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Dr. Yogesh Kumar Manik
Associate Professor,
Department of
Anaesthesiology, L.L.R.M.
Medical College, Meerut, Utter
Pradesh, India

Dr. Sweta
Assistant Professor,
Department of
Anaesthesiology, L.L.R.M.
Medical College, Meerut, Utter
Pradesh, India

Dr. Bijendra Singh
Junior Resident, Department
of Anaesthesiology, L.L.R.M.
Medical College, Meerut, Utter
Pradesh, India

Dr. Vipin Kumar Dhama
Professor, Department of
Anaesthesiology, L.L.R.M.
Medical College, Meerut, Utter
Pradesh, India

Dr. Subhash
Professor, Department of
Anaesthesiology, L.L.R.M.
Medical College, Meerut, Utter
Pradesh, India

A clinical comparative study of haemodynamic response between preeclampsia and normotensive parturients under spinal anaesthesia for cesarean section

Yogesh Kumar Manik, Sweta, Bijendra Singh, Vipin Kumar Dhama and Subhash

Abstract
Background: Haemodynamic adaptation in pre-eclampsia diverges from that in normotensive pregnancies and may predispose pre-eclamptic women to cardiopulmonary complications during pregnancy, at delivery and in early puerperium. This study Aimed to assess the efficacy of spinal anaesthesia for pregnant patients undergoing cesarean section, comparing the haemodynamic response between preeclampsia and normotensive parturients.
Methods: A total of 60 patients were included in the study comprising of 30 patients in each group. The pregnant patients of more than 34 weeks of gestation, ASA Grade 1 and 2 and aged between 18 to 30 years undergoing elective caesarean section were included in the study.
Results: There was no statistically significant difference observed with respect to demographic data, however When compared among study groups, it was noticed that mean Systolic BP, mean Diastolic BP and Mean Arterial Pressure was significantly higher in pre-eclampsic group as compared to normotensive group, which is as per the objective of the study. Patients were randomly allocated to one of the following study groups:
Group I: Preeclampsic 0.5%, 2.5cc (12.5mg) Hyperbaric Bupivacaine group: 30 patient.
Group II: Normotensive 0.5%, 2.5cc (12.5mg) Hyperbaric Bupivacaine group: 30 patients. The mean age of the study group was 25.17+3.61 years (mean+s.d.) and range = 18-30 years in the current study. The post operative ambulation motor block assessment using James Modified Bromage Scale showed mean difference between both groups was significant at 150 min after administration of the drug, with more pre-eclamptic patients being in stage 2. The mean VAS Scores was significantly higher in Pre-eclamptic subjects as compared to Normotensive subjects. We found significant differences in SBP, DBP and MAP at different point of times in both the groups.
Conclusion: So in our study we can conclude that comparison of effect of subarachnoid block amongst pre eclampsia and normotensive group on hemodynamic parameters showed mean SBP mean DBP and mean arterial pressure to be significantly higher among pre eclampsia patients from baseline to 150 minutes after injection. However, the heart rate and SpO$_2$ remained comparable in both the groups. The status of maximum block achieved and the mean time taken for it was also similar in both the groups. There was higher proportion of patients in normotensive group reported hypotension, nausea and vomiting.

Keywords: pre-eclampsia, normotensive, bupivacaine, spinal anaesthesia

Introduction
Hypertensive disorders are the most common complications during pregnancy, affecting 15-24% of pregnancies (Kaaja R, *et al.*, 2005) [1]. The disorders include pre-eclampsia, gestational hypertension, chronic hypertension and superimposed pre-eclampsia.
Pre-eclampsia and gestational hypertension cover nearly 70% of pregnancy related hypertensive disorders (Sibai B *et al.*, 2003) [2]. Pre-eclampsia affects about 5–10% of pregnancies and the incidence of chronic hypertension in pregnancy is estimated to be 3–5% (James P *et al.*, 2004) [3]. In respect of complications, the most problematic disorder is pre-eclampsia. It has remained the major cause of maternal and perinatal morbidity and mortali (Kupferminc M *et al.*, 2005) [4]. Maternal complications in pre-eclampsia are related to high blood pressure, endothelial dysfunction, multi-organ failure and cardiopulmonary failure.

