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A Prospective Comparative Evaluation of Spinal Anesthesia-Induced Hypotension in Preeclamptic versus Healthy Women Undergoing Cesarean Delivery

***Dr Mohammed Mahdi Al-juboori*[1], *Dr Mohammed Kassim AlRubaye*[2] *and Dr Mustafa Sabah Abdulameer*[2]**

[1]*MBChB, FICMs(Anesthesia), Fellowship of Iraqi board of medical specialties of interventional pain medicine, Specialist of Anesthesia and Intervention Pain Medicine, Al-Yarmouk Teaching Hospital, Baghdad, Iraq.*

[2]*MBChB, FICMs, Specialist of Anesthesia and Intensive Care, Baghdad Teaching Hospital, Medical City, Baghdad, Iraq*.

Abstract: Background and Objectives: General anesthesia in preeclamptic patients presents substantial maternal risks due to airway edema, challenging intubation, and aggressive hypertensive responses during laryngoscopy. While neuraxial techniques are generally preferred, concerns historically existed regarding sudden sympathetic blockade and subsequent severe hypotension. This study aimed to compare the hemodynamic profiles, magnitude of blood pressure changes, and incidence of spinal anesthesia-associated hypotension between preeclamptic and healthy normotensive parturients undergoing cesarean sections. Patients and Methods: A prospective comparative study was conducted at Yarmouk Teaching Hospital involving 60 parturients scheduled for cesarean section under spinal anesthesia. The cohort was divided into two equal groups (n = 30 each): Group 1 consisting of healthy normotensive parturients (controls) and Group 2 consisting of patients diagnosed with preeclampsia. All patients received a standardized intravenous fluid co-load of 1500–2000 mL of Lactated Ringer's solution. Spinal anesthesia was administered in the sitting position using hyperbaric 0.5% bupivacaine (10–15 mg). Maternal systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and heart rate (HR) were recorded at 2-minute intervals for the first 10 minutes and every 5 minutes thereafter. Clinically significant hypotension was managed with 5 mg intravenous ephedrine boluses. Results: Baseline SBP, DBP, and MAP were significantly higher in the preeclamptic group ($p<0.001$). Following the spinal block, significant decreases in SBP, DBP, and MAP were observed in both groups ($p<0.001$). However, the magnitude of the drop in blood pressure was significantly smaller, and the rate of decline was slower, in the preeclamptic group compared to the control group ($p<0.001$ for SBP and MAP; $p<0.003$ for DBP). Clinically relevant hypotension requiring rescue ephedrine therapy occurred in only 2 patients (6.6%) in the preeclamptic group, compared to 6 patients (20.0%) in the healthy control group. Baseline heart rate was higher in preeclamptic patients ($p<0.001$), whereas normotensive patients exhibited a more pronounced compensatory heart rate increase following the block. Conclusions: Preeclamptic patients exhibit greater hemodynamic stability and a significantly lower incidence of spinal anesthesia-induced hypotension during cesarean deliveries compared to healthy normotensive parturients. When hypotension does occur in preeclamptic women, its overall magnitude is manageable and successfully corrected with standard vasopressor therapy, confirming that spinal anesthesia is a safe and reliable option for this high-risk population.

Keywords: Spinal anesthesia; Preeclampsia; Cesarean section; Hypotension; Bupivacaine; Hemodynamics.

INTRODUCTION

Preeclampsia is defined as hypertension (SBP > 140 mm Hg or DBP > 90 mm Hg) after 20 weeks' gestation associated with proteinuria. Preeclampsia is diagnosed when urine protein is greater than 300 mg/day or, alternatively, there is a protein/creatinine ratio of at least 0.3. In 2013, massive proteinuria (> 5g in 24 hours) and fetal growth restriction were eliminated as considerations of severe preeclampsia. In addition, the term mild preeclampsia is no longer used. Now only preeclampsia or preeclampsia with severe features are defined. Severe features of preeclampsia include an SBP of 160 mm Hg or greater or DBP of 110 mm Hg or greater on two separate occasions at least 4 hours apart while on bed rest; thrombocytopenia; impaired liver function with twice normal concentrations of liver enzymes; right upper quadrant pain; progressive renal insufficiency with serum creatinine greater than 1.1 mg/dL or a doubling of serum creatinine without other known renal disease; pulmonary edema; and new onset cerebral or visual abnormalities. In the absence of proteinuria, preeclampsia can be diagnosed with new onset hypertension as previously defined and presence of a severe feature. [American College of Obstetricians and Gynecologists, 2013]

Preeclampsia complicates approximately 7–10% of pregnancies.

