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ORIGINAL ARTICLE

Effect of Passive Leg Raising on Blood Pressure in Post-Spinal Anesthesia Caesarean Section Patients: A Study at PKU Muhammadiyah Bantul Hospital

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ABSTRACT

Introduction: *Sectio Caesarea mostly uses spinal anesthesia and is most commonly used. The effect of spinal anesthesia is hypotension. In a study of sectio caesarea more than 40% experienced hypotension. Passive Leg Raising (PLR) can be an alternative for the incidence of hypotension in sectio caesarea spinal anesthesia patients.* ***Objectives:*** *This study aims to determine the effect of passive leg raising on the increase in blood pressure of post spinal anesthesia sectio caesarea patients in the intervention and control groups at PKU Muhammadiyah Bantul Hospital.* ***Methods:*** *This type of research is quantitative experiment with quassy experimental design pre-test post-test with control group. The sampling technique used simple random sampling technique with a total of 30 respondents.* ***Results:*** *The results of the Wilcoxon test on systolic blood pressure with a p-value in the intervention group of 0.001 <0.05 and the control group of 0.007 <0.05, while in diastolic blood pressure, the p-value of the intervention group was 0.001 <0.05 and the control group was 0.001 <0.05. In the results of the mann-whitney test, the p-value on systolic blood pressure was 0.008<0.05 and diastolic blood pressure was 0.005<0.05.* ***Conclusions:*** *There is a significant effect between Passive Leg Raising (PLR) on blood pressure of post spinal anesthesia sectio caesarea patients at PKU Muhammadiyah Bantul Hospital.*

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A. Introduction

Childbirth is a natural event that every pregnant woman will experience. This moment of childbirth is eagerly awaited, as it is here that they will meet their child and see their new face (Siregar et al., 2023). There are two methods of childbirth: normal childbirth through spontaneous labor and abnormal childbirth through a cesarean section procedure. A cesarean

section (SC) is a procedure to deliver a baby, involving an incision in the abdominal wall and uterus. This procedure is known as a cesarean section (SC). This procedure is often necessary for various medical reasons, including placenta previa, prolonged labor, umbilical cord prolapse, malpresentation or transverse lie of the fetus, and preeclampsia (Purba et al., 2021).

According to the WHO (2021), one in five births worldwide is currently performed via cesarean section (21%), and this percentage is expected to increase over the next ten years. By 2030, cesarean sections are projected to account for nearly one-third (29%) of all births. Based on data from RISKESDAS (2021), the percentage of births via cesarean section in Indonesia reached 17.6%, while the cause of cesarean sections was due to complications, with a percentage of 23.2%. One of the anesthetic techniques used in cesarean sections is the neuraxial spinal anesthesia technique, which is highly preferred and the safest for cesarean section surgeries and emergency procedures (Armstrong, 2017).

Spinal anesthesia is a method in which spinal medication is injected into the subarachnoid space, which can block pain resulting from the anesthetic effect in the desired area (Karlina, 2020). Spinal anesthesia techniques have advantages in terms of their simplicity and effectiveness in blocking sensory and motor functions, especially in lower extremity surgery (Santoso et al., 2023). SC surgery carries several potential risks that may endanger the health of the mother and baby. One of the possible risks is hemodynamic compromise due to spinal anesthesia, which can cause hypotension (Pontoh et al., 2023).

Hypotension is a condition in which blood pressure decreases by 20–30% from the initial blood pressure before spinal anesthesia is administered (Wahyuni & Octiara, 2021) The parameters of hemodynamic monitoring are systolic and diastolic blood pressure, namely Mean Arterial Pressure (MAP). If MAP is less than 70 mmHg, tissue perfusion may be impaired. Additionally, if systolic blood pressure reaches 20% of diastolic pressure before surgery, hypotension may occur (Hendro Mustaqim et al., 2021). A study conducted by Nika et al., (2023) found that out of 65 respondents, more than 40% experienced hypotension each month. According to the National Guidelines for Medical Services in Anesthesiology and Intensive Care, No. HK. 01. 07/MENKES/1541/2022, complications and side effects of anesthesia during childbirth via cesarean section include respiratory failure, low blood pressure, nausea, vomiting, pain, and dizziness.

