

A Comparative Study Of Ephedrine, Mephentermine And Phenylephrine In The Treatment Of Hypotension During Spinal Anaesthesia For Cesarean Section Held In Tertiary Care Centre

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Abstract

Background:

Hypotension following spinal anaesthesia for caesarean section is a common complication caused by sympathetic blockade leading to vasodilatation and decreased systemic vascular resistance, which may compromise maternal hemodynamics and uteroplacental perfusion. Vasopressors such as Phenylephrine, Ephedrine, and Mephentermine are commonly used to manage this condition. This study compared the efficacy of these vasopressors in maintaining arterial blood pressure during spinal anaesthesia for caesarean section.

Materials and methods: In this prospective, randomized, double-blind study conducted at Akash Institute of Medical Sciences, 99 parturients were allocated into three groups (n=33 each): Group A received phenylephrine 100 µg IV, Group B ephedrine 6 mg IV, and Group C mephentermine 6 mg IV. Hemodynamic parameters were monitored intraoperatively, and neonatal outcome was assessed using APGAR scores.

Results: Phenylephrine maintained systolic, diastolic, and mean arterial pressure more effectively ($p < 0.001$) and required fewer rescue vasopressor doses. Heart rate was lower with phenylephrine. APGAR scores were comparable among groups.

Conclusion: Phenylephrine was more effective in maintaining hemodynamic stability during caesarean section under spinal anaesthesia.

Key Word: Spinal anaesthesia; Caesarean section; Hypotension; Phenylephrine; Ephedrine; Mephentermine.

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I. Introduction

Spinal anaesthesia is widely used for caesarean section because it is simple, rapid, reliable, and allows the mother to remain awake during delivery while avoiding complications associated with general anaesthesia such as aspiration, failed intubation, and neonatal respiratory depression. However, hypotension is the most common complication of spinal anaesthesia, occurring in up to 85% of patients due to sympathetic blockade resulting in vasodilatation and decreased systemic vascular resistance.

Maternal hypotension may lead to symptoms such as nausea, vomiting, and dizziness, and can adversely affect uteroplacental perfusion, resulting in fetal bradycardia and acidosis. Although preventive measures such as left uterine displacement and fluid preloading with crystalloids or colloids are used, these measures alone are often insufficient.

Therefore, vasopressors are commonly administered to rapidly correct hypotension. Ephedrine and mephentermine, which stimulate both alpha and beta adrenergic receptors, increase blood pressure mainly by increasing cardiac output. Phenylephrine, a selective alpha-1 agonist, raises blood pressure through vasoconstriction and is considered effective in maintaining maternal arterial pressure during spinal anaesthesia.

II. Material And Methods

This study will be conducted with informed consent of female patients between the age 18-40 years under ASA grade 1 and grade 2 undergoing elective caesarean section with a normal singleton pregnancy beyond 36 weeks of gestation, study will be conducted in the department of Anaesthesiology, Akash Institute of Medical Sciences and Research centre, Devanahalli, Bangalore.

Study Design: A Hospital based comparative study

Study Location: Department of ANAESTHESIOLOGY Akash Institute of Medical Sciences and Research Centre Devanahalli, Bangalore rural-562110.

Study Duration: March 2024 to September 2025

Sample size: 99 patients.

Sample size calculation: The sample size was estimated on the basis of a single proportion design. The target population from which we randomly selected our sample was considered 2000. We assumed that the confidence interval of 10% and confidence level of 95%. The sample size actually obtained for this study was 99 patients for each group. We planned to include 99 patients (Group A , Group B and Group C - Cases of 99 patients for each group) with 4% drop out rate.

Subjects & selection method: This study was conducted as a prospective, randomized, double-blind, hospital-based study at Akash Institute of Medical Sciences and Research Centre, Devanahalli, Bangalore. Patients undergoing the procedure was selected based on predefined inclusion and exclusion criteria. Detailed information including history of presenting illness, thorough clinical examination, and relevant investigations were collected for all participants. Prior to enrollment, approval from the Institutional Ethics Committee was obtained, and written informed consent was taken from each patient or their legal guardian.

