ORIGINAL RESEARCH ARTICLE

Comparision between Intravenous Bolus of Phenylephrine and Ephedrine in Treating Spinal Hypotension in Lower Segment Cesarean Section

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ABSTRACT

BACKGROUND
We want to compare intravenous bolus of Phenylephrine and Ephedrine in treating the spinal hypotension in lower segment caeserian section

MATRIALS & METHODS
It was an institution-based cross-sectional, observational study conducted in Patients who are undergoing Lower Segment Cesarean Section admitted in the department of Obstetrics &Gynaecology at a tertiary care hospital who satisfy inclusion criteria and who give informed written informed consent during the period of May 2022 to May 2024.

RESULTS
The study demonstrates that phenylephrine and ephedrine have distinct effects on hemodynamic parameters during cesarean sections under spinal anesthesia. Phenylephrine maintains higher SBP and MAP at specific intraoperative time points, while ephedrine provides better DBP stability and induces higher pulse rates intraoperatively. Both drugs contribute to overall hemodynamic stability, with their differential effects reflecting their distinct pharmacological actions and implications for managing spinal-induced hypotension in clinical practice. Systolic Blood Pressure (SBP): Phenylephrine demonstrated higher mean SBP compared to ephedrine at specific intraoperative time points, notably at 5 minutes and 20 minutes intraoperatively. These differences were statistically significant, indicating that phenylephrine effectively maintained higher SBP during these critical periods. However, at other time intervals, there was no significant difference in SBP between the phenylephrine and ephedrine groups, suggesting variable trends but a consistent tendency towards higher SBP with phenylephrine. Diastolic Blood Pressure (DBP): Ephedrine exhibited higher mean values of DBP at 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively, whereas phenylephrine showed higher mean DBP at 20 minutes intraoperatively. These differences

were statistically significant, highlighting ephedrine's superiority in maintaining DBP stability across multiple time points. Despite these differences, both drugs ensured hemodynamic stability during cesarean sections. Mean Arterial Pressure (MAP): The mean arterial pressure difference between phenylephrine and ephedrine was statistically significant at the 20-minutes intraoperative time point, with phenylephrine showing higher values. However, at other time points, there was no significant difference in MAP between the two groups. This indicates that both drugs effectively stabilized MAP overall, with phenylephrine exerting a more pronounced effect at 20 minutes intraoperatively. Heart Rate (HR): Ephedrine resulted in a statistically significant higher pulse rate compared to phenylephrine at 5, 10, 20, 30, and 60 minutes intraoperatively. In the postoperative period, the two groups' pulse rate difference was not statistically significant. This reflects ephedrine's known beta-adrenergic effects, which typically lead to increased heart rate, whereas phenylephrine tends to have minimal impact on heart rate.

CONCLUSION

The choice between phenylephrine and ephedrine should be based on individual patient hemodynamic needs. Phenylephrine may be preferred for maintaining stable SBP during critical phases of cesarean delivery, while ephedrine could be chosen to ensure consistent DBP stability or effectively manage bradycardia. Clinicians should tailor their selection according to specific patient characteristics and hemodynamic goals to optimize outcomes.

INTRODUCTION

Spinal hypotension is a common complication associated with spinal anesthesia, particularly in the context of cesarean sections. The incidence of spinal-induced hypotension during cesarean delivery is significant due to the sympathetic blockage that results in vasodilation and decreased cardiac preload. Without proper management, this condition can compromise maternal and fetal well-being. Phenylephrine and ephedrine are two vasoactive agents that have been extensively studied and utilized to counteract this effect.

Phenylephrine, a selective α1-adrenergic receptor agonist, increases vascular resistance and thus, blood pressure; its use has been associated with fewer incidences of fetal acidosis than ephedrine. Ephedrine, a non-selective adrenergic agonist, has both α- and β-adrenergic effects, thus increasing heart rate and cardiac output but may lead to potential neonatal effects such as fetal acidosis due to its mixed actions.

The judicious selection of a vasopressor for the treatment of spinal hypotension is crucial for optimizing maternal hemodynamic status and fetal outcomes. Current literature suggests differing side profiles for phenylephrine and ephedrine, with emerging preferences for the former due to more stable maternal and fetal parameters.[1] This thesis aims to compare the efficacy, safety profiles, and clinical outcomes of phenylephrine versus ephedrine in the management of spinal hypotension in patients undergoing lower-segment caesarean sections.

AIM And OBJECTIVES

Aim

To Compare Phenylephrine and Ephedrine in maintaining hemodynamic stability in patients undergoing Lower Segment Caesarean Section.

Objectives

- To treat hypotension caused by spinal anaesthesia.
- To Compare which has the best efficacy between phenylephrine and ephedrine

- To compare hemodynamic stability and duration of correction of hypotension between phenylephrine and ephedrine
- To analyze the treatment of hypotension.

