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Effect of Crystalloid or Colloid Fluid Loading and Vasopressor Pre-Treatment on the Timing of Hypotension in Cesarean Section with Subarachnoid Block

Syafruddin Gaus*, Muhammad Irfan Djafar, Andi Salahuddin, Muhammad Ramli Ahmad, Andi Muhammad Takdir Musba, Ari Santri Palinrungi

Department of Anesthesiology, Intensive Care, and Pain Management, Faculty of Medicine, Hasanuddin University, Dr. Wahidin Sudirohusodo Hospital, Makassar, Indonesia

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***Correspondence:** Syafruddin Gaus, Department of Anesthesiology, Intensive Care, and Pain Management, Faculty of Medicine Hasanuddin University - Dr. Wahidin Sudirohusodo Hospital, Makassar, Indonesia. E-mail: irfandr118@gmail.com
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Abstract

BACKGROUND: Cesarean section (C-section) is the most frequently performed surgery in obstetrics, generally using subarachnoid block (SAB) or epidural block for anesthesia. The previous studies have shown the effectiveness of fluid loading and vasopressor pretreatment in preventing maternal hypotension (decreased blood pressure), the most common side effect of SAB. However, the timing of hypotension in response to these treatments has not been analyzed.

AIM: This study therefore aimed to compare the effects of crystalloid or colloid fluid loading and vasopressor pre-treatment on the timing of hypotension in cases of C-section under SAB anesthesia.

METHODS: The study was a single-blind randomized controlled clinical trial with three treatment groups: Group I, 10 mL/kgBW crystalloid solution (Ringer's lactate) loading 10 min before SAB; Group II, 5 mL/kgBW colloid fluid (gelatin) loading 10 min before SAB; and Group III, pretreatment with 0.1 mg/kgBW vasopressor (ephedrine) intravenous bolus just before SAB.

RESULTS: Significant differences in mean blood pressure between groups were observed between the second and 8th min ($p < 0.05$). Hypotension was observed in the crystalloid group within the first 5 min, while average blood pressure was relatively stable all groups after the first 10 min. In addition, hypotension occurred more frequently in the crystalloid group (nine subjects, 45%), compared with the colloid and vasopressor groups (two subjects per group, 10%; $p < 0.05$).

CONCLUSION: Hypotension occurred more rapidly and more frequently when crystalloid loading was utilized, compared with colloid loading or vasopressor pretreatment. Administration of colloid fluid loading and vasopressor pretreatment has been shown to prevent hypotension in SAB anesthesia.

Introduction

Cesarean section (C-section), the most frequently performed surgery in obstetrics, is performed for various indications, including unsafe delivery for the mother and fetus, dystocia, and conditions that require immediate or emergency action [1], [2]. In addition, there are several factors that affect the choice of anesthetic technique for C-section surgery, such as surgery indicators, patient, and surgeon choices, and the technical skills of the surgeon. Subarachnoid block (SAB) is the most widely used anesthetic technique in C-section surgery [1], [2], [3].

As the maternal mortality rate is higher when using general anesthetic in C-section surgery (32 deaths from 1,000,000 births), compared with regional anesthesia (1.9 deaths from 1,000,000 live births), regional anesthesia is the technique of choice for anesthesiologists in the United States. The high mortality rate associated with general anesthetic is related to airway problems, such as inability to ventilate and intubate, and pneumonia due to aspiration. While the maternal mortality rate under regional anesthesia is lower, this mortality is associated with several factors including high block and local anesthetic toxicity [1], [3].

The prevention and management of hypotension in patients undergoing C-section surgery under SAB anesthesia (e.g., by intravenous fluid loading) have been extensively studied. The high frequency of hypotension in women undergoing C-section surgery under SAB anesthesia means that understanding the management of complications is essential for anesthesiologists [4], [5], [6].

Maternal hypotension is prevented by the administration of intravenous fluids, both crystalloid and colloid [3], [4], [6]. In some studies, anesthesiologists have also given vasopressors as a pretreatment to prevent the occurrence of maternal hypotension (prophylaxis) [7], [8], [9]. Several studies have demonstrated the effectiveness of loading and co-loading intravenous fluids and administering vasopressors to

prevent maternal hypotension in C-section surgery with SAB anesthesia [10], [11], [12], [13]. However, to date, there have been no studies comparing the effects of crystalloid fluid loading, colloid fluid loading, and vasopressor pretreatment in such patients. We therefore conducted this research to identify any initial differences in the occurrence of hypotension resulting from loading of crystalloid (Ringer's Lactate) or colloid (gelatin) fluids or pretreatment with the vasopressor ephedrine in groups of subjects undergoing C-Section surgery using SAB.

