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ORIGINAL ARTICLE

The Relationship Between the Patient's Abdominal Circumference, Symphysis Pubis-Fundal Distance, and Vertebral Column Length with the Incidence of Hypotension and the Level of Block in Cesarean Section Operations Performed Under Spinal Anesthesia

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Abstract

Introduction: The incidence of hypotension in cesarean section operations performed with spinal anesthesia varies between 55-90%. In this study, the relationship between the patient's abdominal circumference, symphyseal fundal height, and vertebral column length with the incidence of hypotension and the level of block in cesarean section operations performed under spinal anesthesia was investigated.

Methods: The prospective, single-center study was conducted with patients who had undergone cesarean section with spinal anesthesia at the Training and Research Hospital. Pregnant and ASA II group patients older than 37 weeks who were to undergo cesarean section with spinal anesthesia were included in the study. Patients with multiple pregnancies, patients with premature rupture of membranes, preterm patients, and patients in active labor were excluded from the study. Those with diagnoses of abnormal presentation, polyhydramnios, oligohydramnios, macrosomic babies, and intrauterine growth retardation were also excluded from the study. Abdominal circumference was measured at the umbilicus level at the end of expiration in the supine position. Vertebral column length was measured and recorded from the C7 vertebra to the sacral hiatus. The distance of the patient from the symphysis pubis to the highest point of the uterine fundus in the supine position was measured and recorded. Spinal anesthesia was performed in the sitting position with a 26G Quincke spinal needle for the first time through the L4-5 interval and 2 mL of 0.5% hyperbaric bupivacaine was administered. When the block reached T6, the operation was started. Electrocardiogram (ECG), SpO_2, and arterial blood pressure were monitored, and the first values were recorded.

Results: A total of 98 parturient patients were included in this study. Overall, the incidence of hypotension was 87.78% (87 out of 98 parturients). Symphyseal fundal height correlated positively with spinal blockade levels at each different time point except for "Min. 4".

Discussion and Conclusion: Symphyseal fundal height is a sensitive marker to determine the risk of hypotension after spinal anesthesia. We found that the symphyseal fundal height is a more sensitive marker for hypotension that will develop after spinal anesthesia compared to the other two parameters.

Keywords: Abdominal circumference; hypotension; spinal anesthesia; symphyseal fundal height; vertebral column length.

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Spinal anesthesia (SA) is a method that is frequently used for cesarean section (CS) operations and is harmless to the fetus. Nausea, vomiting, and hypotension are common in CS operations performed under SA. The most suitable level for CS is T6, and the extent of SA can be variable. Insufficient spinal extension can cause pain in the patient, and excessive sympathetic blockade can cause vomiting and hypotension. The incidence of hypotension in CS operations performed with SA varies between 55-90%[1,2].

Although the factors affecting the spread of SA are controversial, various factors have been suggested such as height, weight, body mass index (BMI), fetal weight, multiple pregnancy, vertebral column length (VCL), and abdominal circumference (AC)[3-7]. These factors affect the extent of local anesthesia and may cause hypotension[8,9]. Hypotension may be caused by the enlarged uterus affecting the delivery of local anesthetic by altering the amount and pressure of fluid in the subarachnoid space, rather than a decrease in cardiac output[2,10]. Onuki et al. [11] found that dural sac surface area and cerebrospinal fluid (CSF) decreased due to pregnancy. Compression of the inferior vena cava in pregnant women causes dilation of the lumbar vein and vertebral arteries around the spinal cavity. This may result in increased cephalic spread of the drug.

Symphyseal fundal height (SFH) and AC measurement are indirect indicators of inferior vena cava (IVC) compression. AC and VCL have previously been found to be highly predictive of block level in operations of non-pregnant patients performed under SA with isobaric bupivacaine[12].

In this study, the relationship between the patient's AC, SFH, and VCL with the incidence of hypotension and the level of block in CS operations performed under SA were investigated.

