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The relationship between abdominal circumference-to-hip ratio and ephedrine requirement in spinal anesthesia for elective cesarean: A prospective observational study

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Abstract

Aim: Maternal hypotension caused by extensive sympathetic blockade is a serious complication of spinal anesthesia during cesarean section. This study planned to determine the relationship between weight, height, BMI, abdominal circumference (AC), hip circumference (HC), and AC-to-hip ratio with the ephedrine consumption in patients who underwent cesarean section with subarachnoid block.

Materials and Methods: The study population comprised 60 women. Prior to spinal anesthesia; patients' demographic characteristics (age, weight, height), abdominal and hip circumferences, basal hemodynamic parameters, and ASA physical status were recorded. To minimize errors, three consecutive measurements were obtained; results were averaged and the AC-to-hip ratio was calculated by dividing the values of the abdominal (cm) and hip circumference (cm). In all patients, spinal anesthesia was done in the sitting position using 2.4 ml 0.5% hyperbaric bupivacaine (12 mg). Persistent hypotension was treated with intravenous ephedrine (5 mg). The number of patients who used ephedrine and the total amount of ephedrine used during surgery were recorded.

Results: Of these 60 participants, 40 (66.6%) patients had hypotension requiring ephedrine administration. There is a positive correlation between ephedrine consumption (mg) and abdominal circumferences ($r=0.280$, $p=0.03$). Also, there is a significant positive correlation between ephedrine consumption (mg) and AC-to-hip ratio ($r=0.608$, $p<0.001$). The correlation coefficient between the ephedrine dose with the AC-to-hip ratio was 56.805, the p-value was <0.001 and AC was 0.211, with a p-value of 0.030 which means the correlation was statistically significant.

Conclusion: Abdominal circumference and AC-to-hip ratio have a significant correlation with ephedrine consumption in patients who underwent cesarean section via subarachnoid block with a given dose of 2.4 ml 0.5% hyperbaric bupivacaine.

Introduction

The spinal anesthesia technique is generally preferred in patients who underwent cesarean section [1]. Because this technique provides minimal anesthetic exposure to the baby. Also, this technique is safe for the mother because it does not involve the risks of maternal aspiration and failed intubation associated with general anesthesia [2]. Maternal hypotension caused by extensive sympathetic blockade is a serious complication following spinal anesthesia during cesarean section. The incidence of hypotension caused by spinal anesthesia ranges from 55 to 100% in the studies [3,4]. Pregnant women have a higher risk for hypotension following spinal anesthesia than that non-pregnant women. Because the gravid uterus leads to aortocaval compression and it reduces the volume of the lumbosacral subarachnoid space. Prolonged hypotension decreases uteroplacental blood flow and increases maternal and fetal morbidity and mortality [5,6]. Therefore, clinicians tried to develop new methods to minimize the potential risks of hypotension in cesarean section surgeries [7-9].

Researchers reported a significant association between the incidence of hypotension associated with spinal anesthesia and the patient's height, duration of crystalloid load,

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speed of injection, spinal additives, baseline systolic blood pressure, and level of blockade [4,10]. Studies investigating the association between the incidence of spinal anesthesia-induced hypotension with maternal BMI, height, and weight revealed inconsistent results. Such as López Hernandez et al. [11] reported that there is no correlation between the risk of hypotension with the waist-to-hip ratio and BMI in patients undergoing cesarean with regional anesthesia. Whereas, Cantürk et al. [12] found a reverse correlation between the height and the spinal block characteristics and they reported no relationship between the age, body mass index, and weight of the patients with the spread of spinal anesthesia. Therefore, the relationship between maternal weight, BMI, and height with the risk of hypotension due to spinal anesthesia is unclear and questionable. This present study aimed to determine the relationship between weight, height, BMI, abdominal circumference (AC), hip circumference (HC), and AC-to-hip ratio with the ephedrine consumption in patients who underwent cesarean section with subarachnoid block.

Materials and Methods

This prospective observational study was performed over eight months from March 2021 to October 2021 at the University of Health Sciences, Erzurum Regional Training and Research Hospital. Before commencing the study, the ethics committee approval was taken from the Ethical Committee of the University of Health Sciences, Erzurum Regional Training and Research Hospital, (Approval Number: 2021/05-100). (ClinicalTrials.gov Identifier: NCT05382624). This study was made according to the principles of the Declaration of Helsinki. Before starting the study, written informed consent was received from all study participants.

