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Effect of Spinal Anesthesia on Blood Pressure During Cesarean Section in Private Indonesian Hospital

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Abstract

The 2018 Indonesian Basic Health Research Data presented an increase in the number of cesarean sections from the previous years, with an increase of 17.6%. In Anugerah Bunda Khatulistiwa Hospital, a private hospital in Pontianak, Indonesia, cesarean section was performed in 689 and 641 cases in 2021 and 2022, respectively. This trend highlights the importance of understanding the anesthesia methods used during this procedure, including spinal anesthesia. Despite the common use of this type of anesthesia, spinal anesthesia an cause changes in the maternal blood pressure. This study aimed to determine the effect of spinal anesthesia on patients' blood pressure during cesarean section. This retrospective observational analytical study was conducted at the Anugerah Bunda Khatulistiwa Hospital Pontianak, Indonesia, from May 2023 to January 2024. Medical records were selected from 246 patients using consecutive sampling method. Most patients aged between 27 and 29 years, with 207 were in the productive age group (20–35 years). The mean weight was 72.77 kg (±10.43) and the mean height was 156.70 cm (±5.85). The majority were overweight based on the BMI score (n=111), and the spinal anesthesia dose used was 15 mg bupivacaine. The Friendman test on the systolic and diastolic blood pressures before and after anesthesia to determine the effect of spinal anesthesia on blood pressure. The results showed a p-value of 0.000 ($p<0.05$) for both systolic and diastolic observations. This indicates that spinal anesthesia influences the blood pressure of patients undergoing cesarean sections under spinal anesthesia.

Keywords: Blood pressure, cesarean section, spinal anesthesia

Introduction

Anesthesia is a loss of the ability to feel pain caused by medication or other medical interventions.[1] There are 3 types of anesthesia: general, regional, and local.[2] In cesarean section, the anesthesia techniques involve either regional or general anesthesia, which has its advantages and disadvantages. The choice depends on the surgery indications, the degree of urgency (urgent circumstances), the mother's conditions, and their wishes.[3] A study conducted at Dr. Kariadi Hospital in Semarang, Indonesia, reported that 85.6% of cesarean sections were performed under regional anesthesia, while only 14.4% used general anesthesia.[4] These figures indicate the increasing trend of regional anesthesia as the primary choice for cesarean sections.[5]

Regional anesthesia, particularly spinal anesthesia, is widely recommended for cesarean sections. This preference is largely due to the risks associated with general anesthesia, such as endotracheal intubation failure and aspiration, as well as its higher potential for maternal morbidity and mortality.[6] As a result, international obstetric anesthesia protocols generally recommend spinal anesthesia for

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cesarean sections in general. This preference is particularly important because fetuses that have experienced asphyxia in the womb will be further affected by the effects of general anesthesia.[7] In developing countries with limited natural resources, spinal anesthesia is the primary choice because it is affordable, relatively safer, and easier to do.[5]

In Indonesia, the rate of cesarean deliveries has increased across both public and private healthcare facilities. Data from the 2013 Basic Health Research (Riskesdas) reported a cesarean section prevalence of 9.8%, which rose to 17.6% by 2018. More recently, a study at Dr. Soedarso Pontianak Hospital in 2021 revealed that there were 527 normal deliveries (53.5%) and 486 cesarean deliveries (46.5%).[8] Similarly, cesarean delivery rates at the Anugerah Bunda Khatulistiwa Hospital in Pontianak continued to increase, reaching 689 and 641 cases in 2021 and 2022, respectively.

One of the risks associated with cesarean sections is a change in the mother's blood pressure. This change is usually a side effect of the use of spinal anesthesia during the cesarean section surgery, both in a sitting and inclined position. Therefore, continuous monitoring for blood pressure, pulse, and oxygen saturation is necessary during this procedure. In spinal anesthesia, rapid changes in blood pressure should be avoided because they can interfere with placental perfusion unless preoperative therapy has been adequately prepared through fluids and vasopressors.[9]

Given the rising prevalence of cesarean sections and the associated risks, this study focuses on the effect of spinal anesthesia on blood pressure. The novelty of this research lies in the extended monitoring periods (pre, 10 minutes, 20 minutes, and 30 minutes), which provide a more comprehensive understanding of blood pressure changes in cesarean section patients..