Materials and Methods

This study was conducted in accordance with the Declaration of Helsinki. The prospective, single-center study was conducted with patients who had undergone CS with SA at the Training and Research Hospital between 01.11.2019 and 01.02.2020. The research protocol was approved by a local Ethics Committee (Reference no: 2019/18) and written consent was obtained from all subjects. Patients with multiple pregnancies, pregnancies less than 37 weeks, patients at risk of bleeding due to placenta previa and coagulation defects, patients with premature rupture of membranes, preterm patients, and patients in active labor were excluded from the study. Those with diagnoses of abnormal presentation, polyhydramnios, oligohydramnios, macrosomic babies, and intrauterine growth retardation were also excluded from the study. In addition, patients with maternal ASA > II, atony, who needed blood transfusion, and an additional dose of oxytocin were not included in the study.

Finally, patients whose block level did not reach T6 after SA, who developed an asymmetrical block, who experienced pain/who were switched to general anesthesia, and who refused to participate in the study were excluded from the study. Pregnant and ASA II group patients older than 37 weeks who were to undergo CS with SA were included in the study. The patients were taken to the operating room after a preoperative standard 8-hour fasting. The patient's height, weight, age, comorbidities, and medications were recorded. Vascular access was established with an 18G cannula. Electrocardiogram (ECG), SpO_2, and arterial blood pressure were monitored, and after the first values were recorded, the patient's AC was measured at the umbilicus level at the end of expiration in the supine position.

VCL was measured and recorded from the C7 vertebra to the sacral hiatus. The distance of the patient from the symphysis pubis to the highest point of the uterine fundus in the supine position was measured and recorded (SFH). SA was performed in the sitting position by the same practicing clinician with a 26G Quincke spinal needle for the first time through the L4-5 interval and 2 mL of 0.5% hyperbaric bupivacaine was administered at a rate of 0.1 mL per second. After spinal anesthesia was administered, the patients were placed in the supine position. Post-procedure 1st, 2nd, 3rd, and 4th-minute vital signs, block level, frequency of nausea, and total fluid administered were recorded. Block level was checked by a pinprick test from the midclavicular line. When the block reached T6, the operation was started. Neonatal weight was recorded. Vital signs, block level, and total fluid given were recorded at 5-minute intervals after delivery. During the entire surgery, the patients were given 5 L/min oxygen support. Bradycardia was considered as the heart rate falling below 60. Hypotension was accepted as a 20% decrease in systolic blood pressure. Intravenous 5 mg ephedrine was given to patients who developed hypotension and repeated if necessary. In the light of this information, the total doses of atropine and ephedrine administered were recorded. Side effects such as nausea, vomiting, and cough, if any, were recorded every 5 minutes. During the study period, 5 patients were excluded from the study due to the transition to general anesthesia due to pain and the need for blood transfusion due to atonia. Data pertaining to the study

was entered into a spreadsheet software (Microsoft Excel 16.43). Statistical analyses were performed using R (version 4.0.3, R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL: https://www.R-project.org/). For assessing the correlation between the variables of interest (VCL, AC, and SFH) and levels of spinal sensory blockade at different time points, Spearman's rank-order correlation test was used. Additionally, for assessing the correlation between the variables of interest and dosage of ephedrine and incidence of nausea/vomiting, Spearman's rank-order correlation test was used.

Results

A total of 98 parturient patients were included in this study. The mean age, height, and weight of parturients enrolled in the study were 28.93±5.13 years, 159.62±6.35 cm, and 76.8±12.84 kg, respectively (Table 1). The mean VCL, AC, and SFH were 56.79±5.58 cm, 110.38±18.17 cm, and 33.78±4.76 cm, respectively. The incidence of nausea/vomiting was 26.53%, and the incidence of shortness of breath was 5.1%. The median level of sensory blockade at 1 minute, 2 minutes, 3 minutes, and 4 minutes after SA and 0 minutes, 5 minutes, and 10 minutes after birth are displayed in Table 2.

Table 1. Clinical characteristics of 98 parturient patients. Data for continuous variables are expressed as mean±standard deviation. Data for categorical variables are expressed as n (%).

