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Hemodynamic Stability of Lidocaine-Based Versus Fentanyl-Based Induction of Anesthesia in Hypertensive Adults: A Randomized, Controlled Study.

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Abstract:

Background: Careful anesthetic management is crucial for hypertensive patients undergoing surgery. The purpose of this research was to evaluate the hemodynamic stability of lidocaine versus fentanyl during the post-induction period in hypertensive adults.

Methods: This randomized, controlled, double-blinded trial involved 40 hypertensive patients aged 18-60 years with American Society of Anesthesiologists Physical Status (ASA) II, who were randomly assigned to receive either lidocaine (1.5 mg/kg) or fentanyl (2 µg/kg) for anesthetic induction. Hemodynamic measures, such as heart rate, blood pressure, and mean arterial pressure (MAP), were documented at different time intervals.

Results: The lidocaine group exhibited significantly more stable systolic, diastolic, and MAP than the fentanyl group from 1-minute post-induction through 15 minutes post-intubation ($p<0.05$). The hypotension incidence was also significantly higher in the fentanyl group than in the lidocaine group (55% vs. 15%, with a relative risk of 0.272, 95% CI (0.089 to 0.832), p=0.018).

Conclusions: Fentanyl-based induction of anesthesia in hypertensive adults resulted in greater hemodynamic instability, with significantly lower blood pressure measurements and a higher incidence of hypotensive episodes compared to lidocaine-based induction.

Keywords: Hypertension, Anesthesia induction, Fentanyl, Lidocaine, Hemodynamic stability

1. Introduction

Hypertension represents a health issue affecting millions of people globally and represents a major risk factor for cardiovascular disease and other comorbidities. (1) General anesthesia in hypertensive adults is usually associated with marked hemodynamic changes due to contracted intravascular fluid volume and arterial vasculature stiffening. Subsequently, careful preoperative evaluation and anesthetic management are crucial in hypertensive patients. (2)

Intraoperative hypotension is a common consequence of anesthetic induction in hypertensive patients. It increases the risk of postoperative morbidity and mortality as it decreases vital organs' perfusion which might lead to acute kidney injury, myocardial ischemia, or cerebrovascular stroke. (3, 4, 5) Approximately two-thirds of hypotensive events that occur during surgery are attributed to postinduction hypotension (PIH) which is defined as as hypotension during the first 20 min after anesthesia induction, or from anesthesia induction until the beginning of surgery. (6) As anesthetic agents primarily induce hypotension in the post-induction period and its risk escalates with advancing age, (7,8) the development of anesthetic induction techniques that ensure sufficient hypnosis while, maintaining the patient's hemodynamics stable during surgery is paramount, particularly in hypertensive patients. (9)

Lidocaine, a local anesthetic, is also used to blunt the hemodynamic responses to endotracheal intubation. (10) It stabilizes the neuronal membrane by inhibiting the initiation and conduction of nerve impulses, and the literature has shown it can effectively reduce the pressor response to intubation, though its efficacy depends on the dosage and timing of administration. (11, 12, 13)

Fentanyl is frequently employed in anesthesia for its rapid onset and potent analgesic effects. (14) Its use has been associated with a reduction in the sympathetic response during intubation, thereby promoting hemodynamic stability during general anesthesia, particularly in hypertensive patients. (15, 16, 17)

Studies comparing the effects of lidocaine and fentanyl found that while both agents were effective, fentanyl provided a more consistent attenuation of hemodynamic responses. (12, 18)

Given these observations, The purpose of this research was to evaluate the hemodynamic stability of lidocaine versus fentanyl in hypertensive adults during the post-induction period, defined as the interval from anesthesia induction to the commencement of surgery.

Methodology:

This study was designed to be a prospective, randomized, controlled, double-blinded study. It was carried out at Theodor Bilharz Research Institute, Egypt after approval of the Research Ethical Committee approval (PT 812), and informed written consent was signed by all participants. The trial was registered in the ClinicalTrials.gov ID: NCT06557473.