Methods

To achieve the research objectives, an observational analytical study with a retrospective approach was employed. The study was conducted at Anugerah Bunda Khatulistiwa Hospital, Pontianak, Indonesia, from May 2023 to January 2024. The sampling technique used was consecutive sampling, in which every patient who met the inclusion criteria was included until the required sample size was reached. The sample size was calculated using the Slovin formula, resulting in a total of 246 respondents. Samples were excluded if there were absolute contraindications (patient rejection, infection at the injection site, increased intracranial pressure, severe hypovolemia, and coagulopathy or hemostasis disorders), relative contraindications (sepsis or bacteriosis, uncooperative patients, neurological deficits, spinal deformities, and stenosis heart disease), patients with a history of disease (uncontrolled diabetes mellitus, uncontrolled hypertension, and stroke), (patients epilepsy, arrhythmias, hypotension, and congenital heart disease), patients with incomplete medical record data, twins, and emergency patients.

The study utilized secondary data obtained from the patients' anesthesia records at Anugerah Bunda Khatulistiwa Hospital. Data processing and analysis were conducted using the SPSS software. The Sturges method was applied for data grouping. Univariate analysis was conducted to describe the minimum, maximum, mean, standard deviation, frequency, and percentage of the variables. The variables analyzed included patient characteristics such as anesthetic dose, body weight, height, body mass index (BMI), age, and blood pressure. To assess the effect of spinal anesthesia on blood pressure, a bivariate analysis using the Friedman test was performed. After that, the normality test was employed using the kolmogorov-smirnov test and the results showed that the data was not distributed normally. This research has received approval from the Research Ethics Committee of the Faculty of Medicine, Tanjungpura University, through a Certificate of Passing the Ethical Assessment (Ethical-Clearance) No: 6285/UN22.9/PG/2023.

Results

This section presents the demographic and clinical characteristics of the participants, along with the findings related to spinal anesthesia and blood pressure changes during cesarean section. *T*his study count dose spinal anesthesia with hyperbaric bupivacaine 0.5% respect to patient height The majority of participants (33.33%) had a height of 156–160 cm and received a 15 mg dose. Only 0.41% of patients were height >170 cm with dose 18 mg bupivacaine. Patients height 151–155 cm with dose 14 mg bupivacaine accounted for 29.67%. Patients height 161–165 cm with dose 16 mg bupivacaine made up

Table 1 Dose of Spinal Anesthesia (0.5% Hyperbaric Bupivacaine) According to Patient Height

Patient height (cm)	Dose (mg)	n
140–145	12	9
146–150	13	24
151–155	14	73
156–160	15	82
161–165	16	43
166–170	17	14
>170	18	1

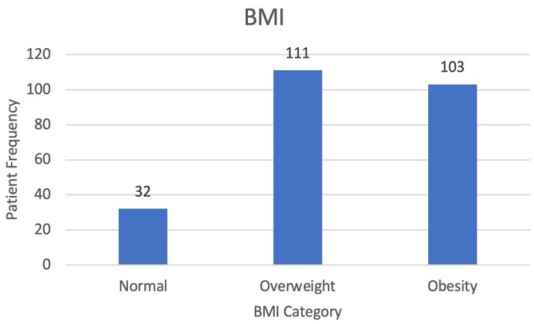

Figure 1 Frequency Distribution of Patients by BMI Category

Table 2 Patient Characteristics Based on Body Weight and Height (n=246)

Variable	n	Minimum	Maximum	Mean	Standard Deviation
Weight (kg)	246	50.50	109	72.77	10.43
Height (cm)	246	140	171	156.70	5.85

17.48%. The height 146-150 cm with dose 13 mg bupivacaine represented 9.76%, followed by 5.69% in the height 166-170 cm with dose 17 mg bupivacaine. Additionaly, 3.66% of the sample was in the height 140-145 cm with dose 12 mg bupivacaine.

