

Comparative Study of Hemodynamic Changes and the Need for Inotropes in Patients Undergoing Cesarean Section with Spinal Anesthesia in Fowler and Left-Lateral Positions

Babak Dabirashrafi¹, Reza Atef-Yekta^{1*}, Mojtaba Marashi², Keyvan Teymourei Khanesari¹, Kamyar Dabirashrafi¹, Mahyar Hashemian¹, Alireza Khajehnasiri²

¹Department of Anesthesiology, Intensive Care and Pain Medicine, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran.

²Department of Anesthesiology and Critical Care, Shariati Hospital, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Background: Although spinal anesthesia is a suitable method of choice for cesarean section, there are many complications, including bradycardia and hypotension. Choosing a suitable position is an effective factor in controlling and reducing these complications. Based on this, this study was designed to investigate the hemodynamic status of pregnant patients undergoing cesarean section and spinal anesthesia in two positions, Fowler and left-lateral.

Methods: A total of 62 patients undergoing elective cesarean section surgery were enrolled in this single-center, prospective cohort trial and no blindness study. Patients aged 18-45 years in Shariati Hospital between February 2023 and September 2023 were entered for evaluation and follow-up. After spinal anesthesia, patients' vital signs, including respiratory rate, heart rate, systolic and diastolic blood pressure, mean arterial pressure, and percentage of arterial oxygen saturation, were recorded in minutes 1, 2, 3, 4, 5, 15, 30, 45, and 60.

Results: From the beginning of spinal anesthesia until minute 4, systolic blood pressure in group Fowler dropped more severely than in group Left-lateral, and this difference was significant ($P<0.001$). The decrease in blood pressure from minute 1 to 4 was much higher in group Fowler than in group Left-lateral, and this difference was significant ($P<0.001$). Patients in group Left-lateral had a significantly lower respiratory rate than group Fowler ($P=0.002$). Changes in the percentage of oxygen saturation between the two groups were statistically insignificant. Although the frequency of receiving inotropes in the group of left-lateral patients was lower than in the group of Fowler patients (40% compared to 60%), this correlation was not significant.

Conclusion: Induction of spinal anesthesia in patients in the left-lateral position had lower hemodynamic changes and better stability than the Fowler position.

Introduction

Choosing the right anesthesia for cesarean section surgery is very important for the safety of the mother and neonates. For this reason, spinal

anesthesia, due to its lower complications and less effect on the fetus, has become a favorable option for cesarean section [1-3].

Spinal anesthesia can cause some adverse effects, including severe bradycardia or hypotension in the fetus, which causes hemodynamic instability. The

The authors declare no conflicts of interest.

*Corresponding author.

E-mail address: atefyekta@tums.ac.ir

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vasodilatation effect of spinal anesthesia is the main reason for this drop in blood pressure [4-5].

Compression of the aorta and inferior vena cava by the pregnant uterus is a known physiological process that reduces venous return and is clinically demonstrated after 20 weeks of gestation [5-7].

There have been reports in studies that the position of the uterus to the left can reduce the pressure effects during the injection of local anesthetic drugs, and the lying position to the left has a positive effect in reducing hemodynamic instability and improving the Apgar score of the newborn [8-11].

Considering these physiological conditions that can increase the hemodynamic instability following the injection of local anesthetic drugs, the present study was designed to evaluate the difference in these hemodynamic changes in the two positions of sitting and lying on the left side during spinal anesthesia in patients undergoing Caesarean section surgery.

The main purpose of this study was to evaluate and demonstrate the benefits and side effects of these two positions.

Methods

This study was a single-center, prospective cohort trial with no blinding in the anesthesiology department of Shariati Hospital of Tehran University of Medical Sciences. The study was approved by the institutional ethics committee of Tehran University of Medical Sciences (Ethical code IR.TUMS.NI.REC.1402.020).

Patients aged 18-45 years in Shariati Hospital between February 2023 and September 2023 were entered for evaluation and follow-up.

The inclusion criteria were patients waiting for elective cesarean section surgery with no emergency conditions. The exclusion criteria were any rheumatoid or inflammatory diseases, serious cardiovascular comorbidities, major psychiatric conditions, absolute or relative contraindications of neuraxial anesthesia, twin pregnancy, and any maternal or fetal emergencies.

A total of 62 patients entered the study after being admitted to the obstetrics ward of Shariati Hospital. Patients were divided into two equal parallel groups, the Fowler and the left-lateral groups. The Fowler group patients received spinal anesthesia in a sitting position, and the left-lateral group patients received spinal anesthesia in the left-lying position.

All patients were selected randomly, and there were no particular arrangements or preferences for their selection. In the operating room, patients underwent standard monitoring: non-invasive blood pressure (NIBP), heart rate (HR), and peripheral oxygen saturation (SPO₂). The anesthesia technique used for the patients was standardized by default and the same for all patients. The

anesthesia technique for all patients was spinal anesthesia using 0.5% bupivacaine in the amount of 12 mg in the level of the L3-L4 or L4-L5 spinal spaces. A 25-G spinal needle was used for all patients. The procedure for all patients was performed by one anesthesiologist.

