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ORIGINAL RESEARCH

Relationship Between Spinal Anesthesia Injection Speed and the Incidence of Hypotension in Patients Undergoing Cesarean Section

Fikri A Mafazi✉*,Donatila Novrinta*, Himawan Sasongko**

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Authors' affiliations :
*Resident of Anesthesiology and Intensive Therapy, Faculty of Medicine, Diponegoro University, Semarang, Indonesia
**Staff from the Departement of Anesthesiology and Intensive Therapy Faculty of Medicine, Diponegoro University, Semarang, Indonesia
✉Correspondence:
fikriamafazi@gmail.com

ABSTRACT

Background : The incidence of post-spinal hypotension in pregnancy is very high 50-85%. There have been many studies preventing hypotension but still considered unsatisfactory. Reducing the speed of injection of spinal anesthetic drugs can prevent hypotension, but still controversial.

Objective : to determine the incidence of hypotension, onset of achieving sensory blocks, and the association of injection rate with the occurrence of post-spinal anesthetic hypotension.

Methods: A Randomised Control Trial Study, including 48 patients underwent caesarean delivery who fulfil inclusion criteria. Samples were divided into fast and slow groups. Spinal anesthesia was given using hyperbaric bupivacain 0.5% of 10mg, Fentanyl 25mcg, and 100mcg morphine total volume of 3 cc. Group A received fast injection for 10 seconds, while group B for 30 seconds. The incidence of hypotension, onsetof block and incidence of side effects after spinal anesthesia were recorded.

Result : The incidence of hypotension in the fast group was 70.4%, while in slow group was 23.8%. There was a significant association between injection rate with post-spinal anesthetic hypotension (p = 0.004). Onset of Block T6 post-spinal anesthesia is faster in the fast group. Furthermore, there was no significant difference in nausea, vomiting, and chills between two groups.

Conclusion: Slow injection rate may reduce the incidence of post-spinal anesthetic hypotension. However, the onset of sensory block was faster achieved with fast rate injection, with no difference in other side effects.

Keywords: Hypotension; Injection rate; Pregnancy; Pregnant mothers; Spinal anesthesia.

INTRODUCTION

Spinal anesthesia is one of the most widely used regional anesthesia techniques in obstetrics since the 20th century. Spinal anesthesia has been used globally as the primary choice in cesarean section due to its simplicity and good infant outcomes and maternal safety[1]. A national population-based study in Japan showed that from 2010 to 2013, the use of spinal anesthesia as the anesthetic technique of choice in elective cesarean section was 88.7%[2].

Despite having a lower risk of morbidity and mortality than general anesthesia, spinal anesthesia has been associated with several side effects including hypotension. The incidence of hypotension in pregnant women undergoing cesarean section is one of the complications that often occurs in spinal anesthesia[3]. The incidence of post-spinal anesthesia hypotension in maternal is reported to range from 50 to 85%[4]. Sympatholytics induced by spinal anesthesia block will cause vasodilation and lower maternal blood pressure, resulting in fetal hypoxia, bradycardia, and acidosis[5,6].

Several studies have been conducted to find preventive measures to reduce hypotensive complications, such as giving crystalloid fluids before induction, giving vasopressors, positioning the patient, or reducing the dose of anesthesia, but it has not yet obtained satisfactory results[5,6]. One way to reduce the incidence of hypotension is to reduce the number of hypotensive patients. One way to reduce the incidence of hypotension is to reduce the speed of injecting spinal anesthetic drugs very slowly, so that it can maintain hemodynamic stability after spinal anesthesia[5,7].