A computer-generated randomization sequence was used to divide the eligible patients into two equal groups. The opaque, sealed envelopes were numbered sequentially and used to conceal allocations. The attending anesthesiologists and the patients were unaware of the group

assignment. An impartial anesthesiologist who had no hand in either patient treatment or data collecting prepared the study's medication.

The study involved 40 patients that were divided into 2 groups; the lidocaine group (L) and the fentanyl group (F). The assigned patients aged 18-60 years of both sexes, classified as American Society of Anesthesiologists Physical Status (ASA) II, diagnosed with controlled hypertension (systolic pressure < 140 mm Hg and diastolic < 90 mm Hg), on continuous medication for over 5 years, and planned for elective non-cardiac surgery requiring general anesthesia.

Patients were excluded from the study if they had uncontrolled hypertension (systolic pressure ≥ 140 mmHg and diastolic pressure ≥ 90 mmHg), stroke volume variability (SVV) ≥ 13%, anticipated difficult intubation, pregnancy, history of drug abuse, obesity (BMI ≥ 35 kg/m^2), and allergy to study medications.

Anesthetic management:

Preoperative assessment was performed on all patients, including history, physical examination, and laboratory data review. In the preparatory room, premedication with midazolam 2 mg IV was administered. An electrical cardiometry device (ICON; Cardiotonic, Osypka; Berlin, Germany) was applied to assess fluid responsiveness using an SVV cut-off value of ≥13%. Patients with SVV ≥13% were excluded from the study.

In the operating theater, basic monitoring (pulse oximetry Spo2, non-invasive blood pressure NIBP, and electrocardiogram ECG) was applied to all patients. Anesthesia was induced using 1.5 mg/kg lidocaine in the lidocaine group or 2 μg/kg fentanyl in the fentanyl group, followed by 2 mg/kg propofol and 0.5 mg atracurium in all patients. After three minutes of mask ventilation, endotracheal intubation was performed by a senior anesthesiologist. Patients experiencing prolonged laryngoscopy (≥ 15 seconds) were excluded. Anesthesia was maintained using 1 MAC of sevoflurane.

Hemodynamic measurements, including HR, systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial blood pressure (MAP), were recorded at baseline. Then every minute for the first 3 minutes before intubation. Immediately after intubation, another reading was recorded, then every 2 min until 15 min after induction of anesthesia.

Any hypotensive episodes that were defined as MAP ≤ 20% of baseline or ≤65 mmHg were managed with 4 μg norepinephrine IV boluses to be repeated if persistent hypotension for more than 2 minutes. Hypertensive episodes which are defined as MAP ≥ 20% of baseline, were treated with 50 μg IV fentanyl. Bradycardia (HR ≤ 45 beats/min) was managed with 0.5 mg atropine, while tachycardia (HR ≥120 beats/min) was treated with 50 μg IV fentanyl.

Hemodynamic stability was assessed by maintaining mean arterial blood pressure (MAP) within 20% above or below the baseline.

Intraoperative fluid maintenance consisted of Ringer's lactate solution at 2 mL/kg/hour. Post-skin incision, hemodynamic, and anesthetic management were managed according to the judgment of the attending anesthesiologist.

The primary outcome measure was MAP changes one minute after anesthesia induction. The secondary outcomes included the frequency of hypotensive, hypertensive, bradycardic, and

tachycardic episodes, as well as the total doses of norepinephrine and supplemental fentanyl administered.

Sample size calculation:

The sample size calculation was calculated using G*Power 3.1.9.2 (Universitat Kiel, Germany). According to a previous study, (19) the mean ± SD of mean arterial blood pressure at T1 (the primary outcome) was 89.6 ± 10.8 mmHg with Lidocaine group and 79.9 ± 11.5 mmHg with Fentanyl. The sample size was based on the following considerations: 1.38 effect size, 95% confidence limit, 95% power of the study, group ratio 1:1, and five cases were added to each group to overcome dropout. Therefore, we will recruit 20 patients in each group.

