Jurnal Penelitian Kesehatan Suara Forikes (Journal of Health Research Forikes Voice)
DOI: http://dx.doi.org/10.33846/sf170508
RESEARCH
p-ISSN 2086-3098 e-ISSN 2502-7778
Volume 17 Number 5, May 2026

Increase in Blood Pressure among Post–spinal Anesthesia Hypotensive Patients Following 30° and 45° Leg Elevation

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ABSTRACT

Spinal anesthesia commonly induces hemodynamic alterations, particularly post–spinal anesthesia hypotension resulting from sympathetic blockade of efferent preganglionic vasomotor fibers. This sympathetic inhibition reduces vascular tone and venous return, leading to a decline in systolic blood pressure. Leg elevation is a simple, non-pharmacological maneuver that may enhance venous return through gravitational redistribution of blood toward the central circulation. This study aimed to determine the effectiveness of 30° and 45° leg elevation in increasing blood pressure among patients experiencing hypotension after spinal anesthesia. A quasi-experimental design employing a Three-Group Pretest–Posttest Control Group Design was used. A total of 30 respondents were selected through purposive sampling and allocated into three groups. Respondents met the inclusion criteria of post–spinal anesthesia hypotension (80 mmHg < systolic ≤ 100 mmHg). The independent variables were 30° leg elevation and 45° leg elevation, while the dependent variable was systolic blood pressure. Statistical analyses included normality testing, homogeneity testing, paired t-test, independent t-test, and one-way ANOVA. The results demonstrated a significant difference in systolic blood pressure following the application of 30° and 45° leg elevation, with a p-value of 0.000 ($p < 0.005$) and a mean difference of 12.3 mmHg. The 45° leg elevation produced a greater increase in systolic blood pressure compared to the 30° elevation. In conclusion, leg elevation at 45° is more effective in increasing systolic blood pressure among post–spinal anesthesia hypotensive patients. A higher elevation angle facilitates greater gravitational blood flow toward the heart, thereby enhancing venous return and improving systolic blood pressure.

Keywords: 30° leg elevation; 45° leg elevation; blood pressure; hypotension; spinal anesthesia

INTRODUCTION

Surgery represents a fundamental medical intervention involving invasive techniques such as making incisions on the skin surface to repair, remove, or modify specific anatomical structures, followed by wound closure through suturing [1]. Patients undergoing surgical procedures require anesthesia to ensure analgesia, muscle relaxation, and optimal operating conditions. Among the various anesthetic modalities, spinal anesthesia is widely utilized due to its strong sensory and motor blockade, rapid onset, and relatively fewer adverse effects compared with general anesthesia [2]. Despite its advantages, spinal anesthesia is well known to induce hemodynamic alterations, including changes in heart rate, mean arterial pressure, and both systolic and diastolic blood pressure [3]. One of the most frequent complications associated with spinal anesthesia is hypotension, occurring in approximately 20–70% of patients [4].

Hospital-based data further highlight the magnitude of this issue. At RSUD Kanjuruhan, Malang Regency, 165 patients underwent surgical procedures under spinal anesthesia in December 2022, with hypotension reported in 83% of cases; in cesarean section procedures, the incidence ranged between 60–70% [5,6]. Similarly, hypotension following spinal anesthesia reached 49% at RS Dr. Hasan Sadikin [7]. Another study conducted at RSUP Prof. Dr. Kandou demonstrated that all patients undergoing cesarean section experienced a reduction in systolic blood pressure after receiving spinal anesthesia with bupivacaine [8]. These findings collectively underscore that post–spinal anesthesia hypotension remains a significant clinical concern across various healthcare settings.

Hypotension following spinal anesthesia may arise from disturbances in preload, cardiac output, and systemic vascular resistance [9]. The sympathetic blockade of efferent preganglionic vasomotor fibers results in the loss of venous tone, thereby reducing venous return and precipitating hypotension [3]. This sympathetic inhibition also compromises the functional integrity of venous walls and venous valves in the lower extremities, making it difficult for blood to return to the heart effectively [10]. The severity of hypotension is strongly influenced by the height of the sensory block achieved; higher block levels, particularly those reaching the cervical vertebrae, are associated with more profound hypotension compared with thoracic-level blocks [11,12]. Severe hypotension is considered one of the dangerous complications of spinal anesthesia and may progress to cardiac arrest if not promptly managed [3].