Table 2 shows characteristic distribution data on the weight and height of patients in this study. The mean score of the patient's body weight was 72.77 kg. Meanwhile, the mean height of the patients was 156.70 cm.

In addition to these physical characteristics, the research results also provide data on the patients' BMI categories. For example, the largest portion of the sample fell into the overweight category, comprising 45.1% of the participants. This was followed by samples with an obesity category with 41.9%. After that 13.0% of the participants had a normal BMI. There was no sample in the underweight category. Obesity in pregnancy is defined as a BMI of 30 kg/m^2 or more at the first antenatal.

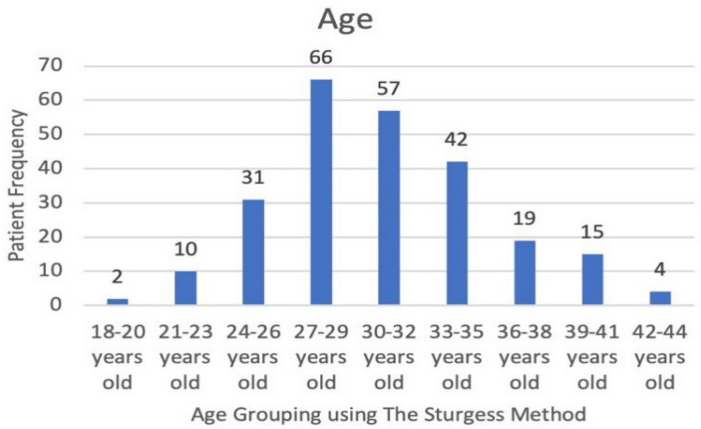

Figure 2 Age Frequency Distribution of Cesarean Section Patients

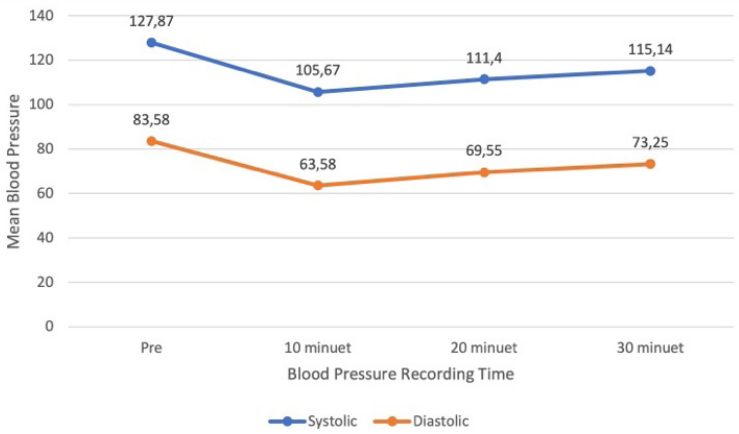

Figure 3 Image of Mean Systolic Blood Pressure And Diastolic Before Administering Spinal Anesthesia, 10th, 20th, And 30th Minutes After the Administration of Spinal Anesthesia

Table 3 Kolmogorov Smirnov Test Result

Variable	Time Points	p-value	Distribution
Systolic	Pre	0.000	Abnormal
	10 minutes	0.000	Abnormal
	20 minutes	0.000	Abnormal
	30 minutes	0.000	Abnormal
Diastolic	Pre	0.000	Abnormal
	10 minutes	0.000	Abnormal
	20 minutes	0.000	Abnormal
	30 minutes	0.000	Abnormal

Furthermore, the study also examined the age distribution of cesarean section patients. Using the Sturgess method, the results showed that most samples were within the 27-29 age range, representing 26.8% of the total sample. Only 0.8% of patients were between 18-20 years old, while 4.1% were in the 21-23 age group. Patients aged 24-26 years made up 12.6%, and those aged 30-32 years accounted for 23.2%. The 33-35 age group represented 17.1%, followed by 7.7% in the 36-38 age range. Additionally, 6.1% of the sample was aged 39-41 years, and 1.6% were between 42-44 years old. The youngest patient was 18 years old, and the oldest was 44 years old. A total of 207 patients, or 84.15% of the samples, were in the productive age range of 20-35 years, while 39 samples (15.85%) fell outside this range.