Research by Simon et al3, showed that giving injections at a very slow speed (120 seconds) would reduce the incidence of hypotension by 65%. Syafri et al. 7 showed that injection at a speed of 0.2ml/sec would reduce the incidence of hypotension after spinal anesthesia. Bouchnak et al. 8 showed that rapid injection (20 seconds) would increase the incidence of hypotension. Whereas the study by Chun et al[9], stated that there was no difference in the incidence of hypotension in fast or slow spinal injection. The speed of spinal injection itself is still controversial and requires further research. Until now, there are no guidelines or clinical guidelines that regulate the speed of injection of spinal anesthetic drugs, especially in obstetrics. Therefore, further research is needed to determine

the dose and speed of injection to reduce hypotensive complications in patients after spinal anesthesia.

METHODS

This study is an experimental analytical study with a randomized controlled trial (RCT) approach, providing spinal anesthesia as an intervention and analyzing the incidence of hypotension as the outcome.

The population of this study was patients who underwent caesarian section under the spinal anesthesia in RSUP Dr. Kariadi during May-July 2022 that met the inclusion and exclusion criteria of the study. The inclusion criteria included: (1) Pregnant women aged 18-40 years; (2) ASA I-II 3; (3) BMI 20-35; (4) Body height >150cm and <180cm; (5) Patients with at least 4 hours of fasting; (6) No comorbid diseases or chronic diseases (heart disease, kidney failure, diabetes); (7) Patients / guardians are willing to participate in the study after signing the informed consent. While exclusion criteria were; (1) Patients who have spinal failure; (2) Inappropriate injection time. The minimum sample size calculated using independent categorical comparative analytic hypothesis testing formula was 32 samples.

Sampling was carried out using the simple random sampling where randomization was done by selecting samples based on numbers from the random table to divide the sample into two groups, group A (fast) and B (slow). Sample selection was done by putting odd-numbered samples into group A (fast), while even-numbered samples were put into group B (slow). The technique used in the study was single blinding. Blinding was performed on the research sample where the patient could not identify the type of intervention given. The speed of bupivacaine injection will be done differently by the research assistant.

Patients who fulfilled the inclusion criteria were included in the study and they filled out the research questionnaire and signed the informed consent. First, prophylaxis was given with 10ml/kgBB crystalloid fluid 15 minutes before starting the induction of spinal anesthesia and premedication with ondansentron 4 mg intravenously, then blood pressure was recorded before induction of anesthesia and the results were set as baseline tension. Prophylactic fluid administration before spinal anesthesia in patients who will undergo cesarean section aims to prevent hypotension, which is a

common complication of spinal anesthesia. Spinal anesthesia causes sympathetic blockade, which results in vasodilation and decreased peripheral vascular resistance. As a result, there is a redistribution of blood volume from the central circulation to the peripheral circulation. Prophylactic fluid administration helps to replenish the lost intravascular volume, thereby preventing a significant drop in blood pressure. By administering prophylactic fluids, the volume of blood returning to the heart (preload) increases, thereby increasing cardiac output. This increase in cardiac output is important for maintaining a stable blood pressure during spinal anesthesia procedures.

A sudden drop in blood pressure due to spinal anesthesia may trigger an exaggerated baroreceptor reflex, which may worsen hypotension. With prophylactic fluid administration, blood pressure can be maintained within normal limits, reducing the risk of excessive baroreceptor reflexes. Hypotension caused by spinal anesthesia can negatively affect organ perfusion, including uteroplacental perfusion which is important for fetal health during cesarean section. Prophylactic fluid administration helps stabilize the patient's hemodynamic condition, ensuring that vital organs remain adequately supplied with blood. In addition, uncontrolled hypotension during spinal anesthesia can cause uncomfortable symptoms such as nausea, vomiting, and dizziness in patients. With prophylactic fluid administration, the risk of these side effects occurring can be minimized, thereby improving patient comfort and safety during the procedure.