Statistical analysis

Statistical analysis was conducted using SPSS v27 (IBM©, Armonk, NY, USA). The Shapiro-Wilk test and histograms assessed the normality of the data distribution. Quantitative parametric data were expressed as mean and standard deviation analyzed via unpaired Student's t-test. Qualitative variables were reported as frequency and percentage analyzed using the Chi-square test or Fisher's exact test as applicable. A two-tailed P value < 0.05 was deemed statistically significant.

Results:

In the current study, 56 patients were evaluated for eligibility; 9 patients did not meet the criteria for eligibility, and 7 patients declined to participate. The remaining patients were randomly assigned to two groups of 20 patients each. All assigned patients were monitored and subjected to statistical analysis.

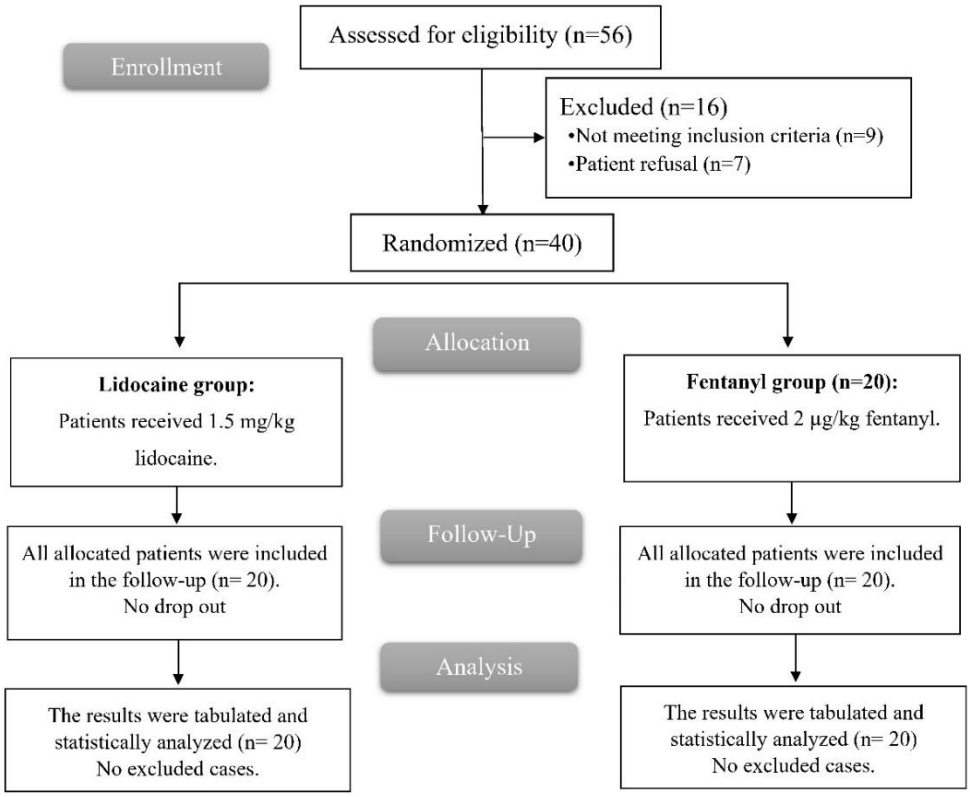

Figure 1: CONSORT flowchart of the enrolled patients

The demographic data including age, sex, height, weight, and BMI were insignificantly different between the studied groups. Table 1

Table 1: Demographic data of the studied groups.