Materials and Methods

Study design

This study was a single-blind randomized controlled clinical trial consisting of three treatment groups, in which the variables were measured before and after treatment. This study was conducted from August 2021 onwards, until the desired number of subjects was reached.

Population and subjects

The study population consisted of patients undergoing C-Section surgery with SAB at Dr. Wahidin Sudirohusodo Hospital and Makassar Network Hospital.

The subjects of this study were obtained from a population that met the following inclusion criteria: (1) The patient was a pregnant woman due to undergo C-section surgery using the SAB procedure at Dr. Wahidin Sudirohusodo Hospital or Makassar Networking Hospital; (2) the patient had American Society of Anesthesia (ASA) I and II emergency scores; and (3) the study was explained to the patient, who voluntarily agreed and signed the informed consent form. The exclusion criteria were as follows: (1) Patients refused to participate and/or did not have an informed consent form; (2) patients aged <18 years or >40 years; (3) patients with systolic blood pressure <100 mmHg before treatment; (4) obese patients with body mass index (BMI) >30 kg/m^2; (5) patients with height <152 cm; (6) patients with a history of hypertension in pregnancy, pre-eclampsia, or eclampsia; (7) patients with a history of chronic hypertension; (8) patients with a history of heart disease; (9) patients with multiple gestations (twin pregnancies); (10) patients who failed induction with total or partial SAB; and (11) patients who fasted <6 h. The dropout criteria were (1) spinal failure, and (2) required general anesthesia during surgery.

Ethical clearance

Ethical clearance was obtained from the Ethics Committee for Biomedical Research in Humans, Faculty of Medicine, Hasanuddin University (551/UN4.6.5.31/PP36/2021). Subjects who met the inclusion criteria were given an oral explanation of the study and signed a consent form to participate voluntarily.

Methods

The distribution of subject groups was determined randomly

The study was a single-blind randomized controlled clinical trial with three treatment groups of 20 subjects each: Group I, subjects received 10 mL/kgBW of crystalloid fluid at maximum infusion rate, 10 min before SAB induction; in Group II, subjects received 5 mL/kgBW of colloid fluid at maximum infusion rate, 10 min before SAB induction; and in Group III, subjects received a bolus of 0.1 mg/kgBW intravenous (IV) ephedrine immediately before the induction of SAB. The study was approved by Ethics Commission in Humans, Faculty of Medicine, Hasanuddin University (registration number: 482/UN4.6.4.5.31/PP36/2021).

Patients who met the study criteria underwent a C-section preparation procedure with SAB. This consisted of premedication with dexamethasone 10 mg/IV slow bolus 3–5 min (diluted with 0.9% NaCl in a 5–10 ml syringe), ondansetron 4 mg/IV, omeprazole 40 mg/IV slow bolus 3–5 min (diluted with 0.9% NaCl in a 5–10 ml syringe), and ketorolac 30 mg/IV slow bolus 3–5 min (diluted with 0.9% NaCl in a 5–10 ml syringe). This was followed by loading of 10 mL/kgBW Ringer's lactate in the crystalloid solution (Group I) or 5 mL/kgBW Gelofusine ® in the colloid fluid (Group II) at maximum infusion rate, 10 min before SAB induction. Administration of a 0.1 mg/kgBW IV bolus of ephedrine was performed just before SAB (group III).

SAB was performed at the L3–L4 or L4–L5 interspace in the left lateral decubitus position with a 25 G spinal needle. Local anesthetic was then administered by injection: 0.5% hyperbaric bupivacaine 12.5 mg (2.5 cc) with fentanyl adjuvant 25 mcg (0.5 cc), total volume 3 cc, at a rate of 1 cc/3–5 s. Patients were in a supine position with a 150° right hip brace and were given oxygen at 2 L/min through nasal cannula. Block height was assessed using a number of methods, namely, Vth-6 (cold test), Vth-8 sensory block (prick test), and motor block using the Bromage scale (target >2.) Blood pressure was recorded every minute after the SAB for the first 8 min and then at 10 min, and then every 3 min until the operation was complete; the time elapsed before decreased blood pressure occurred was recorded in minutes. The data obtained were then analyzed. Results were considered significant at $p < 0.05$.