Non-pharmacological interventions are often employed to stabilize blood pressure, one of which is leg elevation. Leg elevation involves positioning the lower extremities higher than the level of the heart to facilitate gravitational redistribution of blood toward the central circulation [3]. Elevating the legs increases hydrostatic pressure in the peripheral veins, creating a pressure gradient between the distal extremities and the central compartment. When venous tone is diminished due to sympathetic blockade, this pressure gradient allows blood to flow passively from the elevated lower extremities toward the heart, thereby enhancing venous return and improving systolic blood pressure [13].

Previous studies have demonstrated the effectiveness of leg elevation in mitigating post–spinal anesthesia hypotension. Research on Leg Elevation decreases the incidence of post spinal hypotension in cesarean section reported a significant hemodynamic effect at a 45° elevation angle [11]. Another study found that a 30° elevation significantly improved blood pressure stability, with a p-value of 0.000 [3]. These findings suggest that both 30° and 45° leg elevation may be beneficial in restoring blood pressure among patients experiencing hypotension after spinal anesthesia.

Based on the above evidence, leg elevation at 30° and 45° appears to be a promising non-pharmacological strategy for improving blood pressure in post–spinal anesthesia hypotensive patients. However, the comparative effectiveness between these two elevation angles remains unclear. This gap in knowledge prompted the present study, which aims to investigate the effectiveness of 45° and 30° leg elevation in improving blood pressure among patients experiencing hypotension after spinal anesthesia.

METHODS

This study was conducted among patients experiencing hypotension following spinal anesthesia between April and May 2023 at RSUD Kanjuruhan, Malang Regency, specifically in the recovery room area. The research employed a Three-Group Pretest–Posttest Control Group Design, allowing comparison of hemodynamic changes between a control group and two intervention groups receiving different leg elevation angles.

The study population consisted of all postoperative patients who underwent spinal anesthesia at RSUD Kanjuruhan. Respondents were selected based on predefined inclusion and exclusion criteria to ensure sample homogeneity and minimize confounding factors. The inclusion criteria were: (1) patients experiencing post–spinal anesthesia hypotension (80 mmHg < systolic ≤ 100 mmHg); (2) individuals aged 20–60 years; and (3) postoperative patients who had received spinal anesthesia. The exclusion criteria were: (1) a history of cardiac disease; (2) blood loss exceeding 1000 ml accompanied by fluid resuscitation greater than 1000 ml within one hour; and (3) obesity (BMI > 25).

A total of 30 respondents meeting the eligibility criteria were enrolled and subsequently assigned into three groups: a control group (n = 10), a 30° leg elevation group (n = 10), and a 45° leg elevation group (n = 10). The control group received standard postoperative care according to the hospital's operating procedures. In contrast, respondents in the intervention groups received leg elevation therapy for 10 minutes. Blood pressure measurements were taken after the 10-minute intervention using a calibrated digital sphygmomanometer.

The leg elevation procedure was standardized to ensure consistency across participants. The intervention involved placing an inflatable pillow beneath the patient's feet, with the elevation angle measured using a protractor. If the desired elevation height was insufficient, folded blankets were added to achieve the correct angle. The therapy was administered while the patient was in a supine position, with the head supported by a pillow to maintain comfort and alignment.

The research workflow consisted of several sequential steps: (1) obtaining formal approval from the institutional research authority; (2) submitting an ethical clearance application to the Research Ethics Committee of RSUD Kanjuruhan, Malang Regency; (3) providing respondents with detailed information regarding the study's purpose and procedures, followed by obtaining written informed consent; (4) assigning consenting respondents to one of the three study groups; (5) measuring blood pressure before and after the intervention using a digital sphygmomanometer; and (6) analyzing the collected data by comparing pre- and post-intervention blood pressure values across the three groups. Statistical analyses were performed using SPSS software and included paired t-tests, independent t-tests, one-way ANOVA, and Tukey's post hoc test to determine significant differences between groups.