Corresponding Author:
Dr. Yogesh Kumar Manik
Associate Professor,
Department of
Anaesthesiology, L.L.R.M.
Medical College, Meerut, Utter
Pradesh, India

In healthy pregnancy increased volume load and haemodynamic changes are well tolerated and the course of pregnancy, delivery and early puerperium are uneventful in most cases. Increased intravascular volume is needed to create uteroplacental circulation for the developing and growing fetus (McCowan L *et al.*, 1996) [5]. Haemodynamic adaptation in pre-eclampsia diverges from that in normotensive pregnancies and may predispose pre-eclamptic women to cardiopulmonary complications during pregnancy, at delivery and in early puerperium. Furthermore, in cases of chronic hypertension, the underlying haemodynamic aberrancy compared with normotensive subjectsmay change haemodynamic adaptation in the course of pregnancy in these subjects (Mayet J *et al.*, 2003) [6] In normotensive pregnancy vascular relaxation in peripheral arteries and enhanced arterial compliance in conduit arteries has a crucial role in allowing increased intravascular volume without a rise in blood pressure during pregnancy. In hypertensive disorders, the divergent hemodynamic adaptation includes impaired vasorelaxation; higher peripheral vascular resistance has been found in pre-eclampsia (Visser W *et al.*, 1991) [7] and in chronic hypertensive pregnancies compared with normotensive pregenancies.

Since in non-pregnant subjects the distensibility of the arteries has been shown to be proportional to blood pressure, it could be assumed that higher blood pressure is also associated with lower arterial compliance in hypertensive pregnancies.

Spinal Anesthesia
Spinal anesthesia is often the preferred technique of anesthesia for cesarean delivery (Bourne TM, *et al.*, 1997) [8]. It has been mostly reported that it is suitable for use in preeclamptic patients (Wallace DH *et al.*, 1995) [9] Even in cases with a non-reassuring fetal heart rate (HR) pattern. Hypotension may occur as a side effect of this anesthetic technique.

In a previous study, the incidence and magnitude of spinal anesthesia-associated hypotension in severely preeclamptic versus healthy parturients undergoing cesarean delivery has been compared. (Aya AGM *et al.*, 2003) [11] Although the study had some limitations arising from the perioperative management of preeclamptic patients, this group had a decreased incidence and magnitude of hypotension and smaller ephedrine requirement compared with healthy parturients.

Two major factors were advocated to explain these findings. First, physiological changes induce a vasodilation and confer a relative resistance to Vasopressor drugs in normal pregnancy, whereaspre eclampsia is charcterized by vasospasm and increased sensitivity to Vasopressors. (Santos AC *et al.*, 2003) [12].

Material and Methods: Study Design
This Randomized, Prospective and Comparative study was conducted on patients admitted in SVBP Hospital, affiliated to LLRM Medical College, Meerut (UP). Patients undergoing elective caesarean section were included in the study.

Study population
A total of 60 patients were included in the study comprising of 30 patients in each group. Patients for study were divided equally and randomly using sealed envelope method in 2 groups.

Inclusion Criteria include pregnant patients of more than 34 weeks gestation. Patients of ASA Grade 1 and 2 Patient's age between 18 and 30 years informed written consent was taken from the patients for the study. Ethical Approval was taken from the Institutional Ethical Committee after explaining the Aim and Objectives of the Study. A written Informed Consent was obtained from each patient before starting the procedure. The involvement of the subject was voluntary and deliberate.

Method of Data Collection
A thorough pre-anaesthetic check up was done including the detailed history and physical examination. Specific questions were asked related to previous exposure of any surgery under anaesthesia. Patients having any major cardiovascular, neurological or respiratory illness were ruled out from the study in accordance with the exclusion criteria. Proper airway assessment was done and mallampatti grading was noted. Necessary investigations were done such as: Hemoglobin (Hb), Total Leucocyte Count, Differential Leucocyte Count, Prothrombin time, INR, Platelet Count, Blood Sugar, Serum Urea, Serum Creatinine.

A total of 60 patients were included in the study comprising of 30 patients in each group. Patients for study were divided equally and randomly using sealed envelope method in 2 groups. Which were kept inside a plastic box. Random selection of patients by plastic box and preparation of drug was done by a colleague to maintain the blindness of the study. Patients were randomly allocated to one of the following study groups:
- **Group I:** Preeclampsic 0.5%, 2.5cc (12.5mg) Hyperbaric Bupivacaine group: 30 patients.
- **Group II:** Normotensive 0.5%, 2.5cc (12.5mg) Hyperbaric Bupivacaine group: 30 patients. The principal investigator who was blinded to the above groups carried out the necessary assessments.

Anaesthetic technique
After shifting the patient to Operation Theatre, the procedure was explained again. Then multipara monitor was attached and reading of all vitals such as Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), and Oxygen Saturation (SPO2) were marked and baseline values were recorded.

After attaching the monitor, 18G of IV canula was inserted into a peripheral vein and patient was preloaded with 10ml/kg body weight of Lactate ringer's solution over 15 minutes. The patient was placed in a sitting position on the OT table with stool provided as footrest.