Hypotension experienced by pregnant women can lead to unwanted complications. In addition to the adverse effects it causes, including death, hypotension can reduce blood flow in the ureteropelvic junction through mechanisms such as decreased perfusion pressure, blood diversion to the lower extremities, and response to administered vasopressors (Wirawan et al., 2021). Factors contributing to hypotension complications include age, gender, surgical timing, puncture site, rehydration fluids, vasopressor use, sympathetic block depth, body mass index, spinal anesthesia position, and physical status (Yüksek et al., 2020).

The effects caused by post-spinal anesthesia hypotension are very dangerous if left untreated, so patients must be monitored to prevent hypotension after receiving anesthesia. Hypotension problems associated with spinal anesthesia can be prevented using two approaches: pharmacological and non-pharmacological. Pharmacological prevention can be achieved through the administration of vasopressor medications and fluid loading. Non-pharmacological methods include leg elevation or Passive Leg Raising (PLR) and leg compression (Kinanti et al., 2024). In emergency situations, Passive Leg Raising (PLR) can be the first intervention for hypovolemic and hypotensive patients before fluid resuscitation is administered (Yunus et al., 2023).

Passive Leg Raising (PLR) is an alternative method for predicting fluid response in patients. The primary objective of PLR is to increase blood pressure or cardiac preload by redirecting a certain volume of blood from the lower extremities to the thoracic cavity, particularly the heart. It is anticipated that this will result in an increase in blood pressure and the volume of blood returning to the heart following the PLR procedure (Mallat et al., 2022). PLR works by

transferring approximately 300 mL of blood volume from the veins in the lower extremities to the heart (Hastuti et al., 2022). In the study by Rahma & Arofiati (2024), it was explained that the results of the PLR intervention study showed an increase in systolic, diastolic, and MAP blood pressure of ≥ 10%.

On December 4, 2024, researchers conducted a preliminary study of surgical data at PKU Muhammadiyah Bantul Hospital, specifically the total number of spinal anesthesia cesarean section surgeries. The surgical data collected covered the last three months of September, October, and November 2024. Based on the preliminary study conducted on cesarean section surgery data over the past three months at PKU Muhammadiyah Bantul Hospital, the mean number of patients undergoing spinal anesthesia for cesarean section was 43 patients. Hypotension occurred in more than 50% of cesarean section surgeries.

B. Methods

This study uses a quantitative experimental approach and a quasi-experimental design. An experimental research design is a design that uses interventions aimed at determining the impact of the intervention on one or more intervention groups (Sugiyono, 2022). The purpose of this study is to understand the effect of Passive Leg Raising (PLR) on blood pressure in patients receiving spinal anesthesia post-cesarean section at PKU Muhammadiyah Hospital in Bantul.

In this study, a pre-test and post-test research design with a control group was applied. Pre-tests and post-tests were administered to the intervention group and the control group. This design involves a control group, but it is unable to address confounding variables that may interfere with the implementation of the experiment or research. In designing the pre-test and post-test with a control group, random sampling was used to divide the participants into the intervention group and the control group. The division was based on odd/even numbers among the respondents.

In this study, the population consisted of 127 patients who underwent spinal anesthesia SC at PKU Muhammadiyah Hospital in Bantul during the period from September to November 2024. In the previous three months, the average number of patients undergoing spinal anesthesia for cesarean section was 43 patients.

This study applied random sampling, often referred to as simple random sampling. Simple random sampling is the selection of subjects from a population using a random procedure. By conducting random sampling, researchers can determine the probability of subjects being selected for the sample (Pinzon & Edi, 2021). The sample size I will use is 30 samples, with 15 samples in the intervention group and 15 samples in the control group. To avoid dropouts, the sample will be increased by 10% of the total sample, resulting in 33 samples, rounded up to 34 samples.