Data analysis

All data were recorded in the observation and anesthesia status sheet provided by Dr. Wahidin

Sudirohusodo Hospital and Makassar Network Hospital. The data obtained were processed and the results displayed in text form, tables, or graphs. Statistical analysis used SPSS 20 for windows. Data are shown by mean age, BMI, ASA physical status (PS) classification, blood pressure, and time of occurrence of hypotension in the group. The choice of statistical test depended on the type of variable. Differences in the timing of the occurrence of hypotension were tested by analysis of variance (ANOVA), while changes in blood pressure were tested by repeated measures ANOVA, and differences in patient characteristics (ASA PS, gender, age, and BMI) were tested using the Chi-square test.

Results

Characteristics of research subjects

Based on the data in Table 1, the majority of the participants were aged 26–35 years, with 11 subjects (55% of the total) in this age bracket in the crystalloid group, 10 (50%) in the colloid group, and 11 (55%) in the vasopressor group. In addition, according to nutritional status (BMI) assessment, the majority of subjects were overweight. There were 14 subjects (70% of the total) classified as overweight in the crystalloid group, 13 (65%) in the colloid group, and 12 (60%) in the vasopressor group. Finally, based on ASA PS criteria, all patients in each group were included in category II (namely, suffering from mild systemic disease). Statistical analysis using the Chi-square test ($p > 0.05$) indicated that there were no differences in the average characteristics of the patients.

Table 1: Characteristics of research subjects with research variables

Characteristics	Group			p
	Crystalloid (Ringer's lactate) (n = 20), n (%)	Colloid (Gelofusine) (n = 20), n (%)	Vasopressor (ephedrine) (n = 20), n (%)	
Age range				
15–25	7 (35)	8 (40)	6 (30)	0.959
26–35	11 (55)	10 (50)	11 (55)	
36–40	2 (10)	2 (10)	3 (15)	
Nutritional status (BMI)				
Malnutrition	1 (5)	1 (5)	1 (5)	0.975
Normal	5 (25)	6 (30)	7 (35)	
Overweight	14 (70)	13 (65)	12 (60)	
ASA PS score				
II: Suffering from mild systemic disease	26 (100)	26 (100)	26 (100)	-

Chi-square analysis 95% (results were considered significant at $p<0.05$). BMI: Body mass index, ASA: American Society of Anesthesia, PS: Physical status.

Comparison of systolic blood pressure measured every minute

Comparison of mean systolic blood pressure in the first 10 min after injection of spinal anesthesia showed that there were significant differences between the crystalloid, colloid and vasopressor groups between 2 and 8 min ($p < 0.05$; Table 2). However, for the three groups, average blood pressure did not drop below 100 mmHg over the first 10 min of analysis, and blood pressure remained stable thereafter (Table 2).

Comparison of systolic blood pressure measured every 3 min

In the comparisons of mean systolic blood pressure 46 min after injection of spinal anesthesia (measured every 3 min), there were no significant differences between the 13th and 46th min the crystalloid, colloid, and vasopressor groups ($p > 0.05$; Table 3). In addition, for the three groups, blood pressure was not decreased below 100 mmHg between the 13th and 46th min and blood pressure remained stable over this period (Table 3).

Analysis of average systolic blood pressure over 46 min showed that blood pressure decreased more steeply and rapidly in the crystalloid group, compared with the colloid and vasopressor groups, with hypotension occurring after 5 min. Blood pressure in the colloidal group regained its original level by 10 min and remained relatively stable after this point (Figure 1).