A total of 99 patients were included in the study and randomly allocated into three groups of 33 each using a computer-generated randomization method. Group A received Inj. Phenylephrine 100 µg (1 ml) as an intravenous bolus, Group B received Inj. Ephedrine 6 mg (1 ml) as an intravenous bolus, and Group C received Inj. Mephentermine 6 mg (1 ml) as an intravenous **bolus** for the management of hypotension during spinal anesthesia.

Inclusion criteria:

1. Patients with American society of anesthesiologists (ASA) grade I and II.
2. Female patients between age 18 – 40 years.
3. Normal singleton pregnancy beyond 36 weeks of gestational age.

Exclusion criteria:

1. Patients with history of allergy to the drugs.
2. Known case of diabetes, hypertension, cardio and cerebrovascular diseases, hypothyroidism, severe anemia, hepatic or renal dysfunctions.
3. BMI>30kg/m²
4. Maternal history of pregnancy induced hypertension, gestational diabetes mellitus and antepartum hemorrhage, any fetal abnormality and any contraindication for spinal anesthesia.

Procedure methodology: This study was designed as a prospective, randomized, double-blind, hospital-based study conducted at Akash Institute of Medical Sciences and Research Centre, Devanahalli, Bangalore. Patients were selected based on predefined inclusion and exclusion criteria after obtaining approval from the Institutional Ethics Committee and written informed consent from each patient or their legal guardian.

A total of 99 patients were randomly allocated into three groups of 33 each using a computer-generated randomization method. Group A received Inj. Phenylephrine 100 µg (1 ml) IV bolus, Group B received Inj. Ephedrine 6 mg (1 ml) IV bolus, and Group C received Inj. Mephentermine 6 mg (1 ml) IV bolus for the management of hypotension following spinal anesthesia. All patients underwent pre-anaesthetic evaluation, were kept nil per oral for 6 hours, and received premedication with oral ranitidine 150 mg and Inj. metoclopramide 10 mg the night before surgery, followed by Inj. pantoprazole 40 mg IV and Inj. ondansetron 4 mg IV 30 minutes prior to surgery. Baseline vital parameters including heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, and SpO₂ were recorded, and an intravenous line was secured with preloading using Ringer lactate or normal saline. Spinal anesthesia was administered at the L4–L5 interspace using 0.5% hyperbaric bupivacaine (2 ml) after confirming free flow of cerebrospinal fluid. Patients were then placed in the supine position with oxygen supplementation (4–5 L/min) via face mask. Hemodynamic parameters were recorded immediately after spinal anesthesia, every 3 minutes for the first 15 minutes, and thereafter every 5 minutes until the end of surgery. Rescue vasopressor boluses were administered when systolic blood pressure fell below 90 mmHg, and the total number and timing of boluses were documented.

Bradycardia (HR <60 beats/min) was treated with Inj. atropine 0.6 mg IV. Any intraoperative adverse events such as nausea, vomiting, shivering, headache, or restlessness were recorded. Drug allocation was

performed using the opaque sealed envelope technique, with the study drug prepared by the chief investigator while both the patient and the investigator remained blinded until completion of data collection. Following delivery, Inj. oxytocin 5 units IV bolus was administered after cord clamping, followed by 10 units oxytocin infusion in RL/NS. Neonatal outcome was assessed using the APGAR score at 1 and 5 minutes, and intraoperative data including total IV fluids administered, number of rescue vasopressor boluses, and atropine usage were recorded for analysis.

Statistical analysis:

The collected data were entered into Microsoft Excel and analyzed using SPSS version 26 for statistical analysis. Categorical variables were expressed as frequencies and percentages and presented using graphs and tables. Numerical data were expressed as mean ± standard deviation (SD). The Student’s t-test and one-way ANOVA were used to determine the mean differences between the study groups or variables. A p-value ≤ 0.05 was considered statistically significant.

