



The Effectiveness of Hyperbaric Bupivacaine Administration on Hemodynamic Changes in Sectio Caesarea Patients

journal home page: <https://goicare.web.id/index.php/JNJ>

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CROSSECTIONAL STUDY

ARTICLE HISTORY

Received: July 30, 2024

Revised: August 10, 2024

Accepted: August 22, 2024

DOI: 10.61716/jnj.v2i3.56

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Abstract

Background: Sectio Caesarea (SC) is a critical surgical intervention used to manage abnormal labor, addressing potential health risks for both mother and infant. Spinal anesthesia, frequently administered using hyperbaric bupivacaine, plays a crucial role in the procedure. **Purpose:** This study aimed to evaluate the impact of hyperbaric bupivacaine on hemodynamic parameters in SC patients at Kardinah Hospital, Tegal City. **Methods:** A pre-experimental design with a One-Group Pretest-Posttest approach was employed. The study utilized purposive sampling to include 67 SC patients, aged 18-40 years with a BMI >18.5. Hyperbaric bupivacaine was administered as part of the anesthesia protocol. Hemodynamic parameters, including systolic and diastolic blood pressure, pulse rate, mean arterial pressure (MAP), SpO₂, and respiratory rate (RR), were measured before and after administration of the anesthetic. **Results:** Analysis revealed a statistically significant effect of hyperbaric bupivacaine on systolic and diastolic blood pressure, pulse rate, and MAP ($p = 0.00$). In contrast, no significant effects were observed on SpO₂ ($p = 0.34$) or RR ($p = 0.15$). **Conclusions:** The administration of hyperbaric bupivacaine in SC patients resulted in significant hemodynamic changes, particularly affecting blood pressure, pulse rate, and MAP. However, it did not significantly alter SpO₂ or RR. These findings underscore the importance of monitoring hemodynamic parameters during spinal anesthesia to ensure patient safety and optimal management during cesarean sections

Keywords: hyperbaric bupivacaine, spinal anesthesia, hemodynamics, blood pressure

Introduction

Section caesarea (SC) is a method of delivering a fetus by making an incision in the abdominal wall and uterine wall. The uterus must be intact and the fetus must weigh more than 500 grams. SC is performed with certain medical indications such as placenta previa, abnormal fetal location, and other situations that can endanger the mother and fetus.[1] According to the World Health Organization (WHO), the rate of sectio caesarea (SC) surgery worldwide has increased from around 7% in 1990 to 21%

in 2021, SC surgery will likely continue to increase over the next decade, by 2030 it is estimated that nearly 29% of all births will be performed using SC surgery. Basic health research in 2012 stated that the rate of SC surgery in Indonesia continues to increase. The incidence of cesarean section in Indonesia reached 15.3% based on a sample survey conducted on 20,591 mothers who gave birth in the last 5 years in 33 provinces.

The method of sectio caesarea performed during childbirth has potential risks that can threaten the health of the

mother and baby, especially due to anesthesia. The choice of anesthesia in patients undergoing SC surgery is determined by various factors, including indications for surgery, urgency, patient and obstetrician preferences, and anesthesiologist skills.[2] Spinal anesthesia technique in SC patients has many advantages, such as drugs that work quickly, inhibit sensation, and allow faster movement compared to other anesthetics. The risk of spinal anesthesia toxicity is also very small.[3] Spinal anesthesia is a form of regional anesthesia that is often used in lower extremity surgery, including in obstetric patients. The most common anesthetic drugs used in obstetric surgery are bupivacaine.