Two types of analysis were used in the data analysis: univariate and bivariate. The univariate analysis in this study examined the characteristics of the respondents, namely age, occupation, ASA physical status, and changes in blood pressure. In the bivariate analysis, the Wilcoxon test was used to determine the difference in results between the pre-test and post-test groups because the paired data were not normally distributed. After the Wilcoxon test, the Mann-Whitney test will be conducted. The Mann-Whitney test is performed to compare two unrelated groups; in this study, these groups are the intervention group and the non-intervention group.

C. Results

Passive Leg Raising (PLR) affects the blood pressure of patients who have undergone cesarean section surgery with spinal anesthesia. All findings from the study conducted at PKU Muhammadiyah Bantul Hospital will be presented. The results to be presented in this results section include a general description of PKU Muhammadiyah Bantul Hospital, respondent

characteristics in univariate analysis, and results to be analyzed and compared in bivariate analysis. The researcher conducted the study at PKU Muhammadiyah Bantul Hospital on patients who had undergone spinal anesthesia cesarean section surgery. The univariate analysis results to be presented include respondent characteristics such as age and ASA physical status. The sample used in this study consisted of 30 respondents. The effects on blood pressure after Passive Leg Raising (PLR) and fluid loading in patients who have undergone post-spinal anesthesia cesarean section will be explained in the bivariate analysis.

Table 1: Respondent Characteristics

Variable	Category	Intervention Group		Control Group	
		f	%	f	%
Age	17-25 years	2	13.3	3	20
	26-35 years	9	60	8	53.3
	36-45 years	4	26.7	4	26.7
ASA	ASA I	1	6.7	3	20
	ASA II	14	93.3	12	80

Table 1 describe the characteristics of the 30 respondents in the study conducted. Respondents in the 17-25 age group numbered 5 people (16.7%), those aged 26-35 numbered 17 people (56.7%), and those aged 36-45 numbered 8 people (26.7%). The results obtained for ASA I were 4 people (13.3%), while ASA II was 26 people (86.7%). Based on the characteristics of the respondents, ASA II was the most common ASA physical status characteristic.

Table 2: Change in Systolic Blood Pressure

Classification	Intervention Group				Control Group			
	Pre Test		Post Test		Pre Test		Post Test	
	f	%	f	%	f	%	f	%
Optimal	15	100	1	6.7	15	100	7	46.7
Normal	0	0	9	60	0	0	7	46.7
Normal-high	0	0	5	33.3	0	0	1	6.7
Grade 1 Hypertension	0	0	0	0	0	0	0	0
Grade 1 Hypertension	0	0	0	0	0	0	0	0

The table above shows the results of changes in blood pressure before and after the test. The pre-test results for systolic blood pressure in the intervention group showed that 15 people were in the optimal classification (100%). The post-test results showed that 1 patient (6.7%) was in the optimal classification, 9 patients (60%) were in the normal classification, and 5 patients (33.3%) were in the high-normal classification. In the pre-test results, the systolic pressure of the control group was optimal in 15 patients (100%). The post-test results showed that 7 patients (46.7%) were classified as optimal, 7 patients (46.7%) were classified as normal, and 1 patient (6.7%) was classified as normal-high. There was a significant increase from before and after fluid loading.

