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Investigation of effect of blood pressure and heart rate changes in different positions (lying and sitting) on hypotension incidence rate after spinal anesthesia in patients undergoing caesarean section

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ABSTRACT

Due to the relatively high prevalence of hypotension (20% -40%) after spinal anesthesia as well as the adverse effects of hypotension on mother and baby, it is better to prevent hypotension as much as possible. Therefore, this study is aimed to determine the relationship between postural blood pressure and heart rate changes and hypotension incidence rate after spinal anesthesia in cesarean section.63 women aging18 to 45years old with full-term pregnancy, who were candidate for caesarean section with spinal anesthesia, entered the study. Afterwards, the diastolic, systolic, and mean arterial pressures as well as the heart rate (pulse) in different positions (sitting, lying, and left lateral) were measured. After spinal anesthesia, the patients' blood pressure was measured and recorded every minute until the10thmin, then every 3 minute until the15thmin, and then every 5 minute until the end of cesarean section. Data analysis was performed using SPSS (ver. 19) software, descriptive statistics, one-way ANOVA, and post hoc Bonferroni test. In this study, the hypotension incidence rate was 30% and the orthostatic variation rate of the systolic blood pressure in more than half of the people was between 4.39 to 13.49psi, which showed the highest variation compared to the diastolic pressure, mean arterial blood pressure (or: mean arterial pressure [MAP]), and heart(pulse). Considering the correlation coefficient of 0.27, the systolic blood pressure in the lateral position has the highest relationship with the incidence of hypotension. The postural systolic blood pressure changes in patients prior to the spinal anesthesia can be a predictive factor for the post-spinal hypotension incidence.

Keywords: Orthostatic changes, blood pressure, spinal anesthesia, cesarean section

INTRODUCTION

Since 1997, regional anesthesia, due to its numerous advantages, has replaced the general anesthesia in cesarean section. The advantages of the regional anesthesia for cesarean section include reducing the risk of inability of intubation and aspiration of gastric contents, preventing the antidepressant drugs from reaching the fetus, ability to maintain the mother's wakefulness at birth of her baby and enjoying the birth experience, and reducing the intraoperative bleeding rate [1].

Regional anesthesia includes spinal and epidural anesthesia methods, the most preferable of which is the spinal anesthesia due to faster onset of anesthesia (block), ease and speed execution of the technique, completeness of the nerve blocks, less probable occurrence of incomplete blocks, less toxicity of the nerve roots (due to low doses of the local anesthetic drugs),and the administration of the least amount of drug to the fetus[1,3].

Spinal anesthesia can also be performed in a sitting or lateral position. Sitting position is the ideal position for cesarean section because of abdominal distention [1]. One of the most common side effects of spinal anesthesia is hypotension, the incidence rate of which varies between 20% to 40% and, by definition, refers to the systolic blood pressure of below 100mmHg or more than 20% decrease in the systolic blood pressure compared to the initial systolic blood pressure [1,4,5].

The incidence and severity of hypotension caused by the spinal anesthesia depend on the block's height and use or non-use of the prophylactic methods[1,6,7]. The prophylactic methods used in cesarean surgeries to prevent hypotension after the spinal anesthesia include prescription of rehydration and fluids at rate of 10-15ml/kg before the spinal anesthesia, avoidance of exerting pressure on aorta and vena cava through left lateral uterine displacement (LUD), and prescription of prophylactic ephedrine (before performing the technique)[8].

Some of these methods are also associated with some complications. For example, administration of prophylactic vasopressors might increase the incidence rate of unwanted hypertension and tachycardia in mothers, and excessive hydration might be associated with pulmonary edema; therefore, it is better not to administrate it for all patients routinely (9-11). Post-spinal hypotension is basically caused by reduction of the secondary systemic vascular resistance to vasodilatation resulted from the sympathetic fibers block [12]. Post-spinal hypotension prior to the neonate'sbirth can lead to placental hypo perfusion (decreased blood flow) and reduced apgar score of the baby, as well as nausea, vomiting, restlessness, sadness, and dissatisfaction in mothers who want to enjoy their birth experience [1].

Thus, regarding the above explanations, in order to prevent the incidence of such symptoms in mothers, it is better to prevent the post-spinal hypotension[13].

Regarding the fact that the post-spinal hypotension in prenatal stage might reduce the neonatal apgar and maternal nausea and vomiting, the present study seeks to identify the patients exposed to the risk of hypotension and perform the effective preventive methods such as administration of fluids, vasopressors, left lateral uterine displacement, etc[13].

Therefore, the present study is aimed to investigate the effect of blood pressure and heart rate changes in different positions (lying and sitting) on post-spinal hypotension rate in patients who were candidate for caesarean section at Fatemiyeh Hospital in 2013.