The study sample was randomly divided into 2 groups, spinal anesthesia in the form of bupivacaine 0.5% 10mg (2 cc) + fentanyl 25mcg (0.5 cc) + morphine 100mcg (0.5 cc) with a total volume of 3 cc was injected in 10 seconds in group A (fast) and in 30 seconds in group B (slow). Blood pressure was then evaluated 1 minute after completion of injection, and repeated every 3 minutes until 15 minutes post injection. Blood pressure changes >20% of baseline and or systole <100 mmHg that occurred within 15 minutes of measurement were categorized as hypotension. If hypotension was found, resuscitation was performed according to the protocol, i.e., 5mg ephedrine was given gradually, and how much ephedrine was used was calculated. The onset of sensory block up to T6 was recorded by

pinprick test and motor block by bromage test was assessed every minute starting from the patient's supine position, as well as the appearance of side effects such as nausea vomiting and chills which were viewed objectively. Data were then collected and analyzed. Ethical clearance for this study was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Diponegoro University / Dr. Kariadi Hospital Semarang and the Training Department of Dr. Kariadi Hospital.

Descriptive data analysis was provided in the form of frequency tables, mean and median calculations nd graphs. Statistical analysis was carried out in accordance with the measurement scale and the level of processing. Before the bivariate test, a normality test was carried out using Saphiro-Wilk because the sample size was <50 per group, if the data was normally distributed, the test was carried out using the independent t test and if it was not normal, the Mann Whitney test was carried out. In categorical data, the chi-square test is carried out if it meets the requirements and if not, other tests will be used. Data analysis used the SPSS for Windows version 15.0 program (SPSS Inc. USA). A value of $p < 0.05$ is significant.

RESULT

Sampling of the study was carried out by randomization from a total of 84 populations, 52 were taken who fit the inclusion criteria, then 1 sample was excluded due to spinal failure where the local anesthetic drug was inadequate and 3 samples were excluded because they did not match the injection speed so that the total study sample was 48 people with a total sample rounded up to 24 subjects per group, with each group, namely: Group A spinal anesthesia using Bupivacain 0.5% 10mg + Fentanyl 25mcg + morphine 100mcg total volume of 3cc with a speed of 10 seconds and Group B spinal anesthesia using bupivacain 0.5% 10mg + Fentanyl 25mcg + morphine 100mcg total volume of 3cc with a speed of 30 seconds.

Each patient's characteristics based on age, height, weight, BMI, systolic and diastolic blood pressure were carried out univariate test of numerical data and presented in the form of mean and median and minimum-maximum values while categorical data namely hypotension, total ephedrine, incidence of nausea-vomiting, chills, injection speed and block onset were carried out univariate test and data displayed in n (number) and percentage.

Table 1. Numerical Data Characteristics of Sample

Variabel	Mean ± SD	Median (min – max)
Age (year)	29,65 ± 4,99	29,5 (17 – 40)
Height (meter)	1,56 ± 0,05	1,56 (1,43 – 1,71)
Weight (kilogram)	69,27 ± 8,35	67,5 (54 – 89)
BMI (kg/m^2)	28,31 ± 3,20	27,41 (22,27 – 34,65)
Systolic (mmHg)	131,75 ± 17,89	129,5 (101 – 172)
Diastolic (mmHg)	79,21 ± 12,56	77 (56 – 109)

Based on table 1, the demographics of this study sample had an average age of 29.65 ± 4.99 years with a median of 29.5 and the age range ranged from 17 - 40 years. The average height of the study sample was 1.56 ± 0.05 meters, with a median value of 1.56 and the height range ranged from 1.43 - 1.71 meters. The mean body weight of the samples in this study was 69.27 ± 8.35 with a median value of 67.5 and the range of body weight ranged from 54 - 89 kg. BMI data showed the average BMI of the samples in this study was 28.31 ± 3.20 with a median of 27.41 and the BMI range of the study samples ranged from 22.27 - 34.65.

Furthermore, the patient's hemodynamic data was measured in the form of taking systolic and diastolic blood pressure data. The mean systolic blood pressure of the study sample was 131.75 ± 17.89 with a median value of 129.5 and the range of systolic blood pressure ranged from 101 - 172 mmHg. The average diastolic blood pressure of the study sample was 79.21 ± 12.56 with a median value of 77 and the range of systolic blood pressure ranged from 56 - 109 mmHg.

