

Comparison Of Bolus Ephedrine, Mephentermine And Phenylephrine For The Management Of Hypotension During Spinal Anaesthesia For Caesarean Section – A Clinical Study

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Abstract:

Background: Anaesthesia to a parturient is not only unique but also requires highest degree of care because the anaesthesiologist has to look after two individuals, the mother and foetus. Hypotension during spinal anaesthesia for caesarean delivery can have detrimental effects on both mother and neonate. These effects include decreased utero-placental blood flow, impaired foetal oxygenation with asphyxial stress and foetal acidosis and maternal symptoms of low cardiac output such as nausea, vomiting, dizziness and decreased consciousness. Vasopressor like Ephedrine, Mephentermine, Phenylephrine, are used for treating the hypotension. In this study we compared the efficacy of Ephedrine, Mephentermine and Phenylephrine in treating the hypotension for caesarean section and their desirable side effects.

Materials and Methods: In this prospective randomised controlled study, 90 patients of ASA physical status I and II belonging to age group of 18-35 years undergoing elective or emergency LSCS under sub-arachnoid block were randomly allocated into 3 groups of 30 patients each, Group E (Ephedrine) and Group M (Mephentermine) and Group P (Phenylephrine). Group E received Inj Ephedrine 6 mg IV bolus, Group M received Inj Mephentermine 6 mg IV bolus and Group P received Inj Phenylephrine 100 microgram IV bolus for spinal anaesthesia. The changes in hemodynamic parameters, neonatal outcome, side-effects and usage of rescue vasopressor were compared between the groups.

Results: The mean age in group P was 24.2 years, in group E 25.7 years and in group M was 25.7 years, which was similar across the groups. The time between induction and delivery was 87.8 sec in group P, 89.4 sec in group E and 89.6 sec in group M. The time at which 1st vasopressor dose given was 5.2 min in group P, 4.8 min in group E and 4.87 min in group M. The mean heart rate was lower in group P at all the points of study after episode of hypotension. The bolus drug requirement was highest in group P with mean of 3.52 followed by group M with mean of 2.86 and group E with mean of 2.55. The group E required rescue analgesia 73% of time, group M 70% of time and group P also 70% of time in study. The mean APGAR score at 1 minute was 8.2 in group P, 8.4 in group E and 8.6 in group M.

Conclusion: During subarachnoid block for cesarean delivery, all three of the study's vasopressors—phenylephrine, ephedrine, and mephentermine—effectively maintained arterial blood pressure and were safe to use in the treatment of hypotension. Compared to ephedrine and mephentermine, phenylephrine significantly lowered heart rate, which may be helpful for cardiac patients or those in whom tachycardia is not desired.

Keywords: Intrathecal; Phenylephrine, Ephedrine, Mephentermine; Hypotension in CS; Cesarean section.

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I. Introduction

Spinal anaesthesia, a frequently used technique for caesarean delivery may be associated with maternal hypotension in as many 85% of patients.^{1,2} Prolonged and marked maternal hypotension may result in fetal acidaemia due to decreased utero-placental blood flow.^{2,3} Common preventing measures include fluid preload, lateral tilt and use of vasopressor. Various vasopressors have been studied for this purpose, e.g. ephedrine, phenylephrine, mephentermine, metaraminol, methoxamine, and dopamine.⁴⁻⁷ Amongst the vasopressors ephedrine (a and β agonist) has a long history of use and has been considered to be the 'gold standard' for prophylaxis and treatment of hypotension due to spinal anaesthesia in patients undergoing caesarean section.^{8,9} Recently, there have been reports indicating worsening fetal acidosis with the use of ephedrine, and demonstrating the superiority of other vasopressors such as phenylephrine (a-agonist) and claim better fetal acid-base status, and similar efficacy in blood pressure control.¹⁰⁻¹² Mephentermine is an indirect-acting synthetic noncatecholamine that stimulates α and β adrenergic receptors and has been found to increase maternal arterial pressure and preserve

uteroplacental blood flow during spinal anaesthesia. Mephentermine is readily available and most commonly used vasopressor in India to treat spinal induced hypotension.^{8,13} However, the vasopressor of choice to treat the hypotension during spinal anaesthesia for caesarean section is still unknown. The aim of the present study was to compare and evaluate the effects of ephedrine, phenylephrine and mephentermine infusion on maternal blood pressure, heart rate and fetal outcome.