Variable	
Age	28.93±5.13
Height	159.62±6.35 cm
Weight	76.8±12.84 kg
Vertebral Column Length	56.79±5.58 cm
Abdominal Circumference	110.38±18.17 cm
Symphysiofundal Height	33.78±4.76 cm
Baseline HR	97.72±14.09
Baseline SBP	132.71±14.12 mmHg
Baseline DBP	76.9±10.23 mmHg
Neonatal weight	3235.51±530.34 kg
Ephedrine	12.91±14.99 mg
Nausea/Vomiting	26 (26.53%)
Shortness of Breath	5 (5.1%)

Table 2. Summary statistics for the spinal sensory blockade levels at different time points.

	Median	Range
Min. 1	T10	L1-T4
Min. 2	T6	T12-T4
Min. 3	T4	T8-T4
Min. 4	T4	T6-T4
After Birth Min. 0	T4	T6-T4
After Birth Min. 5	T4	T6-T4
After Birth Min. 10	T4	T6-T4

Figure 1 displays the blood pressure trend of the patients over time. Overall, the incidence of hypotension was 87.78% (87 out of 98 parturients).

Spearman's rank-order correlations between VCL, AC, and SFH and sensory blockade level at different time points are presented in Table 3. There were significant negative correlations between VCL and spinal blockade levels at "After birth Min. 0" (ρ=-0.21, p=0.04) and "After birth Min. 5" (ρ=-0.26, p=0.01). There were significant positive correlations between AC and spinal blockade levels at "Min. 2" (ρ=0.25, p=0.01) and "Min. 3" (ρ=0.23, p=0.02). SFH correlated positively with spinal blockade levels at each different time point except for "Min. 4".

Spearman's rank-order correlations between VCL, AC, and SFH and nausea/vomiting, hypotension, and ephedrine are presented in Table 4. This analysis yielded no significant correlations. Between parturients with and without nausea/vomiting, the median VCL was not significantly different (with nausea/vomiting=57.5, without=55.5, Wilcoxon p=0.23). The median AC was also not significantly different (with nausea/vomiting=111, without=110, Wilcoxon p=0.88). The median SFH was also not significantly different (with nausea/vomiting=33, without=34, Wilcoxon p=0.49).

Between parturients with and without hypotension, the median VCL was not significantly different (with hypotension=57, without=55, Wilcoxon p=0.26). The median AC was also not significantly different (with hypotension=111, without=110, Wilcoxon p=0.21). The median SFH was also not significantly different (with hypotension=34, without=32, Wilcoxon p=0.35).

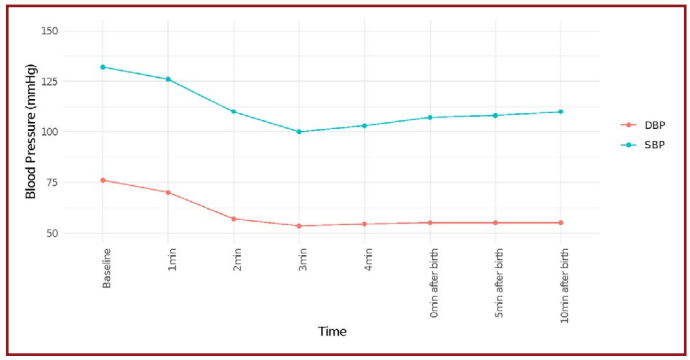

Figure 1. The median systolic blood pressure (SBP, blue) and the median diastolic blood pressure (DBP, blue) of the patients over time.

Table 3. Spearman's rank-order correlations between vertebral column length, abdominal circumference and symphysiofundal height and sensory blockade level at different time points. Statistically significant p-values are indicated with bold italic typeface

	Vertebral Column Length		Abdominal Circumference		Symphysiofundal Height	
Time	**ρ**	**p**	**ρ**	**p**	**ρ**	**p**
Min. 1	-0.1	0.31	0.08	0.41	0.25	0.01
Min. 2	-0.12	0.23	0.25	0.01	0.29	<0.001
Min. 3	-0.13	0.21	0.23	0.02	0.34	<0.001
Min. 4	-0.14	0.18	0.12	0.25	0.17	0.10
After Birth Min. 0	-0.21	0.04	0.18	0.07	0.24	0.02
After Birth Min. 5	-0.26	0.01	0.18	0.08	0.27	0.01
After Birth Min. 10	-0.18	0.08	0.07	0.50	0.27	0.01