The assistant was asked to maintain the patient in a vertical plain while flexing the patient neck and arms over the pillow to open up the lumber vertebral space. Under aseptic precautions part were prepared, painted and draped. Under aseptic precautions, lumbar puncture was done using 26G Quincke spinal needle at L2-L3/L3-L4 space. Patients in Group A received Inj. Hyperbaric Bupivacaine 0.5%, 2.5 cc (12.5 mg) intrathecally. Group B patients were administered Inj. Hyperbaric Bupivacaine 0.5%, 2.5 cc (12.5mg) intrathecally. The sensory level of spinal anesthesia was assessed bilaterally in the midclavicular line by pin prick, using a short beveled 25-gauge needle and cotton swab.

Permission to perform the operation was given once a level of T4-T6 was achieved. Considering the time of intrathecal injection as time 0, the time to onset of sensory block, the time taken to reach maximum sensory block level, the time to regression of two dermatomes of the sensory block, the duration of the regression of the sensory block level to T12 from the maximum level was recorded.

Patient's parameters like Heart rate (HR), Noninvasive blood pressure (NIBP),and Oxygen saturation (SpO2) were recorded at 2 minutes interval up to 10 minutes and then at 10 minutes interval till the 30 minutes, and at 60 minutes, at 90 minutes, and at 150 minutes. In the postoperative phase, vital signs and recovery dynamics (in the same way as during the onset) were checked every 30 minutes until complete regression of motor and sensory block had been attained. Hypotension if occurred, was managed with injectable ephedrine accordingly. Time for onset of analgesia was assessed by loss of sensation to pin prick bilaterally along mid-clavicular line. Motor blockade was assessed using Modified Bromage scale. Time for onset of sensory blockade, Time for onset of motor blockade was noted. Maximum height of required sensory blockade attained, total duration of sensory blockade, and total duration of motor blockade was recorded.

Any intraoperative and postoperative side effects and complications was also noted.

After this patient was assessed for post-operative pain and ambulation as per the following scores

Degree of post-operative pain: recorded on Visual Analogue Scale (VAS)
Visual analogue scale
The patient was shown a 10 cm line marked as above and they were asked to put a mark across the line that indicate the severity of their pain. Then we measured the distance from 1 to 10 marks and submitted the answer in cm.
Pain under VAS was graded as: a) (VAS '0') Patient is comfortable. b) (VAS '1-3') Mild pain. c) (VAS '4-6') Moderate pain. d) (VAS '7-10') Severe pain.

Degree of motor block for post-op ambulation- James Modified Bromage Scale
Bromage-0 -No weakness, able to straight leg raise against resistance
Bromage-1 -Patient unable to straight leg raise, but able to flex knee
Bromage-2 -Patient unable to flex knee, but feet freely movable
Bromage-3 -Patient is unable to move leg or feet.

Statistical analysis
Statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) for Windows (version 15.0). Categorical variables were described as frequency (percentage), mean ± standard deviation was used for continuous parameters. Differences between two groups were compared by the Student T test. For non-parametric variables, the data were presented as median (min-max). In this case, the nonparametric Mann–Whitney test was used for statistical comparisons. Categorical variables were compared between two or more groups using the Chi-square test. For all analyses, a two-tailed p-value of <0.05 was considered statistically significant.

Observations and results
Socio-demographic profile of the study participants
The age wise distribution of study participants showed that majority of them were below or upto 25 years of age. The mean age of the study group was 25.17+3.61 years (mean+s.d.) and range = 18-30 years (Table 1). When compared among both study groups (Pre-eclampsic and Normotensive), it was seen that there is no significant difference among the groups indicating a similar distribution among the study population

Table 1: Age wise distribution of study participants (n=60)

Age group (years)	Pre-eclampsic		Normotensive	
	Frequency	Percent (%)	Frequency	Percent (%)
18-25	14	46.7%	19	63.3%
26-30	16	53.3%	11	36.7%

Table 2: Height, Weight and BMI distribution among study participant:

	GROUP	N	Mean	SD	SE	p-value
Age	Pre-eclampsic	30	25.80	3.662	.669	0.177
	Normotensive	30	24.53	3.521	.643	
Weight	Pre-eclampsic	30	62.37	5.468	.998	0.051
	Normotensive	30	59.93	3.841	.701	
Height	Pre-eclampsic	30	1.542	.0294	.0054	0.093
	Normotensive	30	1.530	.0231	.0042	
BMI	Pre-eclampsic	30	26.649	2.6735	.4881	0.051
	Normotensive	30	25.576	1.2486	.2280	