The study population is comprised of consecutive women ASA I or II, aged between 18-45 years, with uncomplicated term pregnancies, BMI < 30 kg/m^2, and undergoing elective cesarean surgery with subarachnoid blockage. Patients with complicated pregnancies, coagulation abnormalities, fetal anomalies, and multiple pregnancies were excluded. Patients who required general anesthesia were also excluded. Prior to surgery, all patients received 500 milliliters of Ringer's lactate through a 16-18 gauge intravenous cannula. Standard monitorization including electrocardiography, pulse oximetry, and non-invasive blood pressure was provided. All patients' age, body mass indexes, abdominal and hip circumferences, noninvasive blood pressure, ASA physical status, and heart rate (HR) values were recorded. At the end of expiration, the abdominal circumference was measured at the umbilical level in the standing position. Hip circumference was measured at the widest circumference over the buttocks. All the measurements were carried out by the trained anesthesia technician using standard non-stretch tape with the parturients. To minimize errors, three consecutive measurements were obtained; results were averaged and the AC-to-hip ratio was calculated by dividing the values of the abdominal (cm) and hip circumference (cm). Spinal anesthesia was conducted in the sitting position. Following skin sterilization, Spinal blockage was performed via the midline approach between the L3 and L4 intervertebral spaces using a 27-gauge Quincke-tip spinal needle (Spinocan®, Melsungen, Germany). After establishing a free flow of cerebrospinal fluid through the needle, 2.4 ml 0.5% hyperbaric bupivacaine (12 mg) (Marcaine heavy®, Astra Zeneca, Istanbul, Türkiye) was intrathecally injected. Then, the spinal needle was removed and the patients were rested in a supine position. A pinprick test was used to evaluate the sensory block level and surgery was initiated when the sensory block reached the T6 level. Spinal anesthesia was considered unsuccessful when the sensory block was not consistent within the first 20 minutes following the subarachnoid blockage. In this instance, general anesthesia was performed and these patients were excluded. A Modified Bromage scale was used to detect the motor block level. After delivery of the baby, 20 IU oxytocin (Synpitan Forte®, Deva, Türkiye) in 1000 ml Ringer's lactate solution was given intravenously over 5 hours. Hypotension (a 20% decrease in baseline systolic blood pressure values), was treated by uterine displacement and rapid infusion of fluid. Intravenous ephedrine (5 mg) (Biosel®, Abbott, Türkiye) was given in case of persistent hypotension. A <45 beats/min heart rate was considered bradycardia and treated with intravenous atropine (1 mg) (Atropin®, Biofarma, Türkiye). Intravenous ondansetron (4 mg) (Zofran®, Novartis, Türkiye) was used to treat persistent nausea and vomiting. Following spinal injection, hemodynamic parameters were recorded every 2 minutes for 20 minutes and then every 5 minutes during surgery. The operation time, anesthetic complications, the number of patients requiring ephedrine and atropine, and the total amount of ephedrine used during the operation were recorded. After delivery, neonatal Apgar scores at 1 and 5 minutes, and the weight and height of the neonates were recorded. In the recovery room, pain severity was assessed via the Visual analog scale (VAS, 10 cm=worst pain, 0 cm=no pain,). In the case of VAS > 3, 1 gr paracetamol (Parol®, Atabay, Istanbul, Türkiye) was given to patients intravenously. Anesthesia-related side effects (e.g., nausea, vomiting, and headache), the time requiring supplemental analgesics, and sensory block time (the time to the recovery of T10 dermatome) were recorded by an independent observer postoperatively. Patients were sent to the clinics when the motor block had regressed to the T10 level.

Statistical analysis

The sample size was calculated using Russ Lenth's power and sample size calculation application [13]. The primary outcome was determined as the relationship between AC and ephedrine requirement after spinal anesthesia. Based on the data gained from the study's preliminary results, the correlation coefficient was expected to be 0.37. A power analysis showed that a total of 56 patients would be required with a power of 85% and an alpha of 5%; considering 10% of dropouts, 60 patients were enrolled.

Statistical analysis was done with the SPSS 20 software (SPSS Inc., Chicago, IL, USA). The p-values less than 0.05 was considered statistically significant. Variables were presented as number and percentage values or median (min-max), mean values ± standard deviation (SD). The data distribution was evaluated with The Kolmogorov-Smirnov test. To assess the association between anthropometric

measures (i.e., BMI, AC-to-hip ratio) with the incidence of hypotension and the total amount of ephedrine used, Pearson correlation analysis was performed and scatterplots were used to model relationships between parameters. The correlations between the total amount of ephedrine used and the AC, HC, and AC-to-hip ratio were evaluated. The correlation between the total amount of ephedrine used and the fetal weight was also investigated. The regression equations were obtained by using the linear regression method and the obtained coefficients (r^2) were compared.