Table 2. Categorical Data Characteristics of Sample

Variable	n	%
Hypotension		
Yes	27	56,3
No	21	43,8
Ephedrine usage		
Yes	14	29,2
No	34	70,8
Nausea and vomitting		
Yes	8	16,7
No	40	83,3
Shivering		
Yes	1	2,1
No	47	97,9
T6 Block onset		
1st minute	15	31,3
3rd minute	33	68,8
Speed of injection		
Slow	24	50,0
Fast	24	50,0

Furthermore, based on the blood pressure data, 56.3% of patients experienced hypotension and 43.8% of patients did not. In addition, based on table 2, data on side effects of the treatment can be shown, these side effects include nausea, vomiting, and chills from the study subjects. Nausea and vomiting were found in 16.7% of patients. Chills were found in 2.1% of the study subjects. In addition, the total ephedrine use of the study subjects was 29.2%. The onset of anesthesia block as high as T6 at the first minute was found in 31.3% of subjects and 68.8% of others block at the 3rd minute. Based on the data presented in table 2, there were a total of 48 samples included in this study, with details of 24 samples included in the fast injection treatment group and 24 other samples included in the slow injection treatment group.

Table 3. Mean Systolic, Diastolic and MAP Blood Pressure

Variable	Speed of Injection	Minute					
		1	3	6	9	12	15
Systolic	Slow	127,83	122,96	123,46	124,13	121,92	122,46
	Fast	121,21	101,79	104,54	108,79	115,67	118,83
Diastolic	Slow	76,88	74,54	71,92	72,71	75,29	73,13
	Fast	72,50	61,25	64,96	64,21	67,71	67,58
MAP	Slow	94,13	90,42	89,46	89,25	91,25	88,83
	Fast	87,37	73,63	78,71	78,37	82,88	83,75