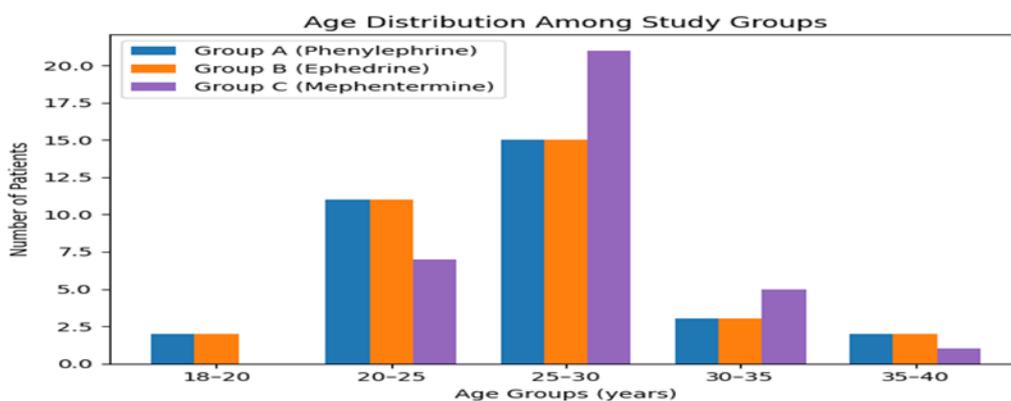
III. Result:

In our study of 99 patients ,Group A received Inj Phenylephrine 100mcg , Group B received Inj Ephedrine 6mg, and Group C received Inj Mephentermine 6 mg IV bolus .The results are as follows:

TABLE 1 :AGE DISTRIBUTION

AGE (years)	GROUPA		GROUPB		GROUPC		P-value
	COUNT	PERCENTAGE	COUNT	PERCENTAGE	COUNT	PERCENTAGE	
18–20	2	6.06%	2	6.06%	0	0%	0.69
20–25	11	33.33%	11	33.33%	7	22.58%	
25–30	15	45.45%	15	45.45%	21	58.06%	
30–35	3	9.09%	3	9.09%	5	16.13%	
35–40	2	6.06%	2	6.06%	1	3.23%	
TOTAL	33	100%	33	100%	33	100%	
Mean+SD	27.40+3.40		26.67+4.28		26.67+4.28		

TABLE 1 shows A total of 99 patients were included, with 33 patients in each group. Most patients in all groups belonged to the 25–30 years age group (Group A: 45.45%, Group B: 45.45%, Group C: 58.06%), followed by the 20–25 years age group. The mean age was 27.40 ± 3.40 years in Group A and 26.67 ± 4.28 years in both Group B and Group C. The difference in age distribution among the three groups was not statistically significant (p = 0.69), indicating that the groups were comparable with respect to age.



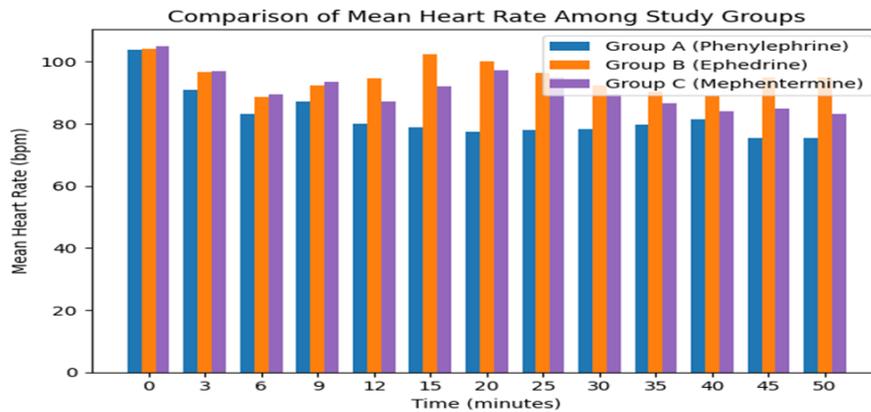
Comparison Of Heartrate (Bpm) Between The Three Groups

TABLE 2 : DISTRIBUTION OF HEART RATE

HR(bpm)	A	B	C	p value
	MEAN+SD	MEAN+ SD	MEAN+SD	
0min	104 +7.77	104.24+9.32	105.12+9.21	>0.05
3min	91.08+2.52	96.70+2.55	97.03+2.37	<0.001
6min	83.32+3.00	88.70+2.08	89.5+2.21	<0.001
9min	87.32+3.00	92.47+1.45	93.40+2.38	<0.001
12min	79.97+4.89	94.67+1.95	87.18+2.32	<0.001
15min	79 +7.55	102.29+1.55	92.21+2.33	<0.001
20min	77.55+8.09	100.20+1.55	97.31+1.80	<0.001