RESULTS

Descriptive statistics of respondent characteristics

To provide a comprehensive overview of the study sample and strengthen the interpretation of the hypothesis testing, respondent characteristics are presented in tabular form. The distribution of respondents based on sex, age, and type of surgery. Table 1 indicates that in the control group, the majority of respondents (70%) were female. In contrast, the 30° leg elevation group consisted predominantly of male respondents (60%), whereas the 45° leg elevation group was dominated by female respondents (60%). This pattern may be influenced by hormonal variations in women, which are known to affect cardiovascular regulation and vascular responsiveness [14].

Regarding age distribution, nearly half of the respondents in the control group (40%) were aged 41–50 years, and another 40% were aged 51–60 years. In the 30° leg elevation group, most respondents (60%) were aged 51–60 years, and similarly, the 45° leg elevation group had a majority (70%) within the same age range. Age is a well-established determinant of blood pressure; as individuals grow older, arterial stiffness increases and vascular elasticity decreases, contributing to changes in systolic and diastolic pressure due to reduced compliance of the vessel walls [14].

Based on the type of surgery, nearly half of the control group (40%) underwent orthopedic procedures. In the 30° leg elevation group, almost all respondents (80%) underwent urological surgery. Meanwhile, in the 45° leg elevation group, approximately one-third of respondents (30%) underwent urological, orthopedic, or gynecological surgery. These variations may be associated with the relatively short duration of these procedures (< 60 minutes), during which residual effects of spinal anesthetic agents may still influence hemodynamic parameters [15].

Table 1. Demograpic characteristics of respondents

Demographic characteristics	Control group		30° leg elevation group		45° leg elevation group	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Sex						
Male	3	30	6	60	4	40
Female	7	70	4	40	6	60
Age						
20–30 years	0	0	1	10	0	0
31–40 years	2	20	1	10	2	20
41–50 years	4	40	2	20	1	10
51–60 years	4	40	6	60	7	70
Type of surgery						
Urological surgery	3	30	8	80	3	30
Orthopedic surgery	4	40	1	10	3	30
Gynecological surgery	1	10	0	0	3	30
Digestive surgery	1	10	0	0	1	10
General surgery	1	10	1	10	1	10

Normality and homogeneity testing

Table 2. The results of normality test and homogeneity test

Shapiro–Wilk		Levene's Test	
Variable	p-value	Variable	p-value
Systolic blood pressure pre-test (control group)	0.124	Pre-test systolic blood pressure (control vs. intervention groups)	0.169
Systolic blood pressure pre-test (30° leg elevation)	0.211	Post-test systolic blood pressure (control vs. intervention groups)	0.112
Systolic blood pressure pre-test (45° leg elevation)	0.508		

To determine whether the data met the assumptions required for parametric analysis, normality and homogeneity tests were conducted. Shapiro–Wilk was used to assess normality, while Levene's test was applied to evaluate homogeneity. Based on Table 2, the Shapiro–Wilk test yielded significance values greater than 0.05 for all three groups, indicating that the data were normally distributed. Table 3 shows that the Levene's test results for both pre-test (0.169) and post-test (0.112) systolic blood pressure were greater than 0.05, demonstrating that the data were homogeneous. Given that both assumptions were met, parametric tests were deemed appropriate for hypothesis testing.

Analysis of blood pressure increase

Table 4 demonstrates that the one-way ANOVA and Tukey post hoc tests revealed significant differences between the groups. The comparison between the control group and the 30° leg elevation group showed a significant difference (p = 0.000), with a mean difference of –6.900, indicating that systolic blood pressure in the 30° group was higher than in the control group. Similarly, the comparison between the control group and the 45° leg elevation group showed a significant difference (p = 0.000), with a mean difference of –19.200, indicating that the 45° elevation produced a substantially greater increase in systolic blood pressure. The comparison between the 30° and 45° leg elevation groups also showed a significant difference (p = 0.000), with a mean difference of –12.300, demonstrating that the 45° elevation resulted in a higher systolic blood pressure increase than the 30° elevation. Overall, these findings indicate that 45° leg elevation produced the greatest improvement in systolic blood pressure, outperforming both the 30° elevation and the control group. Thus, 45° leg elevation is the most effective intervention for increasing blood pressure in post–spinal anesthesia hypotensive patients.