		Lidocaine group (N=20)	Fentanyl group (N=20)	P-value
Age (years)		41.2 ± 9.59	38.65 ± 10.57	0.429
Sex	**Male**	14 (70%)	12 (60%)	0.507
	Female	6 (30%)	8 (40%)	
Weight (kg)		73.65 ± 10.45	72.45 ± 10.59	0.720
Height (cm)		167.1 ± 5.77	167.95 ± 6.76	0.671
BMI (kg/m^2)		26.49 ± 4.24	25.75 ± 3.83	0.568

Data were presented as mean ± SD or frequency (%). BMI: Body mass index.

Regarding the hemodynamic measurements in the studied groups. The recorded HR measurements at different time points: baseline, every minute till 3 minutes after anesthetic induction, immediately after intubation, and then every 2 minutes to 15 minutes after endotracheal intubation were insignificantly different between the studied groups. Table 2

Table 2: Heart rate (beats/min) measurements of the studied groups

Heart rate (HR)		**Lidocaine group (N=20)**	**Fentanyl group (N=20)**	**P-value**
Baseline		78.85±10.12	81.3±9.97	0.445
After induction	**1min**	81±9.74	79.65±10.35	0.673
	2min	82.05±11.14	86.3±17.38	0.363
	3min	85.15±16.56	88.6±19.94	0.555
After intubation	**Immediately**	83.95±13.72	83.2±13.79	0.864
	2min	84.2±14.26	79±13.85	0.249
	4min	80.45±11.71	76.85±13.39	0.371
	6min	79.25±9.37	76.65±11.09	0.428
	8min	79.35±9.22	76.9±9.75	0.419
	10min	80.3±9.32	76.65±9.56	0.229
	12min	80.3±9.17	75.2±9.76	0.097
	15min	80.25±9.3	75.75±9.48	0.138

Data were presented as mean ± SD. *: Significant as P-value <0.05.

The recorded systolic blood pressure (SBP) measurements at different time points showed the following. The baseline reading was comparable between the studied groups. The other readings which were recorded every minute till 3 minutes after anesthetic induction, immediately after intubation, and then every 2 minutes to 15 minutes after endotracheal intubation were significantly higher in the lidocaine group than in the fentanyl group with a P-value < 0.05. Table 3

Table 3: Systolic blood pressure measurements of the studied groups:

Systolic blood pressure (SBP)		**Lidocaine group (N=20)**	**Fentanyl group (N=20)**	**P-value**
Baseline		129±5.56	126.25±7.66	0.202
After induction	**1min**	128.5±7.11	120.2±9.5	**0.003***
	2min	127.8±8.38	118.4±6.06	**<0.001***
	3min	131.85±8.38	121.75±6.17	**<0.001***
After intubation	**Immediately**	128.5±5.07	117.45±6.68	**<0.001***
	2min	127.1±4.39	115.25±9.13	**<0.001***
	4min	124.6±7.57	113.2±12.02	**0.001***
	6min	126.35±4.25	114.85±8.98	**<0.001***
	8min	124.9±5.16	115.25±9.87	**<0.001***
	10min	124.1±4.64	114.6±9.03	**<0.001***
	12min	124.85±4.79	115.5±7.16	**<0.001***
	15min	124.25±4.49	116.35±6.82	**<0.001***

Data were presented as mean ± SD. *: Significant as P-value <0.05.

The recorded diastolic blood pressure (DBP) measurements at different time points showed the following. The baseline reading was comparable between the studied groups. The other readings

which were recorded every minute till 3 minutes after anesthetic induction, immediately after intubation, and then every 2 minutes to 15 minutes after endotracheal intubation were significantly higher in the lidocaine group than in the fentanyl group with a P-value < 0.05. Table 4

Table 4: Systolic blood pressure measurements of the studied groups:

Diastolic blood pressure (DBP)		**Lidocaine group (N=20)**	**Fentanyl group (N=20)**	**P-value**
Baseline		81.5 ± 6.37	80.4 ± 6.01	0.578
After induction	**1min**	80.75 ± 6.3	75.8 ± 6.72	**0.021***
	2min	79.9 ± 6.06	74 ± 4.8	**0.002***
	3min	81.9 ± 5.34	76.25 ± 5.2	**0.002***
After intubation	**Immediately**	79.85 ± 5.15	72.55 ± 5.02	**<0.001***
	2min	79.5 ± 5.07	74.65 ± 4.5	**0.003***
	4min	77.85 ± 7.16	72.25 ± 6.43	**0.013***
	6min	78.75 ± 4.94	74.45 ± 5.26	**0.011***
	8min	76.85 ± 6.47	70.4 ± 6.56	**0.003***
	10min	77.7 ± 4.74	72.9 ± 5.06	**0.004***
	12min	77.2 ± 5.26	72.45 ± 5.03	**0.006***
	15min	76.85 ± 5.31	72.45 ± 4.99	**0.010***

Data were presented as mean ± SD. *: Significant as P-value <0.05.

The recorded mean arterial blood pressure (MAP) measurements at different time points showed the following. The baseline reading was comparable between the studied groups. The other readings which were measured every minute till 3 minutes after anesthetic induction, immediately after intubation, and then every 2 minutes to 15 minutes after endotracheal intubation were significantly higher in the lidocaine group than in the fentanyl group with a P-value < 0.05. Table 5

Table 5: Systolic blood pressure measurements of the studied groups:

Mean blood pressure (MAP)		**Lidocaine group (N=20)**	**Fentanyl group (N=20)**	**P-value**
Baseline		97.27 ± 5.18	95.55 ± 5.08	0.297
After induction	**1 minute**	96.68 ± 5.61	90.6 ± 6.43	**0.003***
	2 minutes	95.78 ± 5.97	88.75 ± 3.29	**< 0.001***
	3 minutes	98.52 ± 3.63	91.45 ± 3.3	**< 0.001***
After intubation	**Immediately**	96.1 ± 3.49	87.55 ± 3.49	**< 0.001***
	2 minnutes	95.4 ± 3.7	88.25 ± 4.13	**< 0.001***
	4 minutes	93.42 ± 6.47	85.95 ± 6.4	**< 0.001***
	6 minutes	94.6 ± 3.57	87.95 ± 3.58	**< 0.001***
	8 minutes	92.87 ± 4.14	85.3 ± 5.63	**< 0.001***

	10 minutes	93.2 ± 3.47	86.8 ± 3.69	**< 0.001***
	12 minutes	93.22 ± 3.86	86.8 ± 3.35	**< 0.001***
	15 minutes	92.75 ± 3.78	87.05 ± 3.41	**< 0.001***

Data were presented as mean ± SD. *: Significant as P-value <0.05.

Concerning the required vasopressors and fentanyl in the studied groups. None of the patients of the lidocaine versus 2 patients of the fentanyl group required norepinephrine with insignificant difference between them. Also, 3 patients in the lidocaine group versus 2 patients in the fentanyl group required additional fentanyl other than the induction dose with no significant difference between them. The total doses of norepinephrine and fentanyl were comparable between the studied groups. Table 6

Table 6: Total dose of norepinephrine and fentanyl of the studied groups

	Lidocaine group (n=20)	**Fentanyl group (n=20)**	**P-value**
Norepinephrine requirement	0 (0%)	2 (10%)	0.487
Total dose of norepinephrine (µg)	0	4 ± 0	---
Fentanyl requirement	3 (15%)	2 (10%)	1
Total dose of fentanyl (µg)	50 ± 0	50 ± 0	---

Data were presented as mean ± SD or number & % as required.

