**Abstract**

**Introduction:** Hypotension after spinal anesthesia is a frequent complication in patients undergoing cesarean section; the incidence of maternal hypotension is 60%–70%. One way to overcome or prevent hypotension due to spinal anesthesia is by administering intravenous fluid boluses. This study was conducted with the aim of comparing the effectiveness of crystalloid fluid preloading and coloading against the incidence of hypotension after spinal anesthesia in cesarean section. **Methods:** This research is a single-blind clinical trial. The number of subjects who participated in this study were 51 subjects. Subjects selected by consecutive sampling with inclusion criteria gravida patients aged 16 years to 40 years with ASA 1 or ASA 2 physical status who would undergo elective cesarean section with spinal anesthesia and there were no contraindications for spinal anesthesia. Participants were divided into three groups, namely preloading group, coloading group, and control group. Systolic blood pressure, diastolic blood pressure, mean arterial pressure (MAP), and pulse rates are measured in basal conditions and 1, 2, 4, 6, 8, 10, 15, 20, 25, and 30 min after spinal anesthesia. Statistical analysis for the differences in hemodynamic parameters among the three groups of subjects were analyzed by the Repeated Measured Multivariate Analysis of Variance (MANOVA) test. Whereas Bonferroni post hoc test was used to compare the differences in hemodynamic parameters between each group. **Results:** Bonferroni post hoc test results showed that there were significant differences in the decrease of systolic, diastolic, and MAP blood pressure differences between the coloading group with the preloading group and the control group (P < 0.001); the lowest decrease was in the coloading group. **Conclusion:** Crystalloid fluid coloading was significantly better in reducing hypotension incidence after spinal anesthesia in cesarean section compared with the preloading and control groups.

**Keywords:** Cesarean section, coloading, crystalloid fluid, hypotension, preloading

**Introduction**

Hypotension after spinal anesthesia is a complication that often occurs with events ranging from 25% to 75% among the general population and in patients undergoing cesarean section for 60%–70% of maternal hypotension.[1,2] Postspinal hypotension is mainly due to sympathetic blockade which causes peripheral vasodilation and venous pooling. As a result, there is a decrease in venous return and cardiac output which then causes hypotension.[1] The risk of hypotension increases in pregnant women undergoing cesarean section surgery that requires block levels as high as 4th thoracic segment dermatome. In addition, the risk of hypotension is also increased due to anatomic and physiological changes in pregnant women with artocaval compression and increased susceptibility to the effects of sympatheticomcy due to reduced sensitivity to endogenous vasoconstrictors coupled with increased synthesis of endothelium-derived vasodilators.[1,3]
Hypotension that occurs can cause adverse effects on both mother and fetus. Effects on the mother can include symptoms such as dizziness, nausea, vomiting, aspiration, syncope, and cardiac arrhythmias. Prolonged maternal hypotension can cause uteroplacental hypoperfusion which adversely affects the fetus.\textsuperscript{[1,4,5]} Risk factors for hypotension caused by spinal anesthesia have been investigated including age (≥35 years), body mass index more than 25 kg/m\(^2\), high block, large doses of local anesthetics, and large infants.\textsuperscript{[3]} To prevent the occurrence of hypotension due to spinal anesthesia can be done with nonpharmacological and pharmacological methods. Nonpharmacological methods are carried out using leg wrapping methods, inflatable splints/boots, or thromboembolic deterrent stockings, although these methods also provide less effective results.\textsuperscript{[6]} Pharmacological methods by administering intravenous vasopressor drugs Ephedrine bolus 5-15 mg or Phenylephrine 25-50 mcg, supplemental oxygen and intravenous fluid bolus administration.\textsuperscript{[3,6,7]}

There have been several studies on administering intravenous fluid boluses to reduce the occurrence of hypotension after spinal anesthesia in cesarean section surgery. Based on evidence from the literature, a method that has often been used to reduce the incidence of hypotension after spinal anesthesia is by administering intravenous fluids 10-15 ml/kg 15-20 min before spinal anesthesia. Several studies have shown results that the administration of preloading fluids reduces the incidence of hypotension after spinal anesthesia compared to if no preloading is given.\textsuperscript{[1]}

This study was conducted with the aim of comparing the effectiveness of crystalloid fluid preloading and coloading to decrease the incidence of hypotension in patients undergoing cesarean section surgery with spinal anesthesia.