Results

During the study period, 100 patients were eligible, 70 patients had inclusion criteria, and 10 patients declined to participate. Data collection was completed on 60 patients (Figure 1). Data preprocessing was performed and z-score was calculated. There were no outlier values, and data from 60 patients were analyzed. Spinal anesthesia was successful in all participants. All participants had a modified Bromage scale of 3 within 15 minutes after the spinal injection. No participant required additional analgesia during surgery. The participants' demographic data, anthropometric measurements, and anesthetic characteristics were presented in Table 1. The mean gestational age was 38.2 weeks. The mean age was 28 years. The mean abdominal and hip circumferences at recruitment were 80.12±10.3 cm and 100.65±9.1 cm, respectively. The mean AC-to-hip ratio was 0.79±0.61. The women had a mean BMI of 25.57±4.48 kg/m^2. Forty patients

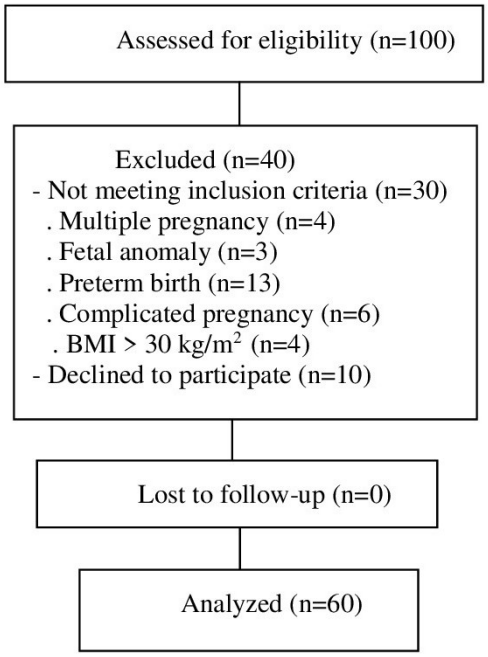

Figure 1. Consort flow diagram of the study.

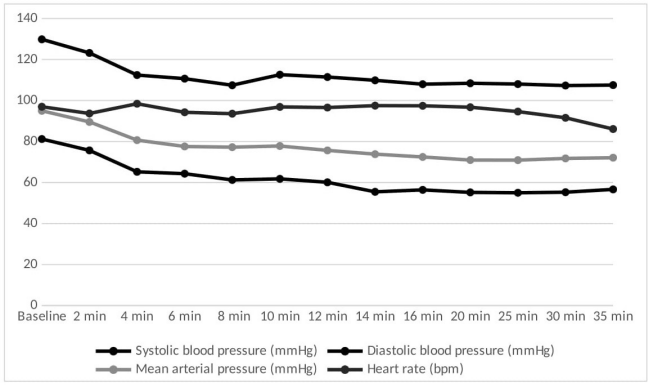

Figure 2. Changes in the patient's systolic, diastolic, mean arterial blood pressure, and heart rate values during the surgery.

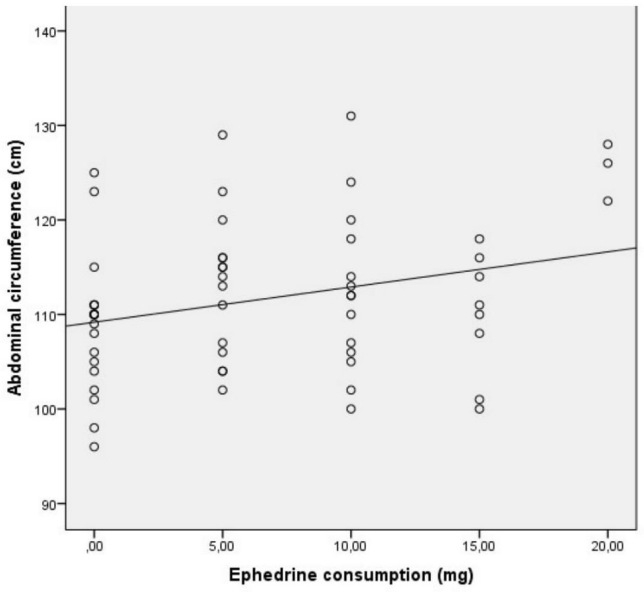

Figure 3. Correlation between Ephedrine consumption and abdominal circumference.

