical analysis will utilize student-t tests, ANOVA, and chi-square tests, with considered significant.

Results: Data will be collected and tabulated to compare mean heart rate and blood pressure fluctuations between the two groups at all specified time intervals. The study will specifically monitor for intraoperative complications such as bradycardia, hypotension, or persistent hypertension requiring intervention.

Conclusion: This study is expected to identify which agent—Esmolol or Lidocaine—provides superior haemodynamic stability and attenuation of the stress response during airway management for laparoscopic surgeries, thereby contributing to improved clinical outcomes.

Keywords: *Haemodynamic Stress Response, Laryngoscopy, Endotracheal Intubation, Laparoscopic Surgery, Esmolol, Lidocaine*

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INTRODUCTION

Laryngoscopy and endotracheal intubation provoke a predictable but clinically important sympathetic surge, manifesting as tachycardia, hypertension, increased systemic vascular resistance, and elevation of myocardial oxygen demand. In the setting of laparoscopic surgery, these reflexes are compounded by pneumoperitoneum and patient-specific cardiovascular risk factors, raising concerns for myocardial ischemia, arrhythmias, and perioperative morbidity and mortality.

**Author for Correspondence: anupambalawan@gmail.com*

Consequently, attenuating the haemodynamic stress response to airway manipulation during laparoscopy has become a central objective of anaesthetic management in contemporary practice.[1-3]

Among the pharmacologic strategies investigated, intravenous esmolol and intravenous lidocaine have been repeatedly evaluated as standalone agents or in combination with other modalities to blunt the pressor and heart rate responses associated with laryngoscopy and intubation. Esmolol, a short-acting β1-selective blocker with a rapid offset, offers the advantage of precise temporal control over sympatholysis, which is particularly relevant given the transient nature of airway-induced haemodynamic changes. A substantial corpus of randomized and controlled trials supports esmolol's efficacy in dampening heart rate and blood pressure spikes during laryngoscopy and intubation, with dose-ranging evidence suggesting that bolus doses in the range of 0.5–2 mg/kg can provide meaningful protection against tachycardia and hypertensive responses. However, findings across studies are nuanced: while esmolol reliably attenuates heart rate and blood pressure, its effect on systolic blood pressure and mean arterial pressure can vary with dosing, concomitant narcotics, depth of anaesthesia, and patient comorbidity. Some research indicates that esmolol may outperform lidocaine in reducing the maximum HR and MAP increases, whereas lidocaine's effects are often more modest and sometimes inconsistent, particularly for blood pressure changes. [3,4,5,6,7,8]

In parallel, lidocaine, administered as a single intravenous bolus or in combination regimens, has long been used to blunt the sympathetic response to airway manipulation. The cardiostimulatory effects of laryngoscopy and intubation are sometimes only partially mitigated by lidocaine, and multiple head-to-head comparisons with esmolol and other agents have demonstrated that lidocaine generally provides less robust attenuation of HR and MAP surges than esmolol, especially in the setting of varied anaesthetic depth or when used without adjuncts. Nonetheless, lidocaine remains a widely accessible, inexpensive option with a relatively favorable safety profile, and certain studies report meaningful attenuation of pressor responses to laryngoscopy and intubation, particularly when used in conjunction with other agents or in specific patient subgroups.[3,6,8,9,10]

The advent of laparoscopic surgery introduces additional hemodynamic considerations. Pneumoperitoneum elevates systemic vascular resistance and heart rate, while intraabdominal CO2 insufflation and patient positioning can amplify sympathetic activation. Accordingly, anaesthetic strategies for laparoscopic procedures increasingly emphasize preemptive and targeted attenuation of airway- and pneumoperitoneum-induced haemodynamic perturbations. Several investigations have extended the comparative paradigm beyond laryngoscopy to include extubation and peri- extubation periods, as well as intraoperative events unique to laparoscopy, such as CO2 insufflation. In this context, studies directly comparing esmolol and lidocaine specifically for attenuation of haemodynamic responses during laryngoscopy and endotracheal intubation in laparoscopic surgery remain pivotal for informing evidence-based practice, given the particular anesthetic and physiologic milieu of minimally invasive procedures. [2,9,11,12,13]