Table 3: Change in Diastolic Blood Pressure

Classification	Intervention Group				Control Group			
	Pre Test		Post Test		Pre Test		Post Test	
	f	%	f	%	f	%	f	%
Optimal	14	73.3	1	6.7	6	40	2	13.3
Normal	4	26.7	0	0	8	53.3	5	33.3
Normal-high	0	0	7	46.7	1	6.7	7	46.7
Grade 1 Hypertension	0	0	7	46.7	0	0	1	6.7
Grade 1 Hypertension	0	0	0	0	0	0	0	0

The table above shows the results of changes in blood pressure before and after the test. The pre-test results for diastolic blood pressure in the intervention group were optimal in 11 patients (73.3%) and normal in 4 patients (26.7%). The post-test results showed 1 patient (6.7%) classified as optimal, 7 patients (46.7%) as normal-high, and 7 patients (46.7%) as Stage 1 hypertension. There was a significant increase from before and after the PLR intervention. In the pre-test and post-test blood pressure changes. The pre-test results for

diastolic blood pressure in the control group were optimal in 6 patients (40%), normal in 8 patients (53.3%), and normal-high in 1 patient (6.7%). The post-test results showed 2 patients (13.3%) classified as optimal, 5 patients (33.3%) as normal, 7 patients (46.7%) as normal-high, and 1 patient (6.7%) as Stage 1 hypertension. There was a significant increase from before and after PLR.

Table 4: Wilcoxon Test of Systolic Blood Pressure

Group	N	Mean	Std. Deviation	Min.	Max.	p-value
Intervension Pre Sistolik	15	1.00	0.000	1	1	0.001
Intervension Post Sistolik	15	2.27	0.594	1	3	
Control Pre Sistolik	15	1.00	0.000	1	1	0.007
Control Post Sistolik	15	1.60	0.632	1	3	

In the results of the Wilcoxon test analysis above, systolic blood pressure was found in the intervention group and control group with details, the intervention group with a significance value of 0.001 ($p<0.05$) and the control group with a significance value of 0.007 ($p<0.05$). The results indicate a difference between pre-test and post-test systolic blood pressure in both the intervention group and the control group.

Table 5: Wilcoxon Test of Diastolic Blood Pressure

Group	N	Mean	Std. Deviation	Min.	Max.	p-value
Intervension Pre Sistolik	15	1.27	0.458	1	2	0.001
Intervension Post Sistolik	15	3.33	0.816	1	4	
Control Pre Sistolik	15	1.67	0.617	1	3	0.001
Control Post Sistolik	15	2.47	0.834	1	4	

The results of the Wilcoxon test analysis of diastolic blood pressure in the intervention group and control group showed that the intervention group had a significance value of 0.001 ($p<0.05$) and the control group had a significance value of 0.001 ($p<0.05$). The results obtained indicate a difference between the pre-test and post-test diastolic blood pressure in the intervention group and the control group.

Table 6: Mann-Whitney Test Systolic Blood Pressure

Group	Mean	Z	Asymp. Sig. (2-tailed)
Intervension	19.37	-2.653	0.008
Control	11.63		

The table above shows the results of the Mann-Whitney test on systolic blood pressure between the intervention group and the control group. The results obtained were a mean of 19.37 for the intervention group and a mean of 11.63 for the control group. The p-value of the Mann-Whitney test was $0.008<0.05$.

Table 7: Mann-Whitney Test Diastolic Blood Pressure

Group	Mean	Z	Asymp. Sig. (2-tailed)
Intervension	19.73	-2.816	0.005
Control	11.27		

The table above shows the results of the Mann-Whitney test for diastolic blood pressure in the intervention group and the control group. The results obtained were a mean of 19.37 for the intervention group and a mean of 11.63 for the control group. The P-value of the Mann-Whitney test was $0.005<0.05$.

D. Discussion

Frequency Distribution of Respondent Characteristics

The study conducted on patients who underwent spinal anesthesia for cesarean section divided the characteristics of the respondents into two categories: age and ASA physical status.

The results of data processing in the age category showed that 17-25 years old (16.7%), 26-35 years old (56.7%), and 36-45 years old (28.7%). The table in the results shows that half of the participants were from the 26 to 35 age group. In the ASA physical status category, it was found that the majority of participants were in ASA II, with a percentage of 86.7%.