Baseline parameters
The baseline parameters among study participants are shown in Table 3. When compared among study groups, it was noticed that mean Systolic BP, mean Diastolic BP and Mean Arterial Pressure was significantly higher in pre-eclampsic group as compared to normotensive group, which is as per the objective of the study

Table 3: Baseline parameters among study sample:

	GROUP	N	Mean	SD	SE	p-value
Heart Rate	Pre-eclampsic	30	98.53	9.265	1.692	0.485
	Normotensive	30	96.47	13.175	2.405	
SPO2 level	Pre-eclampsic	30	99.40	.675	.123	0.071
	Normotensive	30	99.00	.983	.179	
Systolic BP	Pre-eclampsic	30	160.57	14.124	2.579	0.001*
	Normotensive	30	130.53	9.573	1.748	
Diastolic BP	Pre-eclampsic	30	98.33	9.193	1.678	0.001*
	Normotensive	30	76.07	8.399	1.533	
MAP	Pre-eclampsic	30	116.60	6.568	1.199	0.001*
	Normotensive	30	90.80	9.007	1.644	

The VAS Scores had achieved no scores over the follow up duration and hence no significant change was noticed over the period of time. The statistical analysis was therefore not performed. However, VAS Scores were achieved at the 150 min after SAB follow-up indicating reversal of analgesia by that stage. Table 4a shows the mean VAS Scores of both comparison groups at 150 minutes follow-up.

Table 4a: Mean Scores at 150 minutes:

VAS at 150 minutes	N	Mean	SD	SE	p-value
Normotensive	30	2.77	.971	.177	0.021*
Pre-eclampsia	30	3.43	1.194	.218	

The mean VAS Scores was significantly higher in Pre-eclamptic subjects as compared to Normotensive subjects ($p < 0.05$). Table 4b shows the categorical comparison of mean VAS Scores at 150 minutes. There was no significant difference between the categories of VAS score among both comparison groups ($p > 0.05$).

Table 4b: VAS Scores at 150 minutes

VAS at 150 minutes		VAS	
		Mild (0-3)	Moderate (4-6)
Normotensive	N	21	9
	%	56.8%	39.1%
Pre-eclampsia	N	16	14
	%	43.2%	60.9%
p-value = 0.288			

Table 4c shows the mean change in James Modified Bromage Scale over the follow up period between both study groups. The mean difference between both groups was significant at 150 min after administration of the drug.

Table 4c: James Modified Bromage scale among study subjects:

James Modified Bromage scale		GROUP		p-value
		Pre-eclampsia	Normotensive	
At Injection	0	20 (66.7%)	25 (83.3%)	0.233
	1	10 (33.3%)	5 (16.7%)	
After 2 min	1	25 (83.3%)	27 (90%)	0.706
	2	5 (16.7%)	3 (10%)	
After 4 min	2	27 (90%)	28 (93.3%)	0.640
	3	3 (10%)	2 (6.7%)	
After 6 min	2	3 (10%)	1 (3.3%)	0.612
	3	27 (90%)	29 (96.7%)	
After 8 min	3	30 (100%)	30 (100%)	-
After 10 min	3	30 (100%)	30 (100%)	-
After 20 min	3	30 (100%)	30 (100%)	-
After 30 min	3	30 (100%)	30 (100%)	-
After 60 min	3	30 (100%)	30 (100%)	-
After 90 min	2	0 (0%)	1 (3.3%)	1.000
	3	30 (100%)	29 (96.7%)	
After 150 min	1	19 (63.3%)	27 (90%)	0.030*
	2	11 (36.7%)	3 (10%)	

Table 5: Block Height achieved among study subjects:

Block Height		GROUP		p-value
		Pre-eclampsia	Normotensive	
At Injection	T10	5 (16.7%)	3 (10%)	0.706
	T12	25 (83.3%)	27 (90%)	
After 2 min	T10	24 (80%)	27 (90%)	0.204
	T6	0	1 (3.3%)	
	T8	6 (20%)	2 (6.7%)	
After 4 min	T6	11 (36.7%)	4 (13.3%)	0.072*
	T8	19 (63.3%)	26 (86.7%)	
After 6 min	T4	14 (46.7%)	4 (13.3%)	0.612
	T6	16 (53.3%)	26 (86.7%)	
After 8 min	T4	19 (63.3%)	12 (40%)	0.105
	T5	0	2 (6.7%)	
	T6	11 (36.7%)	16 (53.3%)	
After 10 min	T4	19 (63.3%)	12 (40%)	0.105
	T5	0	2 (6.7%)	
	T6	11 (36.7%)	16 (53.3%)	
After 20 min	T4	19 (63.3%)	12 (40%)	0.105
	T5	0	2 (6.7%)	
	T6	11 (36.7%)	16 (53.3%)	
After 30 min	T4	19 (63.3%)	12 (40%)	0.105
	T5	0	2 (6.7%)	