II. Material And Methods

This prospective comparative study was carried out in patients of Department of Anesthesia at Katihar Medical College Katihar, Bihar for 1.5 year after the approval from ethical committee. A total 90 adult subjects (both male and females) of aged ≥ 18 -35 years were enrolled for in this study.

Study Design: Prospective randomized controlled study

Study Location: This was a tertiary care teaching hospital based study done in Department of general anesthesia at Katihar Medical College, Katihar, Bihar.

Study Duration: 18 Months, August 2022- February 2023.

Sample size: 90 patients, undergoing elective and emergency LSCS. 30 patient in each group (three group)

Subjects & selection method:

This study was done in a prospective double blind randomized manner. The patients were divided into three groups of 30 each. Patients meeting the criteria were incorporated into the study. Randomization was achieved by sealed envelope technique

The study participants were divided into 3 groups based on the intervention they received.

Group E: Patients received Inj Ephedrine 6 mg IV bolus on developing hypotension.

Group M: Patients received Inj Mephentermine 6 mg IV bolus on developing hypotension.

Group P: Patients received Inj Phenylephrine 100 microgram IV bolus on developing hypotension.

Inclusion criteria:

1. Patients in age group of 18 – 35 years of age, healthy,
2. ASA I & II patients with singleton full term pregnancy, undergoing elective and emergency LSCS were included in the study.

Exclusion criteria:

1. Patients >35 years of age
2. Known hypertensive patients , patients on anti hypertensive drugs
3. Uncontrolled PIH
4. ASA III , IV patients
5. Multiple Gestation
6. Obese (> 90 kg)
7. Short stature (< 140 cm)

Procedure methodology

After written informed consent was obtained, a well-designed questionnaire was used to collect the data of the recruited patients. The questionnaire included socio-demographic characteristics such as age, gender, nationality, height, weight, and other parameters.

PRE-ANAESTHETIC EVALUATION consisted of -:

1. Hb%, PCV
2. Blood grouping & typing
3. BT, CT, Platelet count
4. Blood sugar, blood urea, Sr. Creatinine
5. Urine albumin, Sugar

PRE-MEDICATION constituted of:-

Elective surgery: T. Ranitidine 150 mg PO

T. Metaclopramide 10 mg PO with sips of water 2 hrs before surgery
 Emergency surgery: Inj. Ranitidine 150 mg IV
 Inj . Metaclopramide 10 mg IV 30 mts before surgery

In Operation Theater:

Appropriate equipment for airway management and emergency drugs were kept ready. Patients were shifted to the operation theatre. The horizontal position of the operating table was checked. The patients was made to lie supine with a pillow under head. The patients were connected to non invasive sphygmomanometer, ECG and pulse oximetry monitor. Intravenous access was obtained with 18 G IV cannula. All patients were preloaded with Ringer lactate (15 ml/Kg) rapidly. The anaesthesiologist unaware of the study drug had performed the subarachnoid block and make the observations in all the patients involved in the study.

After Preloading: -

Heart rate, Systolic BP, Diastolic BP, MAP and SPO2 was recorded and taken as baseline value. The same parameters were monitored every minute till the onset of hypotension and then recorded for every two minutes for ten minutes and there after every 5 minutes till the end of surgery.

1. Hypotension: -

Whenever Hypotension (Fall in Systolic BP < 20 % from baseline value or systolic BP < 90 mm Hg) occurred, the study drug will be given IV bolus. The time of onset of hypotension 10 after SAB, lowest systolic BP recorded, total no. boluses and total mg of vasopressor used was recorded.

2. Bradycardia: -

The time of onset of bradycardia (HR < 60 / min) was noted and treated with Inj. Atropine 0.3 mg IV bolus.

3. Sensory Block: -

The highest level of sensory block was assessed by pinprick method 5 min after the subarachnoid block then delivery interval was recorded.

4. Apgar Score: -

Neonatal outcome was assessed by the pediatrician by APGAR score at first and fifth min.

5. Tachycardia: -

The incidence of tachycardia (HR > 150 / min) and its time of onset was noted.

6. Hypertension: -

The occurrence of hypertension (> 20 % increase in systolic BP from baseline values) was noted.