Bupivacaine is a local anesthetic drug belonging to the amino amide group with a long duration of action.[4] Differences in bupivacaine concentration are thought to affect hemodynamic parameters and block characteristics. These differences in characteristics can affect the degree, onset and duration of sensory and motor blockade. Ideal anesthetic management is influenced by hemodynamic stability, where the use of anesthetic drugs is a factor that can affect this stability. Some anesthetic drugs work by inhibiting sympathetic activity, thereby reducing cardiac contractions which can lead to peripheral vasodilation and hypotension.[5]

The side effects of bupivacaine not only cause peripheral vasodilation and hypotension, but can also cause bradycardia, nausea, and vomiting.[6] Hemodynamic complications in patients given spinal anesthesia, if not handled properly, can cause a decrease in consciousness accompanied by a decrease in blood pressure which is getting heavier, and a decrease in cardiac output.[7] This results in reduced blood flow to all tissues, resulting in hypoxia. The hypoxic state will cause a decrease in oxygen delivery to the

tissues, which can result in damage to vital tissues and organs, and increase the risk of serious complications for mothers and babies.[8]

Material and Methods

This research method uses quantitative methods with Pre-experiment design with One-Group Pretest-Posttest Desing sampling technique using purposive sampling of 67 respondents, the intervention used is hyperbaric bupivacaine given to SC patients with age criteria 18-40 years and BMI > 18.5. The variable in this study is a single variable, namely, the effect of hyperbaric bupivacaine administration on hemodynamics in Sectio Caesarea patients at Kardinah Hospital, Tegal City in March-May. The instruments in this study were bedside monitor and observation sheet. Bedside monitor was used to measure respondents' hemodynamics and observation sheet was used to record name, age, BMI, and the results of hemodynamic changes. Then the data were tested using univariate test (frequency test) and bivariate test (Wilcoxon test). This study used observational techniques, the title in this study was "The Effect of Hyperbaric Bupivacaine Administration on Hemodynamic Changes in Sectio Caesarea Patients at Rsud Kardinah Kota Tegal", the process of data collection and analysis was carried out by documenting all steps in detail. Each result of the observation data was carefully recorded.

Triangulation was done by collecting data from various sources such as direct observation during the procedure, and collecting data from medical records. This study has received approval from the Harapan Bangsa University Research Ethics Committee with approval number 123/KEPUHB/2024.

Result

Table 1. Distribution of respondent characteristics based on age and BMI in

respondents who used 0.5% hyperbaric bupivacaine anesthetic drug. (n=67)

Variabel	Frequency	Percent
Age	18-25	21
	26-40	46
		67
IMT	18,5-22,9	2
	23-24,9	9
	25-29,0	45
	>30	11
		67
		100.0

Table 1. This study shows that the most dominant age that appears is 26-45 years with an age range of 18-45. In BMI, the most dominant respondent is 25-29.0.

Table 2. Distribution of respondents' systolic blood pressure before and after administration of 0.5% hyperbaric bupivacaine spinal anesthesia drug at the 10th minute

Variabel	Negative Ranks	N	Mean Rank	Sum of Ranks	z	Sig
Systol	Negative Ranks	62	35.89	2225.00	6.784	.000
	Positive Ranks	5	10.60	53.00		
	Ties	0				
	Total	67				

Table 2. Shows the results of the comparison of systolic blood pressure before and after the administration of 0.5% hyperbaric bupivacaine in SC patients there is a significant difference which is characterized by sig <0.05. The most significant decrease in systolic blood pressure occurred at the 10th minute in 62 respondents.

Table 3. Distribution of respondents' blood pressure in diastole before and after administration of 0.5% hyperbaric bupivacaine anesthesia at the 10th minute

Variabel	Negative Ranks	N	Sum of Ranks	z	Sig
Diastole	Negative Ranks	59	2138.50	6.244	.000
	Positive Ranks	8	139.50		
	Ties	0			
Total		67			

Table 3 describes the comparison of diastole blood pressure before and after the administration of 0.5% hyperbaric bupivacaine obtained significant differences <0.05. The most significant decrease in diastole blood pressure occurred at minute 10 in 59 respondents.

Table 4. Distribution of respondents' pulse rate in diastole before and after administration of 0.5% hyperbaric bupivacaine anesthetic drug at the 10th minute

Variabel	Negative Ranks	N	Mean Rank	Sum of Ranks	z	Sig
Pulse	Negative Ranks	17	21.59	367.00	4.920	.000
	Positive Ranks	49	37.63	1844.00		
	Ties	1				
	Total	67				

Table 4. Explaining the comparison of the pulse before and after being given 0.5% hyperbaric bupivacaine, the results of pulse changes before and after administration are characterized by a sig value <0.05. The most significant pulse change occurred at the 10th minute as many as 49 respondents experienced an increase in pulse.