Following the analysis of patient characteristics, the study also evaluated changes in blood pressure over time. Figure 3 shows the mean blood pressure. There were significant differences in systolic and diastolic blood pressure before and after spinal anesthesia, at the 10th minutes, 20th minutes, and 30th minutes. To assess the distribution of the data, a normality

Table 4 Friedman Test Results for Systolic and Diastolic Blood Pressure

Variable	Time Points	p-value
Systolic	Pre, 10, 20, 30 min	0.000
Diastolic	Pre, 10, 20, 30 min	

test was conducted. The Kolmogorov–Smirnov normality test results for both systolic and diastolic blood pressure variables at all four time points yielded p-values less than 0.05, indicating non-normal data distribution (Table 3). As a result, non-parametric testing was performed.
The Friedman test was used to analyze the changes in blood pressure over the four time points. The results showed a statistically significant difference in both systolic and diastolic pressure after spinal anesthesia, with p-values of 0.000 for each (Table 4). These findings confirm that spinal anesthesia has a measurable and significant effect on maternal blood pressure during cesarean section procedures.

Discussion

Based on Table 1, the administration of spinal anesthesia using 0.5% hyperbaric bupivacaine was adjusted according to patient height. Taller patients required higher doses to achieve the same dermatome level. This is because an increased height typically corresponds to a larger cerebrospinal fluid volume, necessitating a greater anesthetic dose. However, higher doses are associated with a greater risk of hypotension. Bupivacaine works by blocking nerve fibers, including sympathetic nerve fibers which function to regulate vascular tone. As the dose of bupivacaine increases, sympathetic nerve blockade also increases, leading to vasodilation of blood vessels. This vasodilation results in a decrease in systemic vascular resistance and in turn lowers blood pressure. This finding is in line with research carried out by Huang in Shenzen Hospital. The results indicated that the quality of anesthesia and incidence of maternal hypotension are related to block level, which depends on the dose of local anesthetic injected into the subarachnoid space. The volume of the subarachnoid space is decreased in parturients due to high abdominal pressure. When using a low dose of local anesthetic, the block level of the local anesthetic may also depend on the height of the parturient.[10]

The results of the study showed that the average patient weight was 72.77 kg (72.77 kg±10.43). These findings highlight the importance of monitoring maternal weight during pregnancy. Body weight significantly influences the health conditions of both the mother and the baby. Obese women have a higher potential to give birth to obese children, and fetal and neonatal complications are more prevalent in these cases. One such complication is macrosomia., which is defined as a condition in infancy born with a body weight of over 4 kg. Macrosomia is often an indication for a cesarean section. This finding is in line with research carried out by Ekwendi on pregnant women with obesity. The results indicated that higher BMI, weight, and age in pregnant woman are associated with the increased risk of cesarean deliver compared to vaginal.[11]

The second finding of this research was the average height of the patients, which was 156.70 cm (156.70 cm±5.85). This finding was similar to that performed by Alfarisi during a cesarean section at Dr. Mohammad Hosein Palembang in 2020. The research obtained that 282 patients had heights of more than 145 cm, representing 96.9% of the sample.[12] Interestingly, this was different from research conducted by Strong in singleton births in India. This research showed that the shorter maternal height (<145 cm) was associated with a greater risk of cesarean section.[13] Shorter individuals tend to have a narrow pelvis, which can complicate childbirth. Additionally, shorter maternal stature has been associated with pregnancy outcomes, such as babies born with low birth weight and lower APGAR scores (Appearance, Pulse, Grimace, Activity, and Respiration). However, cesarean section indications are not only determined by height as other indications, such as persistent fetal distress, cord prolapse center, and failed vacuum/forceps also play a significant role.[14]