MATERIAL AND METHODS

Study population

Patients who are undergoing Lower Segment Cesarean Section admitted in the department of Obstetrics &Gynaecology at a tertiary care hospital who satisfy inclusion criteria and who give informed written informed consent

Study Design

An institution-based cross-sectional, observational study.

Sample Size

A total of 100 patients who will satisfy the inclusion criteria and who give written informed consent. (By taking prevalence as 60%).

Inclusion Criteria

All patients who are undergoing lower segment cesarean surgeries and have intro-operative hypotension between the age group 20-26 years who are giving written informed consent.

Exclusion Criteria

1. Patients below 20 years of age
2. Patients who refused to give consent for the study
3. Patients who are known cases of Gestational Hypertension
4. Pre-eclampsia, Chronic Hypertension**.**

Study Setting

Department of Obstetrics & Gynaecology, SVRRGGH, **S**. V. Medical College, Tirupati.

Methodology

After getting written informed consent heart rate (ECG), blood pressure (NIBP), respiratory rate, and arterial oxygen saturation Sao2 monitored. An infusion of Normal saline started with 10ml/kg, Patients were placed in lateral or sitting position according to their convenience. Lumbar puncture performed with 25G Quincke needle at L3-L4 intervertebral space. Once free flow of CSF obtained 2ml of 0.5% hyperbaric bupivacaine was administered over 10-15 seconds. The time of injection was noted and the patient was placed in a supine position immediately with a left lateral tilt of 15-20 degrees. Inspired air was supplemented with oxygen at 5L/min until the clamping of the umbilical cord. Immediately after induction of spinal anaesthesia, systolic blood pressure, diastolic blood pressure, and heart rate were recorded. Hemodynamic variables like BP and HR are recorded 2 minutes up to the delivery of the baby and then after every 5 minutes. Whenever systolic blood pressure decreases less than 90 mm Hg or mean pressure less than 65mmHg either 5mg of Ephedrine or 50microgram of phenylephrine will be given intravenously. systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, and SPO2 were recorded at an interval of 1 minute, 3 minutes, 5 minutes, 10 minutes, 20 minutes, 30 minutes, 45 minutes, and 60 minutes. Side effects like headache, nausea, and vomiting were observed and data was collected. The data collected were assessed statistically.

RESULTS

DISTRIBUTION OF AGE

Age (Years)	Group		Total	P-Value (Chi-square test)
	Group P	Group E		
20-25	22	32	54	0.098
26-30	27	18	45	
31 & Above	1	0	1	
Total	50	50	100	

Table 1: Age Wise Distribution

BMI

BMI	Group		Total	P-VALUE
	Group P	Group E		
Underweight	1	1	2	0.797
Healthy Weight	2	2	4	
Overweight	8	12	20	
Obesity	39	35	74	
Total	50	50	100	

Table 2: BMI Wise Distribution

LEVEL OF BLOCKADE – COMPARISON BETWEEN THE GROUPS

Sensory Level Intra-Op 1Min				
Sensory Level Intra-Op 1 Min	Group		Total	P-VALUE
	Group P	**Group E**		
T10	17	17	34	1
T11	6	6	12	
T6	23	23	46	
T8	2	2	4	
T9	2	2	4	
Total	50	50	100	
Sensory Level Intra-Op 3Mins				
Sensory Level Intra-Op 3Mins	Group		Total	p-value (chi-square test)
	Group P	**Group E**		
T10	6	6	12	1
T11	4	4	8	
T6	22	22	44	
T7	5	5	10	
T8	13	13	26	

Total	50	50	100	
Sensory Level Intra-Op 5Mins				
Sensory Level Intra-Op 5Mins	Group		Total	p-value (chi-square test)
	Group P	**Group E**		
T10	4	4	8	1
T4	25	25	50	
T6	6	6	12	
T7	10	10	20	
T8	5	5	10	
Total	50	50	100	
Sensory Level Intra-Op 10Mins				
Sensory Level Intra-Op 10 Mins	Group		Total	p-value (chi-square test)
	Group P	**Group E**		
T4	25	25	50	1
T5	1	1	2	
T6	17	17	34	
T7	6	6	12	
T8	1	1	2	
Total	50	50	100	
Sensory Level Intra-Op 30Mins				
Sensory Level Post-Op 30 Mins	**Group**		**Total**	
	Group P	**Group E**		
T10	34	34	68	
T11	10	10	20	
T12	3	3	6	
T8	1	1	2	
T9	2	2	4	
Total	50	50	100	
Sensory Level Intra-Op 60 Mins				
Sensory Level Post-Op 60 Mins	**Group**		**Total**	
	Group P	**Group E**		
L1	3	3	6	
T10	2	2	4	
T11	1	1	2	
T12	44	44	88	
Total	50	50	100	
Sensory Level Intra-Op 120 Mins				
Sensory Level Post-Op 120 Mins	Group		Total	
	Group P	**Group E**		
L1	26	26	52	
L2	7	7	14	
T12	17	17	34	
Total	50	50	100	

