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Prophylactic Ephedrine versus Phenylephrine Administration on Hemodynamic Parameters in Surgical Patients in the Prone Position: A Prospective Randomized Study

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Abstract

Background: The changes in position of the patient from supine to prone during general anesthesia often led to hemodynamic disturbances, especially hypotension due to decreased venous return and vasodilation induced by anesthetics. Intraoperative hypotension can jeopardize perfusion of vital organs, and preventive strategies are warranted. Prophylactically, vasopressors like ephedrine and phenylephrine are administered to maintain hemodynamic stability; however, their mechanisms of action and clinical effects vary.
Objective: This study aims to compare the effectiveness of prophylactic ephedrine and phenylephrine on hemodynamic stability for surgical patients in the prone position at Dr. Zainoel Abidin Regional General Hospital, Banda Aceh.
Methods: This is a prospective randomized study of 38 patients who were divided into two groups receiving ephedrine or phenylephrine. The hemodynamic parameters assessed were the systolic blood pressure, diastolic blood pressure, MAP, and heart rate. Measurements were made prior to induction of anesthesia and at 5 and 10 minutes after patients were positioned in the prone position.
Results: There was no statistically significant difference in systolic and diastolic blood pressure between the two groups. Patients who received ephedrine showed a higher and more prolonged rise in MAP. Furthermore, ephedrine induced a significantly greater heart rate at 10 minutes versus phenylephrine.
Conclusion: In conclusion, ephedrine produced higher and longer-lasting MAP and HR increases via β-adrenergic stimulation; phenylephrine showed shorter, moderate hemodynamic effects with stable HR via α_1-mediated vasoconstriction.

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INTRODUCTION

Among the essential components of general anesthesia is stable hemodynamic management (Finsterwald et al., 2018). The preservation of blood pressure, heart rate, and adequate organ perfusion during surgical procedures is vital to avoid systemic complications (Addissouky, 2025). A significant aspect of maintaining a hemodynamically stable patient during surgical interventions is positional alteration associated with the procedure, such as transitioning from the supine to the prone position, as required for various procedures (spinal and urological surgery) (Smajic et al., 2025). This positional transition has been demonstrated to provoke hemodynamic derangement, such as hypotension, diminished cardiac output, and reduced venous return.

The claim that prone positioning causes hemodynamic instability is supported by

(Edgcombe et al., 2008). Vasopressor prophylaxis rationale is supported by Sessler (2018) on perioperative hypotension morbidity and Loubert on fluid and vasopressor management.

The prone position increases intra-abdominal pressure and can compress the inferior vena cava, resulting in decreased cardiac preload and subsequently leading to reduced cardiac output and systemic arterial pressure. Furthermore, the administration of general anesthesia has systemic vasodilatory effects that exacerbate hypotension (Chen et al., 2021; Tamunobelema & Uruaka, 2023). Intraoperative hypotension is associated with serious clinical consequences, including compromised perfusion of vital organs, higher rates of acute kidney injury and neurological dysfunction, and increased mortality (De La Hoz et al., 2022; Wesselink et al., 2018).

The prevention of position-related hypotension is an important perioperative goal. Intravenous fluid administration (as preload or co-load) is frequently employed but may have limited efficacy, particularly when vasodilation from anesthetic agents is the primary mechanism (Zahid et al., 2024). Therefore, prophylactic vasopressor administration has emerged as an increasingly utilized pharmacological strategy to maintain arterial blood pressure and ensure adequate tissue perfusion during surgery in the prone position.

The two vasopressor agents commonly used in anesthetic practice are ephedrine and phenylephrine (Heesen et al., 2019; Shakir et al., 2026). Both agents raise systemic blood pressure, but they have different mechanisms of action. Ephedrine is a mixed α- and β-adrenergic agonist that increases cardiac output by increasing heart rate and myocardial contractility. In contrast, phenylephrine is a selective α_1-adrenergic agonist that primarily causes peripheral arteriolar vasoconstriction with little direct chronotropic effect but may cause reflex bradycardia secondary to elevated arterial pressure.