25min	78.08+6.82	96.32+1.49	94.84+2.68	<0.001
30min	78.41+5.20	92.47+1.43	89.56+2.01	<0.001
35min	79.82+3.94	90.41+1.41	86.56+1.63	<0.001
40min	81.38+2.90	88.94+1.89	84.15+1.63	<0.001
45min	75.48+3.54	94.93+2.78	84.93 +3.65	<0.001
50min	75.39+3.21	95.03+2.88	83.31+3.55	<0.001

TABLE 2 Shows the baseline heart rate (0 min) was comparable among the three groups and was not statistically significant ($p > 0.05$). After spinal anesthesia, Group A showed lower heart rate values, whereas Group B maintained higher heart rates and Group C showed intermediate values during the intraoperative period. From 3 minutes to 50 minutes, the difference in heart rate between the groups was statistically highly significant ($p < 0.001$).

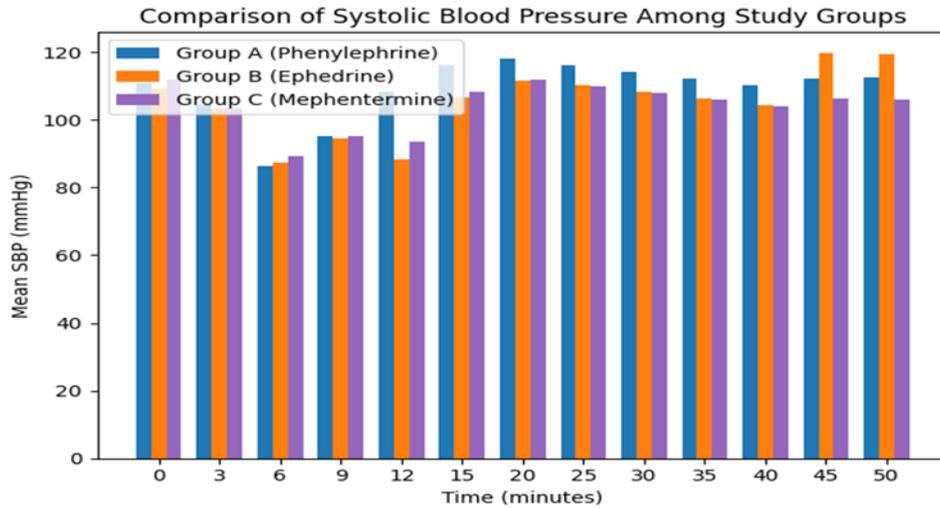


Comparison Of Systolic Blood Pressure In Between Three Groups

TABLE 3 : DISTRIBUTION OF SYSTOLIC BLOOD PRESSURE

SBP(mm Hg)	A	B	C	p value
	MEAN+SD	MEAN+SD	MEAN+SD	
0min	110.84+5.93	109.21+6.39	111.81+9.21	>0.05
3min	104.47+1.88	103.41+1.82	103.53+2.72	0.11
6min	86.5 +5.17	87.41+3.89	89.40+5.10	0.08
9min	95.20+5.08	94.41+4.09	95.15+3.23	0.98
12min	108.41+1.72	88.44+7.71	93.5+5.06	<0.001
15min	116.11+1.94	106.73+7.45	108.37+1.86	<0.001
20min	118 +1.64	111.67+1.82	112 +2.18	<0.001
25min	116.11+1.94	110.41+1.82	110 +2.18	<0.001
30min	114.23+1.64	108.41+1.82	108 +2.18	<0.001
35min	112.17+1.76	106.41+1.82	106.03+2.14	<0.001
40min	110.17+1.76	104.41+1.82	104.15+1.88	<0.001
45min	112.24+4.57	119.87+2.55	106.46+3.23	<0.001
50min	112.66+4.62	119.45+2.47	106.09+3.64	<0.001

TABLE 3 Show the baseline systolic blood pressure (0 min) was comparable among the three groups (Group A: 110.84 ± 5.93 mmHg, Group B: 109.21 ± 6.39 mmHg, Group C: 111.81 ± 9.21 mmHg) and the difference was not statistically significant ($p > 0.05$). Similarly, at 3, 6 and 9 minutes, the differences between groups were not statistically significant. However, from 12 minutes to 50 minutes, the variation in systolic blood pressure among the three groups became statistically highly significant ($p < 0.001$). Group A maintained relatively higher systolic blood pressure, while Group B and Group C showed comparatively lower values during the intraoperative period.