Severe preeclampsia causes or contributes to 20–40% of maternal deaths and 20% of perinatal deaths. Maternal deaths are usually due to stroke, pulmonary edema, and hepatic necrosis or rupture. [Hutcheon, J. A. *et al.*, 2011]

Patients with preeclampsia have widely differing hemodynamic profiles. Most patients have low-normal cardiac filling pressures with high systemic

***Corresponding Author:** Dr Mohammed Mahdi Al-juboori

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vascular resistance, but cardiac output may be low, normal, or high. [Hutcheon, J. A. *et al*., 2011]

The cause of preeclampsia is not known, but hypotheses include maladaptation of the placental circulation, immunologic rejection of paternal antigens, and maternal genetic and environmental factors. Constitutional, genetic, and hemodynamic factors have been proposed for the causes of early preeclampsia. [Forest, J. C. *et al*., 2012]

Because of the risks related to airway edema, difficulty with the airway or failed intubation, hypertensive response to direct laryngoscopy, and aspiration pneumonia, general anesthesia is associated with more unwanted outcomes in this particular group of patients. [Chumpathong, S. *et al*., 2016]

When there is no contraindication for performing regional anesthesia, risk-benefit considerations strongly favor neuraxial techniques over general anesthesia for cesarean delivery in cases of severe preeclampsia. Regional anesthesia techniques have been widely used recently, however, spinal anesthesia, once considered contraindicated due to the common belief that the sudden and extensive sympathetic blockade following the subarachnoid block would result in severe hypotension and compromise uteroplacental blood flow in this group of patients. [Saha, D. *et al*., 2013]

Initial treatment typically includes labetalol and hydralazine. Other considerations are increased airway edema with associated difficulty of intubation and increased rates of postpartum atony related to the use of magnesium sulfate. Methylergonovine (methergine) should be used cautiously in patients with preeclampsia because it may lead to hypertensive crisis. Women with a diagnosis of preeclampsia should have their platelet count checked before initiation of regional anesthesia or removal of an epidural catheter. Patients with severe preeclampsia should have additional coagulation studies, including prothrombin time (PT) with international normalized ratio (INR) and activated partial thromboplastin time, before neuraxial anesthesia. Coagulopathy is a contraindication to regional anesthesia. Although the risk for spinal hematoma is lower in pregnant women than in the elderly. [Moen, V. *et al*., 2004]

OBJECTIVES

Compare the hemodynamic effects and the incidence of spinal anesthesia-associated hypotension after spinal anesthesia with bupivacaine in preeclamptic versus healthy parturients undergoing cesarean sections.

PATIENTS AND METHODS

After ethical approval and inform the patient about spinal anesthesia , 60 patient (30 preeclamptic and 30 healthy parturient) presented in Yarmouk teaching hospital from May 2016 to march 2017 .

Preeclampsia was defined, according to the criteria of Davey and MacGillivray(10) , as systolic blood pressure (SBP) ≥160 mm Hg, diastolic blood pressure (DBP) ≥110 mm Hg, or both.

To allow optimal management of hypertension, the antihypertensive drug was not standardized and was left to the choice of the treating obstetrician.

Exclusion criteria:

- Patient refusal
- Patient with chronic hypertension
- Patient with neurological manifestation
- More than 4 gestations
- Diabetes
- Coagulopathy
- Patient given β-tocolytic drugs

All patients were given an IV-infusion of 1000 ml of lactated Ringer's solution over 20 min before the anesthesia and continues fluid administration 500 ml for oxytocin and another 500 ml , totally all patient received 1500-2000 ml .

The volume of fluids administered to preeclamptic patients was not decreased, because we expected that the intravascular volume depletion could cause severe hypotension because of sympathetic blockade-induced vasodilation.

BP And Heart Rate (HR) were Monitored Continuously.

The IV fluids were given with the patient in the lateral decubitus position or supine position with a wedge placed under the right hip to obtain a 15°–20° left uterine displacement.

Baseline BP and HR Were Obtained as the Mean of Three Consecutive Measurements Taken 2 Min Apart.

The patient was then placed in the sitting position, and spinal anesthesia was administered. After skin infiltration with lidocaine, a 20- or 22-gauge Whitacre needle was inserted at the L2-3 or L3-4 vertebral interspace, and hyperbaric 0.5% bupivacaine (10–15 mg according to the weight and height of the patient).