Multiple previous studies have assessed the relative efficacy of ephedrine versus phenylephrine, particularly in the context of spinal anesthesia and hypotension prophylaxis in obstetric patients (Hassabelnaby et al., 2024). Ngan (2008) reported that phenylephrine better stabilized maternal blood pressure without fetal acid–base compromise compared to ephedrine. However, most of those studies were conducted in obstetric populations and in the context of spinal anesthesia rather than general anesthesia with patients in the prone position.

Park (2024) reviewed vasopressor use in obstetric anesthesia and confirmed that phenylephrine is generally superior in maintaining blood pressure with fewer fetal metabolic effects compared to ephedrine. Nevertheless, that study remains limited to obstetric populations under spinal anesthesia, thereby restricting its applicability to non-obstetric surgical settings and general anesthesia. In another study, Uemura (2023) evaluated vasopressor effects under general anesthesia and found that ephedrine may provide more sustained hemodynamic support due to its combined α- and β-adrenergic activity, whereas phenylephrine produces a more immediate but shorter-lived vasoconstrictive effect. However, that study did not specifically focus on prone-positioned patients or on prophylactic administration strategies across perioperative phases.

Jin (2022) performed a trial in prone-positioned patients undergoing spinal surgery under general anesthesia, finding that ephedrine provided a longer duration of blood pressure elevation and a greater increase in cardiac output compared to phenylephrine. Clinical data comparing the prophylactic effectiveness of these agents in patients in the prone position remain sparse, however, and existing anesthetic guidelines have not reached a clear consensus on their use.

Prophylactic use of vasopressors, defined as administration prior to the onset of hypotension, is thought to reduce blood pressure variability and stabilize perfusion of vital organs early in the perioperative course. This strategy may have implications for clinical practice by improving anesthetic efficiency, minimizing the need for additional pharmacological interventions, and potentially improving overall patient outcomes. However, the optimal vasopressor for prophylactic administration in patients undergoing surgery in the prone position warrants further investigation (Fuchita et al., 2023).

Based on these considerations, this study was designed to assess and compare the effects of prophylactic ephedrine versus phenylephrine administration on hemodynamic stability in patients undergoing prone surgical procedures, with the intention of providing robust empirical data to inform evidence-based anesthetic practice. The objective of this study is to determine whether a difference in hemodynamic stability exists between patients receiving prophylactic ephedrine and those receiving prophylactic phenylephrine.

The primary aim was to assess the comparative efficacy of prophylactic ephedrine and prophylactic phenylephrine for hemodynamic stability during surgery in the prone position. The primary objectives were to evaluate and compare changes in hemodynamic parameters — systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), and heart rate — in patients receiving prophylactic ephedrine versus phenylephrine.

METHOD

Study Design and Type

This study was conducted with an analytic observational cross-sectional design, in which participants were tracked until the assessment of dependent variables. The study population included patients undergoing posterior stabilization surgery in the operating room. Data extracted included demographic characteristics, baseline diagnosis, number of ephedrine or phenylephrine doses administered, and hemodynamic parameters recorded in both the supine and prone positions. Patients were followed until the end of surgery.

Group assignment in this study was non-randomized; patients were allocated to the ephedrine or phenylephrine group based on the attending anesthesiologist's clinical judgment and institutional protocol at RSUDZA. This represents a limitation of the observational design and may introduce selection bias. Although baseline characteristics were compared between groups (Table 1) and no statistically significant differences were found in most parameters, the lack of formal randomization and blinding means that confounding from unmeasured clinical variables cannot be fully excluded. This limitation is further discussed in the Study Limitations section.

Study Setting and Period

This study was conducted at Dr. Zainoel Abidin Regional General Hospital (RSUDZA), Banda Aceh, with approval from the Health Research Ethics Committee (Komite Etik Penelitian Kesehatan [KEPK]) of the Faculty of Medicine, Universitas Syiah Kuala–RSUDZA. Data were collected between September 1 and November 1, 2025.

Patients were assigned to either ephedrine (0.1 mg/kg IV bolus) or phenylephrine (1–2 mcg/kg IV bolus) immediately prior to prone positioning, administered by the attending anesthesiologist. Standard anesthetic induction consisted of propofol (1.5–2 mg/kg IV), fentanyl (2 mcg/kg IV), and rocuronium (0.6 mg/kg IV); maintenance was achieved with isoflurane or sevoflurane in some oxygen–air mixture. All patients received standard monitoring: ECG, non-invasive blood pressure (NIBP) measured every 5 minutes, pulse oximetry, and end-tidal CO_2.