**Methods**

This study is an experimental study single-blind clinical trial. The number of individuals who participated in this study was 51. Participants selected by consecutive sampling with inclusion criteria gravida patients aged 16–40 years with American Society of Anesthesiologists physical status (ASA) 1 or 2 who undergo elective cesarean section with spinal anesthesia, and there were no contraindications for spinal anesthesia. Individuals who refused to participate; those with Gemelli pregnancy; those with height of <150 cm or >180 cm; those with body weight of >100 kg; those with a history of allergies to local anesthetics; those with basal systolic pressure <90 mmHg, preeclampsia, and cardiac abnormalities; and participants who got a blood transfusion were excluded from the study. Individuals were excluded from the study if spinal anesthesia failed.

The participants will be divided into three groups: 17 participants in treatment Group 1 (P1) given 1000 ml of Ringer lactate fluid which is spent within 15 min before spinal anesthesia (preloading), 17 participants in treatment Group 2 (P2) given 1000 ml of Ringer lactate fluid which was spent within 15 min together with spinal anesthesia (coloading), and 17 control group (K) participants who were not given preloading or coloading fluids. Spinal anesthesia was done with levobupivacaine 0.5% plain 10 mg injected at L3–L4 site. This research was conducted at Mother and Child Hospital Dedari, Kupang, after obtaining the ethical approval from the Research Ethics Committee of the Faculty of Medicine, University of Nusa Cendana.

Hemodynamic parameters include systolic and diastolic blood pressure (DBP), mean arterial blood pressure, and pulse rate measured in basal conditions and 1, 2, 4, 6, 8, 10, 15, 20, 25 and 30 min postspinal anesthesia. Statistical analysis for the differences in hemodynamic parameters among the three groups of subjects were analyzed by the Repeated Measured Multivariate Analysis of Variance (MANOVA) test. Whereas Bonferroni post hoc test was used to compare the differences in hemodynamic parameters between each group. The difference was considered significant if the P value <0.05.

**Results**

The total number of participants in this study who met the inclusion and exclusion criteria was 51. At the time of the study, no participants had dropped out, so all the 51 participants were eligible whose data would then be analyzed.

The characteristics of participants based on age, physical status of ASA, and basal hemodynamic parameters are illustrated in the table below:

| Variable                  | Group 1             | Group 2             | Control            | P      |
|---------------------------|---------------------|---------------------|--------------------|--------|
| Age (years), mean±SD      | 31.7±4.9            | 31.3±5.4            | 30.3±6.1           | 0.405* |
| Physical status ASA       |                     |                     |                    |        |
| ASA 1 (%)                 | 0.0                 | 0.0                 | 0.0                | * b    |
| ASA 2 (%)                 | 100                 | 100                 | 100                |        |
| Basal SBP (mmHg), mean±SD | 121.4±11.4          | 125.9±8.8           | 118.8±10.1         | 0.128* |
| Basal DBP (mmHg), mean±SD | 76.4±6.7            | 79.7±5.9            | 77.3±6.6           | 0.295* |
| Basal MAP (mmHg), mean±SD | 91.8±6.9            | 95.3±6.2            | 90.4±7.6           | 0.116* |
| Basal pulse rate (x/minutes), mean±SD | 87.7±6.3          | 85.5±6.2            | 90.5±4.3           | 0.048* |

*One-way ANOVA test, *Chi-square test, *There are no statistical test results because the data are constant. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, SD: Standard deviation, ASA: American Society of Anesthesiologists
The characteristics of hemodynamic changes in each group illustrated the comparison of systolic blood pressure (SBP), DBP, pulse pressure, and pulse rate at 1, 2, 4, 6, 8, 10, 15, 20, 25, and 30 min. The mean SBP, DBP, mean arterial pressure (MAP), and pulse rate of sequence time posttreatment between the three groups of participants were significantly different with $P < 0.001$ [Tables 2-5]. Ephedrine requirements between the three samples were significantly different with $P < 0.001$, where the needs were most in the control group with a mean requirement of $8.8 \pm 4.2$ mg. Likewise, the incidence of nausea and vomiting was significantly different between the three sample groups where the most occurred in the control group that was as much as 90% [Table 6].