MATERIALS AND METHODS

The present study is a clinical trial (through pre- and post-test methods) conducted after providing verbal explanations for patients and obtaining their written consent on 63 patients aging 18 to 45 years old with term pregnancy and ASA class I, II who were candidate forcaesarean section under spinal anesthesia during years 2013 to 2014. The sample size was calculated according to the following formula:

$$n=\left[\frac{(z_{1-\alpha/2}+z_{1-\beta})}{c}\right]^2+3$$

c=0.5*Ln[(1+r)/(1-r)]

Based on the minimum predictable correlation of 0.4 between the blood pressure changes before and after the surgery and with regard to the error types 1and 2 equal to0.05 and 0.1, respectively, the sample size was calculated equal to 63.The exclusion criteria included patients undergoing emergency cesarean, patients with multifetal pregnancies, history of pre-eclampsia and eclampsia, patients with severe vaginal bleeding (abruption, etc.), history of heart disease and hypertension, history of taking drugs such as B-blocker, CCB, and other antihypertensive drugs, and contraindications to spinal anesthesia (increased intracranial pressure, patient's dissatisfaction, coagulopathy, hypovolemia.....). First, the appropriate IV line was taken for patients using the angiocath IV 18, then the systolic-diastolic blood pressure, MAP, and heart rate of the patients were measured 2 times with an interval of two minutes using a non-invasive blood pressure measurement device (Sa'adat - model 1800S - Made in Iran)on the patience's right arm. The obtained values were recorded in the questionnaire. During measurement of blood pressure, the width and length of the inflating cuff bag were about 40% and 80% of the upper arm circumference, respectively. Then the arm was positioned such that the brachial artery in the anterior fold of the elbow rested on the anterior level of the

heart andthe lower side of the cuff was put above the elbow anterior fold by 2.5cm.To measure the heart rate, the radial artery was pressed by the index and middle fingers. In case of regular rhythm, the number of beats would be counted within 15s and then multiplied by4; otherwise,itwould be counted within 60 s.

Then, the patients were laid in left lateral position and the above-mentioned pressures were applied and recorded in the questionnaire in the same way after 2 times of measurement with an interval of 2min.

Next, the patient was put in sitting position and then the systolic-diastolic blood pressures, MAP, and heart rate were recorded in the questionnaire after 2 times measurement with an interval of 2min. Moreover, in order to improve the reliability of the research results, measurements were performed on each patient by two independent individuals and then the results were compared. Attempts were made to keep these individuals unaware of the research objectives.
Then, after receiving10cc/kg of Ringer serum, the patient underwent spinal anesthesia using 25 Quincke needle in the L4-L5 space in sitting position. Specifying the subarachnoid space, 10mg ofbupivacaine5% along with 2.5µg of sufentanil were injected into the subarachnoid space at rate of 0.2ml/sec. After spinal anesthesia, the patient was immediately putin the supine position and then the systolic-diastolic blood pressures, MAP, and heart rate were measured and recorded every 1minuntil the10^{th}minuteand then every 3minuntil the15^{th}minuteand then every 5minuntil the end of surgery.

In case of SBP<100mmhg and 60>PR,10Mg of intravenous ephedrine and intravenous atropine were prescribed, respectively. The total dose of the consumed ephedrine and atropine was recorded at the end of the surgery. The data obtained from the patients was inserted in the questionnaire ; then, after recording the data in computer, data analysis was performed using SPSS (ver.19) software and the descriptive data was displayed in the form of tables, diagrams, central index, and dispersion index.

RESULTS

Repetitive C-section was introduced as the most common cause of cesarean in these subjects(Figure 1).

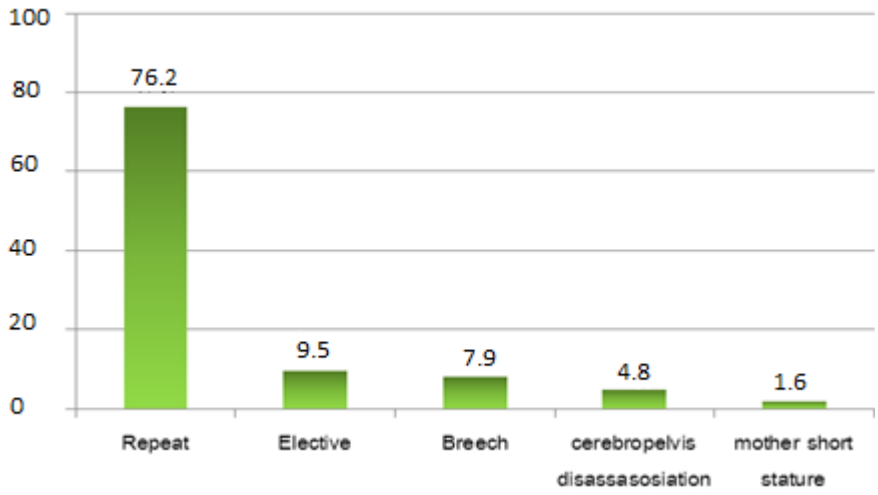

Figure 1: Frequency percentage of subjects based onfor the cause of caesarean section