Statistical analysis

Data was analyzed using SPSS version 20 (SPSS Inc., Chicago, IL). Independent *t*-test was used to ascertain the significance of differences between mean values of two continuous variables and confirmed by nonparametric Mann-Whitney test. Chi-square and Fisher exact tests were performed to test for differences in proportions of categorical variables between two or more groups. The level *P* < 0.05 was considered as the cutoff value or significance.

III. Result

The mean age in group P was 24.2 years, in group E 25.7 years and in group M was 25.7 years, which was similar across the groups. The mean height in group P was 153.3 cm, in group E was 153.4 cm and in group M was 154.4 cm, which was similar across the groups. The mean weight in group P was 55.7 kg, in group E was 54.7 kg and in group M was 55.4 kg, which was similar across the groups. The mean period of gestation was 37 weeks in all study groups.

The most common indication for C section was history of previous C section present in 40% of patients, followed by cephalopelvic disproportion (CPD) in 32%. The distribution of causes were not similar across the groups (p-value<0.00) (Table 1).

Table no 1: Shows distribution of indication of C section in all groups

		Group			Total	p-value
		E	M	P		
Indication of CS	Breech	Count	6	4	4	0.00
		% within Group	20.0%	13.3%	13.3%	

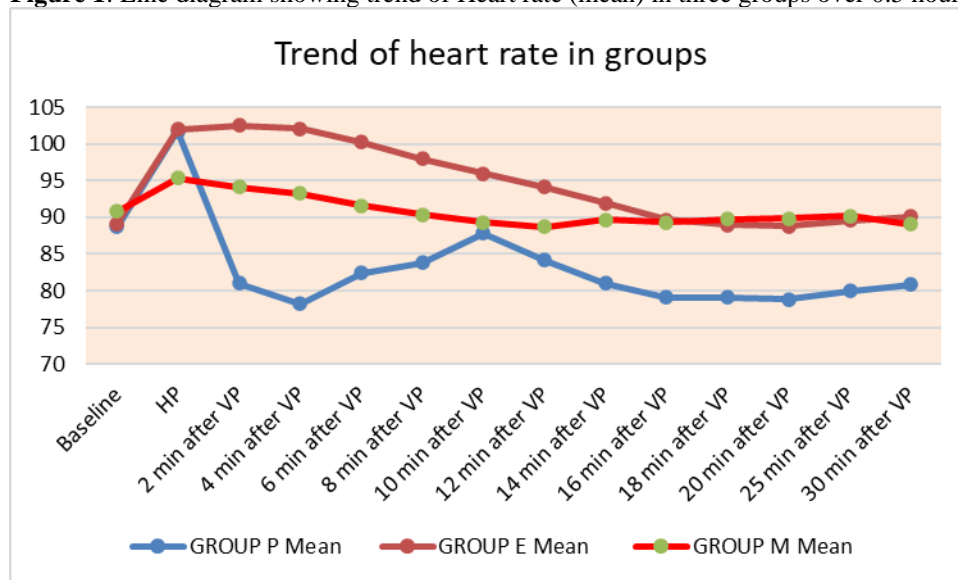
CPD	Count	9	8	12	29
	% within Group	30.0%	26.7%	40.0%	32.2%
Oblique lie	Count	0	1	1	2
	% within Group	0.0%	3.3%	3.3%	2.2%
Post C/s	Count	12	15	12	39
	% within Group	40%	50%	40.0%	40.3%
Transverse lie	Count	3	2	1	6
	% within Group	10.0%	6.7%	3.3%	6.7%
Total	Count	30	30	30	90
	% within Group	100.0%	100.0%	100.0%	100.0%

Table no 2: Descriptive statistics showing Induction-delivery time, Uterine incision-delivery time and time at which 1st vasopressor dose was given in all groups.

Baseline parameters	GROUP P		GROUP E		GROUP M		p-value
	Mean	SD	Mean	SD	Mean	SD	
Induction-delivery time (min)	14.17	2.04	14.37	1.69	14.33	1.95	0.78
Uterine incision-delivery time (sec)	87.83	11.91	89.47	10.4	89.6	13.53	0.97- E&M 0.59-P&M 0.57-P&E
Time at which 1 st vasopressor dose given (min)	5.20	1.79	4.80	1.54	4.87	1.63	0.87- E&M 0.45-P&M 0.35-P&E

The time between induction and delivery was least in group P as compared to group E and M. However, there was no statistically significant variation in all of them (p-value >0.05). It was 14.1 min in group P, 14.3 min in group E and 14.3 min in group M. The time between uterine incision and delivery was least in group P as compared to group E and M. However, there was no statistically significant variation in all of them (p-value >0.05). It was 87.8 sec in group P, 89.4 sec in group E and 89.6 sec in group M. The time at which 1st vasopressor dose given was 5.2 min in group P, 4.8 min in group E and 4.87 min in group M. However, there was no statistically significant variation in all of them (p-value >0.05) (Table 2).