The patient was then returned to the supine position with left uterine displacement. The upper

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sensory level was checked at 5-10 min after the spinal injection by using small syringe needle , and a 10°–15° head down-tilt (Trendelenburg position) was initiated if a T4 sensory level was not achieved.

Maternal BP and HR were recorded at 2-min intervals from the spinal injection for 10 min and then at 5-min intervals until the end of the surgery.
Hypotension was treated with IV ephedrine (5 mg every 2 min).
Definition of hypotension in healthy parturients was a decrease in SBP to <100 mm Hg.
Therefore, for intergroup comparisons, the incidence of ephedrine administration and the mean dosage of ephedrine given taken in consideration.

From total 60 patients included in the study 30 (50%) were pre eclamptic and 30 (50%) were healthy parturients
Randomized into two groups :
Control (1) group (n=30) and preeclampsia (2) group (n=30) no patient was excluded from the study.
The mean age in group 1 was 30.40 years and the mean age in group 2 was 24.53.
The mean number of gravidae in group 1 was 3 and in group 2 was 1.27.
The mean gestational age in group 1 was 36.93 months and in group 2 was 32.07 months.
The mean weight in group 1 was 68.57 kg and in group 2 was 67.23 kg.
The mean height in group 1 was 1.60 meters and in group 2 was 1.61 meters.

RESULTS

Table 1: maternal characteristics**.**

Group		N	Mean	Std. Deviation	Std. Error Mean	P value
Age	1	30	30.40	2.372	0.433	< 0.001
	2	30	24.53	1.737	0.317	
Number of gravidae	1	30	3.00	0.830	0.152	< 0.001
	2	30	1.27	0.450	0.082	
Gestational age	1	30	36.93	1.596	0.291	< 0.001
	2	30	32.07	1.596	0.291	
Weight	1	30	68.57	10.418	1.902	0.582
	2	30	67.23	8.076	1.474	
Height	1	30	1.60	0.063	0.011	0.372
	2	30	1.61	0.064	0.012	

Thirteen patients from group 2 were on anti-hypertensive drugs (methyl dopa) ,eleven patients on 250 mg three times daily ,two patients on 500 mg three times daily , all of them continue medication till the day of the surgery.

Heart rate values of pre eclamptic and healthy parturients are shown in table 2
Heart rate markedly increased in healthy parturient.

Table 2: changes in heart rate after spinal anesthesia.

Group		N	Mean	Std. Deviation	Std. Error Mean	p value
P0	1	30	86.67	8.442	1.541	< 0.001
	2	30	96.33	5.713	1.043	
P1	1	30	88.00	8.052	1.470	< 0.001
	2	30	95.33	6.288	1.148	
P2	1	30	88.67	8.193	1.496	< 0.001
	2	30	96.33	7.761	1.417	
P3	1	30	88.00	7.381	1.348	< 0.001
	2	30	97.00	7.834	1.430	
P4	1	30	90.67	6.661	1.216	< 0.001
	2	30	96.67	5.774	1.054	
P5	1	30	89.67	6.008	1.097	< 0.001
	2	30	97.00	6.379	1.165	
P6	1	30	92.33	6.915	1.262	0.032
	2	30	96.00	5.931	1.083	
P7	1	30	93.33	4.795	0.875	0.367

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	2	30	94.33	3.651	0.667	
P8	1	30	94.00	6.486	1.184	0.823
	2	30	94.33	4.866	0.888	
P9	1	30	93.33	5.142	0.939	0.032
	2	30	96.00	4.235	0.773	
P10	1	30	91.67	5.774	1.054	0.109
	2	30	94.00	5.318	0.971	