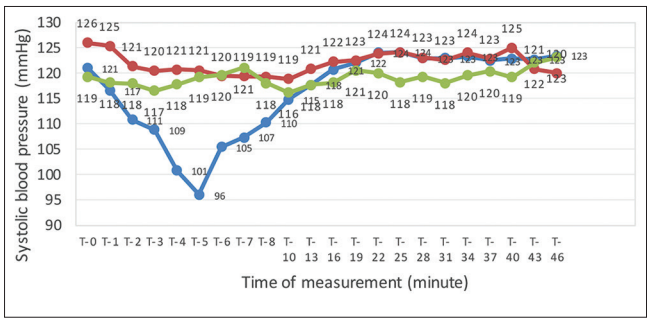

Figure 1: Mean systolic blood pressure over 46 min in the three groups

Comparison of the occurrence of hypotension

Hypotension occurred more frequently in the crystalloid group, being observed in 9 subjects (45% of the total), while only two subjects in each of the other two groups (colloid and vasopressor groups) experienced hypotension (10%); this difference was statistically significant ($p < 0.05$, Table 4 and Figure 2).

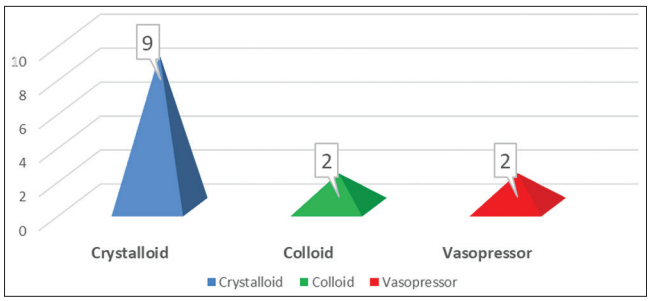

Figure 2: The number of hypotensive subjects in each group

From Figure 3, it can be seen that the lowest systolic blood pressure value in the crystalloid group

Table 2: Comparison of systolic blood pressures measured at 1 min intervals

Systolic blood pressure	Group			p
	Crystalloid (Ringer's lactate) (n = 20), n (%)	Colloid (Gelofusine) (n = 20), n (%)	Vasopressor (ephedrine) (n = 20), n (%)	
1st min (mmHg)				
Mean ± SD	120.10 ± 5.49	125.35 ± 7.56	118.10 ± 5.75	0.004*
Median	120.00	129.00	118.50	
Range (minimum–maximum)	109.00–129.00	110.00–138.00	107.00–130.00	
2nd min (mmHg)				
Mean ± SD	117.5 ± 4.43	121.40 ± 8.63	117.95 ± 7.07	0.129
Median	117.00	123.00	119.00	
Range (minimum–maximum)	108.00–12500	106.00–134.00	103.00–129.00	
3rd min (mmHg)				
Mean ± SD	110.95 ± 8.39	120.45 ± 8.11	116.55 ± 6.10	<0.001*
Median	111.00	122.00	116.50	
Range (minimum–maximum)	96.00–124.00	103.00–130.00	101.00–127.00	
4th min (mmHg)				
Mean ± SD	110.85 ± 1.62	120.75 ± 8.74	117.75 ± 5.67	0.006*
Median	114.00	121.50	117.50	
Range (minimum–maximum)	90.00–130.00	100.00–130.00	106.00–128.00	
5th min (mmHg)				
Mean ± SD	96.0 ± 16.65	120.60 ± 8.62	119.25 ± 7.70	<0.001*
Median	107.50	120.00	121.00	
Range (minimum–maximum)	70.00–130.00	103.00–139.00	102.00–129.00	
6th min (mmHg)				
Mean ± SD	105.45 ± 4.47	119.50 ± 9.51	119.65 ± 6.79	< 0.001*
Median	106.00	121.00	120.50	
Range (minimum–maximum)	83.00–126.00	100.00–129.00	106.00–129.00	
7th min (mmHg)				
Mean ± SD	107.35 ± 14.88	119.40 ± 8.32	121.10 ± 7.55	0.003*
Median	108.00	122.00	122.50	
Range (minimum–maximum)	86.00–133.00	100.00–130.00	103.00–133.00	
8th min (mmHg)				
Mean ± SD	110.30 ± 12.75	119.35 ± 7.99	118.05 ± 4.66	0.043*
Median	115.00	120.00	118.00	
Range (minimum–maximum)	92.00–126.00	100.00–130.00	111.00–130.00	
The 9th min (mmHg)				
Mean ± SD	110.20 ± 14.34	119.60 ± 8.14	119.85 ± 5.68	0.074
Median	117.50	120.50	119.50	
Range (minimum–maximum)	79.00–128.00	102.00–130.00	108.00–129.00	
10th min (mmHg)				
Mean ± SD	114.80 ± 10.37	118.85 ± 11.08	116.15 ± 7.00	0.150
Median	118.00	121.00	115.00	
Range (minimum–maximum)	96.00–132.00	81.00–130.00	102.00–132.00	