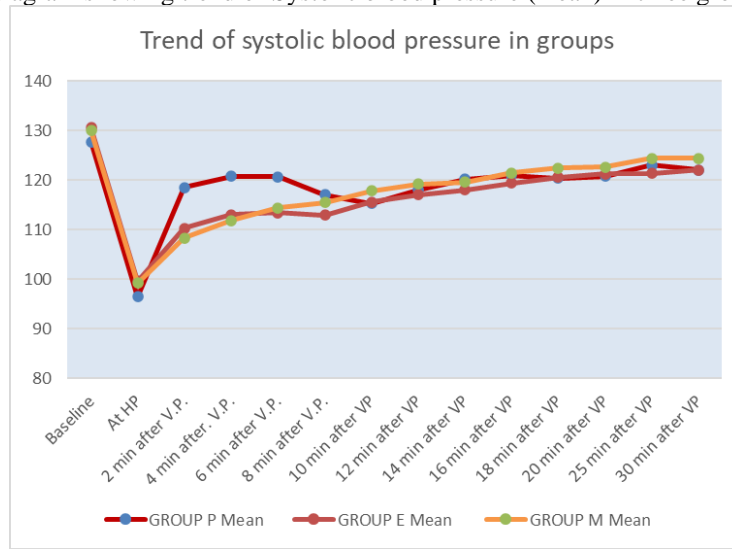
Figure 1: Line diagram showing trend of Heart rate (mean) in three groups over 0.5 hours



There was marked difference between heart rate in group P with respect to group E and group M. The mean heart rate was lower in group P at all the points of study after episode of hypotension. Till 12 minutes after vasopressor was given, the mean heart rate of group E was greater than group M and group P. After, 12 minutes, the mean HR of group M and group E were comparable but group P heart rate was still lower than rest of both groups (p-value<0.05) (Figure 1).

The baseline SBP and mean SBP at time of hypotension was similar across the groups. At 2 minutes, 4 min and 6 min after vasopressor was given, there was significant difference between mean SBP of group P with group E and group M. The mean SBP in group P was higher than group E and M during this period (p-value<0.05) (Figure 2).

Figure 2: Line diagram showing trend of Systolic blood pressure (mean) in three groups over 0.5 hours



The baseline DBP and mean DBP at time of hypotension was similar across the groups. At 2 minutes and 4 min after vasopressor was given, there was significant difference between mean DBP of group P with group E and group M. The mean DBP in group P was higher than group E and M during this period (p-value<0.05) (Figure 3).

Figure 3: Line diagram showing trend of Diastolic blood pressure (mean) in three groups over 0.5 hours

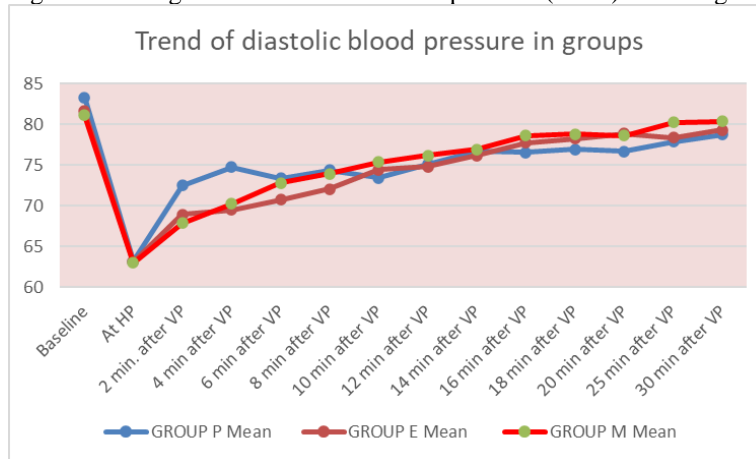
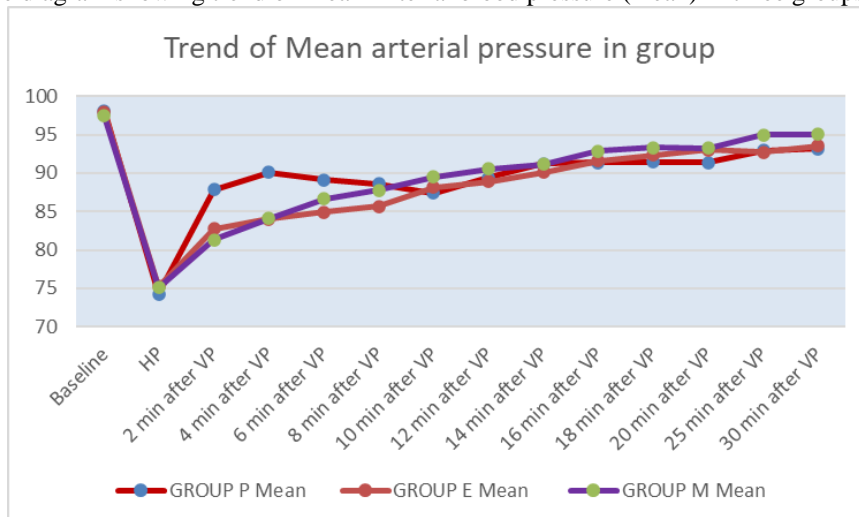