The next result provided by the research was that the largest BMI category was overweight, with 111 people (45.1%) falling into this category. In fact, excessive weight in pregnant women can have various consequences and risks for both the mother and fetus. In overweight pregnant women, obesity can increase the risk of developing gestational diabetes, hypertension, preeclampsia, macrosomia, and weight retention after delivery. It also increases the potential for a cesarean section procedure. The results of this research are supported by those conducted by Liu et al. in 2022. This research showed that pregnant women with an obese BMI had a risk factor for hypotension intraoperative cesarean section. An overweight woman is more susceptible to hypotension due to increased maternal BMI; thus, cerebrospinal fluid gradually decreases. In obese patients, Epidural blood vessels are more enlarged, and a large number of fat deposits cause epidural stenosis. This can cause fetal umbilical artery blood flow to become abnormal, putting the fetus in a state of chronic hypoxia and

ultimately leading to a poor perinatal prognosis. Clinically, pre-infusion fluid expansion is often used to prevent hypotension. At the same time, the supine position is 30 ° left, used to move the uterus to the left, and vasoconstrictor drugs are given to avoid hypotension.[15]

Regarding age groups, this research reported that cesarean section patients were typically between 27 and 29 years, with 66 people (26.8%). The youngest age given this procedure was 18 years old, while the oldest was 44 years old. In addition, most of the samples 84.15% were at a productive age of 20–35 years. This finding confirmed the research by Alfarisi in 2020. The research revealed that 204 (70.1%) mothers who gave birth with cesarean section were within 20–35 years.[12] However, 15.85% of the samples in this study were outside the productive age, with mothers either younger than 20 years or older than 35 years. Both age groups carry additional risks during pregnancy. At a younger age, a woman's reproductive system may not be fully developed, and their psychological growth is immature. On the other hand, women of advanced maternal age are vulnerable to various pregnancy complications, such as diabetes, gestational, and preeclampsia.[12]

The effects of spinal anesthesia on blood pressure during cesarean section procedures are an important aspect to consider in managing patient safety. The study's results of this study showed significant differences in both systolic and diastolic blood pressure before and after the administration of spinal anesthesia at the 10^{th}, 20^{th}, and 30^{th} minutes. These differences occur because of arterial vasodilation, which results in a decrease in systemic resistance. As a result, there is a decrease in cardiac output accompanied by a decrease in heart rate. This finding was in line with Ferre et al. in 2020, which obtained results of hypotension that occurred during anesthesia for cesarean section surgery. This is the most common side effect caused by spinal anesthesia that requires precautions and special treatment. Spinal anesthesia causes hypotension through several pathophysiological mechanisms, with the most significant being the rapid onset of sympatholytic due to the increased sensitivity of nerve fibers to spinal anesthesia.[16]

In line with previous findings on anesthesia effects, the degree of blockage of the sympathetic chain is related to the rate of spinal anesthesia spread to the cranial region, which is often difficult to predict and usually reaches some dermatomes above the level of sensory block. The increased sensitivity to spinal anesthesia, combined with compression of the aortic cavity by the pregnant uterus, is the main reason for the higher incidence and rate of hypotension in pregnant women compared to non-pregnant patients. Furthermore, pregnant women showed increased levels of sympathetic activity compared to parasympathetic activity. Therefore, sympatholysis causes higher levels of peripheral vasodilation and activity dominance parasympathetic, consequently reducing venous return and preload heart. This decrease in preload contributes to a reduction in cardiac output (CO), which causes systemic hypotension.[16]