The occurrence of bradycardia, hypertension, and tachycardia was not substantially different between the two groups. The occurrence of hypotension and the frequency of hypotensive episodes were markedly reduced in the lidocaine group compared to the fentanyl group, with a relative risk (RR) of 0.272, 95% CI (0.089 to 0.832) (P=0.018). Hemodynamic stability was markedly superior in the lidocaine group compared to the fentanyl group (P=0.010). Table 7

Table 7: Hypotension, bradycardia, hypertension, and tachycardia of the studied groups

	Lidocaine group (N=20)	**Fentanyl group (N=20)**	**P-value**
Hypotension	3 (15%)	11 (55%)	**0.018***
Number of hypotensive episodes	0(0 - 0)	1(0 - 1)	**0.030***
Hypertension	2 (10%)	3 (15%)	1
Hemodynamic stability	15 (75%)	6 (30%)	**0.010***
Bradycardia	0 (0%)	2 (10%)	0.487
Tachycardia	3 (15%)	7 (35%)	0.273

Data are presented as median (IQR) or frequency (%). *: Significant as P-value <0.05.

Discussion:

The maintenance of hemodynamic stability during anesthetic induction in hypertensive patients remains a critical concern for anesthesiologists. (6) In the scope of hypertensive adults, our results showed that lidocaine exhibited more stable hemodynamic profile than the commonly used opioid

“ fentanyly” in general anesthetic induction with lower incidence of hypotensive episodes and lower requirements of vassopressors.

Our study verified that there were statistically significant variations in SBP between the two sets of participants. The fentanyl group exhibited lower SBP compared to the lidocaine group at all time points from 1-minute post-induction through 15 minutes post-intubation (all $P < 0.05$). This finding is particularly noteworthy given the hypertensive status of our study population. The observed trend aligns with the results reported by Amin et al. (9) who found that the fentanyl group had lower MAP at all time points following anesthesia induction than the lidocaine group.

In contrast to SBP, our study revealed no statistically significant differences in HR measurements between the lidocaine and fentanyl groups at any time point, from baseline through 15 minutes post-intubation. This observation suggests that both agents have comparable effects on HR during anesthesia induction in hypertensive patients. These results correspond with those reported by Amin et al., (9) who similarly found no significant differences in HR between lidocaine and fentanyl groups in individuals over the age of 60 scheduled for elective non-cardiac surgeries. The consistency in HR stability across studies reinforces the notion that both lidocaine and fentanyl can maintain relative cardiac chronotropy during anesthetic induction.

The propensity for fentanyl to induce more significant reductions in BP is further corroborated by Ferguson et al., (20) who reported a higher incidence of post-intubation hypotension in patients receiving fentanyl pretreatment (17%) compared to those who did not receive fentanyl (6%). This relative risk of 2.81 (95% CI: 2.00-3.92) underscores the potential for fentanyl to precipitate more pronounced hypotensive episodes during anesthesia induction.

Our study found significantly lower DBP and MAP in the fentanyl group compared to the lidocaine group at all time points from 1-minute post-induction through 15 minutes post-intubation (all $p < 0.05$). All of these results line up with the observed trends in SBP and further emphasize the more pronounced hypotensive effect of fentanyl during anesthesia induction.

Interestingly, despite the observed differences in BP profiles, our study found there were no notable disparities in the occurrence of or total dose of norepinephrine or fentanyl required. This suggests that while fentanyl induces a more pronounced initial hypotensive response, the overall need for vasopressor support may not differ significantly between the two induction protocols.

Fentanyl patients were more likely to experience hypotension. (55% vs. 15%, $p = 0.018$) than lidocaine patients. Considering this discovery in conjunction with the outcomes, fentanyl patients were more likely to experience hypotension (55% vs. 15%, $p = 0.018$) than lidocaine patients. Considering this discovery in conjunction with the outcomes of Amin et al. (9), who revealed that none of the patients in the lidocaine cohort experienced hypotension, whereas 61% of the fentanyl cohort developed at least one episode of hypotension necessitating norepinephrine delivery.