Figure 4: Line diagram showing trend of Mean Arterial blood pressure (mean) in three groups over 0.5 hours



The baseline MAP and mean MAP at time of hypotension was similar across the groups. At 2 minutes and 4 min after vasopressor was given, there was significant difference between mean MAP of group P with group E and group M. The mean MAP in group P was higher than group E and M during this period (p-value<0.05) (Figure 4)

Table No 3: Mean distribution of No of bolus of drug required in all the groups during surgery

Time	GROUP P		GROUP E		GROUP M		p-value
	Mean	SD	Mean	SD	Mean	SD	
No of bolus	3.52	0.53	2.55	0.51	2.86	0.36	0.00

The bolus drug requirement was highest in group P with mean of 3.52 followed by group M with mean of 2.86 and group E with mean of 2.55 (Table 3).

Table No 4: Comparison of frequency of Rescue Vasopressor given during the study in study groups

Group	Rescue Vasopressor	Frequency	Percent	P-VALUE
E	Absent	8	26.7	0.94
	Present	22	73.3	
	Total	30	100.0	
M	Absent	9	30	
	Present	21	70	
	Total	30	100.0	
P	Absent	9	30	
	Present	21	70	
	Total	30	100.0	

The group E required rescue vasopressor 73% of time, group M 70% of time and group P also 70% of time in study (Table 5).

Table No 6: Descriptive statistics showing Mean, Standard Deviation between APGAR score at 1 minute and 5 minute in groups

Time	GROUP P		GROUP E		GROUP M		p-value P-E	p-value E-M	p-value P-M
APGAR score	Mean	SD	Mean	SD	Mean	SD			
1 min	8.22	0.56	8.46	0.45	8.67	0.54	>0.05	>0.05	>0.05
5 min	8.92	0.45	8.85	0.32	8.86	0.27	>0.05	>0.05	>0.05

The mean APGAR score at 1 minute was 8.2 in group P, 8.4 in group E and 8.6 in group M. Similarly, the mean APGAR score at 5 minutes was 8.9 in group P, 8.85 in group E and 8.86 in group M (Table 6).

The frequency of nausea observed in group E was 2/3rd, in group M and P, it was 73%. The frequency of bradycardia was highest in group P being 46.7% followed by 10% in both group E and M. The frequency of tachycardia was 3.3% in group M and P and 6.6% in group E.

IV. Discussion

Numerous benefits, including a quick start of action, efficient neural block, low risk of local anaesthetic toxicity, and restricted drug transfer to the fetus, are associated with spinal anesthesia during cesarean birth (14,15). However, spinal anesthesia frequently causes common and dangerous adverse effects, such as bradycardia in the fetus, dizziness, nausea, vomiting, cardiovascular collapse, fetal acidosis, and, in extreme situations, fetal hypotension (16).

Maternal hypotension and bradycardia have been avoided by a number of strategies, including frequent monitoring, vasopressor medication, left uterine displacement, volume preloading with crystalloid or colloid, and more.