Study Population and Subjects

All surgical patients placed in the prone position at RSUDZA formed the study population. All patients from this population who fulfilled the predetermined inclusion criteria were enrolled as study subjects.

Inclusion criteria were as follows: (1) adult patients aged 18–70 years; (2) ASA physical status I–III; (3) scheduled for elective posterior spinal surgery requiring prone positioning under general anesthesia; and (4) written informed consent obtained. Exclusion criteria were as follows: (1) ASA physical status IV or V; (2) pre-existing severe cardiovascular disease (uncontrolled hypertension, cardiac arrhythmia, or heart failure); (3) known allergy to ephedrine or phenylephrine; (4) pregnancy; (5) BMI >40 kg/m^2; and (6) emergency surgical procedures. These criteria were established to ensure a homogeneous surgical population and to minimize confounding from cardiovascular comorbidities.

Sample Size

All eligible subjects present throughout the study period were enrolled using a total sampling technique. Also known as census sampling, this approach entails enrolling every individual who fulfills the inclusion criteria rather than selecting a sample from the population. Total sampling ensures that the entire study population is adequately represented and minimizes the risk of sampling error, thereby contributing to improved accuracy of study results.

Data Analysis

Data were processed in five sequential steps: (a) data cleaning, collected data were reviewed and checked for errors or inconsistencies; (b) data editing, completeness and consistency of data were verified; (c) data coding, variables were assigned numeric or categorical codes to facilitate analysis; (d) data tabulation, coded data were organized into tables summarizing the information across the primary variables; and (e) data entry.

Categorical variables were summarized as frequencies and percentages, and continuous variables were expressed as means with standard deviations. Bivariate analyses of independent and dependent variables were performed using SPSS. The paired t-test and chi-square test were used for group comparisons, and the Kolmogorov–Smirnov test was used to assess the normality of data distribution.

RESULTS AND DISCUSSION

Results

Data were collected from October 5 to November 5, 2025, at RSUDZA. Approval for the study was obtained from the Research and Development Department of Dr. Zainoel Abidin Regional General Hospital (RSUDZA), as well as ethical clearance from the Health Research Ethics Committee (HREC) of the Faculty of Medicine, Universitas Syiah Kuala. In total, 38 patients met the inclusion criteria and provided informed consent to participate. The final sample size was 38 subjects, as no participants were excluded. Data were collected on patient sex, age, and body mass index (BMI), as well as hemodynamic parameters recorded during anesthetic induction and after repositioning to the prone position.

The lack of a statistically significant difference in SBP and DBP between the ephedrine and phenylephrine groups may be explained by the fact that both agents ultimately achieve blood pressure elevation through convergent pathways — increased cardiac output (ephedrine) or increased systemic vascular resistance (SVR) (phenylephrine) — resulting in comparable absolute SBP and DBP values despite mechanistically distinct routes. These findings are consistent with those of Santarpino (2022), who also reported comparable blood pressure outcomes between the two agents in prone-positioned surgical patients while demonstrating differential effects on heart rate and cardiac output.

1. Study Subjects

Baseline characteristics of the two vasopressor groups were analyzed for comparability: the ephedrine group (n = 19) and the phenylephrine group (n = 19). The variables assessed included age, sex, body weight, height, and BMI.

Table 1. Characteristics of Research Subjects

Features	Ephedrine (n=19)		Phenylephrine (n=19)		P Value
	n	%	n	%	
Age (mean±SD),	50.68 ± 12.62		53.00 ± 13.73		0,058b
Year Gender, n(%)					0.042a
Male- Male	5	26.4	7	36.8	
Women	14	73.6	12	63.1	
Weight	66.13 ± 11.08		65.37 ± 13.84		0.081 [b]
Height Nutritional Status	159.38 ± 7.00		161.63 ± 6.53		0.034b 0.029a
Normal Nutrition	10	57.9	9	47.3	
More nutrition	2	10.5	6	31.5	
Obesity I	3	15.8	2	10.5	
Obesity II	3	15.8	2	10.5	

The ephedrine group had a mean patient age of 50.68 ± 12.62 years, compared to 53.00 ± 13.73 years in the phenylephrine group. An independent t-test yielded a p-value of 0.058, indicating no statistically significant difference in age distribution between the groups ($p > 0.05$). Clinically, this finding indicates that the age distribution was similar across both groups, and thus hemodynamic responses to vasopressors were not expected to have been meaningfully

influenced by age-related effects.