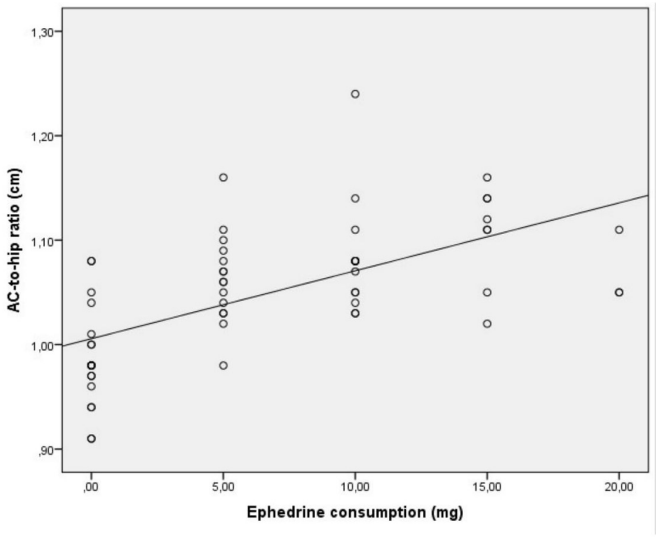

Figure 4. Correlation between Ephedrine consumption and AC-to-hip ratio. AC: Abdominal circumference.

Table 1. Demographic data, anthropometric measurements and anesthetic characteristics of the participants.

Variables (n=60)	
Age (years)	29.85 ± 5.52
Height (cm)	163.73 ± 6.19
Weight (kg)	75.00 ± 7.05
BMI (kg/m^2)	27.89 ± 1.60
ASA I/II (n)	30/30
Gravidity	2.83 ± 1.23
Gestational week	38.28 ± 0.86
Ephedrine requirement n, (%)	40, (66.7)
Ephedrine consumption (mg)	6.58 ± 6.07
Operation time (min)	36.58 ± 8.25
Baseline mean blood pressure (mmHg)	94.98 ± 12.51
Baseline heart rate (bpm)	96.97 ± 16.30
Total fluid volume (ml)	1281.67 ± 286.70
Abdominal circumference (cm)	111.63 ± 8.07
Hip circumference (cm)	106.57 ± 8.62
AC-to-hip ratio (cm)	1.04 ± 0.64
Baby weight (mg)	3013.75 ± 401.59
Baby length (cm)	48.93 ± 1.31
The time to T6 level (minute)	3.92 ± 1.36
The time of regression to T10 (min)	216.00 ± 51.00

BMI: body mass index, ASA: American Society of Anesthesiologists AC: Abdominal circumference.

Table 2. Multiple logistic regression analysis of parameters associated with ephedrine dose following spinal anesthesia in parturients.

	r^2	p	Correlation coefficient	Intercept
AC	0.078	0.030*	0.211	-16.948
AC-to-hip ratio	0.369	0.000*	56.805	-52.977
HC	0.040	0.125	-0.141	21.617
Fetal weight	0.007	0.523	0.001	2.753

r^2: Coefficient of determination, *p<0.05. AC: Abdominal circumference, HC: Hip circumference.

(66.6%) had hypotension requiring ephedrine administration. Changes in the hemodynamic parameters of the patients during the surgery are presented in Figure 2. There is a significant positive correlation between ephedrine consumption (mg) and abdominal circumferences (r=0.280, p=0.03) (Figure 3). A significant positive correlation was found between ephedrine consumption (mg) and AC-to-hip ratio (r=0.608, p<0.001) (Figure 4). APGAR scores were more than seven at 5 minutes in all neonates. The correlation coefficient between the ephedrine dose with the AC-to-hip ratio was 56.805, the p value was <0.001 and AC was 0.211, with a p value of 0.030 which means the correlation was statistically significant (Table 2). In the postoperative period, the neurological complication was not present in any patients.

Discussion

This present study reported a significant relationship between the AC and AC-to-hip ratio with the ephedrine consumption in patients who underwent cesarean section with subarachnoid block.

The spinal anesthesia technique is usually used in cesarean section operations. But, hypotension is the most common and feared complication following a spinal block. Serious maternal hypotension may lead to detrimental maternal and fetal effects, such as apnea, cardiovascular collapse, and fetal acidosis [14]. A study done by Shitemaw et al. [4] showed that the incidence of spinal-induced hypotension for cesarean section was 64%. In Chekol et al.'s study [10], the incidence of hypotension following subarachnoid block in the emergency cesarean section was reported as 56.8%. In this present study, the incidence of spinal-induced hypotension requiring ephedrine was found to be 66.6%.