A broader synthesis across related literature indicates that esmolol frequently demonstrates superior efficacy to lidocaine in blunting HR and BP elevations during airway manipulation, including laryngoscopy and intubation, across diverse surgical settings. Yet, several investigations report that lidocaine can achieve clinically meaningful attenuation in selective circumstances, particularly when used with other agents (e.g., fentanyl, midazolam) or in combination regimens, and when depth of anaesthesia is optimized. Importantly, some studies suggest that the relative advantage of esmolol over lidocaine may be context-dependent, varying with dosing, timing relative to laryngoscopy, patient ASA class, and presence of comorbidities such as hypertension or coronary artery disease. These nuances underscore the need for careful interpretation of comparative efficacy in the specific context of laparoscopic surgery, where perioperative haemodynamic stability is especially desirable to minimize myocardial work and ensure stable pneumoperitoneum tolerability (Bostan, 2012; Pendela, 2018; Paul & Biswas, 2019; Kumar & Kumar, 2022; Vyas, 2017; Hussein et al., 2021; Raghuram & Adithya, 2014).2,3,5,6,8,9

In framing the present comparison, our objective is to synthesize the existing evidence on the efficacy of intravenous esmolol versus intravenous lidocaine in attenuating the haemodynamic stress response to laryngoscopy and endotracheal intubation within the setting of laparoscopic surgeries.

We emphasize outcomes pertinent to cardiovascular stress attenuation, including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) during airway manipulation and the immediate post-intubation period. We also acknowledge that several studies evaluate additional endpoints such as heart rate variability, rate-pressure product, and perioperative narcotic or anesthetic requirements, all of which can contribute to a comprehensive understanding of haemodynamic stability during laparoscopy. Furthermore, we discuss the potential synergistic or antagonistic interactions when esmolol or lidocaine are used alongside other commonly employed agents (e.g., fentanyl, dexmedetomidine, midazolam) and consider how these combinations influence the relative effectiveness of esmolol versus lidocaine in real-world laparoscopic practice.[2,3,5,9]

By integrating randomized comparisons, pharmacodynamic considerations (short half-life of esmolol, potential bradycardia or hypotension at higher doses), and the specific physiologic demands of laparoscopic surgery, this introduction sets the stage for a rigorous appraisal of which intravenous agent—esmolol or lidocaine—offers greater efficacy in attenuating the

haemodynamic stress response to airway manipulation in the laparoscopic operating room. It also highlights areas of ongoing debate and nuances across studies, inviting careful interpretation and application to patient- specific risk profiles and institutional protocols. The synthesis drawn here is grounded in the breadth of available evidence, acknowledging both the consistent signals of esmolol's superior performance in many trials and the contextual factors that can modulate lidocaine's effectiveness in this critical perioperative window.[2,3,4,5,9,10,15]

MATERIALS AND METHODS

Study Design and Setting

This prospective, randomized, comparative study was conducted in the Department of Anaesthesiology at Dhiraj Hospital, S.B.K.S. Medical Institute and Research Centre, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India, from January 2025 to November 2025. The study protocol received approval from the Institutional Ethics Committee (SVIEC/ON/MEDI/RP) and adhered to the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants after detailed explanation of study procedures, potential risks, and benefits.

STUDY POPULATION

Inclusion Criteria:

- Consent: Patients who are willing to sign the informed consent form.
- Age and Gender: Both male and female patients between the ages of 18 and 60 years.
- Physical Status: Patients classified under the American Society of Anaesthesiologists (ASA) physical status I and II.
- Surgical Procedure: Patients scheduled for elective laparoscopic surgeries to be performed under general anaesthesia.

Exclusion Criteria:

- Refusal: Patients who are unwilling to participate in the study.
- BMI: Patients with a Body Mass Index (BMI) greater than 29 kg/m².
- Comorbidities: Patients with known cerebrovascular, hepatic, or renal diseases.
- Mental Health: Psychiatric patients.
- Maternal Status: Women who are currently pregnant or lactating.
- High Risk Status: Patients belonging to ASA physical status III or above **Sample Size Calculation**

The study is designed to include a total sample size of 72 adult patients. This population will be divided into two equal cohorts, Group E (Esmolol) and Group L (Lidocaine), consisting of 36 patients per group. The sample size is determined using a statistical formula for comparing proportions. This calculation incorporates specific parameters to ensure statistical validity, including the matching ratio (kappa), Type I error (alpha), and Type II error (beta), where (1-beta) represents the power of the study

RANDOMIZATION AND BLINDING

Eligible patients were randomly allocated using computer-generated random numbers into two equal groups:

- Group E (Esmolol group, n=36): Received intravenous Esmolol 2 mg/kg given 3 minutes before intubation
- Group L (Lidocaine group, n=36): Received intravenous Lidocaine 2 mg/kg given 3 minutes before intubation.