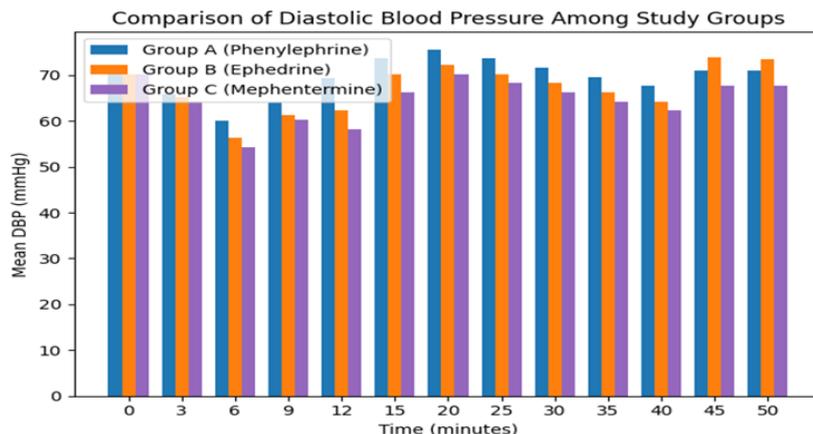


Comparison Of Diastolic Blood Pressure Between The Three Groups

TABLE 4 : DISTRIBUTION OF DIASTOLIC BLOOD PRESSURE

DBP(mmHg)	A	B	C	p value
	MEAN+SD	MEAN+SD	MEAN+SD	
0min	70.18+6.12	70.18+6.12	70.15+6.08	>0.05
3min	65.91+2.06	65.23+1.81	64.25+1.84	0.16
6min	60.14+3.28	56.23+1.81	54.25+1.84	<0.001
9min	64.02+2.23	61.23+1.81	60.25+1.84	<0.001
12min	69.44+3.19	62.23+1.81	58.25+1.84	<0.001
15min	73.73+2.12	70.23+1.81	66.25+1.84	<0.001
20min	75.61+2.23	72.23+1.81	70.25+1.84	<0.001
25min	73.73+2.35	70.23+1.81	68.25+1.84	<0.001
30min	71.61+2.23	68.23+1.81	66.25+1.84	<0.001
35min	69.55+2.36	66.23+1.81	64.25+1.84	<0.001
40min	67.67+2.15	64.23+1.81	62.31+1.80	<0.001
45min	70.96+3.18	73.87+2.55	67.62+3.76	<0.001
50min	71 +3.31	73.45+2.47	67.71+3.74	<0.001

TABLE 4 Shows the baseline diastolic blood pressure (0 min) was comparable among the three groups (Group A: 70.18 ± 6.12 mmHg, Group B: 70.18 ± 6.12 mmHg, Group C: 70.15 ± 6.08 mmHg) and the difference was not statistically significant (p > 0.05). At 3 minutes, the difference remained not statistically significant (p = 0.16). However, from 6 minutes to 50 minutes, the differences in diastolic blood pressure among the three groups were statistically highly significant (p < 0.001). Group A maintained relatively higher diastolic blood pressure, while Group C showed comparatively lower values during the intraoperative period.

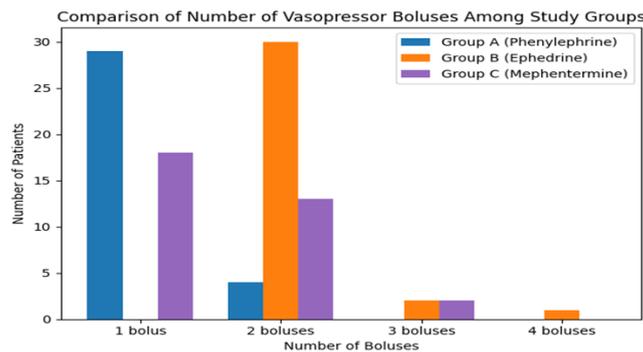


Comparison Of Number Of Boluses Between The Three Groups

TABLE 5 :NUMBER OF BOLUSES GIVEN

No of boluses	GROUPA		GROUPB		GROUPC		pvalue
	COUNT	PERCENTAGE	COUNT	PERCENTAGE	COUNT	PERCENTAGE	
1	29	87.88%	0	0	18	54.55%	<0.001
2	4	12.12%	30	90.91%	13	39.39%	
3	0	0	2	6.06%	2	6.06%	
4	0	0	1	3.03%	0	0	
Total	33	100%	33	100%	33	100%	
MEAN+SD	1.12+0.33		2.15+0.49		1.53+0.67		