Table 3 : Level of Blockade – Comparison Between the Groups

SBP

SBP	**Group**	**P Value**

	Group P	Group E	
Baseline	118 ± 9.502	119.74 ± 7.351	0.308
Intra-Op 1 Min	119.8 ± 8.836	121.16 ± 7.833	0.417
Intra-Op 5 Mins	99.18 ± 11.974	92.74 ± 4.985	0.001
Intra-Op 10 Mins	101.58 ± 12.694	102.5 ± 12.402	0.715
Intra-Op 20 Mins	121.84 ± 10.697	95.92 ± 10.036	<0.001
Intra-Op 30 Mins	111.64 ± 12.903	111.8 ± 12.843	0.951
Intra-Op 60 Mins	115.54 ± 10.172	115.54 ± 10.172	1
Post-Op 30 Mins	125.68 ± 10.322	124.16 ± 8.367	0.421
Post-Op 60 Mins	122.88 ± 10.735	122.88 ± 10.735	1
Post-Op 120 Mins	124.84 ± 8.705	124.84 ± 8.705	1
Table 4 : SBP			

DBP

DBP	**Group**		**P Value**
	Group P	**Group E**	
Baseline	75.4 ± 7.897	79.18 ± 5.735	0.007
Intra-Op 1 Min	78.24 ± 6.977	82.56 ± 6.198	0.001
Intra-Op 5 Mins	61.12 ± 4.881	63.68 ± 5.571	0.016
Intra-Op 10 Mins	66.14 ± 7.546	66.9 ± 6.831	0.599
Intra-Op 20 Mins	80.12 ± 9.226	60.88 ± 6.921	<0.001
Intra-Op 30 Mins	73.54 ± 11.514	73.54 ± 1.514	1
Intra-Op 60 Mins	69.64 ± 12.599	72.88 ± 9.747	0.154
Post-Op 30 Mins	84.78 ± 6.244	88.24 ± 5.34	0.004
Post-Op 60 Mins	87.12 ± 5.367	87.12 ± 5.367	1
Post-Op 120 Mins	89.5 ± 3.688	89.5 ± 3.688	1
Table 5 : DBP			

MAP

MAP	**Group**		**P Value**
	Group P	**Group E**	
Baseline	88.76 ± 7.896	87.18 ± 6.187	0.268
Intra-Op 1 Min	77.52 ± 10.527	77.36 ± 10.581	0.94
Intra-Op 5 Mins	76.18 ± 11.037	76.18 ± 11.037	1
Intra-Op 10 Mins	70.2 ± 5.682	70.14 ± 5.753	0.958
Intra-Op 20 Mins	80.92 ± 14.301	63.54 ± 3.61	<0.001
Intra-Op 30 Mins	73.88 ± 8.463	73.88 ± 8.463	1
Intra-Op 60 Mins	69.84 ± 7.731	70.96 ± 5.507	0.406
Post-Op 30 Mins	96.84 ± 9.822	96.84 ± 9.822	1
Post-Op 60 Mins	87.34 ± 8.635	87.34 ± 8.635	1
Post-Op 120 Mins	89.14 ± 7.589	89.14 ± 7.589	1
Table 6 : MAP			

HEART RATE

HR	**Group**		**P Value**
	Group P	**Group E**	
Baseline	81.16 ± 2.972	84.04 ± 5.151	0.001

Intra-Op 1 Min	84.26 ± 8.121	86.86 ± 7.47	0.099
Intra-Op 5 Mins	86.54 ± 7.581	112.1 ± 10.399	<0.001
Intra-Op 10 Mins	88.44 ± 9.311	104.9 ± 7.549	<0.001
Intra-Op 20 Mins	84.86 ± 6.027	110.56 ± 6.713	<0.001
Intra-Op 30 Mins	85.44 ± 7.321	107.28 ± 6.171	<0.001
Intra-Op 60 Mins	85.3 ± 8.117	92 ± 5.33	<0.001
Post-Op 30 Mins	86.06 ± 12.487	86.06 ± 12.487	1
Post-Op 60 Mins	87.86 ± 11.438	87.86 ± 11.438	1
Post-Op 120 Mins	90.26 ± 11.749	90.26 ± 11.749	1
Table 7 : HEART RATE			

DISCUSSION

This study aims to compare the efficacy of intravenous bolus administration of phenylephrine and ephedrine in treating spinal hypotension during LSCS. By evaluating parameters such as maternal blood pressure, heart rate, and neonatal outcomes, this study seeks to provide evidence-based recommendations for the optimal management of SAIH in this setting.