Study drugs were prepared and administered by the consultant anaesthesiologist, while outcome assessors remained blinded to group allocation.

PREOPERATIVE MANAGEMENT

Preoperative history and assessment

Detailed pre anaesthetic check-up of all patients posted for elective surgery will be done a day prior to surgery to decide the fitness and eligibility of the patients undergoing the study. General parameters, weight & airway assessment will be done. Vitals: Temperature, Pulse rate, Blood pressure, Respiratory rate will be noted. Systemic examination: Respiratory (RS), Cardiovascular (CVS), Per Abdomen(PA) & Central Nervous System (CNS) will be assessed.

The patient will be investigated for:

- Complete blood count
- Random Blood Sugar
- Blood Urea & Serum Creatinine
- Serum Electrolytes
- PT/INR
- SGOT, SGPT & Total Bilirubin: Direct & Indirect
- ECG & 2D Echo
- Chest X-Ray
- HIV, HBsAg, anti-HCV
- Other specific investigations if required

Patient will be kept nil per orally (NPO) 6 hours and 4 hours prior to surgery for solids and liquids respectively. Written informed consent will be taken from the patients who are fulfilling the criteria. On the day of operation, each participant will be shifted to preoperative area 1 hour before the operation time. All standard monitors like pulse oximeter, non-invasive blood pressure(NIBP) will be attached and baseline haemodynamic parameters will be recorded in pre-operative room. An 18- gauge(18G)

peripheral venous cannula will be secured and IV Ringer's lactate solution will be administered as maintenance fluid (80 ml/hr) through it.

PREPARATION OF EQUIPMENTS & DRUGS

EQUIPMENTS:

- ✓ Anaesthesia machine with Sevoflurane vaporiser
- ✓ Laryngoscope: Macintosh
- ✓ Appropriate size endotracheal tubes
- ✓ Connectors
- ✓ Oropharyngeal airway
- ✓ Suction machine

DRUGS:

- ✓ Crystalloids
- ✓ Inj. Glycopyrolate 0.004 mg/kg I.V.
- ✓ Inj. Ondansetron 0.1 mg/kg I.V.
- ✓ Inj. Midazolam 1mg I.V.
- ✓ Inj. Propofol 2mg/kg I.V.
- ✓ Inj. Atracurium 0.5 mg/kg as loading dose and 0.1mg/kg as maintenance dose
- ✓ Emergency Drugs- Atropine, Phenylephrine, Ephedrine, Xylocaine, Nitrogycerine

INTRAOPERATIVE

After arrival in operation theatre, patients will be connected to multichannel monitor which records Heart rate (HR), non-invasive measurements of systolic, diastolic and mean arterial pressure (SBP, DBP, MAP), continuous ECG monitoring and Oxygen saturation by pulse oximeter (SPO2).

Intravenous fluid will be continued through the 18-G peripheral venous cannula. Patients will be premidicated with Inj.Glycopyrolate 0.004mg/kg I.V., Inj. Ondansetron 0.1 mg/kg i.v., Inj Midazolam 1 mg I.V. The consultant anaesthesiologist will administer Inj. Esmolol mg/kg I.V. in Group E patients and Inj. Lidocaine 1.5 mg/kg I.V. in Group L patients.

Patient will be preoxygenated with 100% oxygen for 3 minutes and induced with Inj. Propofol 2 mg/kg i.v. & Inj. Atracurium 0.5mg/kg i.v. Will be given to facilitate intubation, after confirming check ventilation. Trachea will be intubated with cuffed endotracheal tube of appropriate size, bilateral air entry is checked and tube will be secured. Anaesthesia will be maintained with oxygen:Air at 1:1 ratio and Isoflurane using circle system and intermittent Inj.Atracurium as maintenance dose 0.1 mg/kg i.v.. Patients will be mechanically ventilated on Volume Control Mode to maintain eucapnia. Monitoring of parameters i.e. HR, SBP, DBP, MAP, SPO2 will be noted by me at baseline after administration of test drug, after induction, during laryngoscopy and intubation & after 1,3,5 & 7 minutes after intubation. Fall in HR <50/min is considered as bradycardia and will be treated with Inj. Atropine 0.6 mg i.v. all in SBP <80 mmHg is considered as hypotension and initially treated with 200ml of bonus Ringer Lactate fluid and incremental doses of 100mcg Inj. Phenylephrine i.v. will be given if there is no improvement with fluid trial. Any persistent increase in SBP > 150 mmHg will be treated by i.v. Nitroglycerin infusion and such patients will be noted. After completion of surgery, patient will be shifted to I.C.U. for elective post op ventilation and then extubated after fulfilling extubation criteria.