TABLE 5 Shows that the majority of patients in Group A required only one bolus (87.88%), whereas most patients in Group B required two boluses (90.91%). In Group C, 54.55% required one bolus and 39.39% required two boluses. A small proportion of patients in Groups B and C required three boluses, and only one patient in Group B required four boluses. The mean number of boluses was 1.12 ± 0.33 in Group A, 2.15 ± 0.49 in Group B, and 1.53 ± 0.67 in Group C. The difference among the groups was statistically highly significant ($p < 0.001$).

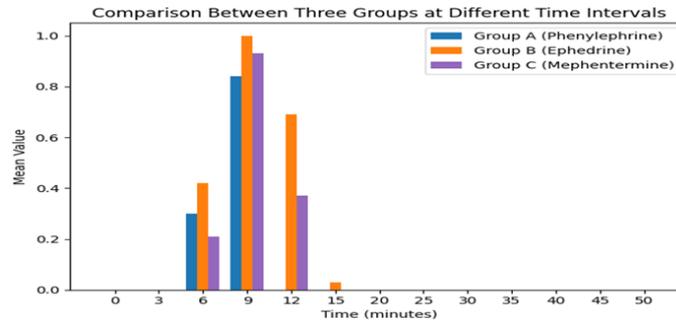


Comparison Of Time Of Administration Of Vassopressors

Table 6 : Time Of Administration Of Vassopressors

TIME(MIN)	GROUPA	GROUPB	GROUPC	pvalue
	MEAN+ SD	MEAN+SD	MEAN+ SD	
0MIN	0	0	0	>0.05
3MIN	0	0	0	
6MIN	0.30+0.45	0.42+0.49	0.21+0.42	
9MIN	0.84+0.33	1+0	0.93+0.24	
12MIN	0	0.69+0.47	0.37+0.49	
15MIN	0	0.03+0.17	0	
20MIN	0	0	0	
25MIN	0	0	0	
30MIN	0	0	0	
35MIN	0	0	0	
40MIN	0	0	0	
45MIN	0	0	0	
50MIN	0	0	0	

TABLE 6 Shows at 0 and 3 minutes, the values were zero in all three groups, showing no difference. At 6 minutes, small increases were observed in Group A (0.30 ± 0.45), Group B (0.42 ± 0.49) and Group C (0.21 ± 0.42). The values peaked at 9 minutes, with Group B showing the highest value (1.0 ± 0) followed by Group C (0.93 ± 0.24) and Group A (0.84 ± 0.33). At 12 minutes, values decreased in all groups, and by 15 minutes only Group B showed a minimal value (0.03 ± 0.17). From 20 minutes to 50 minutes, the values were zero in all groups.



Comparison Of Complications

Table 7: Complications

Complications	Groupa(33)	Groupb(33)	Groupc(33)
	Count	Count	Count
Bradycardia	0	0	0
Nausea	0	0	0
Vomiting	0	0	0
Shivering	0	0	0
Dizziness	0	0	0

TABLE 7 Shows no intraoperative complications were observed in any of the study groups. Bradycardia, nausea, vomiting, shivering, and dizziness were not reported in Groups A, B, or C during the study period. Hence, there was no statistically significant difference in the incidence of complications among the three groups.

IV. Discussion

Spinal anesthesia is the most commonly used anesthetic technique for Caesarean section because it provides rapid onset of anesthesia, adequate muscle relaxation, and minimal fetal drug exposure. However, maternal hypotension following spinal anesthesia remains one of the most frequent complications, primarily due to sympathetic blockade leading to peripheral vasodilation and decreased systemic vascular resistance. Vasopressors are therefore routinely used to prevent and treat hypotension. The present study compared the efficacy of phenylephrine, ephedrine, and mephentermine in maintaining hemodynamic stability during spinal anesthesia.