Hypotension can occur during spinal anesthesia due to sympathetic nerve pressure, which controls smooth muscle tension in blood vessels. Increased sympathetic nerve activity causes blood vessels to dilate, affecting blood volume and reducing blood flow returning to the heart (Chandraningrum et al., 2022). Age, sympathetic block height, gender, ASA physical status, BMI, surgical duration, rehydration fluids, and vasopressor use are factors influencing hypotension (Nika et al., 2023).

Based on the results obtained using existing theories, the data shows that as age increases, blood pressure also increases. The cause of high blood pressure is decreased blood elasticity and thickening of the left ventricle and valves in the heart (Chasanah & Sugiman, 2022).

Changes in Pre and Post Blood Pressure in the PLR Intervention Group and the Fluid Loading Control Group

Research conducted on systolic and diastolic blood pressure yielded Wilcoxon test results showing significant values for systolic blood pressure in the intervention group (0.001<0.05) and the control group (0.007<0.05), while the significant value for diastolic blood pressure in the intervention group was 0.001<0. 005, and the control group at 0.001<0.05. Based on these results, it can be concluded that there is a difference between pre-test and post-test systolic and diastolic blood pressure in the PLR group and the control group, or Ha is accepted and H0 is rejected.

The results obtained from data processing show that the intervention group, namely Passive Leg Raising (PLR), had a higher difference compared to the fluid loading control group. This PLR action can be used as a reference for patients experiencing hypotension because if PLR is combined with fluid loading, it will help patients raise their blood pressure more quickly.

Spinal anesthesia is one of the factors contributing to a decrease in blood pressure in pregnant women undergoing cesarean section. The application of spinal anesthesia can reduce venous flow, especially when the patient is in a supine position (Puspitasari et al., 2023). The patient's response to spinal anesthesia is influenced by the decrease in blood pressure caused by the blockade of the venous system, leading to vasodilation. This, in turn, causes arterioles to obstruct the return of venous blood to the heart, resulting in blood accumulation. The reduction in venous blood flow to the heart leads to a decrease in cardiac output, circulating volume, and blood pressure (Nika et al., 2023).

Of the two groups that underwent treatment, Passive Leg Raising (PLR) was proven to increase blood pressure more quickly than fluid loading alone. Assistance in situations of hypotension needs to be provided as quickly as possible to reduce the possibility of the patient's condition worsening after surgery. PLR is considered quite effective in raising blood pressure in a short time and is even more effective when assisted by fluid loading. This occurs because elevating the lower extremities causes fluid to flow from the lower extremities into the venous return. Fluid loading can indeed raise blood pressure in hypotensive patients, but excessive fluid use can lead to negative effects such as pulmonary edema (Ferré et al., 2020).

Comparison of Blood Pressure Results in the Intervention Group and Control Group

Based on the research conducted, data analysis was performed to compare the results of the two groups using the Mann-Whitney test. This analysis was conducted to determine whether there was a significant difference between the intervention group and the control group. The results obtained from the Mann-Whitney analysis showed that the mean systolic blood pressure in the intervention group or PLR was 19.37, while in the control group it was 11.63. For diastolic blood pressure, the mean obtained for the intervention group or PLR was 19.73,

while for the control group it was 11.27. For the p-value results, systolic blood pressure was 0.008<0.05, while diastolic blood pressure was 0.005<0.05.

The conclusion that can be drawn from the results is that there is a clear or significant difference between the intervention group or PLR and the control group in terms of systolic and diastolic blood pressure measurements, so H0 is rejected and Ha is accepted.

During the administration of spinal anesthesia during the anesthesia process, one of the effects experienced by the patient is a decrease in blood pressure, caused by the drug's direct effect on smooth muscle in veins and the dilation of blood vessels in almost all veins and arteries throughout the body. The ongoing dilation process causes blood to accumulate in venous flow, while the relaxation of smooth muscle results in suboptimal blood distribution in the periphery. As a result, cardiac output is impaired because the blood flow that is not properly distributed to the heart chambers decreases (Sajidah et al., 2020). Poor blood distribution can be addressed through several methods to restore proper blood flow, such as fluid loading, medication administration, and Passive Leg Raising (PLR).