Few among them, the use of vasopressors and expansion of intravascular volume through preloading with IV fluids immediately before spinal anaesthesia induction are common practices (17). Mephentermine, phenylephrine, and ephedrine are a few of them.

The current study was conducted to compare the effects of Ephedrine, Mephentermine and Phenylephrine in the management of hypotension during spinal anesthesia for cesarean section based on the efficacy of vasopressor in treating hypotension, incidence of undesirable side effects, and effect on neonatal outcome. This study was done in a prospective double blind randomized manner. The patients were divided into three groups of 30 each

Group P patients received Inj Ephedrine 6 mg IV bolus on developing hypotension, group M received Inj Mephentermine 6 mg IV bolus on developing hypotension and group E patients received Inj Phenylephrine 100 microgram IV bolus on developing hypotension.

In our study, the mean age in group P was 24.2 years, in group E 25.7 years and in group M was 25.7 years, which was similar across the groups. The mean height in group P was 153.3 cm, in group E was 153.4 cm and in group M was 154.4 cm, which was similar across the groups and the mean weight in group P was 55.7 kg, in group E was 54.7 kg and in group M was 55.4 kg, which was similar across the groups. The mean age in study by Sinha G et al (18) was 26 years, in Bhattarai B et al (19) study mean age was 25 years and Dua D et al (20) had mean age of 25 years like our study findings. The mean weight was between 64 to 68 kg across various groups in study by Sinha G et al (18) which was more than our study. The mean weight in our study was similar to findings of Bhattarai B et al (19) and Dua D et al (20).

The mean period of gestation in our study was 37 weeks in all study groups which was similar to study by Dua D et al (20) and Mahajan L et al (21). The most common indication for C section in our study was history of previous C section present in 40% of patients, followed by cephalopelvic disproportion (CPD) in 32%. The distribution of causes were not similar across the groups (p-value<0.00). In study by Sinha G et al (18), 46% were due to previous LSCS and 11% due to CPD similar to our findings.

The time between induction and delivery was least in group P as compared to group E and M. However, there was no statistically significant variation in all of them (p-value >0.05). It was 14.1 min in group P, 14.3 min in group E and 14.3 min in group M in our study. The skin incision to delivery time was 5.3 minutes in study by Sinha G et al (18) and 2.25 minutes from uterine incision to delivery. This time between uterine incision and delivery in our study was least in group P as compared to group E and M. However, there was no statistically significant variation in all of them (p-value >0.05). It was 87.8 sec in group P, 89.4 sec in group E and 89.6 sec in group M. This was lesser in our study. Our study findings were similar to Dua D et al (20). Mahajan L et al (21) also observed time between induction and delivery to be 850 seconds (approx. 14 min) like our study.

The time at which 1st vasopressor dose given in our study was 5.2 min in group P, 4.8 min in group E and 4.87 min in group M. However, there was no statistically significant variation in all of them (p-value >0.05) similar to Dua D et al (20). It was lower in study by Bhattarai B et al (19) with mean 3.63 minutes in group P, 4.5 in group E and 4.2 in group M.

The baseline SBP and mean SBP at time of hypotension in our study was similar across the groups. At 2 minutes, 4 min and 6 min after vasopressor was given, there was significant difference between mean SBP of group P with group E and group M which was similar to findings of Dua D et al (20). The mean SBP in group P was higher than group E and M during this period (p-value<0.05). In study by Bhattarai B et al (19) and Chandak AV et al (22) also, the SBP was higher in group P as compared to Group M and E and the difference continued till 12 minutes after vasopressor.

In our study, the baseline DBP and mean DBP at time of hypotension was similar across the groups. At 2 minutes and 4 min after vasopressor was given, there was significant difference between mean DBP of group P with group E and group M. The mean DBP in group P was higher than group E and M during this period (p-value<0.05). These findings were in line with Dua D et al (20). Bhattarai B et al (19) observed difference in mean DBP across at 6 minutes post vasopressin usage. The mean DBP was however higher in group P like our study.

The baseline MAP and mean MAP at time of hypotension in our study was similar across the groups. At 2 minutes and 4 min after vasopressor was given, there was significant difference between mean MAP of group P with group E and group M. The mean MAP in group P was higher than group E and M during this period (p-value<0.05). Chandak AV et al (22) did not find any variability across groups in mean MAP but it was higher in group P similar to our study findings.