The predominantly middle-aged to older patient population is clinically relevant, as age-related cardiovascular changes — including reduced β-adrenergic sensitivity, diminished baroreceptor reflexes, and decreased cardiac reserve — may influence vasopressor responsiveness. However, since age did not differ significantly between groups, it is unlikely to confound the hemodynamic outcomes observed in this study. Furthermore, the physiological similarities between groups at baseline suggest that any differences detected in hemodynamic parameters are more plausibly attributable to the pharmacological effects of the respective vasopressors than to age-related cardiovascular differences.

Physiologically, age is an important determinant of cardiovascular responses to both vasopressors and anesthetic agents. In older patients, β-adrenergic receptor sensitivity is decreased, while α-adrenergic responsiveness is relatively preserved. As a result, phenylephrine — a pure α_1-adrenergic agonist — may be more efficacious than ephedrine, which exerts its effects through mixed α-adrenergic and indirect β-adrenergic stimulation, in maintaining arterial blood pressure in geriatric populations. However, since mean ages were comparable between groups in this study, age may be regarded as an unlikely confounder of the hemodynamic results.

The mean body weight of the ephedrine group was 66.13 ± 11.08 kg, compared to 65.37 ± 13.84 kg in the phenylephrine group. An independent t-test revealed no statistically significant difference in body weight between the two groups ($p = 0.081$). The relatively small difference in mean body weight (approximately 0.7 kg) suggests that both groups were comparable, minimizing potential bias in hemodynamic comparisons. From a physiological standpoint, body weight influences the volume of distribution of certain drugs as well as vasopressor dose requirements. Patients with greater body mass typically have a larger circulating blood volume, which may attenuate blood pressure responses to a given vasopressor dose. However, given that body weights were similar between groups, the hemodynamic differences observed are primarily attributable to the pharmacological actions of phenylephrine and ephedrine rather than to anthropometric variation.

The mean height of patients in the ephedrine group was 159.38 ± 7.00 cm, compared to 161.63 ± 6.53 cm in the phenylephrine group. An independent t-test yielded a statistically significant result ($p = 0.034$). Nevertheless, the mean difference of approximately 2.2 cm, although statistically significant, is clinically negligible and cannot be expected to exert any meaningful effect on vasopressor efficacy or hemodynamic outcomes. Vasopressor pharmacodynamics is not directly dependent on height, which primarily influences total body size and oxygen consumption requirements. In anesthesiology, height is principally used to estimate dosing of inhalational anesthetics or to predict the spread of neuraxial blockade, not to determine the hemodynamic impact of ephedrine or phenylephrine. Therefore, such a small difference in height is unlikely to influence the study results.

The mean BMI category score was 3.06 ± 1.18 in the phenylephrine group versus 2.74 ± 1.05 in the ephedrine group ($p = 0.29$). Overall, both groups were classified within the mildly overweight range. The phenylephrine group was numerically slightly heavier, but this difference did not reach statistical significance. Physiologically, obesity is associated with elevated baseline sympathetic tone and systemic vascular resistance, alongside reduced β-adrenergic sensitivity. Under such conditions, phenylephrine (an α_1-adrenergic agonist) may produce a more pronounced pressor effect compared to ephedrine, which depends in part on endogenous norepinephrine release. Higher BMI may also be associated with increased preload and afterload, potentially influencing blood pressure responses. However, since BMI values were similar between groups in this study, these physiological effects are unlikely to have introduced significant intergroup bias.