	T6	11 (36.7%)	16 (53.3%)	
After 60 min	T4	19 (63.3%)	12 (40%)	0.105
	T5	0	2 (6.7%)	
	T6	11 (36.7%)	16 (53.3%)	
After 90 min	T4	19 (63.3%)	11 (36.7%)	0.067
	T5	0	2 (6.7%)	
	T6	11 (36.7%)	17 (56.7%)	
After 150 min	T10	10 (33.3%)	4 (13.3%)	0.005*
	T11	5 (16.7%)	0	
	T12	15 (50%)	26 (86.7%)	

Table 5 shows the change in achieved Block Height over the follow up period between both study groups. The mean difference between both groups was significant at 4 minutes and after 150 min after administration of the drug.

Table 6: Mean Arterial Pressure among study subjects:

MAP	Group A			Group B			p-value
	Mean	SD	SE	Mean	SD	SE	
At baseline	116.60	6.568	1.199	90.80	9.007	1.644	0.001*
At Injection	111.73	7.263	1.326	89.93	10.382	1.896	0.001*
2 min	105.27	7.982	1.457	86.53	10.773	1.967	0.001*
4 min	99.17	9.135	1.668	82.23	12.508	2.284	0.001*
6 min	95.93	9.417	1.719	80.13	11.808	2.156	0.001*
8 min	93.53	8.186	1.495	80.07	9.093	1.660	0.001*
10 min	92.07	7.803	1.425	81.43	12.170	2.222	0.001*
20 min	92.17	7.966	1.454	75.20	9.148	1.670	0.001*
30 min	91.13	9.420	1.720	76.60	10.434	1.905	0.001*
60 min	91.80	9.963	1.819	78.37	9.725	1.776	0.001*
90 min	95.03	9.133	1.667	81.10	9.481	1.731	0.001*
150 min	96.50	7.789	1.422	86.80	6.646	1.213	0.001*

Table 6 shows the change in Mean Arterial Pressure over the follow up period between both study groups. The mean difference between both groups was statistically significant at all levels of follow-up after administration of the drug
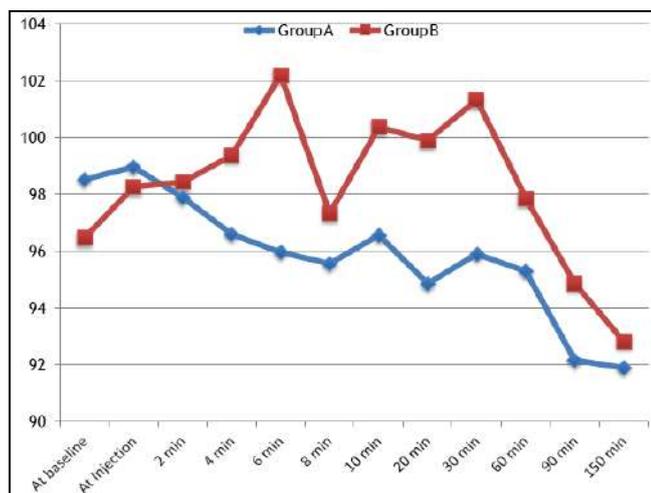

Fig 1: Heart Rate among study subjects

Figure 1 shows the mean change in Heart Rate over the follow up period between both study groups. The mean difference between both groups was not statistically significant at any of the follow-ups after administration of the drug.

Discussion
Severe preeclampsia poses a dilemma for anesthesiologists, and there is some controversy about the best anesthetic technique for cesarean delivery in such cases (Aya AG *et al.*, 2003) [11]. Because of the risks related to airway edema, difficulty with the airway or failed intubation, hypertensive response to direct laryngoscopy, and aspiration pneumonitis, general anesthesia is associated with more untoward outcomes in this particular group of patients (Pournajafian A, *et al.*, 2012) [14].

There is growing interest in using spinal anesthesia on pre-eclamptic patients because of its simplicity, faster onset, lower dose of injected local anesthetic (which decreases the probability of systemic toxicity), and less tissue trauma caused by the use of a smaller gauge spinal needle (Van de Velde M *et al.*, 2004) [16] As a result of this interest, a number of studies have been conducted to show the hemodynamic consequences of spinal anesthesia in patients with preeclampsia. This is the rationale for present study.