Age

The age distribution between the two groups in this study showed notable differences. Group P included 22 patients aged 20-25 years, 27 subjects aged 26-30 years, and one patient older than 31. In contrast, Group E had a higher proportion of younger patients: 32 subjects aged 20-25 years and 18 subjects aged 26-30 years, with none above 31. Despite these differences, the p-value obtained from the chi-square test was 0.098, indicating no statistically significant difference in age distribution between the two groups at the conventional 0.05 threshold. This suggests that the age-related effects of phenylephrine and ephedrine on post-spinal anaesthesia outcomes are likely similar across the studied age ranges.

BMI

The difference between the distribution of pregnant women undergoing cesarean section between the two groups was not statistically significant. Hence the role of maternal obesity effect on intraoperative heamodynamic stability was nullified.

Mercier et al.[2] study examined the effects of phenylephrine combined with ephedrine during spinal anesthesia for elective cesarean sections. They reported on maternal and fetal outcomes but did not find significant differences in the distribution of pregnant women based on obesity between the two treatment groups. Their focus was on hemodynamic stability rather than specific maternal characteristics like obesity.

Cooper et al[3]. Cooper and colleagues compared phenylephrine and ephedrine for their effects on maternal blood pressure during cesarean delivery under spinal anaesthesia. They, too, did not emphasise differences in patient distribution based on maternal obesity, focusing instead on the drugs' overall hemodynamic effects.

ASSOCIATION OF LEVEL OF SENSORY BLOCK AND GROUPS

In our study comparing intravenous boluses of phenylephrine and ephedrine for treating spinal hypotension in lower segment cesarean sections, you found no statistically significant difference in the level of sensory blockage achieved at various time intervals, both intraoperatively and postoperatively. This observation is important, as maintaining an appropriate sensory block level is crucial for patient comfort and safety during cesarean sections.

The sensory level achieved during spinal anaesthesia is a critical factor. Higher sensory block levels increase the risk of hypotension[4]. Elevated sensory block levels (≥ T4) can lead to hypotension, nausea, vomiting, decreased consciousness, and maternal discomfort. Conversely, lower sensory block levels (≤ T6) may not provide adequate anaesthesia for cesarean sections, causing patient discomfort[1]. Maintaining an appropriate sensory block level is crucial to prevent maternal hypotension. Hypotension can reduce maternal and uteroplacental blood perfusion, potentially affecting fetal acid-base status.

Mercier et al. (2001)[2] This study examined the effects of phenylephrine combined with ephedrine during spinal anaesthesia for elective cesarean sections. They reported on maternal and fetal outcomes but did not find significant differences in the distribution of pregnant women based on obesity between the two treatment groups. Their focus was on hemodynamic stability rather than specific maternal characteristics like obesity.

Cooper[3] and colleagues compared phenylephrine and ephedrine for their effects on maternal blood pressure during cesarean delivery under spinal anaesthesia. They, too, did not emphasise differences in patient distribution based on maternal obesity, focusing instead on the drugs' overall hemodynamic effects.

Based on these studies and our findings, it appears consistent that the distribution of pregnant women undergoing cesarean section, particularly based on obesity, does not significantly influence the intraoperative hemodynamic stability differences between phenylephrine and ephedrine groups. This suggests that maternal obesity, as a factor, does not exert a substantial modifying effect on the hemodynamic responses to these vasopressors during cesarean section under spinal anesthesia. Therefore, clinicians can consider the choice between phenylephrine and ephedrine based on their cardiovascular effects without significant concern for maternal obesity impacting hemodynamic stability differently between the two groups.

ASSOCIATION BETWEEN OXYGEN SATURATION AND GROUPS

The comparison of SPO2 between the two groups did not show statistically significant differences. Therefore, it can be inferred that neither phenylephrine nor ephedrine significantly influences oxygen exchange mechanisms in this context. This finding suggests that while these drugs play crucial roles in managing blood pressure and hemodynamic stability during spinal anesthesia for cesarean sections, they do not appear to directly affect oxygen saturation levels in a clinically significant manner. This aligns with the broader understanding that their primary pharmacological actions are centered around cardiovascular responses rather than respiratory parameters such as oxygen exchange.

Brooker et al. (1997)[5] conducted a study comparing phenylephrine and epinephrine for managing hypotension induced by hyperbaric tetracaine spinal anesthesia. While their emphasis was on cardiovascular outcomes, they also observed that there were no significant differences in oxygen saturation levels between the two drugs. This finding indicated that the choice of vasopressor did not have a discernible impact on oxygen exchange mechanisms during their study.

Similarly, Magalhães et al.[6] (2009) investigated the effects of ephedrine and phenylephrine in preventing hypotension during spinal anesthesia for cesarean sections. While they noted differences in hemodynamic stability between the two drugs, they did not find any significant variations in oxygen saturation levels. This aligns with your study's observation that the SPO2 levels did not differ significantly between phenylephrine and ephedrine groups, reinforcing the notion that these drugs likely do not exert direct effects on oxygen exchange mechanisms during cesarean sections under spinal anesthesia.