Table 5. Distribution of respondents' MAP before and after administration of 0.5% hyperbaric bupivacaine at the 10th minute

Variabel	Negative Ranks	N	Mean Rank	Sum of Ranks	z	Sig
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Variabel	Negative Ranks	61	34.66	2114.00	-6.091	.000
MAP	Positive Ranks	6	27.33	164.00		
	Ties	0				
	Total	67				

Table 5. explains the results of the comparison of MAP before and after the administration of 0.5% hyperbaric bupivacaine in SC patients there is a difference or effect of giving 0.5% hyperbaric bupivacaine on MAP, which is indicated by the results of Sig <0.05. The most significant change in MAP occurred at the 10th minute as many as 61 (91%) respondents experienced a decrease in MAP.

Table 6. Distribution of SpO2 of respondents before and after administration of 0.5% hyperbaric bupivacaine at the 10th minute

Variabel	Negative Ranks	Mean Rank	Sum of Ranks	z	Sig
SpO2	18	21.06	379.00	-0.948	.343
	Positive Ranks	24	21.83	524.000	
	Ties	2			
	Total	67			

Table 6. Showing the comparison of SpO2 before and after the administration of hyperbaric bupivacaine in SC patients, it was found that there was no effect of giving 0.5% hyperbaric bupivacaine on SpO2 which was characterized by sig>0.05.

Table 7. Distribution of respondents' RR before and after hyperbaric bupivacaine administration at 10 minutes

Variabel	Negative Ranks	Mean Rank	Sum of Ranks	z	Sig
RR	18	24.03	432.50	1.423	.155
	Positive Ranks	29	23.98	695.50	
	Ties	2			
	Total	67			

Table 7. Explaining the comparison of RR before and after administration of 0.5% hyperbaric bupivacaine in SC patients, the sig value> 0.05 was obtained, which means that there is no effect of hyperbaric bupivacaine administration on changes in RR in respondents.

Discussions

Respondent Characteristics Based on Age

Characteristics of Respondents by Age The results showed that the most dominant age of respondents appeared to be 26-40 years. In line with research conducted by entitled [9]. The Effect Spinal Anesthesia on Hemodynamics in Sectio Caesarea Patients at Cut Meutia General Hospital, North Aceh, this study shows that the majority of respondents who underwent SC with spinal anesthesia were in the age range of 26-30 years. The causes of cesarean section in 20-35-year-olds can be various factors, including complications that occur during labor or pregnancy. These complications potentially pose a high risk of death or morbidity for both the mother and the baby. In some cases, certain medical conditions or abnormal developments during pregnancy can affect the body's ability to perform natural childbirth, so SC is considered the best option to ensure the safety of both mother and baby.

Age is a factor that can increase the risk of intraoperative hemodynamic changes. With age, the elasticity and flexibility of the arterial wall decreases. This causes the blood vessels to be less able to compensate for the decrease in systolic blood pressure

induced by spinal anesthesia. This decrease in arterial wall elasticity is significant as blood pressure is influenced by arterial wall flexibility, blood viscosity and vascular capacity. The older a person is, the greater the risk of experiencing hypotension during surgery as the body's ability to regulate blood pressure decreases.[10] This is in line with research conducted by,[11] there is a significant relationship between age and hemodynamic changes, especially in terms of blood pressure after spinal anesthesia.

Characteristics of respondents based on BMI

The results showed that the average BMI of respondents who underwent SC surgery using 0.5% hyperbaric bupivacaine spinal anesthesia drug was 25-29.9. In line with research conducted by [10] entitled Hemodynamic Overview of Sectio Caesarea Patients With Spinal Anesthesia Given Leg Elevation at Rsad Tk. II Udayana which states that the average BMI of patients undergoing SC action ranges from 25-29.9. Maternal weight gain is caused by increasing gestational age in the mother. Maternal weight gain is not only influenced by maternal physiological changes but also influenced by other factors, namely biological factors and other characteristics. [12] stated that Body Mass Index (BMI) affects hemodynamics in patients undergoing cesarean section. Patients with higher BMI will experience a greater decrease in blood pressure than patients with normal BMI. This is due to the effect of spinal anesthetic drugs that reduce systemic vascular resistance and reduce venous capacity in patients with higher BMI tend to have a longer duration of sensory block, so that it will affect postoperative recovery.