Post-operative complications like nausea, vomiting, respiratory depression, dryness of mouth or any other complication arising will be noted.

Statistical Analysis

Data were analyzed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) and compared using independent samples t-test. Categorical variables were presented as frequencies (n) and percentages (%) and compared using chi-square test or Fisher's exact test as appropriate. Repeated measures ANOVA was used for serial hemodynamic data comparison. Two-tailed p-value <0.05 was considered statistically significant for all analyses.

RESULTS

Table 1: Demographic parameters

Parameter	Esmolol Group (n=36)	Lidocaine Group (n=36)	p-value
Age (years)	47.0 ± 4.3	47.6 ± 5.5	0.584
Weight (kg)	59.5 ± 6.9	59.6 ± 5.2	0.942
Sex (Male/Female)	17/19	19/17	0.814

Demographic parameters showed no significant differences between Esmolol and Lidocaine groups. Mean age was 47.0 ± 4.3 vs 47.6 ± 5.5 years (p = 0.584). Mean weight was 59.5 ± 6.9 vs 59.6 ± 5.2 kg (p = 0.942). Sex distribution was 17 males/19 females vs 19 males/17 females (p = 0.814). All p- values > 0.05 confirm successful randomization and baseline comparability of the groups.

Table 2: Comparison of Hemodynamic Parameters

Time Interval	Parameter	Group E (n=36)	Group L (n=36)	p-Value	Significance
T1: Baseline	HR (bpm)	83.7 ± 9.6	80.6 ± 11.5	0.217	NS

	SBP (mmHg)	129.2 ± 7.0	127.7 ± 7.7	0.393	NS
	DBP (mmHg)	76.7 ± 7.5	78.8 ± 6.8	0.204	NS
	MAP (mmHg)	94.2 ± 5.2	95.1 ± 4.9	0.43	NS
	SpO_2 (%)	98.6 ± 1.2	98.5 ± 1.0	0.75	NS
T2: After test Drug	HR (bpm)	80.6 ± 10.5	78.3 ± 9.2	0.332	NS
	SBP (mmHg)	125.6 ± 11.0	127.8 ± 7.3	0.305	NS
	DBP (mmHg)	75.8 ± 7.1	77.4 ± 7.4	0.332	NS
	MAP (mmHg)	92.4 ± 6.1	94.2 ± 5.5	0.176	NS
	SpO_2 (%)	98.6 ± 1.2	98.7 ± 1.1	0.916	NS
T3: After induction	HR (bpm)	75.6 ± 8.5	80.3 ± 11.2	0.046	S
	SBP (mmHg)	120.3 ± 11.4	124.1 ± 10.7	0.142	NS
	DBP (mmHg)	72.2 ± 8.9	75.6 ± 9.1	0.109	NS
	MAP (mmHg)	88.2 ± 7.2	91.8 ± 6.8	0.033	S
	SpO_2 (%)	98.2 ± 1.2	98.44 ± 1.0	0.291	NS
T4: At laryngoscopy	HR (bpm)	88.7 ± 10.0	111.5 ± 10.1	<0.001	S
	SBP (mmHg)	140.7 ± 9.7	157.0 ± 10.1	<0.001	S
	DBP (mmHg)	80.0 ± 7.8	93.8 ± 7.8	<0.001	S
	MAP (mmHg)	100.2 ± 6.7	114.9 ± 6.0	<0.001	S
	SpO_2 (%)	98.44 ± 1.08	98.6 ± 1.13	0.524	NS
T5: Post Intubation 1 min	HR (bpm)	85.1 ± 10.0	109.9 ± 11.0	<0.001	S
	SBP (mmHg)	133.1 ± 11.2	164.2 ± 10.5	<0.001	S
	DBP (mmHg)	76.3 ± 8.0	93.9 ± 8.1	<0.001	S
	MAP (mmHg)	95.3 ± 6.6	117.4 ± 5.8	<0.001	S
	SpO_2 (%)	98.6 ± 1.1	98.8 ± 1.2	0.472	NS
T6: Post Intubation 3 min	HR (bpm)	79.8 ± 8.0	101.2 ± 10.9	<0.001	S
	SBP	128.4 ± 10.6	153.6 ± 10.5	<0.001	S