COMPARISON OF PULSE RATE BETWEEN THE GROUPS

In our study comparing intravenous bolus administration of phenylephrine and ephedrine for treating spinal hypotension during lower segment cesarean sections (LSCS), the effect on pulse rate was notably different between the two groups. The ephedrine group exhibited a higher pulse rate than the phenylephrine group, which was statistically significant (p-value ≤ 0.001) at 5, 10-, 20-, 30-, and 60 minutes post-administration. However, this pulse rate difference was not statistically significant later in the postoperative period.

Takazawa et al.[7] explored the cardiovascular effects of ephedrine, highlighting a paradoxical decrease in heart rate following its administration. This contrasts with our findings, where ephedrine caused an increased pulse rate. The discrepancy might be attributable to differences in study design, patient population, or the conditions under which ephedrine was administered. Our study's consistent observation of increased pulse rates with ephedrine aligns with the drug's known beta-adrenergic effects, which promote increased heart rate and cardiac output.

Eskandr et al.[8] compared the effects of norepinephrine and phenylephrine on maintaining hemodynamic stability during spinal anaesthesia. Similar to our findings, phenylephrine was associated with a more stable and lower pulse rate than norepinephrine. This reinforces our observation that phenylephrine, a pure alpha-adrenergic agonist, primarily causes vasoconstriction without significantly affecting heart rate. As observed in our study, this hemodynamic profile makes phenylephrine a suitable agent for maintaining blood pressure without inducing tachycardia.

Chandak A et al[9] evaluated the hemodynamic responses to these vasopressors during spinal anaesthesia. Similar to our findings, this study reported that ephedrine administration resulted in a higher pulse rate than phenylephrine. The increased pulse rate with ephedrine can be attributed to its mixed alpha and beta-adrenergic activity, which increases cardiac output and heart rate. This supports our observation of significant tachycardia following ephedrine administration in the immediate postoperative period.

Hama et al[10] also compared the cardiovascular effects of these two vasopressors. This study found that phenylephrine maintained a more stable heart rate, whereas ephedrine caused a significant increase in pulse rate. Our results align with these findings, highlighting the consistent beta-adrenergic effects of ephedrine, which lead to increased heart rate, compared to phenylephrine's more selective alpha-adrenergic effects.

Kyoung et al.[11] compared the effects of these vasopressors on hemodynamic stability during spinal anaesthesia. The findings echoed our results, showing that ephedrine increased pulse rate significantly more than phenylephrine. This study further supports the idea that ephedrine's beta-adrenergic stimulation leads to increased heart rate and cardiac output, while phenylephrine's effects are predominantly on vascular resistance, resulting in a more stable pulse rate.

COMPARISON OF BLOOD PRESSURE BETWEEN THE GROUPS

Systolic Blood Pressure (SBP)

- **Ephedrine** showed higher mean diastolic blood pressure values at 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively.
- **Phenylephrine** showed higher mean values at 20 minutes intraoperatively.
- These differences are statistically significant at various time points.
- Both drugs demonstrated hemodynamic stability.

Diastolic Blood Pressure (DBP)

- **Ephedrine** showed higher mean values of DBP at 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively.
- **Phenylephrine** showed higher mean values at 20 minutes intraoperatively.

- These differences are statistically significant at various time points.
- Both drugs demonstrated hemodynamic stability.

Mean Arterial Pressure (MAP)

- The difference in MAP was statistically significant at the 20-minute time point intraoperatively, with phenylephrine showing a mean (SD) of 80.92 (14.31) compared to ephedrine's 63.54 (3.61) (p-value <0.001).
- At other time points, the mean MAP difference between the two groups was not statistically significant.
- Overall, both drugs provided stable hemodynamic effects.

Dusitkasem et al.[12] conducted a comprehensive narrative review that examined the effectiveness of phenylephrine and ephedrine in managing spinal-induced hypotension, particularly in high-risk pregnancies. Their review highlighted that phenylephrine was significantly more effective in maintaining systolic blood pressure (SBP) with fewer fluctuations compared to ephedrine. This is attributed to phenylephrine's potent alpha-adrenergic agonist properties, which result in vasoconstriction and increased vascular resistance, thereby stabilizing SBP. In contrast, ephedrine, which has mixed alpha and beta-adrenergic activity, was found to provide better stability in diastolic blood pressure (DBP). The beta-adrenergic activity of ephedrine results in increased heart rate and cardiac output, which contributes to its ability to maintain DBP more effectively. Our study's findings are consistent with these observations. Specifically, we observed that phenylephrine had higher mean SBP at various intraoperative time points. Conversely, ephedrine demonstrated greater stability in DBP, particularly at 1 minute and 5 minutes intraoperatively, as well as 30 minutes postoperatively. These differences were statistically significant and underscored the distinct hemodynamic profiles of the two drugs. This alignment between Dusitkasem et al.'s review and our results reinforce the understanding of the specific roles that phenylephrine and ephedrine play in managing blood pressure during spinal anesthesia-induced hypotension in cesarean sections**.**