Age Distribution

In the present study, the majority of patients in all three groups belonged to the 25–30 years age group, followed by the 20–25 years group. The mean age was 27.40 ± 3.40 years in Group A, 26.67 ± 4.28 years in Group B, and 26.67 ± 4.28 years in Group C. Statistical analysis showed no significant difference among the groups ($p = 0.69$).

This indicates that the groups were demographically comparable with respect to age, thereby eliminating age as a potential confounding factor influencing hemodynamic responses. Similar findings were reported in several studies evaluating vasopressors during spinal anesthesia for Caesarean section, where patient demographics were comparable among study groups to ensure validity of the results.

Heart Rate

The baseline heart rate was comparable among the three groups and showed no statistically significant difference ($p > 0.05$). However, following spinal anesthesia, a significant variation in heart rate was observed among the groups.

Patients in Group A (Phenylephrine) demonstrated a progressive reduction in heart rate, whereas Group B (Ephedrine) maintained relatively higher heart rates throughout the intraoperative period. Group C (Mephentermine) showed intermediate values. From 3 minutes onwards until 50 minutes, the differences in heart rate among the three groups were statistically highly significant ($p < 0.001$).

The decrease in heart rate observed with phenylephrine can be explained by its pure alpha-adrenergic agonist activity, which causes vasoconstriction and reflex bradycardia through baroreceptor stimulation. Ephedrine, on the other hand, has both alpha and beta adrenergic effects, resulting in increased heart rate and cardiac output. Mephentermine also exerts indirect sympathomimetic action but to a lesser extent compared to ephedrine. These pharmacological properties likely explain the variations in heart rate observed in this study.

Systolic Blood Pressure The baseline systolic blood pressure was comparable among the three groups and showed no statistically significant difference ($p > 0.05$). Similarly, the values recorded at 3, 6, and 9 minutes were not significantly different.

However, from 12 minutes onwards until 50 minutes, the differences in systolic blood pressure among the groups were statistically highly significant ($p < 0.001$). Group A maintained higher systolic blood pressure values compared to Groups B and C.

This finding suggests that phenylephrine was more effective in maintaining systolic blood pressure during spinal anesthesia. The vasoconstrictive effect of phenylephrine increases systemic vascular resistance and thus effectively counteracts the hypotension associated with spinal anesthesia. Ephedrine and mephentermine also increase blood pressure but through a combination of cardiac stimulation and indirect sympathomimetic mechanisms.

Diastolic Blood Pressure

The baseline diastolic blood pressure was similar among all groups with no statistically significant difference ($p > 0.05$). At 3 minutes, the difference remained statistically insignificant. However, from 6 minutes onwards until 50 minutes, the variation in diastolic blood pressure between the groups became statistically highly significant ($p < 0.001$).

Throughout the intraoperative period, Group A maintained relatively higher diastolic blood pressure, while Group C demonstrated comparatively lower values. These findings further support the superior ability of phenylephrine to maintain vascular tone during spinal anesthesia due to its potent alpha-adrenergic vasoconstrictive effect

Number of Boluses Required

The number of vasopressor boluses required to maintain hemodynamic stability differed significantly among the groups. In Group A, the majority of patients (87.88%) required only one bolus, while in Group B, 90.91% of patients required two boluses. In Group C, 54.55% required one bolus and 39.39% required two boluses.

The mean number of boluses required was 1.12 ± 0.33 in Group A, 2.15 ± 0.49 in Group B, and 1.53 ± 0.67 in Group C, and the difference was statistically highly significant ($p < 0.001$).

This suggests that phenylephrine required fewer repeat doses to maintain adequate blood pressure, indicating better efficacy in preventing recurrent hypotension. Ephedrine required more frequent boluses, which may be due to its indirect mechanism of action and shorter duration of effect compared to phenylephrine.

Complications

No intraoperative complications such as bradycardia, nausea, vomiting, shivering, or dizziness were observed in any of the groups. This indicates that all three vasopressors were safe and well tolerated when used in the studied doses.

The absence of significant complications also suggests that the drugs were administered appropriately and patients were carefully monitored throughout the intraoperative period.

V. Conclusion

The present study concludes that phenylephrine, ephedrine, and mephentermine are effective in managing hypotension following spinal anesthesia during Caesarean section. Phenylephrine maintained blood pressure more effectively and required fewer rescue boluses compared to ephedrine and mephentermine. All three drugs were safe and well tolerated with no significant intraoperative complications.

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