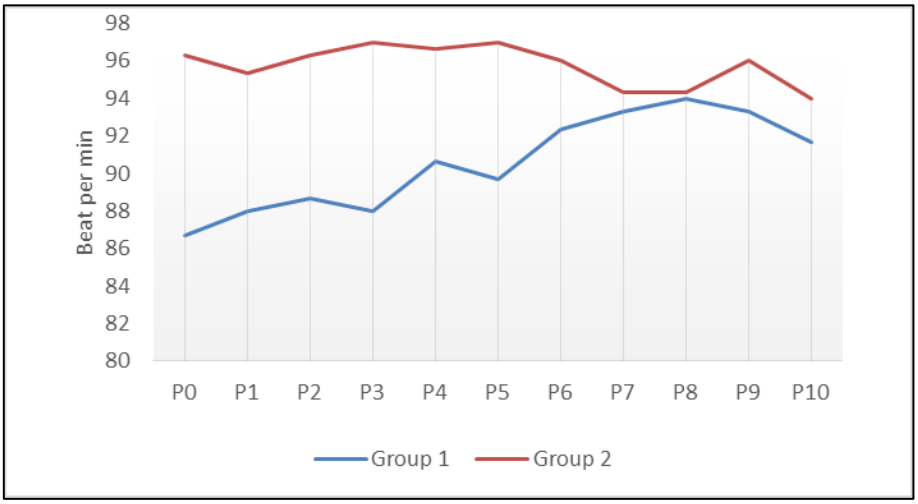

Figure 1: Pulse rate between the groups.

The mean baseline values of SBP and DBP and mean BP were larger in the pre eclamptic group These three variables decreased significantly in both groups after the spinal block.

The decrease in SBP shown in table 3, SBP decreased in both groups.

Table 3: Changes in systolic blood pressure after spinal anesthesia

Group		N	Mean	Std. Deviation	Std. Error Mean	p value
S0	1	30	122.00	17.499	3.195	< 0.001
	2	30	165.33	7.303	1.333	
S1	1	30	122.00	17.499	3.195	< 0.001
	2	30	165.33	7.303	1.333	
S2	1	30	120.00	16.189	2.956	< 0.001
	2	30	160.00	8.305	1.516	
S3	1	30	114.67	16.965	3.097	< 0.001
	2	30	152.67	8.683	1.585	
S4	1	30	110.67	15.522	2.834	< 0.001
	2	30	145.33	8.996	1.642	
S5	1	30	108.67	16.132	2.945	< 0.001
	2	30	139.33	10.148	1.853	
S6	1	30	104.00	14.288	2.609	< 0.001
	2	30	134.00	8.944	1.633	
S7	1	30	101.33	14.794	2.701	< 0.001
	2	30	126.67	8.023	1.465	
S8	1	30	101.33	11.666	2.130	< 0.001
	2	30	122.67	7.849	1.433	
S9	1	30	104.00	11.017	2.011	< 0.001
	2	30	118.00	7.611	1.390	
S10	1	30	102.67	11.427	2.086	< 0.001
	2	30	118.00	9.248	1.688	

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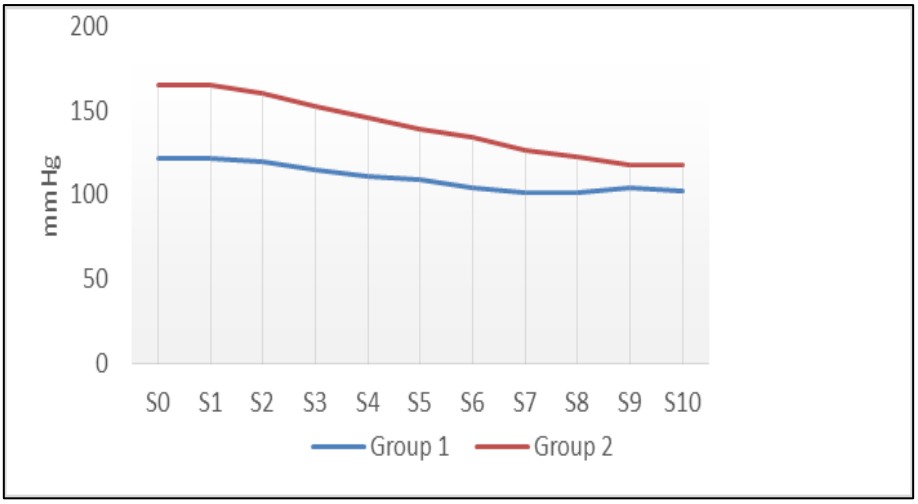

Figure 2: SBP between the groups.

However, the incidence of clinically relevant hypotension leading to ephedrine treatment was two patients(6.6%) in the preeclamptic group and 6 patients (20%) in the normotensive group . All healthy parturients given ephedrine fitted the 2 definitions of hypotension planned in the protocol, so that no patient received ephedrine because of a decrease in SBP to 100 mm Hg with 30% decrease in mean BP. All but one patient in both study group had symptoms such as nausea, vomiting, or dizziness at the time of hypotension, which disappeared after effective treatment with ephedrine.