Comparison of Heart Rate Response to Ephedrine and Phenylephrine

The significantly greater heart rate elevation observed in the ephedrine group at 10 minutes is consistent with the β_1-adrenergic chronotropic mechanism of ephedrine and corroborates the findings of Jin (2022), who reported a greater increase in cardiac output with ephedrine in prone-positioned patients undergoing spinal surgery. Similarly, Meng (2011) demonstrated that ephedrine produced more pronounced hemodynamic stimulation compared to phenylephrine. However, unlike obstetric studies Ngan (2008), in which phenylephrine better

preserved fetal acid–base status, the clinical context in the present study is entirely different — these are non-pregnant, non-obstetric surgical patients in whom the primary concern is maintenance of organ perfusion rather than fetal wellbeing. The sustained MAP elevation observed with ephedrine in this study may be clinically advantageous in preventing prolonged organ hypoperfusion; however, the associated increase in heart rate warrants careful monitoring in patients with pre-existing coronary artery disease or risk of tachyarrhythmia.

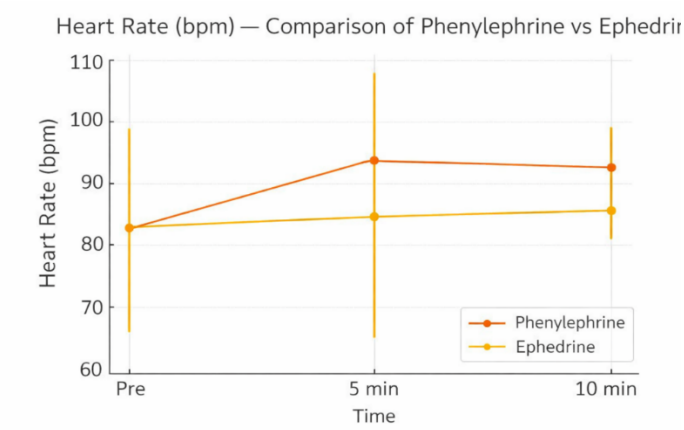

Figure 1. HR against Ephedrine and Phenylephrine

A significant increase in heart rate (HR) was noted at both 5 and 10 minutes after patient positioning, with the most considerable difference reaching statistical significance at 10 minutes (P = 0.002), clearly indicating higher HR levels in the ephedrine group. This response is consistent with the known β-adrenergic pharmacological activity of ephedrine, which increases heart rate and myocardial contractility. By contrast, phenylephrine tended to preserve or reduce heart rate via baroreceptor-mediated reflex bradycardia secondary to an increase in systemic vascular resistance. These observed hemodynamic response patterns are consistent with findings reported in previous studies.

Table 2. Comparison of Heart Rate Between Ephedrine and Phenylephrine Groups

	Ephedrine	**Phenylephrine**	p Value
HR Pre Induction	78.56 ± 20.71	77.34 ± 16.70	0.843
HR 5 minutes Post Prone	88.84 ± 19.60	77.84 ± 17.11	0.074
HR 10 minutes Post Prone	87.76 ± 8.77	79.93 ± 4.94	0.002

Blood Pressure Comparison Between Ephedrine and Phenylephrine

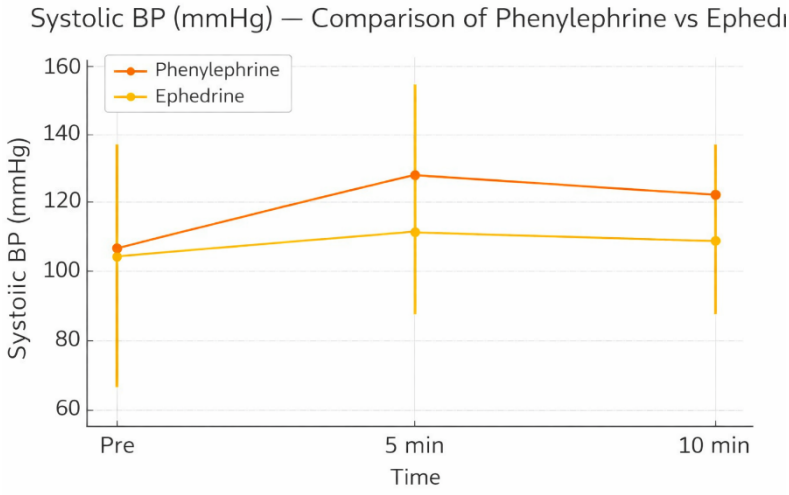

Figure 2. Systolic and diastolic blood pressure against Ephedrine and Phenylephrine