*p < 0.05. p-values were tested using ANOVA (data with normal distribution) or the Kruskal–Wallis test (data distribution not normal). Results were considered significant at p < 0.05. SD: Standard deviation.

was 70 mmHg; this was the lowest pressure recorded at any time point in any of the groups. The graph also shows that between the second and 13th min, the minimum systolic blood pressure in the crystalloid group was still below the normal level (exhibited hypotension), in contrast to the colloid and vasopressor groups.

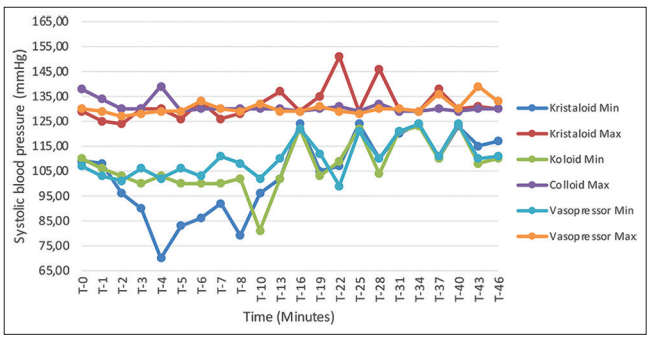

Figure 3: Minimum and maximum values of average systolic blood pressure over 46 min in the three groups. The data are presented in the form of minimum and maximum values per minute of measurement

Discussion

In this study, we aimed to analyze systolic blood pressure in response to three fluid-loading treatments aimed at preventing hypotension in C-section patients undergoing SAB anesthesia. We compared three groups receiving crystalloid fluid loading (Ringer's lactate), colloid fluid loading (Gelofusine), or a vasopressor (ephedrine). Hypotensive episodes can be unpleasant for both the mother and the fetus and can potentially result in death if prolonged [14]. According to a recent study, babies whose mothers had low diastolic blood pressure during pregnancy had a higher risk of perinatal death [15].

Fluid administration is a frequent non-pharmacological method used in the prevention of hypotension. Several studies have shown positive results for this technique, which has therefore been routinely chosen by anesthesiologists. However, some studies have questioned this method due to a number of limitations, namely, the route of fluid administration and the volume of fluid given. For example, hypotension has been shown to persist despite the administration of large volumes of fluid due to continuous uterine contractions, as approximately 300 mL of blood is pumped into the maternal circulation with every contraction. In addition, fetal development (particularly increasing head size) can result in aortocaval compression. Each uterine contraction increases aortocaval compression and causes hypotension. Interestingly, a previous study found that administration of fluid with the patient tilted to the left to reduce aortocaval compression also reduced the occurrence of hypotension [16].