Effect of systole and diastole blood pressure after injection of 0.5% hyperbaric bupivacaine spinal

anesthesia drug in respondents undergoing sectio caesarea action

Based on the results of research that has been done there is a decrease in blood pressure in patients undergoing SC. According to, [13] the decrease in blood pressure is due to sympathetic blockade which causes vasodilation in patients undergoing cesarean section with spinal anesthesia caused.[14–17] Spinal anesthesia can cause sympathetic blockade resulting in decreased systemic vascular resistance and venous vasodilation. This may lead to decreased venous return to the heart (preload) and decreased arterial blood pressure. The decrease or change in blood pressure that occurs can be caused by several factors including the patient's height, age, drug dose. The use of bupivacaine spinal anesthesia drugs must be adjusted to height, because height and weight can affect anesthetic blockade which can affect blood pressure in patients. In another study, it was mentioned that rapid injection of bupivacaine anesthetic drugs more often caused hypotension and the researcher showed that slow injection with a dose of 10 mg and an injection duration of 60-120 seconds could reduce the incidence and side effects of lowering blood pressure during anesthesia in patients undergoing surgery.[18]

The effect of pulse after injection of 0.5% hyperbaric bupivacaine anesthetic drug on respondents undergoing Sectio Caesarea surgery.

Based on the results of the research that has been done, it is found that the most significant increase in pulse occurs in the 10th minute. This is in line with research,[11] entitled Hemodynamic Overview in Sectio Caesarea Patients With Spinal Anesthesia Using Enhanced Recovery After Caesarean Section (Eracs) obtained the results of pulse research at

minute 10 experiencing tachycardia as many as 54 respondents, this increase is due to changes in blood pressure after SAB. In general, spinal anesthesia can affect the autonomic nervous system, which regulates body functions such as heart rate and blood pressure. Spinal anesthesia can cause sympathetic blockade which causes vasodilation and hypotension. As a compensatory response to the decrease in blood pressure, the body may increase the pulse rate to maintain organ perfusion.[19]

Increased pulse during intra-anesthesia can show the pathophysiology and clinical aspects of hypovolemic shock which shows that the heart tries to compensate for blood volume loss by responding to sympathetic nerves.[7,20–22] This response causes an increase in contraction and heart frequency which is characterized by an increase in pulse. an increase in pulse or tachycardia in hypovolemic patients is the body's attempt to balance the need for oxygen and nutrients by body tissues by optimizing blood flow [11].

The effect of MAP after injection of 0.5% hyperbaric bupivacaine anesthetic drug on respondents undergoing Sectio Caesarea surgery.

Based on the results of the research that has been done, there is a decrease in MAP in patients undergoing SC surgery using 0.5% hyperbaric bupivacaine anesthetic drug. Significant changes in MAP occurred at minute 10 as many as 61 respondents experienced changes in MAP. A decrease in MAP in patients undergoing cesarean section (SC) often occurs in the first minutes after induction of anesthesia. This is usually caused by the effects of anesthetic drugs and physiological changes that occur during induction. In general, a decrease in MAP most often occurs in the first 5-10 minutes after induction, in the

administration of regional anesthesia there is often a decrease in blood pressure due to sympathetic nerve blockade which causes vasodilation and a decrease in systemic vascular resistance. The decrease in MAP variables with spinal anesthesia can be influenced by several factors, namely height, weight, dose of anesthetic drugs given, patient position, intravascular volume status.[23]

Effect of SpO2 after injection of 0.5% hyperbaric bupivacaine anesthetic drug on respondents undergoing Sectio Caesarea surgery.