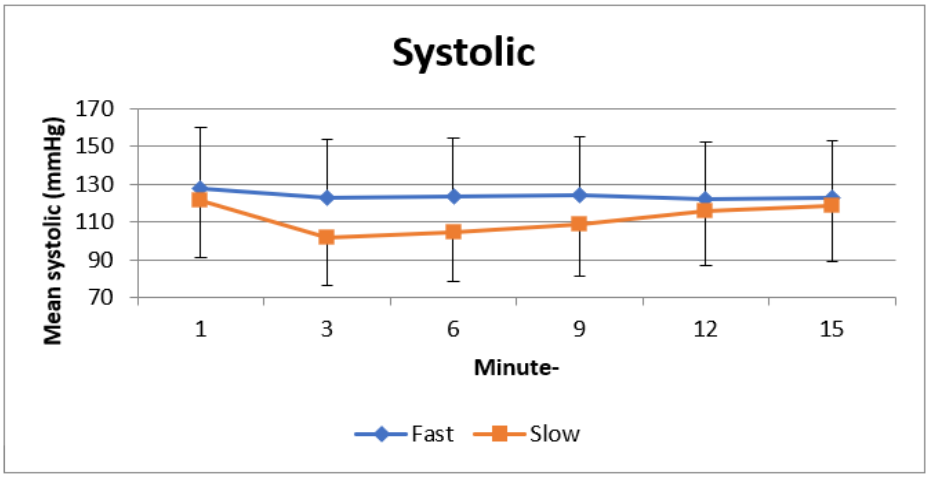

Figure 1. Mean Diastolic Blood Pressure Chart

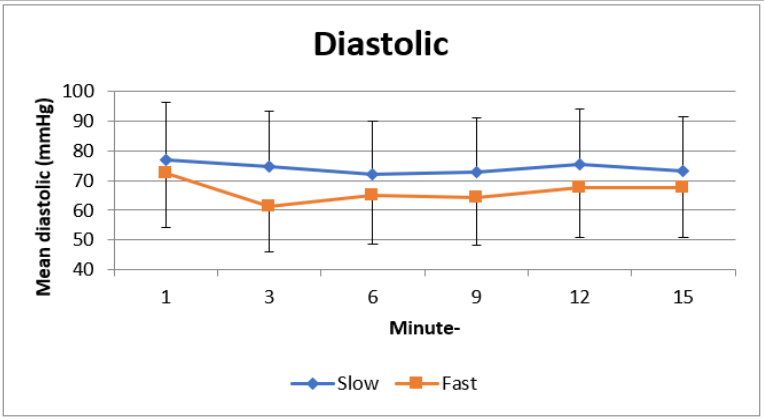

Figure 2. Mean Diastolic Blood Pressure Chart

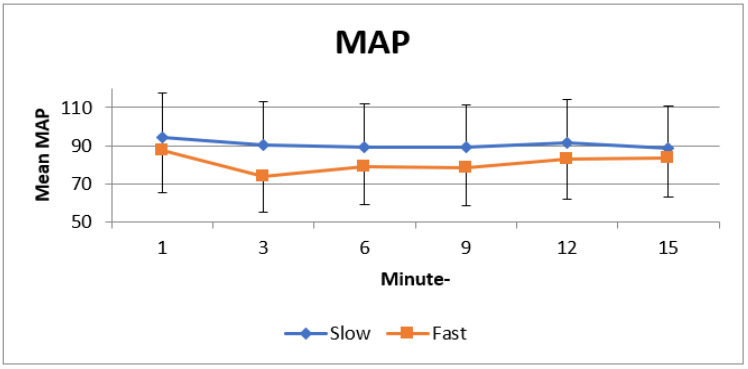

Figure 3. Mean Arterial Pressure (MAP) Chart

From Table 3 and Figures 1,2,3, the results of blood pressure measurement data at 1 minute and then measuring every 3 minutes to 15 minutes, with almost the same baseline average in both groups, it was found that rapid injection caused a decrease in blood pressure, especially at the 3rd minute with the lowest MAP of 73.63, the lowest systole of 101.79 and the lowest diastole of 61.25 in rapid injection.

Table 4. Univariate Analysis and Normality Test of Data

Variable	Speed of Injection	Mean ± SD	Median (min – max)	p
Age	Slow	29,83 ± 4,40	30 (22 – 39)	0,485*
	Fast	29,46 ± 5,60	28 (17 – 40)	0,185*
Height	Slow	1,58 ± 0,05	1,58 (1,50 – 1,71)	0,143*
	Fast	1,55 ± 0,05	1,55 (1,43 – 1,66)	0,328*
Weight	Slow	69,17 ± 8,60	67,5 (57 – 87)	0,332*
	Fast	69,38 ± 8,27	67,5 (54 – 89)	0,327*
BMI	Slow	27,80 ± 3,37	27,06 (22,27 – 34,65)	0,431*
	Fast	28,83 ± 3,00	29,14 (22,48 – 32,85)	0,060*
Systolic	Slow	132,58 ± 17,42	128 (106 – 165)	0,081*
	Fast	130,92 ± 18,67	130 (101 – 172)	0,459*
Diastolic	Slow	79,92 ± 11,83	77 (59 – 99)	0,325*
	Fast	78,50 ± 13,47	76 (56 – 109)	0,246*

Niote : * Normal (p > 0,05), using the *sapphiro-wilk* test

Table 4 shows the descriptive data followed by the normality test of each data presented in the study. All of the variables has normal distribution of data.

The data were then further analyzed by comparing the two treatment groups using a t-test between groups according to the results of the normality test of the data distribution of each variable group. In this difference test, statistical analysis was carried out using an independent t-test.