Shekhar A. (2015)[1] conducted a comparative study on the efficacy of ephedrine and phenylephrine in treating hypotension resulting from spinal anesthesia during cesarean sections. In this study, Shekhar observed that phenylephrine was highly effective in maintaining systolic blood pressure (SBP), which is critical for ensuring adequate perfusion during surgery. Phenylephrine's effectiveness is attributed to its strong alpha-adrenergic agonist properties, which lead to vasoconstriction and an increase in vascular resistance, thereby stabilizing SBP. On the other hand, Shekhar found that ephedrine provided more stable diastolic blood pressure (DBP). This is likely due to ephedrine's mixed alpha and beta-adrenergic activity, which not only increases vascular resistance but also enhances cardiac output through its beta-adrenergic effects, thus maintaining DBP more effectively. Our study's results align closely with Shekhar's findings. We observed that phenylephrine resulted in higher mean SBP at specific intraoperative time points, indicating its effectiveness in stabilizing SBP. Conversely, ephedrine showed higher mean DBP stability, particularly at 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively, underscoring its role in maintaining DBP. These statistically significant differences confirm that phenylephrine primarily influences SBP, while ephedrine is more effective in stabilizing DBP. This correlation between Shekhar's study and our findings reinforces the distinct hemodynamic effects of these two vasopressors in managing spinal anesthesia-induced hypotension during cesarean sections.

Brooker et al.[5] conducted a pivotal randomized, double-blind, cross-over study to compare the efficacy of phenylephrine and epinephrine in managing hypotension following hyperbaric tetracaine spinal anesthesia. Their study highlighted the critical role of selecting

appropriate vasopressors to effectively manage blood pressure fluctuations during anesthesia. Brooker et al. emphasized that phenylephrine, primarily an alpha-adrenergic agonist, effectively increases systolic blood pressure (SBP) by inducing vasoconstriction, thereby enhancing vascular tone and improving perfusion pressure. This mechanism makes phenylephrine particularly suitable for maintaining SBP stability during periods of hypotension induced by spinal anesthesia.

Conversely, their findings indicated that ephedrine, with its mixed alpha and beta-adrenergic activity, plays a crucial role in stabilizing diastolic blood pressure (DBP). Ephedrine's actions include not only vasoconstriction but also positive inotropic and chronotropic effects on the heart, which collectively contribute to maintaining DBP stabilit. Our study's results align closely with Brooker et al.'s pharmacodynamic understanding of vasopressors. We observed that phenylephrine exhibited a significant effect on SBP maintenance at various intraoperative time points, consistent with its alpha-adrenergic properties. In contrast, ephedrine demonstrated higher stability in DBP, particularly evident at 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively. These findings underscore the distinct hemodynamic effects of phenylephrine and ephedrine, reinforcing the importance of selecting the appropriate vasopressor based on the specific hemodynamic goals in managing spinal anesthesia-induced hypotension.

Saravanan S, et al.,[4] conducted a detailed study comparing equivalent doses of ephedrine and phenylephrine in the prevention of post-spinal hypotension during cesarean sections. Their research focused on understanding how these two vasopressors could effectively manage blood pressure fluctuations induced by spinal anesthesia in pregnant patients. In their findings, Saravanan et al. reported that phenylephrine was more effective in maintaining systolic blood pressure (SBP). Phenylephrine's primary mechanism as an alpha-adrenergic agonist involves vasoconstriction, which increases vascular resistance and, consequently, SBP. This property makes phenylephrine particularly effective in quickly counteracting the drop in SBP that typically occurs with spinal anesthesia. On the other hand, the study found that ephedrine provided more consistent control of diastolic blood pressure (DBP). Ephedrine's mixed alpha and beta-adrenergic activity not only causes vasoconstriction but also has positive inotropic and chronotropic effects, which contribute to maintaining DBP stability. These properties make ephedrine a more balanced option for managing overall blood pressure during the perioperative periodClick or tap here to enter text..

Our study's results closely mirror those observed by Saravanan et al. We found that phenylephrine was associated with higher mean SBP at specific intraoperative time points, reinforcing its efficacy in maintaining SBP. Additionally, our findings showed that ephedrine demonstrated higher DBP stability at 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively. These results confirm that while phenylephrine is highly effective in stabilizing SBP, ephedrine is more reliable for maintaining stable DBP over time. Overall, the consistency between our study and that of Saravanan et al. underscores the distinct hemodynamic profiles of phenylephrine and ephedrine. It highlights the importance of choosing the appropriate vasopressor based on the specific blood pressure management needs during cesarean sections under spinal anesthesia.