The mean age of the study group was 25.17+3.61 years (mean+s.d.) and range = 18-30 years in the current study. This is comparable to study by Nikooseresht *et al.* in 2016 in Iran where the mean age of the study group was around 28.5 years. The VAS Scores had achieved no scores over the follow up duration and hence no. (Nikooseresht M *et al.*, 2016) [19] Significant change was noticed over the period of time. However, VAS Scores were achieved at the 150 min after SAB follow-up indicating reversal of analgesia by that stage.

The mean VAS Scores was significantly higher in Pre-eclamptic subjects as compared to Normotensive subjects. However, there was no significant difference between the categories of VAS score (mild/ moderate/ severe) between both comparison groups. Very few studies exist in this regard. A study done by El-Kerdawy H *et al.* in 2010 demonstrated a significant decrease in VAS score in the first hour after administration of analgesia ($P < 0.05$) (El-Kerdawy H *et al.*, 2010) [20]. But, no study corresponds to post-operative pain in pre-eclamptic patients, requiring further research.

The post-operative ambulation motor block assessment using James Modified Bromage Scale showed mean difference between both groups was significant at 150 min after administration of the drug, with more pre-eclamptic patients being in stage 2. The reason for this needs further exploration.

Also the block height achieved varied significantly between patients with pre-ecclampsia and normotensives at 150 minutes. These differences could be attributed to hormonal changes during pregnancy. Coupled with hemodynamic changes during pre-ecclampsia as evidenced by Datta *et al.*, 1983 [21].

Previously, subarachnoid block (SAB) was not a preferred choice for caesarean section in parturient with severe preeclampsia. The reason behind this was the possibility of severe hypotension in volume-contracted individuals and

those receiving anti-hypertensives.

Spinal anesthesia-associated hypotension may occur in up to 64%-100% of pregnant women undergoing cesarean delivery (Aya AG *et al.*, 20003) [13]. Epidural anesthesia has traditionally been regarded to be safer for preeclamptic parturients as it does not produce sudden hypotension. However, some studies have shown that the two techniques produce a similar incidence and severity of hypotension in preeclamptic parturients (Hood DD *et al.*, 2003).

(Wallace *et al.*, 1995) [9] Conducted a randomised study to evaluate the maternal and fetal effect of SAB and general anesthesia in patients with severe eclampsia and found both techniques to be equally acceptable. Aya *et al.* compared the incidence and severity of SAB associated hypotension in severely preeclamptic (n = 30) versus healthy (n = 30) parturients undergoing cesarean delivery and found six times less risk of hypotension in patients with severe preeclampsia. (Khatri *et al.*, 2014) [26] conducted a similar study and found less hypotension but comparable Apgar score in patients with severe pre-eclampsia (86). Saha *et al.*, 2013 also found similar outcome in terms of perioperative hypotension, phenylephrine consumption and apgar score.

(Ahmed *et al.*, 1999) [28] Compared general anesthesia and SAB in preeclamptic toxaemia patients and opined in favour of SAB for its less severe complications (88). Hood and Curry in a large retrospective clinical series examined the blood pressure effects of spinal and epidural anaesthesia in severely preeclamptic patients requiring caesarean section and found similar magnitude of decline in blood pressures as well as similar postoperative maternal and fetal outcome in both the groups.

(Visalyaputra *et al.*, 2004) conducted a multi-centric randomized study to compare the hemodynamic effects of spinal and epidural anesthesia for cesarean delivery in severely pre-eclamptic patients and observed in spite of the hypotension (SBP < or + 100 mmHg) being more frequent in the spinal group than the epidural group (51% versus 23%), the duration was short and it was easily treatable with ephedrine.

Neonatal outcome as assessed by Apgar score and the umbilical artery blood gas analysis was similar in both the groups. Similar to the studies by Aya *et al.*, the incidence of hypotension in severely preeclamptic patients undergoing spinal anesthesia for cesarean delivery was found to be significantly lower in comparison to the rate among healthy parturients in our study. Factors such as difference in gestational age, the carrying of a smaller fetus, less aortocaval compression, sympathetic hyperactivity, and high vascular tone might have led to this finding.

In our study, we found significant differences in SBP, DBP and MAP at different point of times in both the groups. One possible explanation for this could be the fact that the preoperative blood pressure values were significantly different in both the groups. This may influence the intraoperative values.

Considering the neonatal outcomes after various anesthesia techniques in cesarean delivery among preeclamptic patients, statistically significant difference was found in the one- and five-minute Apgar scores.

In comparison with healthy subjects, patients with severe preeclampsia had a younger gestational age (34 weeks versus 39 weeks) in our study, which is one of the likely causes of the lower one-minute Apgar scores of the neonates among the first group. Although there was evidence as early as 1950 that preeclampsia attenuates spinal anesthesia-induced hypotension, it has taken a long time for clinical trials to demonstrate the safety of spinal anesthesia in preeclamptic parturients.