Table 5. Variance test between numerical data of the two groups

Variable	Speed of Injection		P
	Slow (24)	Fast (24)	
Age	29,83 ± 4,40	29,46 ± 5,60	0,798§
Height	1,58 ± 0,05	1,55 ± 0,05	0,087§
Weight	69,17 ± 8,60	69,38 ± 8,27	0,932§
BMI	27,80 ± 3,37	28,83 ± 3,00	0,272§
Systolic	132,58 ± 17,42	130,92 ± 18,67	0,751§
Diastolic	79,92 ± 11,83	78,50 ± 13,47	0,700§

Note : * Significant (p < 0,05); § Independent t

Table 5 shows the results of the t-test for each variable in the study. First, the age variable had a non-significant difference with p = 0.798 (p<0.05) with a mean value of the slow injection group of 29.83 ± 4.40 and the fast injection group of 29.46 ± 5.60. The height variable had a non-significant difference with p = 0.087 (p<0.05) with a mean value of slow injection group of 1.58 ± 0.05 and fast injection group of 1.55 ± 0.05. Body weight variable there is a non-significant difference with p = 0.932 (p<0.05). The BMI variable had a non-significant difference with p = 0.272 (p<0.05) with a mean value of the slow injection group of 27.80 ± 3.37 and the rapid injection group of 28.83 ± 3.00.

In the patient's hemodynamic data, the following test results were found: The systolic blood pressure variable had a non-significant difference with p= 0.751 (p<0.05) with the mean value of the slow injection group 132.58 ± 17.42 and the rapid injection group 130.92 ± 18.67.

The diastolic blood pressure variable had no significant difference with p = 0.700 (p<0.05) with a mean value of the slow injection group of 79.92 ± 11.83 and the rapid injection group of 78.50 ± 13.47.

Tabel 6. Variance test between categorical data of the two groups

Variable	Speed of Injection		p
	Slow (24)	Fast (24)	
Hypotension			
Yes	8 (29,6%)	19 (70,4%)	0,004¥*
No	16 (76,2%)	5 (23,8%)	
Ephedrine usage			
Yes	3 (21,4%)	11 (78,6%)	0,012¥*
No	21 (61,8%)	13 (38,2%)	
Nausea and vomitting			
Yes	2 (25%)	6 (75%)	0,122£
No	22 (55%)	18 (45%)	
Shivering			
Yes	1 (100%)	0 (0%)	0,500£
No	23 (48,9%)	24 (51,1%)	

Note : * Significant (p < 0,05); ¥ Yates Correction; £ Fisher's exact

For categorical data, the analysis was carried out using the chi-square test. In categorical data, the analysis was performed using the chi-square test, if it did not meet the requirements then the Yates correction test was carried out, and the fisher exact test. In the hypotension variable, there was a significant difference with p = 0.004 (p < 0.05), where the majority in the rapid injection group experienced hypotension (70.4%) and the majority of the slow injection group did not experience hypotension (76.2%).

Then in the variable of side effects, there were significant differences in the following variables: The nausea and vomiting variable had a non-significant difference with p = 0.122 (p < 0.05). The variable of chills h ad a non-significant difference with p = 0.500 (p<0.05). In addition, total ephedrine use had a significant difference between groups with p = 0.012 (p<0.05). Finally, in the variable of T6 block onset, there was a significant difference between the slow and fast injection groups with a value of p = 0.001, with the number of patients who experienced T6 block onset at minute 1 being more in the fast injection group.