Table 4. Spearman's rank-order correlations between vertebral column length, abdominal circumference and symphysiofundal height and Nausea/Vomiting, Hypotension and Ephedrine

	Vertebral Column Length		Abdominal Circumference		Symphysiofundal Height	
	ρ	**p**	**ρ**	**p**	**ρ**	**p**
Nausea/Vomiting	0.12	0.23	-0.02	0.88	-0.07	0.49
Hypotension	0.11	0.26	0.13	0.21	0.09	0.35
Ephedrine	0.14	0.17	0.06	0.56	0.07	0.47

Discussion

Hypotension is common after SA and varies depending on the degree of autonomic block that occurs[13]. Previous studies have shown that the amount of lumbosacral cerebrospinal fluid is the main determinant of the level of block during SA[14]. Increased local anesthetic diffusion and decreased local anesthetic requirement in the pregnant patient depend on many factors. The most important factor in terms of anatomy is increased intra-abdominal pressure[15] and increased cephalic diffusion of the drug due to the narrowing of the subarachnoid space and a decrease in CSF as a result of vertebral artery and lumbar vein expansion due to compression of the inferior vena cava[14,16].

Some previous studies investigated the relationship of SFH and AC with SA level and hypotension[1], and the relationship of AC and VCL with hyperbaric bupivacaine spread in pregnant patients[17]. Considering the relationship between the above-mentioned parameters (SFH, AC, and VCL) and the amount of CSF, all three parameters were investigated together in our study to reach more reliable data on the effect of SA in pregnant women. In this prospective observational study, we found a significant negative correlation between VCL and spinal block level. The study by Hartwell et al.[18] with fixed-dose bupivacaine also supports our study. They showed that there is a correlation between VCL and spinal block level. We found a positive correlation between the AC and the spinal block level at the 2nd-3rd minute, between the SFH and the spinal block level at the 2nd and 3rd minute, and at the 0th, 5th, and 10th minutes after cesarean delivery.

We think that the SFH will be a more sensitive marker for the block level that will develop after SA compared to the other two parameters ($p<0.001$). We could not standardize the fasting times of the patients because we could not intervene in the hospital surgical operation program. While SFH was associated with the level of block, we could not find a relationship with the incidence of hypotension. We think that hypotension in pregnant women is related not only to the level of block but also to the duration of fasting. The minimal fasting period of our patients was 8 hours.

The results of previous non-obstetric studies were found to be positively correlated with AC and spinal extension, and negatively correlated with VCL, similar to our study[12]. In the study of Lee et al.,[7] it was found that higher AC caused the block level to reach higher dermatome levels. Although some previous studies have shown a relationship between SFH and increased IV ephedrine need, we did not find a significant relationship between ephedrine requirement and parameters in our study[19].

Although it is thought that preoperative hydration is not effective in preventing hypotension, we think that the

high rate of hypotension (87%) in our study is related due to the lack of preoperative hydration[20]. In a 2019 study with isobaric bupivacaine without preoperative hydration, it was shown that the height-dependent dose had a lower incidence of hypotension than the fixed dose[21].

Limitations

Since the patients were fasted for at least 8 hours and we could not standardize the fasting duration, the relationship between SFH and block level could not be established with the incidence of hypotension. We were unable to standardize fluid therapy due to the excess of patients and the lack of infusion pumps. Fluid therapy was different for each patient at each hour. If we could have standardized the amount of fluid supplied, we might have found different rates of hypotension and ephedrine administration.

Conclusion

There is a significant negative correlation between VCL and spinal block level. Spinal spread of the anesthetic drug is positively correlated with AC and negatively correlated with VCL. We found that SFH will be a more sensitive marker for block level that will develop after SA compared to the other two parameters.

Ethics Committee Approval: This study was conducted in accordance with the Declaration of Helsinki. The prospective, single-center study was conducted with patients who had undergone CS with SA at the Training and Research Hospital between 01.11.2019 and 01.02.2020. The research protocol was approved by a local Ethics Committee (Reference no: 2019/18) and written consent was obtained from all subjects.

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