In our study, there was marked difference between heart rate in group P with respect to group E and group M. The mean heart rate was lower in group P at all the points of study after episode of hypotension. Till 12 minutes after vasopressor was given, the mean heart rate of group E was greater than group M and group P. After, 12 minutes, the mean HR of group M and group E were comparable but group P heart rate was still lower than rest of both groups (p-value<0.05). In study by Chandak AV et al (22), men HR was lower in group P significantly till 16 minutes of vasopression usage similar to our findings. There was difference in mean HR between P-E and P-M groups from 6 minutes till 60 minutes in study by Bhattarai B et al (19).

The bolus drug requirement was highest in group P in our study, with mean of 3.52 followed by group M with mean of 2.86 and group E with mean of 2.55 which was similar to findings of Bhattarai B et al (19).

The frequency of nausea observed in our study in group E was 2/3rd, in group M and P, it was 73% similar to Dua D et al (20). In our study, the group E required rescue analgesia 73% of time, group M 70% of time and group P also 70% of time in study.

The frequency of bradycardia was highest in group P being 46.7% followed by 10% in both group E and M. In the study by Sinha G et al (18), the frequency of bradycardia in group P was 45% similar to our study

findings, however it was only 1.5% in study by Mahajan L et al (21). In our study, the frequency of tachycardia was 3.3% in group M and P and 6.6% in group E.

Maximum neonates had APGAR score of 10 at 1 minute in all three groups. About one third had APGAR score of 8 in first minute in group E and M. APGAR score was 10 at 5 minutes in 90% of group P, 70% of group M and 66.7% of group E neonates.

The mean APGAR score at 1 minute was 8.2 in group P, 8.4 in group E and 8.6 in group M. Similarly, the mean APGAR score at 5 minutes was 8.9 in group P, 8.85 in group E and 8.86 in group M. This was similar to findings of mean 8.32 in group E, 8.36 in group M, 8.57 in group P in study by Mahajan L et al (21). Bhattarai B et al (19), found APGAR 7.4 at 1 minute in group P, 7.31 in group E, 7.32 in group M.

V. Conclusion

During subarachnoid block for cesarean delivery, all three of the study's vasopressors—phenylephrine, ephedrine, and mephentermine—effectively maintained arterial blood pressure and were safe to use in the treatment of hypotension. Compared to ephedrine and mephentermine, phenylephrine significantly lowered heart rate, which may be helpful for cardiac patients or those in whom tachycardia is not desired. Clinically, none of the medications had any statistically significant negative effects on either the mother or the fetus.