There is mounting evidence that induction techniques based on lidocaine may provide better hemodynamic stability than those based on fentanyl, and our results give support to this claim, particularly in hypertensive patients. Hans et al. (21) provide additional context, demonstrating that intravenous lidocaine can reduce propofol requirements during anesthesia maintenance and attenuate the hemodynamic response to surgical stimulation. This synergistic effect between

lidocaine and propofol may contribute to the improved BP stability observed in lidocaine-based induction protocols.

The potential benefits of lidocaine extend beyond its effects on BP. Altermatt et al. (22) found that patients receiving intravenous lidocaine required lower maintenance doses of propofol during total intravenous anesthesia for laparoscopic cholecystectomy. While this study noted a slightly longer time to extubation in the lidocaine group, the reduced propofol requirements may offer advantages regarding overall anesthetic management and recovery.

In the context of patients with septic shock, Fathy et al. (23) revealed that the combination of ketamine and lidocaine for anesthesia induction resulted in higher MAP, and relative to ketamine alone, there was a decreased occurrence of post-intubation hypotension. While our study focused on hypertensive patients undergoing elective surgery, these findings highlight the potential for lidocaine to contribute to hemodynamic stability across various patient populations and clinical scenarios.

Several limitations are included in this investigation. Because of the small sample size, our results may not apply to a broader population. Due to our exclusive concentration on short-term hemodynamic effects, we did not evaluate long-term results following surgery. The study was conducted at a single center, potentially introducing institutional bias. Future research should address these limitations by including larger, multicenter cohorts and examining the impact of different induction protocols on long-term patient outcomes.

Conclusions:

Lidocaine-based induction of anesthesia in hypertensive adults resulted in greater hemodynamic stability, with significantly stable BP measurements compared to fentanyl-based induction. The fentanyl group also had a higher incidence of hypotensive episodes.

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Conflict of Interest: Nil

References:

1. Yancey R. Anesthetic management of the hypertensive patient: Part II. Anesth Prog. 2018;65:206-13.
2. Miller RD, Pardo M. Basics of anesthesia e-book: Elsevier Health Sciences ; 2011.
3. Walsh M, Devereaux PJ, Garg AX, Kurz A, Turan A, Rodseth RN, et al. Relationship between intraoperative mean arterial pressure and clinical outcomes after non-cardiac surgery: toward an empirical definition of hypotension. Anesthesiology. 2013;119:507-15.
4. Sessler DI, Khanna AK. Perioperative myocardial injury and the contribution of hypotension. Intensive Care Med. 2018;44:811-22.
5. Brady KM, Hudson A, Hood R, DeCaria B, Lewis C, Hogue CW. Personalizing the definition of hypotension to protect the brain. Anesthesiology. 2020;132:170-9.
6. Sessler DI, Bloomstone JA, Aronson S, Berry C, Gan TJ, Kellum JA, et al. Perioperative quality initiative consensus statement on intraoperative blood pressure, risk, and outcomes for elective surgery. Br J Anaesth. 2019;122:563-74.