Recently, after five decades of research, the relationship between spinal anesthesia, pre-eclampsia, and hypotension can be properly acknowledged and put into clinical practice (Henke VG *et al.* 2013) [29]. Because of an altered balance of vascular tone, reduced responses to endogenous pressors, and increased synthesis of vasodilator prostaglandins and nitric oxide, the normal pregnant patient is very sensitive to spinal anesthesia.

These effects increase dependence on sympathetic vascular tone in normal pregnancy, and this can be the main cause of spinal anesthesia-induced hypotension in healthy parturients, while damaged vascular epithelium results in persistent vasoconstriction in preeclampsia (Sharwood-Smith G *et al.*, 2009) [30]. Nausea and vomiting during regional anesthesia for cesarean section are very common and unpleasant events. They have multiple etiologies, which include hypotension, vagal hyperactivity, visceral pain, i.v. opioid supplementation, uterotonic agents and motion. In the current study because of hypotension, normotensive patients suffered from nausea and vomiting more than pre-eclampsia patients.

Conclusion

So in our study we can conclude that comparison of effect of subarachnoid block amongst pre eclampsia and normotensive group on hemodynamic parameters showed mean Systolic blood pressure, mean Diastolic blood pressure and mean arterial pressure to be significantly higher among pre eclampsia patients from baseline to 150 minutes after injection. However, the heart rate remained comparable in both the groups. The mean SpO2 values also remained comparable over the follow up period between the two groups. APGAR score was significantly higher at 1 and 5 minutes for newborns born to normotensive mothers. The status of maximum block achieved and the mean time taken for it was also similar in both the groups. The mean difference for bromage scale was significant at 150 minutes after administration of the drug. There was higher proportion of patients in normotensive group reported hypotension, nausea and vomiting.

Conflict of interest: Nil

Reference

1. Kaaja R, Kinnunen T, Luoto R. Regional differences in the prevalence of pre-eclampsia in relation to the risk factors for coronary artery disease in women in Finland. Eur Heart J. 2005; 26:44-50.
2. Sibai B. Diagnosis and management of gestational hypertension and preeclampsia. Obstet Gynecol. 2003; 102:181-92.
3. James P, Nelson-Piercy C. Management of hypertension before, during, and after pregnancy. Heart. 2004; 90:1499-504.
4. Sibai B, Kupferminc M. Pre-eclampsia. Lancet. 2005; 363:785-799.
5. McCowan L, Buist R, North R, Gamble G. Perinatal morbity in chronic hypertension. Br J Obstet Gynaecol. 1996; 103:123-129.
6. Mayet J, Hughes A. Cardiac and vascular

pathophysiology in hypertension. Heart. 2003; 89:1104-1109.

7. Visser W, Wallenburg H. Central hemodynamic observations in untreated preeclamptic patients. Hypertension. 1991; 17:1072-1077.

8. Bourne TM, deMelo AE, Bastianpillai BA, May AE. A survey of how British obstetric anaesthesiologists test regional anaesthesia before Caesarean section. Anaesthesia. 1997; 52:901-3.

9. Wallace DH, Leveno KJ, Cunningham FG *et al.* Randomized comparison of general and regional anesthesia for cesarean delivery in pregnancies complicated by severe preeclampsia. Obstet Gynecol. 1995; 86:193-9.

10. Dyer RA, Farbas J, Torr GJ *et al.* Prospective, randomized trial comparing general with spinal anesthesia for cesarean delivery in preeclamptic patients with a nonreassuring fetal heart trace. Anesthesiology. 2003; 99:561-9.

11. Aya AGM, Mangin R, Vialles N *et al.* Patients with severe preeclampsia experience less hypotension during spinal anesthesia for elective cesarean delivery than healthy parturients: a prospective cohort comparison. Anesth Analg. 2003; 97:867-72.

12. Santos AC, Birnbach DJ. Spinal anesthesia in the parturient with severe preeclampsia: time for reconsideration. Anesth Analg. 2003; 97:621-2.

13. Aya AG, Mangin R, Vialles N, Ferrer JM, Robert C, Ripart J *et al.* Patients with severe preeclampsia experience less hypotension during spinal anesthesia for elective cesarean delivery than healthy parturients: a prospective cohort comparison. Anesth Analg. 2003; 97(3):867-72.