Researchers have tried different methods to prevent spinal anesthesia-induced hypotension during cesarean section [7-9]. Also, researchers investigated the risk factors of hypotension after spinal anesthesia in patients undergoing cesarean section. The possible risk factors for hypotension caused by spinal anesthesia include the baseline blood pressure, body mass index, spinal additives, sensory block height, the duration between spinal induction and fetal delivery, crystalloid load duration, and injection speed [10,15,16]. In this current study, the age, weight, height, HC, and body mass index of the patients did not correlate with ephedrine consumption. But, a significant correlation was achieved between ephedrine consumption with the abdominal circumferences and the AC-to-hip ratio. These results are consistent with the findings of Thomard et al. [17]. They reported that the incidence of hypotension following spinal anesthesia was similar among pregnant women with larger and smaller abdominal circumferences. However, patients with a larger abdominal circumference had a greater decrease in mean arterial pressure from baseline than patients with a smaller abdominal circumference. In another study, Baysal et al. [18] observed a positive correlation between the prevalence of hypotension and AC, BMI, and waist/hip ratio. But, we observed no correlation between ephedrine consumption and BMI in this present study. The reason for these different results may be due to the difference in BMI of the participants in the studies. While the average BMI in their study was 30.1 ± 2.1, the average BMI in the current study was 27.89 ± 1.60.

Studies investigating factors that affect the level of anesthesia, such as height, BMI, and weight had conflicting results. Such as, Kim et al. [19] reported a positive correlation between BMI and the level of spinal anesthesia at 1,5,10, and 15 minutes after the spinal anesthetic injection. They also reported higher BMI, weight, and supine AC/height ratio in patients with hypotension compared to the parturients without hypotension. Fakhari et al. [20] observed a similar hypotension rate in the normal and overweight parturients in another study. But, they reported higher ephedrine requirements in the overweight group compared to the normal group. Contrary to these results, Ozkan Seyhan et al. [21] observed no association between intra-abdominal pressure, block characteristics, and ephedrine requirements. Also, they found no correlation between sensory block level and the patient's age, height, and newborn weight. Chung et al. [22]

reported a significant correlation between the symphysis-fundal height with the amount of ephedrine administrated for hypotension during the spinal anesthesia for cesarean section. But they reported no correlation between the symphysis-fundal height and maximum sensory blockade. In another study, a significant correlation between the spread of anesthesia and abdominal circumference, hip width, shoulder width, and vertebral column length was found by Bhiwal et al. [23]. In this present study, there was a positive correlation between the ephedrine consumption with the AC and AC-to-hip ratio in parturients choosing elective cesarean section with spinal anesthesia. However, this association was stronger between AC-to-hip ratio and ephedrine consumption than AC and ephedrine consumption. A possible mechanism for more ephedrine consumption in pregnant women with higher AC and AC-to-hip ratio may be associated with the degree of aortocaval compression. We speculated that aortocaval compression increases with increasing AC but increasing HC may decrease aortocaval compression. It was shown years ago that aortocaval compression syndrome occurs in those who are pregnant over 20 weeks when the patient was placed in the supine position due to posterior displacement of the uterus onto the lordotic spine [24]. The compression of the uterus on the inferior vena cava and aorta leads to a decrease in blood flow backing from the lower extremities to the maternal heart and central circulation. Thus, hypotension occurs, blood flow to the placenta decreases and it may result in serious mortality and morbidity in both mother and fetus. We thought that wide hip circumference may be a factor in reducing intraabdominal pressure and aortocaval compression.

The results of this current study are very important in terms of predicting hypotension in surgical interventions in clinics. The AC-to-hip ratio may be used to predict the patient who may develop severe hypotension and to adjust the spinal anesthetic dose in patients undergoing cesarean surgery via spinal blockage. Studies with larger numbers of patients are needed to support our results.

Conclusion

This study demonstrated that pregnant women with increased abdominal circumference and AC-to-hip ratio are at increased risk of hypotension requiring ephedrine during cesarean section, despite normal BMI. Measurements obtained from the patient's abdominal circumference and AC-to-hip ratio may help the anesthesiologists to predict the risk of hypotension caused by spinal anesthesia and decide the amount of intrathecal drug for patients.

Ethical approval

Ethics committee approval was obtained from the Health Sciences University Erzurum Regional Training and Research Hospital Ethics Committee for the study (Approval No: 2021/05-100).

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