Table 3. Comparative Study of Ephedrine and Phenylephrine with Respect to Blood Pressure

	Ephedrine	***Phenylephrine***	**p Value**
Pre Induction Systolic TD	133.08 ± 21.55	126.63 ± 18.32	0.327
TDS 5 minutes Post Induction	143.65 ± 21.05	131.93 ± 18.35	0.075
TDS 10 minutes Post Induction	136.15 ± 21.01	126.24 ± 18.50	0.132

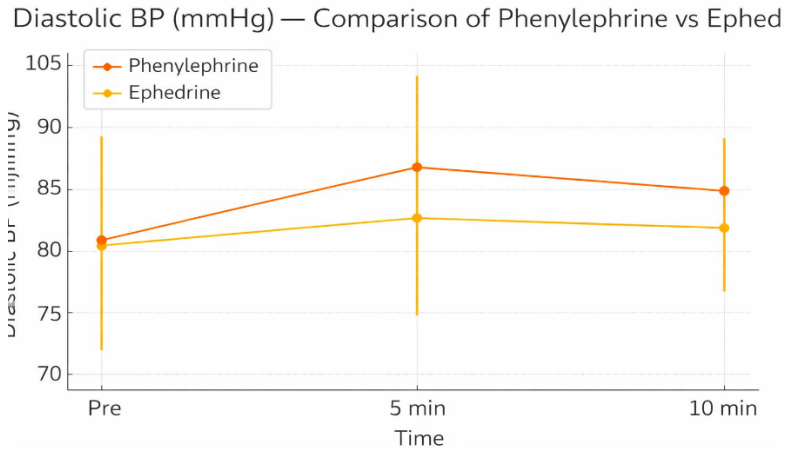

Figure 4. Comparison of Diastolic Blood Pressure Changes Between the Phenylephrine and Ephedrine Groups

Table 4. Comparison of Diastolic Blood Pressure Between the Ephedrine and Phenylephrine Groups

	Ephedrine	*Phenylephrine*	p Value
Pre-Induction Diastolic TD	85.40 ± 14.33	84.28 ± 7.37	0.763
TDS 5 minutes Post Induction	90.68 ± 13.87	87.38 ± 7.43	0.366
TDS 10 minutes Post Induction	87.13 ± 13.58	84.15 ± 7.74	0.411

Discussion

Ephedrine resulted in a greater increase in SBP at 5 minutes (143.65 vs. 131.93 mmHg) and continued to produce significantly elevated values at 10 minutes compared with the phenylephrine group. The between-group p-values for SBP at each time point did not achieve conventional statistical significance. Ephedrine is a mixed sympathomimetic agent with indirect α- and β-adrenergic actions, whereby its β-adrenergic stimulation increases heart rate and cardiac output, thereby elevating arterial pressure. Phenylephrine, on the other hand, is a selective α_1-adrenergic agonist that increases peripheral vascular resistance and MAP but is commonly associated with reflex bradycardia, resulting in an unchanged or reduced heart rate. Therefore, phenylephrine primarily raises blood pressure through vasoconstriction, whereas ephedrine exerts a more pronounced influence on heart rate and cardiac output.

Physiologically, this observation is explained by the mechanism of action of phenylephrine as a selective α_1-adrenergic agonist, which increases systemic vascular resistance (SVR) through arteriolar vasoconstriction, thereby elevating arterial pressure in response to anesthetic-induced vasodilation. In contrast, ephedrine increases blood pressure by augmenting endogenous norepinephrine release and stimulating β_1-adrenergic receptors; consequently, its pressor effect is dependent on the patient's catecholamine reserve. The relatively greater attenuation of the pressor response in the ephedrine group suggests that this indirect mechanism may be less effective during early anesthetic induction, particularly in patients with higher baseline heart rates.

Diastolic blood pressure concurrently represents coronary diastolic perfusion pressure and correlates closely with peripheral vascular resistance. Due to its more potent vasoconstrictive action, phenylephrine preserved coronary and cerebral perfusion to a greater extent by maintaining diastolic blood pressure more reliably. In contrast, the more substantial

increase in cardiac output associated with ephedrine redistributes a greater volume of blood to the peripheral circulation, thereby reducing diastolic blood pressure.