A comparison of decreases in SBP, DBP, MAP, and pulse rate between the treatment groups was performed with the Bonferroni post hoc test. In this test, the results showed that there were significant differences in SBP, DBP, and MAP reduction between the preloading group and the coloading group ($P < 0.001$), likewise between the coloading group and the control group ($P < 0.001$). The coloading group significantly decreases the reduction in SBP, DBP, and MAP compared to the preloading and control groups. Different results in the comparison of decreases in SBP, DBP, and MAP between the preloading group and the control group showed no significant difference ($P > 0.05$). In the comparison of the pulse rate parameters, there were no significant differences between the preloading and coloading groups ($P = 0.429$), as well as the comparison between the preloading and control groups ($P = 0.010$). However, the comparison of the coloading group with the control group found a significant difference ($P < 0.001$) [Table 7].

**DISCUSSION**

The results show that there is a statistically significant difference in the incidence of hypotension between the three groups. The incidence of hypotension seen from a reduction in SBP, DBP, and MAP decreased significantly in the coloading group compared with the preloading and control groups. This result is similar to the results of a study conducted by Rao et al. in 2015 comparing the effectiveness of preloading with coloading with crystalloid fluid in cesarean section with spinal anesthesia. In Rao study, the incidence of hypotension in the coloading group was significantly lower compared to the preloading group, where the incidence of hypotension in the coloading group was 40% ($P = 0.023$). This was also consistent with the results of the study of Oh et al. in 2014, where the incidence of hypotension was significantly lower in the coloading group compared to preloading group ($P = 0.026$).

This study also found that the need for ephedrine in the coloading group decreased significantly compared to the preloading and control groups ($P < 0.001$). This is similar to Rao’s study where the total dose of ephedrine needed...
The results of this study indicate that the incidence of hypotension after spinal anesthesia in cesarean patients compared with the administration of crystalloid fluids during vasodilation is more effective than prophylactic in preventing hypotension during spinal anesthesia in cesarean section surgery. The administration of fluid at the same time as the administration of local anesthesia into the intrathecal space is considered more rational to obtain maximum effect during the time of blockade because crystalloid fluid still persists intravascularly during vasodilation due to sympathetic blockade.\[9,10\]

Hypotension after spinal anesthesia usually occurs in the first 15–20 min, and this time is the time required by local anesthetic drugs to cause a certain level of nerve block and will persist. This is called fixation time.\[9\] The results of this study indicate that the administration of Ringer lactate fluid coloading has the effect of preventing blood pressure drops better than preloading in cesarean section. Crystalloids are not limited to the intravascular space; they are rapidly distributed into the extracellular space so that the administration of crystalloid fluids during vasodilation is more effective than prophylactic in preventing hypotension during spinal anesthesia in cesarean section surgery. The administration of fluid at the same time as the administration of local anesthesia into the intrathecal space is considered more rational to obtain maximum effect during the time of blockade because crystalloid fluid still persists intravascularly during vasodilation due to sympathetic blockade.\[9,10\]

**Table 5: Pulse rate parameters in the group of participants (n=17)**

| Variable               | Groups, mean±SD | P         |
|------------------------|-----------------|-----------|
| Pulse rate min 1 (mmHg) | 87.4±6.6        | <0.001*   |
| Pulse rate min 2 (mmHg) | 85.5±7.9        | <0.001*   |
| Pulse rate min 4 (mmHg) | 83.4±11.5       | <0.001*   |
| Pulse rate min 6 (mmHg) | 82.6±13.1       | <0.001*   |
| Pulse rate min 8 (mmHg) | 86.9±12.9       | <0.001*   |
| Pulse rate min 10 (mmHg)| 87.1±10.1       | <0.001*   |