Table 3: Comparison of systolic blood pressures measured at 3 min intervals

Systolic blood pressure	Group			p
	Crystalloid (Ringer's lactate) (n = 20), n (%)	Colloid (Gelofusine) (n = 20), n (%)	Vasopressor (ephedrine) (n = 20), n (%)	
13th min (mmHg)				
Mean ± SD	117.70 ± 8.93	120.80 ± 7.35	117.70 ± 6.03	0.330
Median	119.50	124.00	117.00	
Range (minimum–maximum)	102.00–137.00	102.00–130.00	110.00–129.00	
16th min (mmHg)				
Mean ± SD	125.42 ± 1.52	126.42 ± 1.76	125.73 ± 1.34	0.413
Median	123.00	124.00	123.00	
Range (minimum–maximum)	124.00–129.00	122.00–129.00	122.00–129.00	
19th min (mmHg)				
Mean ± SD	122.05 ± 6.86	122.55 ± 7.04	120.55 ± 5.84	0.611
Median	123.00	123.50	121.50	
Range (minimum–maximum)	105.00–135.00	103.00–130.00	112.00–131.00	
22nd min (mmHg)				
Mean ± SD	124.05 ± 11.05	123.85 ± 5.74	120.00 ± 6.96	0.149
Median	122.50	124.50	120.50	
Range (minimum–maximum)	107.00–151.00	109.00–31.00	99.00–129.00	
25th min (mmHg)				
Mean ± SD	125.42 ± 1.52	126.00 ± 1.766	125.73 ± 1.343	0.401
Median	122.00	124.50	121.00	
Range (minimum–maximum)	124.00–129.00	122.00–129.00	121.00–128.00	
28th min (mmHg)				
Mean ± SD	123.00 ± 9.34	123.10 ± 7.49	119.30 ± 6.61	0.231
Median	123.00	125.50	118.00	
Range (minimum–maximum)	125.00–132.00	104.00–132.00	110.00–130.00	
31st min (mmHg)				
Mean ± SD	126.34 ± 1.09	126.30 ± 1.12	126.42 ± 1.02	0.912
Median	124.00	123.00	121.00	
Range (minimum–maximum)	120.00–130.00	121.00–129.00	121.00–130.00	
34th min (mmHg)				
Mean ± SD	125.692 ± 1.37	126.23 ± 1.24	126.06 ± 1.17	0.142
Median	124.00	125.00	118.00	
Range (minimum–maximum)	124.00–129.00	123.00–129.00	124.00–129.00	
37th min (mmHg)				
Mean ± SD	122.50 ± 6.72	122.85 ± 5.55	120.35 ± 6.39	0.396
Median	122.50	122.00	119.00	
Range (minimum–maximum)	110.00–138.00	110.00–130.00	111.00–136.00	
40th min (mmHg)				
Mean ± SD	125.69 ± 3.79	126.26 ± 1.21	126.15 ± 0.84	0.182
Median	125.00	120.00	122.00	
Range (minimum–maximum)	123.00–130.00	124.00–129.00	124.00–130.00	
43rd min (mmHg)				
Mean ± SD	122.75 ± 5.04	120.85 ± 6.57	122.10 ± 6.19	0.595
Median	123.00	120.50	124.50	
Range (minimum–maximum)	115.00–131.00	108.00–130.00	110.00–139.00	
46th min (mmHg)				
Mean ± SD	123.45 ± 3.79	120.00 ± 6.39	123.15 ± 5.93	0.147
Median	125.00	120.00	122.00	
Range (minimum–maximum)	117.00–130.00	110.00–130.00	111.00–133.00	

*p < 0.05. p-values were tested using ANOVA (data with normal distribution) or the Kruskal–Wallis test (data distribution not normal). Results were considered significant at p < 0.05. SD: Standard deviation.

Table 4: Comparison of the occurrence of hypotension in treatment groups

Variable	Groups			p
Hypotension	Crystalloid (Ringer's lactate) (n = 20), n (%)	Colloid (Gelofusine) (n = 20), n (%)	Vasopressor (ephedrine) (n = 20), n (%)	
Occurred	9 (45)	2 (10)	2 (10)	0.008*
Did not occur	11 (55)	18 (90)	18 (90)	

*p < 0.05, Chi-square analysis.

Fluid management is determined by loading. Crystalloid loading has been found to be more effective at reducing both hypotension and the need for vasopressors, compared with preloading or no fluids [10]. This is in line with research conducted by Oh *et al*., who found that the frequency of hypotension was significantly lower in the coloading group compared to the preloading group, while a greater proportion of mothers who delivered in the preloading group required treatment with ephedrine (83.3% vs. 53.3%, p = 0.026) [3]. Vasopressor treatment is widely used by medical personnel during C-sections, with over 60% of anesthesiologists using ephedrine as a vasopressor to treat hypotension during spinal anesthesia [17].

For these patient characteristic variables, no statistically significant differences were found between the three groups, indicating both the homogeneity of the three groups and the feasibility of group comparisons. In addition, the overall majority of study participants were in the age range 26–35 years (p > 0.05). This is in line with research conducted by Linden *et al*. showing that the average age of pregnant women in low-to-middle income countries is 28 years [18]. A study conducted by Chumpathong *et al*. on patients at Siriraj Hospital showed that age was not an independent factor influencing the occurrence of hypotension complicated by spinal anesthesia in C-section patients [19].