The patients' systolic blood pressure score in the sitting position was 126.06, which was higher than the mean scores in the supine (125.67) and lateral positions (117.55).The highest was related to the lateral position. According to the ANOVA results, the difference of the mean scores was significant(p=0.001).The mean scores of the patients' diastolic blood pressure in the sitting position was 76.16, which was higher than the mean scores in the supine position (75.56) and the lateral position(70.40). There was a significant difference between the mean scores (p=0.001)(Table-1).

Further, based on the post hoc Bonferroni test, the patients' systolic blood pressure in the sitting position was not significantly different from that in the supine position; however, the value of this type of blood pressure in the sitting and supine positions was significantly higher than that in the lateral position(p=0.001). The highest hypotension rate was related to the lateral position. Further, there was no significant difference between the diastolic blood pressure in the sitting and supine positions; nevertheless, the value of this type of blood pressure in the sitting and supine positions was significantly higher than that in the lateral position (p=0.001) (Table-2).

Table1: Results of intragroup one way ANOVA for investigation of significance of difference between mean scores of systolic and diastolic blood pressures of patients in sitting, supine, and lateral positions

Variable	Condition	n	$\overline{X}$	Sd	F	Df	Sig	η^2
Mean systolic blood pressure	Sitting	63	126.0	12.17	18.57	2,124	0.001	0.231
	Supine	63	125.67	12.83				
	Lying on its side	63	117.55	14.86				
Mean Diastolic blood pressure	Sitting	63	76.16	10.23	15.41	2.124	0.001	0.199
	Supine	63	75.56	8.91				
	Lying on its side	63	70.40	12.39				

Table2: Results of post hoc Bonferroni test for investigation of significance of difference between mean scores of diastolic blood pressure in sitting, supine, and lateral positions

Sig.	S.D	$\overline{X}$	condition	Variable
0.78	1.41	0.39	sitting / supine	Systolic blood pressure
0.001	1.67	*8.51	Sitting / lying on the side	
0.001	1.64	*8.12	Supine / lateral lying	
0.525	0.94	0.60	sitting / supine	Diastolic blood pressure
0001	1.36	*5.76	Sitting / lying on the side	
0.001	1.08	*5.16	Supine / lateral lying	

Table (3) shows minimum changes in systolic and diastolic blood pressures, mean arterial blood pressure, and number of heart beats in three positions (sitting, supine, and lateral positions before spinal anesthesia). The change rate of the systolic blood pressure in more than half of the studied subjects was between 4.39 to 13.49,while the change rate of the diastolic blood pressure and the arterial blood pressure in the same group of the subjects was between 2.70 to 9.68 and 21.10 to 32.54, respectively; further, the number of heart beats in more than half of the subjects was between 4.39 to 13.49.

Table3: Results of descriptive statistics of changes in systolic and diastolic blood pressure and heartrate of patients in supine, lateral, and sitting positions before spinal anesthesia

Sd	$\overline{X}$	Max	Min	N	Variable
4.55	8.94	21.47	1.73	63	Systolic blood pressure changes
3.49	6.19	13.81	0.50	63	diastolic blood pressure changes
3.29	6.27	15.23	1	63	Pressure changes MAP
4.01	6.99	19.07	0.76	63	Heart rate Changes

Table (4) shows the minimum and maximum changes in systolic and diastolic blood pressures, mean arterial blood pressure (MAP), and the heart rate changes after spinal anesthesia. The change rate of the systolic, diastolic, and mean arterial blood pressures in more than half of the studied patients were between 7.26 to 16.58, between 6.29 to 12.15, and between 6.33 to 13.91, respectively; while, the heart rate change in more than half of the patients was reported to be between 7.83 to 16.39.

Table-4: Results of descriptive statistics of changes in systolic, diastolic, and mean arterial blood pressures and heart rate of patients during spinal anesthesia.