Table 5. Comparison of Ephedrine and Phenylephrine Against MAP

	Ephedrine	*Phenylephrine*	p Value
Pre Induction MAP	133.08 ± 21.55	126.63 ± 18.32	0.327
MAP 5 minutes Post Induction	143.65 ± 21.05	131.93 ± 18.35	0.075
MAP 10 minutes Post Induction	136.15 ± 21.01	126.24 ± 18.50	0.132

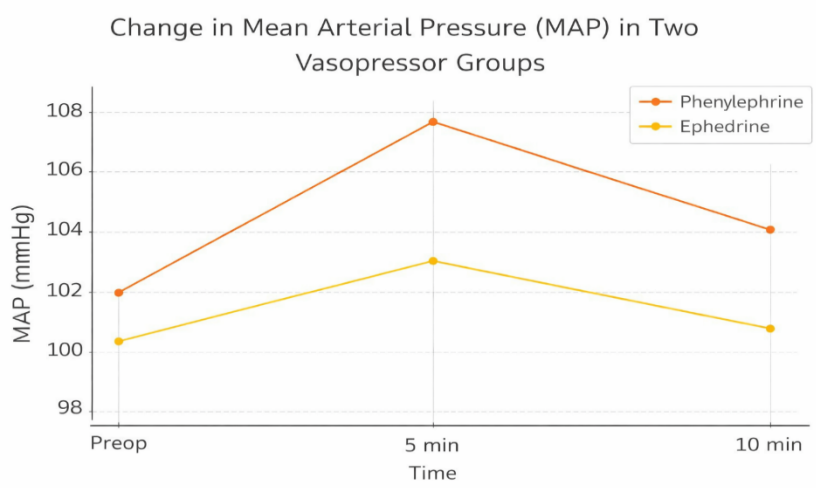

Figure 5. Changes in Mean Arterial Pressure (MAP) in the Ephedrine and Phenylephrine Groups Before and After Induction

Considering the table and graph above, the phenylephrine group's pre-induction MAP was 98.40 ± 10.45 mmHg, compared to a slightly higher baseline MAP of 101.29 ± 16.43 mmHg observed in the ephedrine group. Five minutes following induction, the MAP in the phenylephrine group was 102.23 ± 10.39 mmHg, while MAP increased further in the ephedrine group, reaching 108.34 ± 15.80 mmHg ($p = .015$).

At 10 minutes after induction, the MAP in the phenylephrine group returned to near baseline (98.18 ± 10.70 mmHg), while MAP decreased in the ephedrine group but remained higher than that of the phenylephrine group (103.47 ± 15.71 mmHg). Across all observation intervals, mean arterial pressure (MAP) was consistently greater in patients receiving ephedrine compared with those in the phenylephrine group.

Statistical analysis performed with SPSS confirmed a highly significant effect of time ($p < 0.001$, partial $\eta^2 = 0.844$), indicating that MAP changed significantly from baseline through 5 and 10 minutes post-induction, suggesting that the vasopressor administered during this period contributed meaningfully to the overall variability observed. A significant Time × Vasopressor interaction ($p < 0.001$, partial $\eta^2 = 0.310$) was also identified, indicating that the pattern of MAP change over time differed significantly between the two vasopressor groups. Specifically, ephedrine produced a larger and more sustained rise in MAP, while phenylephrine produced a transient increase followed by a return toward baseline values.

However, the between-subjects effect showed no significant difference in overall mean MAP between the phenylephrine and ephedrine groups ($p = 0.283$). Given the high inter-individual variability, as reflected by the relatively large standard deviations, this finding is likely attributable to statistical variation that may have obscured true differences between groups.

From a physiological standpoint, ephedrine produced a greater and more consistent elevation in MAP through 10 minutes post-induction, attributable to its mixed α–β-adrenergic mechanism, which increases both cardiac output and systemic vascular resistance. Phenylephrine, by contrast, produced a weaker and more transient pressor response, consistent with its profile as a selective α_1-adrenergic agonist that increases arterial pressure through vasoconstriction without augmenting cardiac output. Although the graphical data suggest a

clinically meaningful difference between the two agents, the absence of a statistically significant difference in overall mean MAP underscores that the dynamic pattern of MAP change over time — rather than absolute mean values — accounts for the divergent hemodynamic responses observed with these vasopressors.