Based on nutritional status (BMI) assessment, most of the study participants were characterized by overweight nutritional status. This study is therefore in agreement with research conducted by Linden *et al*. in Ghana showing that the majority of pregnant women in low-to-middle income countries are overweight, as indicated by BMI [18]. Research conducted by Basu *et al*. showed that pregnant women with a high BMI tend to require cesarean delivery [20].

The results of this study revealed significant differences in blood pressure responses in the crystalloid, colloid, and vasopressor groups in the first few minutes after SAB; the greatest decrease in systolic blood pressure was observed in the crystalloid group between the first and 7th min, while blood pressure was more stable in the colloid and vasopressor groups. Blood pressure also decreased more rapidly in the crystalloid group, compared with the colloid and vasopressor groups. Our results also showed that the frequency of hypotension was significantly higher in the crystalloid group (45%), compared with the colloid and vasopressor groups (10% in each group).

The results of this study are in line with research conducted by Whiteside [21], who found that colloids given by co-loading were beneficial for preventing post-anesthesia hypotension in obstetric patients without any abnormalities. Administration of colloid fluids can be a more effective alternative for preventing hypotension after spinal anesthesia compared with crystalloids, as colloid fluid remains in the blood vessels for a longer period. In this study, the volume of colloid fluid given was sufficient to compensate for the vasodilating effect occurring immediately after spinal drug injection, thus preventing the occurrence of hypotension.

Ephedrine is commonly used in anesthesia as a vasopressor to increase cardiac output and peripheral vascular resistance [22]. This drug is a non-catecholamine sympathomimetic agent that acts either directly or indirectly by stimulating alpha- and beta-adrenergic receptors. The indirect agonist properties result from the release of post-synaptic norepinephrine or the inhibition of epinephrine reuse [23]. Effects on the cardiovascular system include increasing blood pressure, heart rate, and heart contractility [24]. The previous studies have compared the effectiveness of ephedrine given by bolus or continuous infusion [25]. These studies were in line with research conducted by Ahmed *et al*. [25] compared the administration of 25 mg ephedrine infusion and crystalloid fluid administration in C-section patients who underwent spinal anesthesia. The results showed that the frequency of hypotension was significantly higher in the crystalloid group (48%) than the ephedrine infusion group (24%) due to differences in the type of fluid, method of administration, and amount of fluid used. Administration of ephedrine intravenously by infusion or bolus is considered the gold standard for preventing and treating hypotension.

Comparison of mean systolic blood pressures measured at regular intervals between 13 and 46 min after injection of spinal anesthesia showed no significant differences between groups. In addition, blood pressure did not drop below 100 mmHg in any of the groups and was stable from the 13th min onwards (Table 3). This may be due to the onset of the local anesthetic by the 2nd min after injection. After reaching its lowest level, systolic blood pressure is known to increase spontaneously by 5–10 mm Hg over the following 10–15 min as a result of compensatory circulatory activity by unblocked sympathetic nerves, as well as a slight return of smooth muscle tone in the peripheral vasculature affected by denervation. Blood pressure then stabilizes and remains relatively constant until the effects of the local anesthetic wear off [26].

The occurrence of maternal hypotension is associated with high spinal blockade. Patients who have a high spinal blockade will also have a higher block of sympathetic pathways, which play a role in vascular muscle tone. Therefore, if there is blockade of preganglionic sympathetic nerve fibers, venous vasodilation will occur, causing a shift in blood volume (especially to the lower extremities) and decreasing blood flow back to the heart [27]. Hypotension can occur suddenly and severely at any time after drug injection until the newborn is born, while prolonged hypotension can affect uteroplacental perfusion and cause fetal acidosis [28]. This shows the importance of investigating methods of preventing hypotension when spinal blockade is used.

Onset of the effects of ephedrine occurs more rapidly than the onset of spinal blockade, thereby preventing vasodilation and hypotension after intravenous injection. Administration of ephedrine after spinal anesthesia maintains blood pressure by increasing cardiac output and heart rate, ensuring that blood pressure remains stable and hypotension is avoided [29].

Conclusion

Hypotension in C-section surgery with SAB anesthesia occurred more rapidly and at a higher frequency with crystalloid loading, compared with colloid loading or vasopressor pretreatment. Administration of colloid fluid loading and vasopressor pretreatment has been shown to prevent decreases in blood pressure in SAB anesthesia.

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