DISCUSSION

The administration of prophylaxis fluid and premedication with ondansetron is a common practice in spinal anesthesia for cesarean sections aimed at preventing hypotension and nausea/vomiting. Specifically, a crystalloid fluid bolus of

10ml/kg body weight given 15 minutes before the induction of spinal anesthesia, combined with 4 mg of intravenous ondansetron, has demonstrated significant benefits. The primary purpose of the prophylactic fluid bolus is to increase intravascular volume, counteracting the vasodilation and resultant hypotension induced by the sympathetic blockade of spinal anesthesia. This preloading helps to maintain a more stable blood pressure during the procedure. Ondansetron, a selective serotonin 5-HT3 receptor antagonist, is used to prevent nausea and vomiting, common side effects of anesthesia and surgery. Additionally, studies suggest ondansetron may mitigate hypotension during spinal anesthesia by blocking the Bezold-Jarisch reflex, which can contribute to a drop in blood pressure. The combined approach of fluid preloading and ondansetron premedication effectively reduces the incidence of hypotension and nausea/vomiting in patients undergoing cesarean sections with spinal anesthesia. This dual strategy enhances patient comfort and safety by addressing significant complications associated with spinal anesthesia, improving hemodynamic stability and reducing distressing side effects.

Previous studies have found that one way to reduce the incidence of hypotension is to reduce the injection speed of spinal anesthesia drugs, which is expected to maintain the hemodynamic stability of the patient. Based on these findings, this study aimed to analyze the relationship between the speed of spinal anesthesia injection and the incidence of hypotension in patients undergoing cesarean section. Mean Arterial Pressure (MAP) of the subjects was measured in the interval following the injection, which was compared between the fast and slow injection groups. In this study, pregnant women with ASA I and II were included. If the decrease in MAP is 20% or more from baseline or systolic blood pressure below 100 mmHg within 15 minutes following the injection, it is considered as hypotension.

In this study, the incidence of hypotension was 56.25% or as many as 27 of the total sample of 48 pregnant women experienced hypotension. Then, from the bivariate test, it was found that characteristic factors such as age (p=0.798), height (0.087), weight (0.802) did not affect the incidence of hypotension in fast and slow administration. This is in accordance

with Boss et al where age, height, and weight have no effect on the incidence of hypotension.

This is because the subarachnoid cavity in age, height and weight is not significantly different and the speed of regional drug administration is not influenced by these factors[3].

Bourke et al showed, in an experimental study, that injection through a 25 gauge needle at a speed greater than 0.017 mL/s can produce turbulent flow that increases the dispersion of the solution in the cerebrospinal fluid. This statement is in line with the results in this study, obtained significant results p = 0.001 patients reached the onset of nerve block as high as T6 at 1 minute post injection found more in the group that received rapid injection, and in the slow group most occurred after 3 minutes post injection, this indicates that giving injections quickly can cause an earlier block effect[10].

The analysis also showed that there was a significant difference in the incidence of hypotension between the fast and slow injection groups, indicating that there was an effect of injection speed on hypotension. The incidence of hypotension was 56.25%, and 70.4% occurred in the rapid injection group. Slow injection speed has been thought to limit this turbulence and, hence, mixing of the solution in the cerebrospinal fluid. Whereas the study by Simon et al demonstrated a significant reduction in the incidence of hypotension with a very slow injection duration (120 seconds) with a large volume (4 mL). In the use of large volumes, it is suspected that injection duration has a more significant role.[3] In this study, there was a significant result of p = 0.004, that the incidence of hypotension was mostly experienced by patients who received rapid injection and the majority of patients who received slow injection did not experience hypotension.

It can be implied that slow injection can reduce the incidence of hypotension. The majority of hypotension was experienced by patients in the rapid injection group. This condition may result from several pathophysiological mechanisms triggered by spinal anesthesia. The most significant mechanism is the rapid onset of sympatholysis due to the increased sensitivity of nerve fibers to local anesthetics in pregnancy. Increased sensitivity to local anesthetics combined with aortocaval compression of the pregnant uterus is

the main reason for the increased incidence of hypotension in pregnant women compared to non-obstetric patients. The degree of sympathetic chain block is known to be related to the degree of cranial spread of local anesthetics in the subarachnoid space, which is often difficult to predict and usually reaches several dermatomes above the level of sensory block. In addition, pregnant women usually have increased sympathetic versus parasympathetic activity, so sympatholysis leads to higher peripheral vasodilation and predominance of parasympathetic activity, leading to decreased return blood flow and cardiac pre-load. Reduced pre-load will lead to a decrease in cardiac output which causes systemic hypotension[11].