7. Südfeld S, Brechnitz S, Wagner J, Reese P, Pinnschmidt H, Reuter D, et al. Post-induction hypotension and early intraoperative hypotension associated with general anesthesia. Br J Anaesth. 2017;119:57-64.
8. Kawasaki S, Kiyohara C, Tokunaga S, Hoka S. Prediction of hemodynamic fluctuations after induction of general anesthesia using propofol in non-cardiac surgery: a retrospective cohort study. BMC Anesthesiol. 2018;18: 1-10.
9. Amin SM, Hasanin A, ElSayed OS, Mostafa M, Khaled D, Arafa AS, et al. Comparison of the hemodynamic effects of opioid-based versus lidocaine-based induction of anesthesia with propofol in older adults: a randomized controlled trial. Anaesth Crit Care Pain Med. 2023;42:101225.
10. Mohammadi SS, Maziar A, Saliminia A. Comparing Clonidine and Lidocaine on attenuation of hemodynamic responses to laryngoscopy and tracheal intubation in controlled hypertensive patients: a randomized, double-blinded clinical trial. Anesth Pain Med. 2016;6:e34271.
11. Zou Y, Kong G, Wei L, Ling Y, Tang Y, Zhang L, et al. The effect of intravenous lidocaine on hemodynamic response to endotracheal intubation during sufentanil-based induction of anesthesia. Anaesthesiol Intensive Ther. 2020;52:287-91.
12. Doba DN, Ferede ZA, Kasa SM, Gebre EE, Ayalew N, Workneh SA, et al. Comparison of intravenous fentanyl versus lidocaine for attenuation of hemodynamic response to laryngoscopy and endotracheal intubation in patients undergoing elective surgery in Dilla University Referral Hospital, Ethiopia, a randomized controlled trial. IJS Glob Health. 2020;3:e27.
13. Mostafa HM, Ibrahim RW, Hasanin A, Helmy NY, Abdel Nasser Mahrous A. Intravenous lidocaine for attenuation of pressor response after endotracheal intubation. A randomized, double-blinded dose-finding study. Egypt J Anaesth. 2023;39:241-8.
14. Feng C-K, Chan K-H, Liu K-N, Or C-H, Lee T-Y. A comparison of lidocaine, fentanyl, and esmolol for attenuation of cardiovascular response to laryngoscopy and tracheal intubation. Acta Anaesthesiol Sin. 1996;34:61-7.
15. Teong CY, Huang C-C, Sun F-J. The hemodynamic response to endotracheal intubation at different times of fentanyl given during induction: a randomized controlled trial. Sci Rep. 2020;10:8829.
16. Hancı V, Yurtlu S, Karabağ T, Okyay D, Hakimoğlu S, Kayhan G, et al. Effects of esmolol, lidocaine, and fentanyl on P wave dispersion, QT, QTc intervals and hemodynamic responses to endotracheal intubation during propofol induction: a comparative study. Braz J Anesthesiol. 2013;63: 235-44.
17. Ali T, Soomro ZA, Sultan SF, Perchance A. Comparison of the efficacy of lidocaine vs. Fentanyl in reducing hemodynamic response to endotracheal intubation. Pak J Med Health Sci. 2022;16:287-.
18. Mahjoubifard M, Heidari M, Dahmardeh M, Mirtajani SB, Jahangirifard A. Comparison of dexmedetomidine, lidocaine, and fentanyl in attenuation hemodynamic response of laryngoscopy and intubation in patients undergoing cardiac surgery. Anesthesiol Res Pract. 2020;2020:4814037.
19. Hu Y, Cha N, Zhu G, Long X, Jiang J, Zhang Q, et al. Effect of opioid-free anesthesia with lidocaine on post-induction hemodynamic stability. 2023.

20. Ferguson I, Bliss J, Aneman A. Does the addition of fentanyl to ketamine improve hemodynamics, intubating conditions or mortality in emergency department intubation: A systematic review. Acta Anaesthesiol Scand. 2019;63:587-93.
21. Hans G, Lauwick S, Kaba A, Bonhomme V, Struys M, Hans P, et al. Intravenous lidocaine infusion reduces bispectral index-guided requirements of propofol only during surgical stimulation. Br J Anaesth. 2010;105:471-9.
22. Altermatt F, Bugedo D, Delfino A, Solari S, Guerra I, Munoz H, et al. Evaluation of the effect of intravenous lidocaine on propofol requirements during total intravenous anesthesia as measured by bispectral index. Br J Anaesth. 2012;108:979-83.
23. Fathy S, Hasanin A, Mostafa M, Ramzy E, Sarhan K, Almenesey T, et al. The benefit of adding lidocaine to ketamine during rapid sequence endotracheal intubation in patients with septic shock: a randomized controlled trial. Anaesth Crit Care Pain Med. 2021;40:100731.