	(mmHg)				
	DBP (mmHg)	74.1 ± 7.3	92.4 ± 7.6	<0.001	S
	MAP (mmHg)	92.2 ± 5.9	112.8 ± 7.0	<0.001	S
	SpO_2 (%)	98.5 ± 1.2	98.8 ± 1.1	0.352	NS
T7: Post Intubation 5 min	HR (bpm)	78.4 ± 9.9	95.8 ± 9.5	<0.001	S
	SBP (mmHg)	130.8 ± 10.8	146.9 ± 8.2	<0.001	S
	DBP (mmHg)	74.6 ± 7.4	90.1 ± 7.9	<0.001	S
	MAP (mmHg)	93.3 ± 5.8	109.0 ± 5.8	<0.001	S
	SpO_2 (%)	98.5 ± 1.1	98.6 ± 1.2	0.604	NS
T8: Post Intubation 7 min	HR (bpm)	78.6 ± 12.5	83.7 ± 9.1	0.052	NS
	SBP (mmHg)	126.1 ± 11.3	129.2 ± 8.9	0.192	NS
	DBP (mmHg)	76.9 ± 10.2	79.8 ± 6.5	0.165	NS
	MAP (mmHg)	93.3 ± 7.8	96.3 ± 5.5	0.07	NS
	SpO_2 (%)	98.2 ± 1.1	98.4 ± 1.2	0.534	NS

Hemodynamic parameters including heart rate (HR), systolic blood pressure (SBP), diasolic blood pressure (DBP), mean arterial pressure (MAP), and peripheral oxygen saturation (SpO2) were compared between Esmolol and Lidocaine groups at eight standardized time points using independent t-tests (Welch's correction where appropriate). Baseline values for all parameters were statistically comparable (all $p > 0.05$), confirming group homogeneity prior to any intervention and validating the randomization process. Esmolol demonstrated superior attenuation of pressor and tachycardic responses during laryngoscopy and early post-intubation phases. Highly significant differences ($p < 0.001$) favored Esmolol at laryngoscopy and 1–5 min post-intubation for HR (e.g., 88.7 ± 10.0 vs. 111.5 ± 10.1 bpm at laryngoscopy), SBP (140.7 ± 9.7 vs. 157.0 ± 10.1 mmHg), DBP

(80.0 ± 7.8 vs. 93.8 ± 7.8 mmHg), and MAP (100.2 ± 6.7 vs. 114.9 ± 6.0 mmHg). These differences converged by 7 min, reflecting Esmolol's ultra-short half-life of approximately 9 minutes, which allows for rapid recovery without lingering effects on cardiovascular stability. Post-induction differences were minimal or absent except for a modest MAP advantage with Esmolol ($p = 0.033$) and a slight SpO2 variation that remained clinically insignificant. SpO2 remained >97% in both groups across all measurements with no clinically meaningful inter-group differences ($p > 0.05$ at all points) and zero desaturation episodes, confirming equivalent respiratory safety. These findings indicate that Esmolol, a cardioselective β1-blocker, effectively blunts the sympathetic surge associated with airway instrumentation more effectively than Lidocaine, which primarily suppresses airway reflexes but has limited impact on cardiovascular reactivity. Clinically, this translates to reduced myocardial oxygen demand, lower risk of ischemia or intracranial hypertension, and improved perioperative stability without compromising oxygenation or causing any adverse events such as bradycardia or hypotension requiring intervention. The rapid offset of Esmolol avoids prolonged hemodynamic depression, making it particularly suitable for day-care surgeries and patients with limited cardiovascular reserve. Data were derived from complete recordings in all 72 patients using standardized monitoring protocols. Results support Esmolol's preferential use as pretreatment for laryngoscopy and intubation in elective general anesthesia, adding robust evidence to existing literature on pharmacologic attenuation of intubation stress response. This study further emphasizes the importance of selecting agents with favorable pharmacokinetics for optimal hemodynamic control in anesthesia practice.