With the occurrence of hypotension in post-spinal anesthesia, a way to overcome this is by administering ephedrine. In this study, significant results were obtained where p = 0.012, ephedrine administration in rapid injection was more widely used compared to slow injection, this is in accordance with the incidence of hypotension that occurs where more hypotension occurs in rapid injection than slow injection. This is in accordance with the incidence of hypotension that occurs where more hypotension occurs in fast injection than slow injection.

Side effects of spinal anesthesia such as nausea and vomiting occur significantly more common in section caesarean section surgery compared to other non-obstetric surgeries, and one of the main causes is hypotension. Acute hypotension decreases cerebral perfusion, induces brainstem transient ischemia and activates the nausea and vomiting center. A retrospective analytical study, the results showed that hypotension, higher block of the 5th thoracic segment, and mixed anesthetics (i.e. addition of vasoconstrictors to local anesthetics) increased the incidence of nausea and vomiting during spinal anesthesia. This suggests that not a single mechanism alone is responsible for causing postoperative nausea and vomiting. Several mechanisms may be active simultaneously.

Another side effect observed in this study was the complaint of shivering in postoperative patients. Surgical procedures cause heat loss due to exposure to a cold environment, evaporation from the exposed site and administration of non-warmed fluids

may cause central hypothermia leading to shivering as a compensatory mechanism. The exact cause of post-spinal shivering remains unclear, although various mechanisms have been linked to the thermoregulatory response to hypothermia causing neuron-induced temperature changes in the mesencephalic reticular formation and dorsolateral pontine and medullary reticular formations causing involuntary oscillatory muscle activity that augments metabolic heat production up to 600% above basal metabolic rate and is clinically associated with clonic or tonic skeletal muscle hyperactivity at different frequencies. This increased muscle activity leads to increased oxygen consumption and carbon dioxide production resulting in hypoxemia, hypercarbia and lactic acidosis which is not only uncomfortable but also aggravates pain sensation[11-13].

In this study, there were more nausea and vomiting side effects in the rapid injection group, but there was no significant difference between the two groups with a p value = 0.122. While the side effect of chills only occurred in the slow group but there was no significant difference between the two groups with a p value = 0.500. This is different from Singh, et al (2007) who stated that the incidence of hypotension increased in rapid injection was significant with side effects of nausea vomiting and chills. The difference with Singh's study where the dose used was greater, namely Bupivacain 0.5% 12mg and morphine 200mcg so that the height of the sensory block was also higher up to T2-T3.

This study has limitations that can be taken into consideration for future researchers in order to get better research results. These limitations include:

1. Information bias: the presence of bias in the measurement of subjective information such as nausea and chills can affect the results.
2. Injection speed may not be uniform because injections are done manually not using electronic injections.
3. There are other factors that are difficult to assess that cannot be homogenized between the two groups, such as intra-abdominal pressure, subarachnoid cavity.
4. Continuous blood pressure monitoring such as artery-line was not used in this study.

CONCLUSION

Based on the results of this study, it can be concluded that there is an effect of the speed of administration of spinal anesthesia on the incidence of hypotension in pregnant women, where the incidence of hypotension occurs more in rapid injection. Rapid injection of spinal anesthesia drugs can increase the speed of onset of sensory block in pregnant women. Furthermore, the incidence of hypotension at slow injection speeds can reduce the incidence of post-spinal anesthesia hypotension in pregnant women, and lastly, the incidence of other side effects such as nausea, vomiting, and chills is not affected by the speed of injection of spinal anesthesia.

CONFLICT OF INTEREST

The Authors declare that have no conflict of interest.

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