References

- [1] Riley Et, Cohen Se, Rubenstein Aj, Flanagan B. Prevention Of Hypotension After Spinal Anaesthesia For Caesarean Section: 6% Hetastarch Versus Lactated Ringer's Solution. *Anesth Analg* 1995; 81: 838-42. *Anesth Analg*, Volume 107(4). 2008; 1295-1302
- [2] Rout Cc And Rocke Da. Prevention Of Hypotension Following Spinal Anaesthesia For Caesarean Section. *Int Anesthesiol Clin* 1994; 32:117-35.
- [3] Hughes Sc, Levinson G, Rosen Ma. Anesthesia For Caesarean Section. In: Shinder And Levinson's Anesthesia For Obstetrics. 4 Ed. 2001, P 201-36.
- [4] Morgan P. The Role Of Vasopressors In The Management Of Hypotension Induced By Spinal And Epidural Anaesthesia. *Can J Anaesth* 1994; 41: 404-13.
- [5] Ngan Kee Wd, Lau Tk, Khaw Ks, Lee Bb. Comparison Of Metaraminol And Ephedrine Infusions For Maintaining Arterial Pressure During Spinal Anaesthesia For Elective Caesarean Section. *Anesthesiology* 2001; 95: 307-31.
- [6] Cooper Dw, Carpenter M, Mowbray P, Desira Wr, Kokri Ms. Fetal And Maternal Effects Of Phenylephrine And Ephedrine During Spinal Anaesthesia For Caesarean Delivery. *Anesthesiology* 2002; 97: 1582-90.
- [7] Sahu D, Kothari D, Mehrotra A. Comparison Of Bolus Phenylephrine, Ephedrine And Mephentermine For Maintenance Of Arterial Pressure During Spinal Anaesthesia In Caesarean Section-A Clinical Study. *Indian J Anaesth*. 2003; 47(2): 125-8.
- [8] Ralston Dh, Shnider Sm, Delorimier Aa. Effects Of Equipotent Ephedrine, Metaraminol, Mephentermine And Methoxamine On Uterine Blood Flow In The Pregnant Women. *Anesthesiology* 1974; 40: 354-70.
- [9] Burns Sm, Cowan Cm, Wilkes Rg. Prevention And Management Of Hypotension During Spinal Anaesthesia For Elective Caesarean Section: A Survey Of Practice. *Anaesthesia* 2001; 57: 794-8.
- [10] Shearer Ve, Ramin Sm, Wallace Dh, Dax Js, Gilstrap Iii Lc. Fetal Effects Of Prophylactic Ephedrine And Maternal Hypotension During Regional Anaesthesia For Cesarean Section. *J Matern Fetal Med* 1996; 5: 79-84.
- [11] Ngan Kee Wd And Lee A. Multivariate Analysis Of Factors Associated With Umbilical Arterial Ph And Standard Base Excess After Caesarean Section Under Spinal Anaesthesia. *Anaesthesia* 2003; 58: 125-30.
- [12] Ngan Kee Wd, Khaw Ks, Ng Ff And Lee Bb. Prophylactic Phenylephrine Infusion For Preventing Hypotension During Spinal Anaesthesia For Caesarean Delivery. *Anesth Analg* 2004; 98: 815-21.
- [13] Hoffman Bb. Catecholamines, Sympathomimetic Drugs, And Adrenergic Receptor Antagonist. In Hardman Jg, Limbird Le, Gilman Ag (10th Eds.) Goodman And Gilman's, *The Pharmacological Basis Of Therapeutics*. The Mcgraw-Hill Companies, 2001, Pp215-68.
- [14] Shibli Ku, Russell If. A Survey Of Anaesthetic Techniques Used For Caesarean Section In The Uk In 1997. *Int J Obstet Anaesth*. 2000;9(3):160-67.
- [15] Afolabi Bb, Lesi Fe, Merah Na. Regional Versus General Anaesthesia For Caesarean Section. *Cochrane Database Syst Rev*. 2006;18(4):Cd004350.
- [16] Skillman Ca, Plessinger Ma, Woods Jr, Clark Ke. Effect Of Graded Reductions On Uteroplacental Blood Flow On The Fetal Lamb. *Am J Of Physiol*. 1985;249(6 Pt 2):H1098-105.
- [17] Wollman Sb, Marx Gf. Acute Hydration For The Prevention Of Hypotension Of Spinal Anaesthesia In Parturients. *Anesthesiology*. 1968;29(2):374-80.
- [18] Sinha G, Hemalatha S, Gurudatt C L. Effectiveness Of Intravenous Boluses Of Phenylephrine, Ephedrine And Mephentermine As Vasopressors For Management Of Perioperative Hypotension In Elective Lower Segment Caesarean Section Under Spinal Anaesthesia – A Prospective Comparative Study. *Indian J Clin Anaesth* 2020;7(1):46-53
- [19] Bhattarai B, Bhat Sy, Upadya M. Comparison Of Bolus Phenylephrine, Ephedrine And Mephentermine For Maintenance Of Arterial Pressure During Spinal Anesthesia In Cesarean Section. *Jnma J Nepal Med Assoc*. 2010;49(177):23-28.
- [20] Dua D, Jadhwal R, Gondalia D, Parmar V, Jain A. Comparison Of Bolus Phenylephrine, Ephedrine And Mephentermine For Maintenance Of Arterial Pressure During Spinal Anaesthesia In Caesarean Section. *International Journal Of Pharmaceutical Sciences And Research*. 2014;5(6); 2412-2417.
- [21] Mahajan L, Anand Lk, Gombar Kk. A Randomized Double-Blinded Comparison Of Ephedrine, Phenylephrine And Mephentermine Infusions To Maintain Blood Pressure During Spinal Anaesthesia For Cesarean Delivery: The Effects On Fetal Acid-Base Status And Haemodynamic Control. *J Anaesth Clin Pharmacol* 2009; 25(4): 427-432.
- [22] Chandak Av, Bhuyan D, Singam Ap, Patil B. Comparison Of Bolus Phenylephrine, Ephedrine And Mephentermine For Maintenance Of Arterial Pressure During Spinal Anaesthesia In Caesarean Section. *Research Journal Of Pharmacy And Technology*. 2021;14(3):1349-1352.