PLR intervention has been proven to increase blood pressure in patients experiencing hypotension after spinal anesthesia. Passive Leg Raising (PLR) helps accelerate blood flow to the heart from the lower extremities. PLR can increase cardiac preload. The mechanism of PLR is similar to Earth's gravity, where blood returns from the lower extremities to the thoracic cavity, thereby increasing venous return. The resulting blood volume is larger and subsequently enters the heart, after which the blood can increase the volume of blood pumped by the heart. The venous return that occurs increases cardiac preload. The increased preload improves cardiac contraction and output (Rahma & Arofiati, 2024).

PLR intervention itself can be an alternative to increase venous and arterial resistance, which in turn can improve myocardial and cerebral blood flow. In addition, PLR can also be used to predict fluid responsiveness in shock patients (Boontoterm & Feungfoo, 2021). PLR is not intended as a complete replacement for fluid therapy but as a temporary alternative during emergencies or critical situations. If hypotension is managed solely through fluid loading, it may take longer to achieve the desired effect. However, if fluid loading is supplemented with PLR, the results will be more effective in accelerating the resolution of hypotension in patients.

Implication and limitation

The findings of this study demonstrate that Passive Leg Raising (PLR) is an effective non-pharmacological intervention for increasing blood pressure in patients experiencing hypotension following spinal anesthesia in cesarean section procedures. This highlights the importance of integrating simple, rapid, and low-risk interventions into perioperative nursing care to stabilize hemodynamic status. The results suggest that PLR can be used as an initial or adjunctive intervention alongside fluid therapy to accelerate blood pressure recovery and prevent complications associated with hypotension. However, this study has several limitations. The quasi-experimental design with a relatively small sample size may limit the generalizability of the findings. The short observation period restricts the evaluation of long-term hemodynamic outcomes. Additionally, potential confounding factors such as fluid administration, patient positioning, and individual physiological variability were not fully controlled. Future studies using randomized controlled designs and larger samples are recommended to strengthen the evidence.

Relevance for Practice

This study provides important practical implications for perioperative and anesthesia nursing practice by emphasizing the role of Passive Leg Raising as a rapid and effective intervention to manage hypotension after spinal anesthesia in cesarean section patients. Nurses and healthcare providers can implement PLR as part of standard monitoring and early management protocols to improve venous return, enhance cardiac preload, and stabilize blood pressure. Incorporating PLR into routine clinical practice can reduce the risk of hemodynamic

complications, improve patient safety, and optimize postoperative recovery outcomes, particularly in resource-limited healthcare settings.

E. Conclusion

Based on the results of the research and discussion described above, it can be concluded that Passive Leg Raising (PLR) has an effect on the blood pressure of patients undergoing spinal anesthesia for cesarean section. The majority of respondents in this study were of productive age, between 26 and 35 years old, and had ASA II status. Changes in blood pressure between the intervention and control groups showed significant differences before and after the intervention. There were significant changes between the intervention group and the control group. Suggestions for future researchers, this study could be further developed and improved in other spinal anesthesia populations. Researchers could create leg supports so that when performing PLR, researchers do not have to lift the patient themselves. Patients using vasopressors could be excluded from the inclusion criteria.

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Author Contribution

Muhammad Sobari Rasidin contributed to the study conceptualization, data collection, and initial manuscript drafting. Istiqomah Rosidah contributed to the study design, data analysis, and interpretation of the results. Aisyah Nur Azizah contributed to supervision, critical revision of the manuscript, and final approval of the manuscript. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Declaration of Conflicting Interest

The authors declare no conflict of interest.

Declaration of Use of AI in Scientific Writing

The authors declare that generative AI and AI-assisted technologies were used to support language editing and grammatical refinement of the manuscript.

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