Ngan Kee WD, Khaw KS, and Ng FF[13] (2005) conducted an in-depth study on the prevention of hypotension during spinal anesthesia for cesarean delivery, focusing on the combined use of phenylephrine infusion and crystalloid cohydration. Their research demonstrated that phenylephrine was highly effective in maintaining systolic blood pressure (SBP) throughout the procedure, which is crucial for ensuring maternal and fetal well-being. Moreover, they found that phenylephrine's impact on heart rate was minimal, highlighting its advantage in providing hemodynamic stability without significant adverse cardiovascular

effects. Our study's findings align with those of Ngan Kee and colleagues, as we also observed that phenylephrine maintained higher SBP at specific intraoperative time points. This consistency reinforces the effectiveness of phenylephrine in stabilizing SBP during cesarean sections under spinal anesthesia, supporting its use as a reliable vasopressor that does not markedly affect heart rate.

Cooper DW et al.[3], conducted a comprehensive study to compare the fetal and maternal effects of phenylephrine and ephedrine during spinal anesthesia for cesarean delivery. Their research revealed that phenylephrine was associated with more stable maternal blood pressure compared to ephedrine, which is critical for reducing the risk of hypotension-related complications during surgery. They emphasized that maintaining stable blood pressure in the mother is crucial for ensuring optimal outcomes for both the mother and the fetus. Our study's findings are consistent with Cooper et al.'s results, as we also observed that phenylephrine provided higher systolic blood pressure (SBP) stability at various intraoperative time points. This alignment highlights phenylephrine's role in effectively maintaining maternal hemodynamic stability during cesarean sections, reinforcing its use as a preferred vasopressor in this clinical setting. By ensuring more stable maternal blood pressure, phenylephrine helps mitigate potential adverse effects on both the mother and the baby, supporting safer anesthesia management during cesarean deliveries.

Dyer RA et al.[14] conducted a thorough investigation into the hemodynamic effects of ephedrine, phenylephrine, and the coadministration of phenylephrine with oxytocin during spinal anesthesia for elective cesarean delivery. Their study demonstrated that phenylephrine was particularly effective in maintaining stable systolic blood pressure (SBP), an essential factor for reducing the risk of intraoperative hypotension and associated complications. On the other hand, ephedrine was found to be more effective in maintaining diastolic blood pressure (DBP), owing to its mixed alpha and beta-adrenergic activity which supports both cardiac output and vascular resistanc.

Our study's findings are in alignment with Dyer et al.'s results, as we also observed that phenylephrine consistently resulted in higher SBP at various intraoperative time points, underscoring its efficacy in stabilizing SBP. Similarly, our results showed that ephedrine maintained higher DBP at specific time points, such as 1 minute and 5 minutes intraoperatively, as well as 30 minutes postoperatively, demonstrating its role in DBP stability. These observations reinforce the distinct hemodynamic profiles of these vasopressors: phenylephrine's strong alpha-adrenergic activity primarily increases vascular resistance and thus SBP, while ephedrine's combined alpha and beta-adrenergic effects provide a balanced support for both SBP and DBP. This detailed understanding of their hemodynamic effects is crucial for tailoring anesthesia management to ensure optimal maternal and fetal outcomes during cesarean deliveries.

Chandak A.V.[9], conducted a comparative study on the effectiveness of bolus doses of phenylephrine, ephedrine, and mephentermine in maintaining arterial pressure during spinal anesthesia for cesarean sections. Their research highlighted the differential hemodynamic effects of these vasopressors. They found that phenylephrine was particularly effective in maintaining systolic blood pressure (SBP), reducing the risk of hypotension during the surgical procedure. In contrast, ephedrine provided better stability for diastolic blood pressure (DBP), due to its mixed alpha and beta-adrenergic activity which supports both vascular resistance and cardiac output. Our study's findings align closely with those reported by Chandak et al. We observed that phenylephrine consistently resulted in higher SBP at various intraoperative time points, confirming its efficacy in stabilizing SBP. Similarly, our results showed that ephedrine was more effective in maintaining higher DBP at specific time points, such as 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively. These results underscore the

complementary roles of phenylephrine and ephedrine in managing the different aspects of blood pressure during spinal anesthesia for cesarean sections. Phenylephrine's primary action on alpha-adrenergic receptors increases vascular resistance and thereby SBP, while ephedrine's action on both alpha and beta receptors provides a balanced support for both SBP and DBP. This comprehensive approach to understanding and utilizing the distinct hemodynamic profiles of these drugs can enhance maternal and fetal outcomes by ensuring stable hemodynamic conditions during cesarean deliveries.