After spinal anesthesia, patients' vital signs, including respiratory rate, heart rate, systolic and diastolic blood pressure, mean arterial pressure, and percentage of arterial oxygen saturation, were recorded in minutes 1, 2, 3, 4, 5, 15, 30, 45, and 60. Furthermore, after the birth of the baby, the Apgar score was measured and recorded at 1 and 5 minutes.

Data analysis

The obtained data were analyzed using SPSS V.25 (IBM SPSS Statistics, 2018). Continuous data with normal distribution were presented as mean (95% CIs) or percentage.

Baseline comparisons between the groups were made using Student's t-test based on the viability of the normality assumption for continuous variables. Statistical significance was set at $p < 0.05$ for each outcome based on a one-tailed probability.

Results

All 62 patients who enrolled in the study were available for evaluation and follow-up. There was no significant difference in demographic characteristics between the two groups. From the beginning of spinal anesthesia until minute 4, systolic blood pressure in group Fowler dropped more severely than in group left-lateral, and this difference was significant ($P < 0.001$). After 4 minutes to 60 minutes, the average systolic blood pressure in group Fowler was higher (Table 1).

The decrease in blood pressure from minute 1 to 4 was much higher in group Fowler than in group Left-lateral, and this difference was significant ($P < 0.001$). After 5 minutes, changes and fluctuations of mean arterial pressure between the two groups did not show significant differences (Figure 1).

Patients in group Left-lateral had a significantly lower respiratory rate than group Fowler ($P = 0.002$). Fluctuations in the number of breaths per minute were higher in group Fowler, so an increase in the number of breaths was observed from the 1st to the 3rd minute, and then a continuous decrease in the number of breaths was observed until the 60th minute (Table 1).

Changes in the percentage of oxygen saturation between the two groups were statistically insignificant (Figure 2).

Although the frequency of receiving inotropes in group Left-lateral patients was lower than in group Fowler (40% compared to 60%), this correlation was not significant (Table 2).

Table 1- Patient hemodynamic characteristics in two groups (mean $\pm$ SD)

	Left-lateral	Fowler	P value
Systolic Blood Pressure	119.3 $\pm$ 15.6	133.8 $\pm$ 16.2	<0.001
Mean Arterial Pressure	91.8 $\pm$ 14.4	102.4 $\pm$ 12.3	<0.001
Respiratory Rates per minute	12.4 $\pm$ 1.2	16.9 $\pm$ 3.8	<0.01
Oxygen Saturation	99.7 $\pm$ 0.4	99.5 $\pm$ 0.7	0.4

Table 2- Patient outcomes in two groups (number(percentage))

Group	Left lateral (n=31)	Fowler (n=31)	P value
Nausea	3 (9.6%)	8 (25.8%)	0.07
Shivering	0	0	-
Headache	2 (6.4%)	0	0.4
Ondansetron usage	3 (9.6%)	5 (16.1%)	0.7
Opioid usage	0	1 (3.2%)	0.9
Inotrope usage	12 (38.7%)	18 (58.2%)	0.1

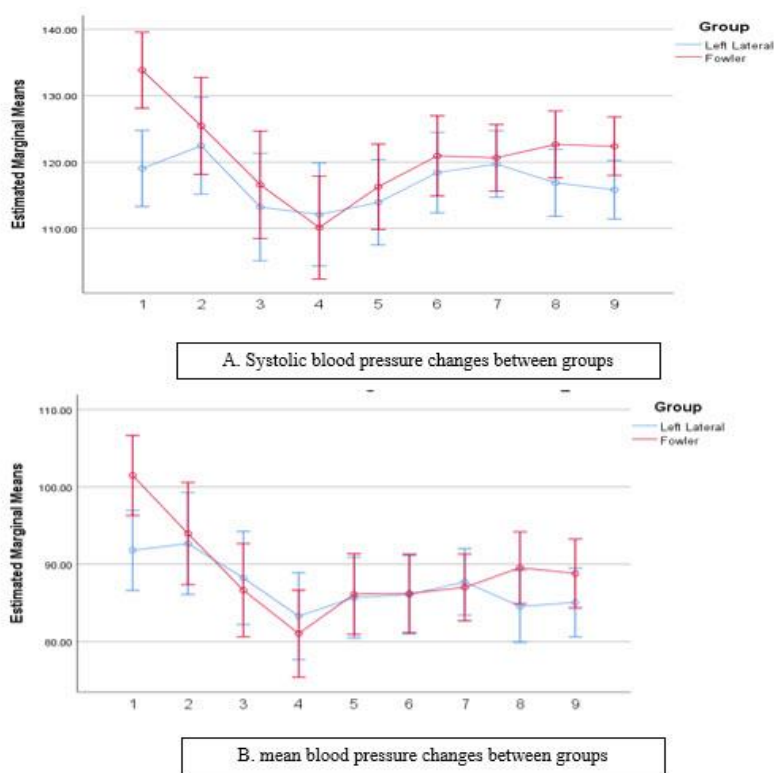
**Figure 1- (A)(B) Comparison of SBP and mean BP changes between the two groups demonstrated significant differences (P<0.001).****Commented [MB1]:**