Based on the results of the research conducted, patients who underwent SC surgery using 0.5% hyperbaric bupivacaine anesthesia drug did not experience significant changes in SpO2 as indicated by Sig value > 0.05. Researchers speculate because all respondents who underwent SC surgery were given 3L/min nasal cannula oxygen after injecting spinal anesthetic drugs. This can prevent a decrease in SpO2 in patients undergoing SC surgery. In line with research conducted [13] states that patients undergoing cesarean section (SC) with spinal anesthesia had an average SpO2 of 98.82%, and there was no significant difference in SpO2 values before and after administration of spinal anesthesia. These results indicate that spinal anesthesia has no significant effect on oxygen saturation in patients.[24–27]

Oxygen saturation describes the body's oxygenation status, which can be affected by several factors including the level of hemoglobin in the blood, body temperature, individual oxygenation ability, fraction of oxygen inhaled (FiO2), and the power and accuracy of the oximeter sensor [13]. This suggests that although spinal anesthesia may affect some respiratory parameters such as respiratory rate, in general SpO2 can remain stable, although the results of other studies indicate

the possibility of changes. Careful monitoring of various important parameters during and after spinal anesthesia procedures is essential.

The effect of RR (respiration rate) after injection of 0.5% hyperbaric bupivacaine anesthetic drug on respondents undergoing Sectio Caesarea surgery.

Based on the results of the research that has been done, there is no significant change in RR marked by $\text{Sig} > 0.05$. The effect of bupivacaine on the respiratory rate of patients undergoing SC can vary depending on the dose and the level of block achieved in patients. This is in line with research conducted by [28] entitled "Hemodynamic Effect Of Low Dose Bupivacaine Spinal Anesthesia For Cesarean Section" which states that in most cases bupivacaine does not significantly affect respiration rate. Because the block that occurs is usually several segments below the sensory block, therefore, the function of respiratory muscles such as the diaphragm and other upper muscles is not disturbed. Although respiratory complications in women undergoing SC are relatively rare, this risk may occur in patients who have a history of diseases such as heart disease, lung disease and obese patients, therefore the administration of hyperbaric bupivacaine doses and proper anesthesia techniques in SC patients can reduce the risk of respiratory depression in patients undergoing SC. [29]

Limitations and Future Research

The limitations of this study are that it only assesses the effects of hyperbaric bupivacaine administration without evaluating other variables that may affect hemodynamics in patients. Monitoring in this study was only done for the first 20 minutes after hyperbaric bupivacaine administration, which will limit the

understanding of the long-term effects of spinal anesthesia on hemodynamics. We suggest that future researchers expand this study such as including other variables that may have a significant influence on the hemodynamic response to spinal anesthesia, we also recommend that monitoring be extended beyond the first 20 minutes after hyperbaric bupivacaine administration

Conclusion

Conclusion Based on the results of this study, the average age of respondents who underwent cesarean section was 26-40 years, and the majority of respondents' BMI was 26-29. Significant hemodynamic changes occurred in blood pressure, pulse rate and MAP characterized by a sig value < 0.05 , while SpO₂ and RR did not experience significant changes after being given hyperbaric bupivacaine.

Acknowledment

The researcher would like to thank Mr. Asmat Burhan and Mrs. Indri Heri Susanti as supervisors who have guided and provided input before and after this research was conducted, as well as the respondents who have been willing to help this research. So that this research can be carried out properly.

Funding Information

None

Conflict of Interest Statement

The writers have confirmed that they do not have any conflicting interests.

Data Availability

The datasets utilised or generated for this investigation may be obtained from the appropriate author upon a reasonable request.

Author Contributions

Misbachul Hayati: Conception and design of the study, Search Data Base, Methodology, Extration Data Qualitative, Extration Data Quantitative, Analysis Risk of Bias, Data Analysis and Interpretation, Writing, Review and Editing. **Asmat Burhan:** Study conception and design, search database, methodology, extraction of qualitative and quantitative data, analysis of bias risk, data analysis and interpretation, and writing, review and editing. **Indri Heri Susanti:** Study conception and design, search database, methodology, extraction of qualitative and quantitative data, analysis of bias risk, data analysis and interpretation, and writing, review and editing.

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