14. Pournajafian A, Rokhtabnak F, Kholdbarin A, Ghodrati M, Ghavam S. Comparison of remifentanil and fentanyl regarding hemodynamic changes due to endotracheal intubation in preeclamptic parturient candidate for cesarean delivery. Anesth Pain Med. 2012; 2(2):90-3. doi: 10.5812/aapm.6884.

15. Chumpathong S, Sirithanetbhol S, Salakij B, Visalyaputra S, Parakkamodom S, Wataganara T. Maternal and neonatal outcomes in women with severe pre-eclampsia undergoing cesarean section: a 10-year retrospective study from a single tertiary care center: anesthetic point of view. J Matern Fetal Neonatal Med, 2016, 1-5. Doi: 10.3109/14767058.2016.1159674.

16. Van de Velde M, Berends N, Spitz B, Teunkens A, Vandermeersch E. Low-dose combined spinal-epidural anaesthesia vs. conventional epidural anaesthesia for Caesarean section in pre-eclampsia: a retrospective analysis. Eur J Anaesthesiol. 2004; 21(6):454-9.

17. Berends N, Teunkens A, Vandermeersch E, Van de Velde M. A randomized trial comparing low-dose combined spinal-epidural anesthesia and conventional epidural anesthesia for cesarean section in severe preeclampsia. Acta Anaesthesiol Belg. 2005; 56(2):155-62.

18. Chaudhary S, Salhotra R. Subarachnoid block for caesarean section in severe preeclampsia. J Anaesthesiol Clin Pharmacol. 2011; 27(2):169-73. doi: 10.4103/0970-9185.81821.

19. Nikooseresht M, Seif Rabiei MA, Hajian P, Dastaran R, Alipour N. Comparing the Hemodynamic Effects of Spinal Anesthesia in Preeclamptic and Healthy Parturients During Cesarean Section. Anesth Pain Med. 2016; 6(3):e11519. Published 2016 Jun 5. doi:10.5812/aapm.11519.

20. El-Kerdawy H, Farouk A. Labor analgesia in preeclampsia: remifentanil patient controlled intravenous analgesia versus epidural analgesia. Middle East J Anaesthesiol. 2010; 20(4):539-45.

21. Datta S, Lambert DH, Gregus J, Gissen AJ, Covino BG. Differential sensitivities of mammalian nerve fibres during pregnancy. Anesthesia and Analgesia. 1983; 62:1070-1072.

22. Hood D, Curry RRN. Spinal versus Epidural Anesthesia for cesarean section in severely preeclamptic patients: A retrospective survey. Anesthesiol. 1999; 90(5):1276-82.

23. Visalyaputra S, Rodanant O, Somboonviboon W, Tantivitayatan K, Thienthong S, Saengchote W *et al.* Spinal versus epidural anesthesia for cesarean delivery in severe preeclampsia: a prospective randomized, multicenter study. Anesth Analg. 2005; 101(3):862-8. doi: 10.1213/01.ANE. 0000160 535.9567 8.34.

24. Hood DD, Boese PA. Epidural and Spinal Anesthesia for Elective Cesarean Section in Severely Pre-Eclamptic Parturients. Reg Anesth. 1992; 17(1):35.

25. Wallace DH, Leveno KJ, Cunningham FG, Giesecke AH, Shearer VE *et al.* Randomized comparison of general and regional anesthesia for cesarean delivery in pregnancies complicated by severe preeclampsia. Obstetrics & Gynecology. 1995; 86:193-199.

26. Khatri RK, Sethi P, Ujawal S. Perioperative hemodynamic response and vasopressor requirement during spinal anesthesia for cesarean section in healthy and severe preeclampticparturients: a prospective cohort comparison. Anaesth Pain & Intensive Care. 2014; 18:152-156.

27. Saha D, Ghosh S, Bhattacharyya S, Mallik S, Pal R *et al.* Comparison of hemodynamic response and vasopressor requirement following spinal anaesthesia between normotensive and severe preeclamptic women undergoing caesarean section: A prospective study. Journal of Obstetric Anaesthesia and Critical Care. 2013; 3:23.

28. Ahmed SM, Khan RM, Bano S, Ajmani P, Kumar A. Is spinal anaesthesia safe in pre-eclamptic toxaemia patients? J Indian Med Assoc. 1999; 97:165-168.

29. Henke VG, Bateman BT, Leffert LR. Focused review: spinal anesthesia in severe preeclampsia. Anesth Analg. 2013; 117(3):686-93. doi: 10.1213/ANE.0b013e31829eeef5.

30. Sharwood-Smith G, Drummond GB. Hypotension in obstetric spinal anaesthesia: a lesson from pre-eclampsia. Br J Anaesth. 2009; 102(3):291-4. doi: 10.1093/bja/aep003.