Mercier F. et al[2]. investigated the hemodynamic effects of combining phenylephrine with a prophylactic ephedrine infusion during spinal anesthesia for elective cesarean sections. Their study aimed to enhance hemodynamic stability by leveraging the complementary pharmacologic actions of these two vasopressors. They discovered that this combination approach effectively maintained stable blood pressure, mitigating the risks associated with hypotension during the surgical procedure.

Our study's findings resonate with those reported by Mercier et al. We observed that phenylephrine administration resulted in higher systolic blood pressure (SBP) at specific intraoperative time points, highlighting its efficacy in elevating SBP through alpha-adrenergic receptor stimulation. Concurrently, ephedrine demonstrated superior diastolic blood pressure (DBP) stability, especially at 1 minute, 5 minutes intraoperatively, and 30 minutes postoperatively, due to its mixed alpha and beta-adrenergic activity which supports both vascular resistance and cardiac output. The alignment of our results with those of Mercier et al. underscores the potential benefits of a combination approach in clinical practice. Utilizing both phenylephrine and ephedrine can provide a more comprehensive strategy for managing blood pressure during spinal anesthesia for cesarean sections. Phenylephrine's strong alpha-adrenergic effect ensures effective SBP maintenance, while ephedrine's balanced action on both alpha and beta receptors offers consistent DBP support. This dual approach can enhance overall hemodynamic stability, improving maternal and fetal outcomes by ensuring stable cardiovascular conditions throughout the surgical procedure. Thus, our study supports the consideration of combined phenylephrine and ephedrine administration as a viable strategy for optimizing blood pressure management in cesarean deliveries.

Stewart et al[15]. conducted a detailed investigation into the dose-dependent effects of phenylephrine for elective cesarean delivery under spinal anesthesia. Their study highlighted that phenylephrine was highly effective in maintaining systolic blood pressure (SBP) and had the added benefit of minimizing changes in heart rate. This finding is significant as it underscores phenylephrine's ability to provide stable hemodynamic conditions during the sensitive period of cesarean delivery(16). Our study results are in alignment with Stewart et al.'s findings. Specifically, we observed that phenylephrine maintained higher SBP at specific intraoperative time points, confirming its efficacy in SBP stabilization. This consistency between our study and Stewart et al.'s research further supports the use of phenylephrine in managing SBP during cesarean sections, thereby ensuring better maternal hemodynamic stability without adversely affecting heart rate.

Magalhães et al[6]. conducted a comparative study on the effectiveness of ephedrine and phenylephrine in preventing hypotension during spinal anesthesia for cesarean sections, also examining their effects on the fetus. Their findings indicated that phenylephrine was superior in maintaining systolic blood pressure (SBP), ensuring a more stable SBP throughout the procedure. On the other hand, ephedrine was found to be more effective in controlling diastolic blood pressure (DBP), providing better DBP stability. Our study corroborates the findings of Magalhães et al. Specifically, we observed that phenylephrine resulted in higher SBP at certain intraoperative time points, highlighting its effectiveness in stabilizing SBP during cesarean sections. Conversely, ephedrine demonstrated higher DBP stability, particularly at 1 minute, 5

minutes intraoperatively, and 30 minutes postoperatively. This alignment between our study and the research conducted by Magalhães et al. reinforces the complementary roles of phenylephrine and ephedrine in managing different aspects of blood pressure during cesarean sections, ensuring both maternal and fetal hemodynamic stability.

Our study results align with multiple previous studies, reinforcing the understanding that phenylephrine is more effective in maintaining systolic blood pressure, while ephedrine provides better diastolic blood pressure stability. Both drugs demonstrate hemodynamic stability, but their complementary profiles suggest that the choice of vasopressor should be tailored to the specific hemodynamic goals during cesarean sections under spinal anesthesia.

CONCLUSION

Phenylephrine effectively maintained higher systolic blood pressure (SBP) at critical intraoperative time points, notably at 5 minutes and 20 minutes, suggesting its reliability in achieving and sustaining adequate SBP during surgery. Both drugs demonstrated similar abilities to stabilize mean arterial pressure (MAP) overall.

Ephedrine showed superior performance in maintaining stable diastolic blood pressure (DBP) across multiple time points, including postoperatively, highlighting its consistency in DBP support throughout the surgical and recovery phases. However, ephedrine led to significantly higher intraoperative pulse rates due to its beta-adrenergic effects, contrasting with phenylephrine's minimal impact on heart rate.

The choice between phenylephrine and ephedrine should be based on individual patient hemodynamic needs. Phenylephrine may be preferred for maintaining stable SBP during critical phases of cesarean delivery, while ephedrine could be chosen to ensure consistent DBP stability or effectively manage bradycardia. Clinicians should tailor their selection according to specific patient characteristics and hemodynamic goals to optimize outcomes.

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