Change in DBP Shown in Table 4 There is Decrease in Both Groups

Table 4: changes in diastolic blood pressure after spinal anesthesia

Group		N	Mean	Std. Deviation	Std. Error Mean	p value
D0	1	30	72.67	10.148	1.853	< 0.001
	2	30	106.67	4.795	0.875	
D1	1	30	73.33	10.283	1.877	< 0.001
	2	30	106.00	4.983	0.910	
D2	1	30	73.00	9.432	1.722	< 0.001
	2	30	100.67	5.833	1.065	
D3	1	30	65.33	10.250	1.871	< 0.001
	2	30	95.33	6.288	1.148	
D4	1	30	63.33	10.283	1.877	< 0.001
	2	30	90.00	5.252	0.959	
D5	1	30	62.00	10.635	1.942	< 0.001
	2	30	83.33	7.112	1.298	
D6	1	30	58.67	11.059	2.019	< 0.001
	2	30	77.33	5.833	1.065	
D7	1	30	57.33	7.849	1.433	< 0.001
	2	30	73.33	4.795	0.875	
D8	1	30	58.67	7.303	1.333	< 0.001
	2	30	69.33	4.498	0.821	
D9	1	30	60.67	6.915	1.262	0.002
	2	30	66.67	7.112	1.298	
D10	1	30	62.00	7.611	1.390	0.003
	2	30	68.00	7.611	1.390	

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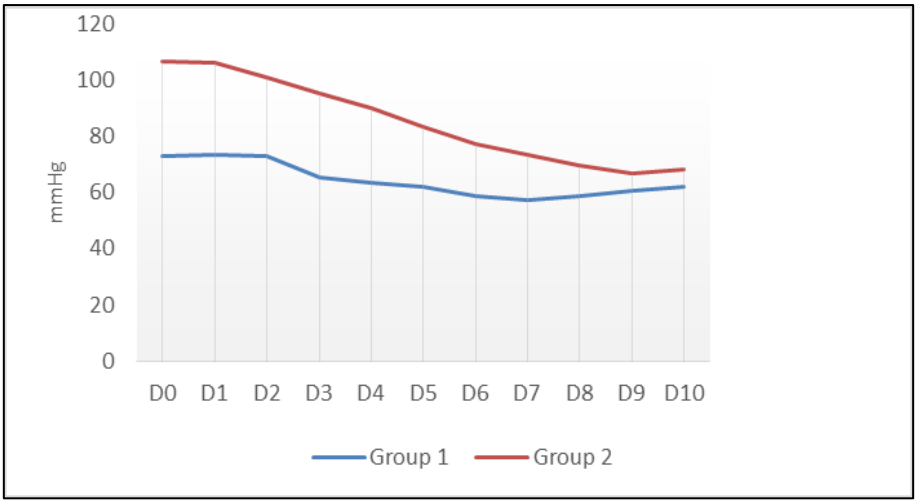

Figure 3: DPB between the groups.

Mean BP tended to decrease more in healthy parturients and was partially restored by ephedrine treatment. In severely preeclamptic patients, mean BP decreased more slowly and remained at a significantly Lower level at the end of the study period as compared with baseline. In both groups, the decrease in mean BP was significant starting 8 min after injection of the spinal anesthetic.

Changes in Mean BP Shown in Table 5.

Table 5: Changes in mean arterial pressure after spinal anesthesia

Group		N	Mean	Std. Deviation	Std. Error Mean	p value
M0	1	30	88.6000	11.97008	2.18543	< 0.001
	2	30	126.0000	3.91284	.71438	
M1	1	30	89.0667	11.99693	2.19033	< 0.001
	2	30	125.5333	3.82130	.69767	
M2	1	30	88.2667	10.96368	2.00169	< 0.001
	2	30	120.1333	4.66634	.85195	
M3	1	30	81.4000	12.00460	2.19173	< 0.001
	2	30	114.0667	5.32355	.97194	
M4	1	30	78.6667	11.31777	2.06633	< 0.001
	2	30	108.0667	5.01675	.91593	
M5	1	30	77.1333	11.90692	2.17390	< 0.001
	2	30	101.6667	6.23302	1.13799	
M6	1	30	73.4000	11.52987	2.10506	< 0.001
	2	30	95.9333	5.38794	.98370	
M7	1	30	71.6000	9.51079	1.73643	< 0.001
	2	30	90.7333	4.77734	.87222	
M8	1	30	72.5333	8.30344	1.51599	< 0.001
	2	30	86.7333	3.72256	.67964	
M9	1	30	74.7333	7.73230	1.41172	< 0.001
	2	30	83.4000	5.78702	1.05656	
M10	1	30	75.2667	8.19980	1.49707	< 0.001
	2	30	84.3333	6.33182	1.15603	