*Repeated multivariate ANOVA test. SD: Standard deviation

**Table 6: Parameters of ephedrine requirements and the incidence of nausea and vomiting in the group of participants (n=17)**

| Variable               | Groups          | P         |
|------------------------|-----------------|-----------|
| Ephedrine requirements (mg), mean±SD | 2.4±2.6         | <0.001*   |
| The incidence of nausea and vomiting | 10 | 0 | 90 | <0.001* |

*Repeated multivariate ANOVA test, *Chi-square test

**Table 7: Comparison of changes in hemodynamic parameters between groups**

| Variable               | Comparison between groups | P         |
|------------------------|----------------------------|-----------|
| Decrease of SBP        | P1-P2                      | <0.001*   |
|                        | P1-K                       | 0.177*    |
|                        | P2-K                       | <0.001*   |
| Decrease of DBP        | P1-P2                      | <0.001*   |
|                        | P1-K                       | 0.087*    |
|                        | P2-K                       | <0.001*   |
| Decrease of MAP        | P1-P2                      | <0.001*   |
|                        | P1-K                       | 0.138*    |
|                        | P2-K                       | <0.001*   |
| Pulse rate             | P1-P2                      | 0.429*    |
|                        | P1-K                       | 0.010*    |
|                        | P2-K                       | <0.001*   |

*Bonferroni post hoc test. P1: Treatment Group 1 (preloading), P2: Treatment Group 2 (coloading), K: Control group, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure

Bali Journal of Anesthesiology | Volume 4 | Issue 1 | January-March 2020
Conflicts of interest
There are no conflicts of interest.

References
1. Bajwa SS, Kulshrestha A, Jindal R. Co-loading or pre-loading for prevention of hypotension after spinal anaesthesia: a therapeutic dilemma. Anesth Essays Res 2013;7:155-9.
2. Mercier FJ, Auge M, Hoffmann C, Fischer C, LeGouez A. Maternal hypotension during spinal anesthesia for cesarean delivery. Minerva Anestesiol 2013;79:62-73.
3. Tawfik MM, Hayes SM, Jacoub FY, et al. Comparison between colloid preload and crystalloid co-load in cesarean section under spinal anesthesia: a randomized controlled trial. International Journal of Obstetric Anesthesia (2014) 23, 317-23.
4. Loubert C. Fluid and vasopressor management for cesarean delivery under spinal anesthesia: Continuing Professional Development. JCan Anesth (2012) 59:604-19.
5. Butterworth JF, Mackey DC, Wasnick HD. Morgan & Mikhail’s Clinical Anesthesiology 5th ed. USA: McGraw-Hill Education, LLC; 2013.p 855-7, 955-9.
6. Kee WDN. Chapter 3 Uteroplacental Blood Flow in: Chesnut’s Obstetric Anesthesia 5th ed. Philadelphia: Elsevier Saunders; 2014. p 47-8.
7. Rao AR, Vijaya G, Mahendra BVVN. Comparison of Effects of Preloading and Colloading with Ringer Lactate in Elective Cesarean Cases Under Spinal Anesthesia. IOSR-JDMS Volume 14, Issue 10 Ver. II (Oct.2015):57-64.
8. Fikran Z, Tavianto D, Maskoen TT. Comparison of the Effect of Crystalloids Fluid Provision Before Spinal Anesthesia (Preload) and Shortly after Spinal Anesthesia (Co-load) on Maternal Hypotension Incidence in Caesarean Delivery. JAP.2016;4(2):124-30.
9. Oh AY, Hwang JW, Song IA, et al. Influence of the timing of administration of crystalloid on maternal hypotension during spinal anesthesia for cesarean delivery: preload versus coload. BMC Anesthesiol. 2014;14:1-5.
10. Melcier FJ. Cesarean delivery fluid management. Curr Opin Anesthesiol 2012;25:286-29.
11. Ni HF, Liu H, Zhang J, Peng K, Ji FH. Crystalloid Coload Reduced the Incidence of Hypotension in Spinal Anesthesia for Cesarean Delivery, When Compared to Crystalloid Preload : A Meta-Analysis. Hindawi BioMed Res Int 2017: 3462529:1-10.