Data were analyzed using a General Linear Model (GLM) with repeated measures, in which time (pre-induction, 5 minutes, and 10 minutes) was designated the within-subjects factor and vasopressor type (phenylephrine vs. ephedrine) the between-subjects factor. Multivariate analysis revealed a significant Time × Vasopressor interaction (Pillai's Trace, $p < 0.001$), demonstrating differing hemodynamic response patterns between the groups over time. In contrast, comparison of overall mean values between groups did not achieve statistical significance (vasopressor main effect: $p = 0.063$).

Variable-specific comparative analyses showed a significantly greater increase in heart rate at 10 minutes in the ephedrine group ($p = 0.002$). Notably, Levene's test indicated heterogeneity of heart rate variance at 10 minutes between groups ($p = 0.049$), suggesting unequal variances and warranting cautious interpretation of this finding, particularly with respect to ephedrine use. Ephedrine significantly increased both systolic and diastolic blood pressure overall and produced a substantial rise in heart rate attributable to its β-adrenergic effects. In comparison, phenylephrine elevated arterial pressure primarily through α_1-mediated vasoconstriction and was frequently associated with reflex bradycardia. Changes in respiratory rate and oxygen saturation were attributed to anesthetic induction rather than to vasopressor effect.

Study Limitations

This study has several limitations. First, the cross-sectional observational design precludes causal inference and does not permit assessment of long-term hemodynamic changes. Second, the absence of randomization and blinding introduces the potential for selection bias. Third, the sample size was relatively small, as total sampling was applied within a limited study period. Additionally, heterogeneity in patient conditions and surgical procedures could not be fully controlled for. Hemodynamic measurements were obtained using non-invasive blood pressure (NIBP) monitoring; invasive arterial lines or advanced cardiovascular monitoring were not employed. Finally, the absence of a control group is an additional limitation; however, as described in the study design section, the inclusion of a control group was not feasible within the observational framework of this study.

Going forward, the authors recommend that future studies adopt a prospective experimental or randomized controlled design with larger sample sizes, invasive hemodynamic monitoring where feasible, and well-matched study cohorts to more rigorously evaluate the preventive impact of ephedrine and phenylephrine administration in patients undergoing surgical procedures in the prone position.

CONCLUSION

A total of 38 subjects were allocated into two vasopressor groups (phenylephrine and ephedrine). Three principal findings were identified. First, systolic and diastolic blood pressure did not differ statistically between the phenylephrine and ephedrine groups at any measurement point (pre-induction, 5 minutes post-induction, and 10 minutes post-induction). Although ephedrine showed a trend toward higher systolic blood pressure at 5 minutes, this difference did not reach statistical significance. Second, MAP demonstrated a significant time-dependent effect in both vasopressor groups. MAP increased significantly at 5 minutes post-induction and subsequently declined to above-baseline values, reflecting the dynamic nature of hemodynamic recovery in the early post-induction phase.

Importantly, the pattern of MAP change differed between the two groups. Ephedrine produced a higher and more sustained increase in MAP, whereas phenylephrine produced a moderate increase followed by a return toward baseline values at 10 minutes. Clinically, ephedrine appeared more effective in elevating MAP during the early post-induction period, while phenylephrine produced a shorter-duration but comparatively more stable effect, likely reflecting the distinct pharmacological profiles of each agent. Third, heart rate differed significantly at 10 minutes, with the ephedrine group demonstrating a significantly greater increase compared to

the phenylephrine group. This finding is consistent with the β-adrenergic activity of ephedrine on heart rate and cardiac output.

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AUTHOR CONTRIBUTION STATEMENT

Reza Irawan as the author confirm that they have full access to all data in this study and takes responsibility for the integrity of the data and the accuracy of the data analysis. The author conceptualized and designed the study. Author was responsible for data gathering, data analysis and interpretation of results. In addition, this author drafted the manuscript, performed critical revisions, and approved the final version of the manuscript for publication.

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