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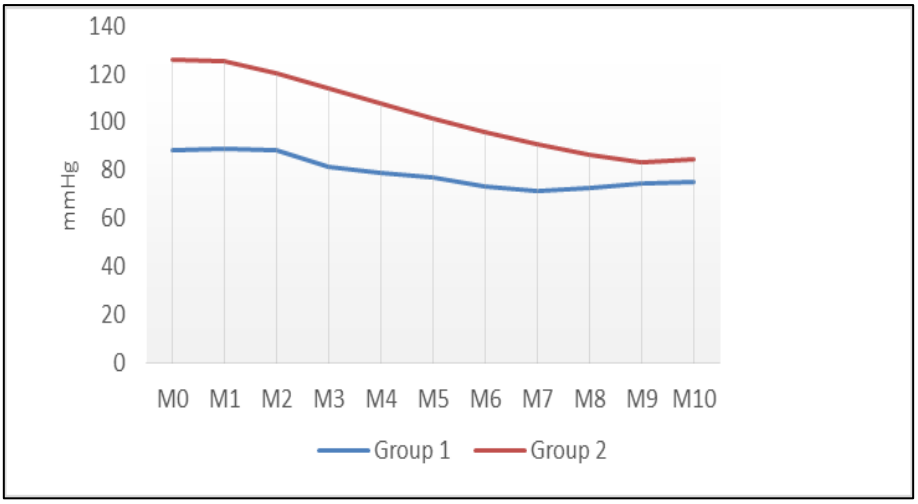

Figure 4: MAP between the groups**.**

DISCUSSION

This study shows that the incidence of significant hypotension leading to ephedrine treatment is less in patients with preeclampsia undergoing spinal anesthesia for cesarean delivery as compared with healthy parturients. The magnitude of the decrease in SBP, DBP and mean BP decreased less in preeclamptic patients. These findings were observed despite the use of similar volume of IV fluid and a similar dose of bupivacaine in preeclamptic patients and healthy parturients.

We found stable maternal hemodynamic values in pre eclamptic patient undergoing cesarean section during spinal anesthesia after pre loading with 1-liter crystalloid severe hypotension was seen in two patients(6.6%) in the pre eclamptic group and 6 patients (20%) in the normotensive group and this was corrected by increasing the crystalloid infusion and giving ephedrine 5–10 mg.

There is decrease in SBP in both groups , more significant readings in healthy parturients ,SBP used to determine hypotension in normotensive parturients

Magnitude of decrease in SBP was significantly smaller in pre eclamptic group from the Baseline reading - tenth reading p value < 0.001 ,which is similar to the p value of previous study. [Aya, A. G. *et al*., 2003; Karinen, J. *et al*., 1996]

There is decrease in DBP in both groups, magnitude is smaller in pre eclamptic group from Baseline reading - tenth reading p value < 0.003, which was 0.021 in previous study10 and was 0.001 in previous study. [Aya, A. G. *et al*., 2003]

There is decrease in MAP in both groups, magnitude is smaller in pre-eclampsia group from Baseline reading - tenth reading p value < 0.001 , which is similar in previous study[9] and was 0.021 in previous study. [Karinen, J. *et al*., 1996]

Maternal heart rate was significantly higher in pre eclamptic group in Baseline readings p value < 0.001 which was also significant in previous study[9], maternal heart rate increase significantly after anesthesia in healthy group in the seventh reading p value 0.367 which is similar in previous study[9] which was the highest increase after spinal anesthesia and in the eighth reading p value 0.823 which was not similar.

CONCLUSIONS

In conclusion, the use of spinal anesthesia for cesarean section in patient with pre-eclampsia, have significant low hemodynamic changes.

The incidence of hypotension during spinal anesthesia for cesarean delivery is infrequent in preeclamptic patients.

Like normotensive patients, however, pre-eclamptic may also experience hypotension after spinal anesthesia for cesarean delivery. When hypotension occurs, the magnitude does not appear to be decreased in preeclamptic patients as compared to healthy women.

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