Understanding the impact of the sympathetic block is crucial as a higher sympathetic block proportionally reduces the occurrence of compensatory mechanisms through baroreceptors and increases the risk of cardioinhibitory reflexes such as Bezold Jarisch Reflex (BJR), which can ultimately cause an attack heart to death. BJR is a cardiovascular and neurological process that causes bradycardia. Additionally, acute hypotension reduces cerebral perfusion, causing ischemia in the temporary brainstem. To mitigate this, oxygen inhalation can help prevent cerebral hypoxia. Furthermore, neonates born to mothers with hypotension due to spinal anesthesia were significantly more acidotic.[16]

To assess the distribution of the data, a normality test was conducted using the kolmogorov-smirnov test. The test revealed that the data was not normally distributed. This deviation is attributed to the presence of a large interval difference.[17] For systolic blood pressure values, the lowest recorded value was 80 mmHg, and the highest value was 150 mmHg at the 30^{th} minute. Similarly, the lowest value for diastolic blood pressure was 40 mmHg, with the highest value at 105 mmHg at the 30^{th} minute.

The findings of this research highlight the significant impact of spinal anesthesia on both systolic and diastolic blood pressure in patients undergoing cesarean section, as indicated by a value of $p<0.05$ from the Friedman test. While spinal anesthesia can be safely administered to cesarean section patients, it may lead to several complications. One of them is a decline in blood pressure. This reduction in blood can affect the health condition of the mother and baby. If this lasts a long time and is unaddressed properly, it can cause tissue hypoxia, decreased consciousness, and even death.[2]

Following the earlier discussion on spinal anesthesia's impact on blood pressure, this study showed significant changes in blood

pressure after the procedure. The results revealed differences in systolic and diastolic blood pressure before and after administering spinal anesthesia, especially at the 10th minute. These changes occur due to the vasodilation of the veins, resulting in the accumulation of blood in the viscera and lower extremities. As a result, there is less resistance in the blood vessels, leading to a decrease in cardiac output and heart rate.[2]

Furthermore, at the 20th minutes, differences in systolic and diastolic blood pressure were noted, indicating that the effect of the sympathetic block from spinal anesthesia is still strong for cesarean section patients during this phase. By the 30th minute, the differences between systolic and diastolic blood pressure began to approach pre-anesthesia (baseline) values. Researchers need to observe up to 30 minutes after anesthesia to ensure patient safety and manage potential hemodynamic complication.

The results of this research were supported by the existing research, for instance, carried out by Elfeil et al. in 2021. The research showed that changing position from a supine to a side position is a significant predictor of blood pressure. However, this is just mildly associated with intraoperative hypotension. Higher sympathetic activity before neuraxial anesthesia is associated with an increased risk of post-spinal hypotension. Meanwhile, large hemodynamic variability after changes in position from a supine to a sideways position indicates sympathetic activity higher in blood vessels. The higher the autonomic activity, the higher the risk of hypotension after spinal anesthesia.[18]

Previous research results also support the current results, as exemplified by Chauhan et al. in 2022. The research revealed that prophylactic use of ephedrine and phenylephrine are both effective in preventing maternal hypotension during cesarean section surgery under soinal anesthesia. Particularly, phenylephrine is superior to ephedrine in treating hypotension, as evidenced by a higher umbilical blood pH value. Ephedrine is a mixed adrenoceptor and agonist. It maintains blood pressure primarily by activating adrenoreceptors and increases cardiac output and heart rate. However, ephedrine can cross the placental barrier and cause an increase in the fetal heart rate and increase fetal catecholamine levels, which may mediate elevated levels of fetal catecholamines. It also mediates increased consumption of oxygen and increased concentrations of glucose and lactic acid. Phenylephrine is a pure adrenergic agonist that can antagonize a decrease in systemic vascular resistance caused by spinal anesthesia.[19]

A limitation of this study is the reliance on handwritten medical records, which slowed the data retrieval and recapitulation process. Despite this, the study concludes that spinal anesthesia influences blood pressure in patients undergoing cesarean sections.

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