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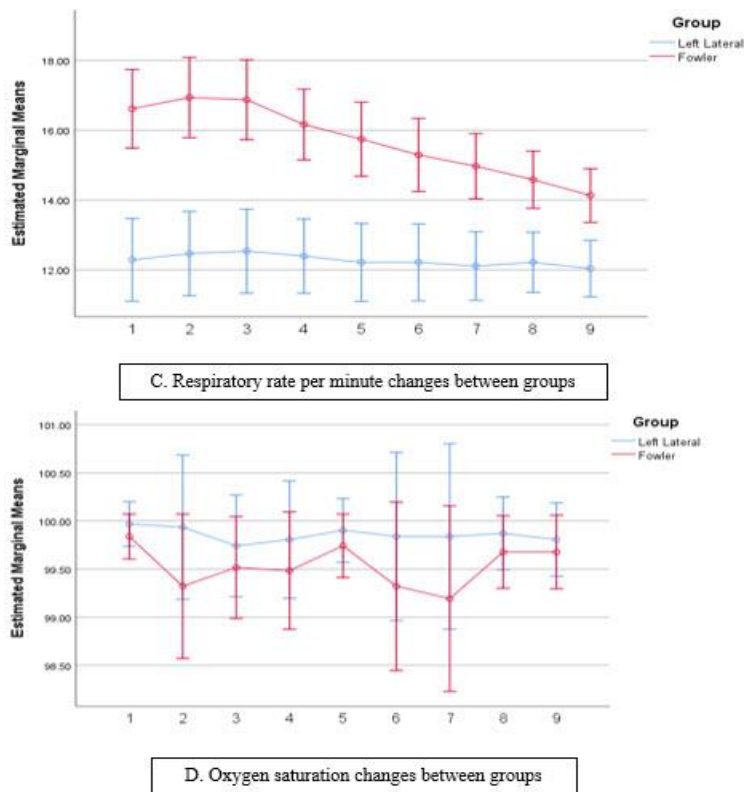


Figure 2- (C) Respiratory rates per minute in patients between the two groups showed a significant difference ($P<0.01$). (D) Difference of oxygen saturation between groups was not significant ($P=0.4$)

Discussion

The drop in systolic blood pressure and mean arterial pressure in the first 4 minutes is very rapid and statistically significant. This may indicate the need for an inotrope in the first minutes of spinal induction, as more fluids were used in the Fowler group to maintain blood pressure and intravascular volume. However, there is more research needed to confirm this finding.

In addition to the fact that Fowler group patients received more inotropes than the other group during the operation (this difference was not significant), the amount of fluid received during the operation was clearly higher. The greater volume of fluid received during the operation in the Fowler group can indicate a greater drop in blood pressure and the need for a greater intravascular volume. However, it is not known exactly when the inotrope was received after the spinal anesthesia was

performed because the amount of fluid received was measured at the end of the procedure. In addition to receiving more inotropes in the Fowler group during the operation (this difference was not significant), the patients of the Fowler group also had a higher amount of blood loss during the operation than the other group (an average of 580 cc versus 570 cc), which this difference was also not significant. Although the volume of received fluid and received inotrope was greater in the Fowler group, which can be a slight indicator of more blood loss, the blood loss does not make a significant difference in the need for inotrope.

The results of the study by Mohammad Ali and his colleagues in 2018, which was conducted on 130 pregnant women under spinal anesthesia using hyperbaric bupivacaine in the sitting position, showed that the incidence of hypotension in the side-lying position was significantly lower. The findings of our

study are in good agreement with this, which shows that the amount of blood pressure drop in the sitting position (Fowler) is more than that of lying on the side (left lateral) [12].

In the study by Manouchehrian and his colleagues about the effects of sitting and lateral positions on hemodynamic changes, the occurrence of blood pressure drop during surgery in cesarean section patients under spinal anesthesia was investigated. This study indicated that systolic blood pressure is lower in the lateral position than in the sitting position. Increasing the range of systolic blood pressure changes from the lateral position to the sitting position before spinal anesthesia has shown a higher blood pressure drop in the sitting position during cesarean section. The results of our study and this study in the field of systolic pressure drop in the sitting position are in satisfactory harmony [13].

Conclusion

Induction of spinal anesthesia in the left lateral or Fowler (sitting) position has no significant difference in the rate of complications after cesarean section. However, significant changes were found after induction of anesthesia in terms of patients' respiratory rate and blood pressure. Also, although more patients in the Fowler group needed inotropes, based on the observations of this study, no significant relationship was found between the position of the patient during spinal induction and the need for inotropes. Finally, hemodynamic changes did not show a significant relationship or interaction with the need for inotropes. Patients in Fowler's position had significantly more blood loss during surgery and significantly more fluid received in the operating room.

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