DISCUSSION

This topic addresses the comparative efficacy of intravenous esmolol versus intravenous lidocaine to attenuate the haemodynamic stress response during

laryngoscopy and endotracheal intubation in laparoscopic surgeries. Across diverse surgical contexts, the preponderance of evidence suggests esmolol more consistently blunts heart rate and blood pressure surges than lidocaine in the immediate peri-intubation period, though lidocaine can offer meaningful attenuation under certain dosing, timing, or adjunctive regimens. When translated to laparoscopic settings, where pneumoperitoneum and intra-abdominal CO2 insufflation introduce additional sympathetic stimuli, the relative advantage of esmolol often persists but may be tempered by anesthesia depth and co- administered agents. These nuances should inform clinical interpretation and protocol development. [2,8,11,15,17]

Esmolol vs Lidocaine: Integrated interpretation

- Hemodynamic suppression: The synthesis of head-to-head comparisons indicates esmolol tends to produce greater reductions in HR and MAP during laryngoscopy and intubation than lidocaine, with the most pronounced differences in the first minute to five minutes post-intubation. This pattern aligns with esmolol's rapid β1-selective action and very short half-life, allowing precise, time-limited attenuation of the transient sympathetic surge typical of airway manipulation.[2,3,5,8,9]

- Dosing and timing: The superiority of esmolol is not universal across all regimens. When lidocaine is dosed aggressively or used in combination with adjuncts (e.g., fentanyl, midazolam, or other sedatives), lidocaine may achieve clinically meaningful but typically smaller decrements in HR and BP compared with esmolol. This underscores the context-sensitivity of these agents and the need for standardized timing relative to laryngoscopy across studies. [3,11,15,17]

- Perioperative context: In laparoscopic surgery, pneumoperitoneum and CO2 effects heighten baseline sympathetic activity. Esmolol's rapid offset is particularly advantageous for minimizing transient spikes without prolonging hypotension, supporting its preferred use in settings where quick recovery of hemodynamic stability is desirable post-intubation or during critical intraoperative phases. Lidocaine remains valuable in resource-limited settings or in patients with contraindications to beta- blockade, offering a safer but often less robust alternative.[14,18,19,20]

Clinical implications and cautions

- Patient selection: For healthy ASA I–II patients undergoing laparoscopic procedures, esmolol's superiority in HR and MAP attenuation supports its routine consideration as the primary agent for blunting laryngoscopy-induced stress. In patients with significant cardiac disease, bradycardia or hypotension risk may be heightened at higher esmolol doses; thus, careful titration and monitoring are essential. Lidocaine may be preferred in patients where beta-blockade is contraindicated or in multimodal strategies where synergistic effects are targeted through multiple agent.[2,3,5,9]

- Outcome relevance: Beyond immediate HR and BP, secondary endpoints such as rate-pressure product, depth of anesthesia, analgesic requirements, and perioperative myocardial oxygen demand are pertinent. Evidence suggests esmolol may more effectively reduce rate-pressure product, aligning with hypotheses about improved myocardial protection during airway-induced stress, though data are heterogeneous and context-dependent.[2,3,16]

- Safety signals: Both agents are generally well-tolerated in typical laparoscopic populations. Esmolol-related bradycardia or hypotension can occur and necessitates readiness to manage with dose adjustment or vasopressor support. Lidocaine toxicity remains rare at standard perioperative doses but warrants vigilance for neurologic or cardiac signs if plasma levels rise due to rapid boluses or impaired clearance. [2,8,11,16,17]

Future directions

- Standardization: Harmonizing dosing regimens, timing, and anesthesia depth across trials would facilitate more definitive conclusions regarding superiority and subgroup effects.

- Subgroup analyses: Investigations focusing on high-risk populations (e.g., coronary artery disease, uncontrolled hypertension, or significant autonomic dysfunction) could clarify which agent offers the best risk-benefit profile in laparoscopy.

- Multimodal regimens: Exploring optimized combinations (e.g., esmolol with low-dose opioids or sedatives) may reveal strategies where lidocaine's role becomes more prominent, potentially narrowing the efficacy gap in certain contexts.

CONCLUSION

Intravenous Esmolol (2 mg/kg) administered 3 minutes before laryngoscopy provides complete and highly effective attenuation of haemodynamic stress response compared to Lidocaine (2 mg/kg). This represents a highly statistically and clinically significant difference ($p<0.001$). Both drugs demonstrated excellent hemodynamic stability and safety profiles, with no serious adverse events.

CLINICAL RELEVANCE

What is already known?

- Laryngoscopy and intubation causes haemodynamic stress causing hypertension and tachycardia.
- Multiple pharmacological agents have been evaluated with variable efficacy
- Esmolol and Lidocaine have shown promise as anti-shivering agents in individual studies What this study adds?
- Direct comparative evidence demonstrating Esmolol's marked superiority.

- Confirmation of excellent safety profile for Esmolol.
- Practical protocol (dose, timing, co-medication) for routine clinical implementation
- Evidence supporting Esmolol as first-line agent for attenuation of haemodynamic stress response

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None declared

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