Sd	$\overline{X}$	Max	Min	N	Variable
4.66	11.92	27	4.80	63	Systolic blood pressure changes
2.93	9.22	21.72	4.22	63	diastolic blood pressure changes
3.79	10.12	24.36	4.51	63	Pressure changes MAP
4.28	12.11	2.24	4.55	63	Heart rate Changes

The incidence rate of hypotension, bradycardia, tachycardia, nausea and vomiting, and atropine consumption was reported as 29%, 0%, 41%, 41%, and 0%, respectively. Further, 44% of the subjects had taken ephedrine by 10mg, 27% by 20mg, 5% by 15mg, 5% by 30mg, and 3% by 25mg; while, 16% of them hadn't used ephedrine at all.
The minimum and maximum apgar scores of the infants at first minute were4 and 10, respectively. The apgarscores at the first minute in more than half of the patients were between 8.01 and9.79.The minimum and maximum apgar scores of the infants at the fifth minute were5and 10, respectively. The apgarscores at the fifth minute in more than half of the patients were between 8.46 and9.84.

DISCUSSION

This study is aimed to investigate the effect of blood pressure and heart rate changes in different positions (lying and sitting) on the post-spinal hypotension incidence rate in patients who were candidate forces are an section. In this study, the changes in the diastolic and systolic blood pressures, mean arterial pressure, and heart rate in various positions (sitting, lateral, and supine) were measuredin63 patients. Then, the patients underwent spinal anesthesia for cesarean section, and again the systolic and diastolic blood pressures, heart rate, and mean arterial pressure were measured and recorded in the questionnaire. In this study, the systolic blood pressure demonstrated the highest postural changes, and the relationship between the postural changes of the systolic blood pressure before spinal anesthesia and the incidence of hypotension after spinal anesthesia was significant; however, norelationship was observed between the postural changes of the diastolic blood pressure, mean arterial pressure, and heart rate before spinal anesthesia and the incidence of hypotension after spinal anesthesia. Moreover, hypotension prevalence rate of 29% was reported, which was similar to the statistics obtained in previous studies (20% - 40%) [4,5]. In addition, in this study, the repetitive C-section was found as the cause of the non-emergent cesarean cases at Fatemiyeh Hospital; furthermore, the incidence rate of bradycardia and tachycardia as well as the dosage of atropine and ephedrine were measured so that none of the patients were afflicted by bradycardia to need atropine. The prevalence rate of nausea and vomiting was 59% and 11%, respectively.

It can be said that the higher the blood pressure variation between the sitting, supine, and lateral positions, the higher the probability of post-spinal hypotension; nevertheless, due to the fact that there is no significant difference between the patients' systolic blood pressure in sitting and supine positions, it is enough to obtain only the difference between their blood pressure in sitting or supine positions and the lateral position (left side).Hence, the contingent cases of intraoperative hypotension incidence can be pre-identified and, thereby, the incidence of hypotension can be prevented using the necessary treatments, which is beneficial both for the baby and the mother. Results of the present study are similar to those of Young & Hans [7].

In the study conducted by Yang (2010) on 66 pregnant women, the blood pressure and heart rate in supine and lateral positions were measured and recorded. Finally, it was concluded that the higher theorthostatic changes, the greater the reduction of blood pressure in patients [7].The present study also led to similar results for the systolic blood pressure changes.

In a study by Hans (2005) on 60 women who were candidate forcesarean section, it was concluded that increase of the sympathetic tone before anesthesia would be associated with further reduction of blood pressure after surgery [12].

In a study on 56 pregnant women in 1996,Kinslow et al. couldn't find any relationship between the changes in orthostatic blood pressure and heart rate and the incidence of post-spinal hypotension [14]; however, in the present study, the postural changes of systolic blood pressure before spinal anesthesia were associated with higher incidence of hypotension, and the results of that study were inconsistent with the results of their study, which might be due to the difference of the measurement tools or the sample size.

In a study on 40 pregnant women in 2002, Ferulic measured the blood pressure and heart rate changesin the supine and sitting positions. Finally, it was concluded that there was a significant relationship between the patient's base heart rate and hypotension incidence, no significant relation was observed between the changes in orthostatic blood pressure and intraoperative hypotension prevalence[5]. Although, in the present study, there was a significant relationship between the changes in orthostatic blood pressure and the intraoperative hypotension prevalence, no significant relationship was observed in relation to the heart rate. Regarding the relatively high prevalence rate of post-spinal hypotension and its adverse effects on both mother and baby, prevention of it is of great importance. The present study attempted to find a predictive factor for preventing the incidence of hypotension; however, it is very valuable by itself because there are few studies in this area and majority of these studies have investigated the relationship between the base heart rate and incidence of post-spinal hypotension. Obtaining the prevalence rate of hypotension, nausea, and vomiting during cesarean section under spinal anesthesia as well as the relationship between the postural blood pressure changes and the incidence rate of intraoperative hypotension are the strong points of the present study.

The limitation of this study was only the patients didn’t provide the required co-operations for measurement of their blood pressure in various positions and were excluded from the study.

CONCLUSION

The postural systolic blood pressure changes in patients prior to the spinal anesthesia can be a predictive factor for the incidence of post-spinal hypotension.

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