Table 4. Analysis of systolic blood pressure increase

Comparison	Mean difference (post-SBP)	Std. error	p-value
Control vs. 30° leg elevation	-6.900	1.320	0.000
Control vs. 45° leg elevation	-19.200	1.320	0.000
30° leg elevation vs. control	6.900	1.320	0.000
30° leg elevation vs. 45° leg elevation	-12.300	1.320	0.000
45° leg elevation vs. control	19.200	1.320	0.000
45° leg elevation vs. 30° leg elevation	12.300	1.320	0.000

DISCUSSION

Blood circulation in the human body begins when deoxygenated blood enters the right atrium from the systemic circulation through the superior and inferior vena cava, as well as from the myocardium through the coronary sinus. From the right atrium, blood flows into the right ventricle through the tricuspid valve. As pressure within the right ventricle increases, the pulmonary semilunar valve opens, allowing blood to be ejected into the pulmonary arteries and transported to the lungs. After undergoing gas exchange, oxygen-rich blood returns to the left atrium via the pulmonary veins. The left atrium then propels blood into the left ventricle through the bicuspid (mitral) valve, after which the left ventricle pumps blood into the systemic circulation through the aorta, supplying oxygenated blood to all body tissues [16].

When blood flows into the ventricles, myocardial fibers undergo stretching. This stretch enhances the strength of contraction due to the actin and myosin filaments approaching an optimal degree of overlap, thereby generating maximal contractile force. During ventricular contraction, systolic pressure rises. The stretching of myocardial fibers prior to contraction is referred to as preload, whereas the resistance against which the ventricle must contract is known as afterload. In clinical terms, preload is commonly represented by diastolic pressure, while afterload corresponds to systolic pressure generated during ventricular ejection [17].

Blood pressure itself is defined as the force exerted by circulating blood against the walls of blood vessels. It is influenced by the volume of blood within the vascular system and determined primarily by cardiac output and peripheral vascular resistance. An increase in blood volume or vascular elasticity can elevate blood pressure [18]. Cardiac output; typically ranging from 4 to 8 liters per minute in adults is the volume of blood pumped by the ventricles into the pulmonary and systemic circulation each minute. It is affected by stroke volume and heart rate. Meanwhile, peripheral vascular resistance is influenced by arteriolar radius and blood viscosity, both of which determine the overall resistance encountered by blood flow within the venous and arterial systems [19].

The pressure that drives blood through the vasculature consists of three combined components: pressure energy, kinetic energy, and gravitational energy, all of which influence cardiac output. Gravitational force plays a central role in leg elevation. Adjusting the leg elevation position can reduce aortic compression and enhance venous return. In this position, the lower extremities are elevated above the level of the heart, creating a hydrostatic pressure gradient in which pressure at the distal extremities becomes greater than at the central circulation. This gradient facilitates passive blood flow from the legs toward the heart, especially when venous tone is diminished due to sympathetic blockade following spinal anesthesia [3].

Elevating the legs maximizes venous return from the lower extremities to the heart. Venous return increases because blood from the lower extremities flows through the dorsal venous arch, posterior and anterior tibial veins, popliteal vein, femoral vein, iliac veins, abdominal vena cava, hepatic veins, and finally enters the right atrium through the inferior vena cava. Consequently, leg elevation enhances stroke volume and cardiac output, both of which contribute to increased blood pressure [11].

The findings of this study align with previous research by Octavirani & Murdiyanto [20], which demonstrated that leg elevation at 40° or 45° is more effective in managing hypotension compared with 30°. Although a 30° elevation can increase blood pressure, the effect is relatively modest because the elevation is insufficient to mobilize a substantial volume of blood pooled in the peripheral circulation toward the central compartment.

From the researcher's perspective, leg elevation; particularly at 45° is strongly recommended for patients experiencing post–spinal anesthesia hypotension. It is a simple, efficient, and non-pharmacological intervention with minimal risk of complications such as injury, pain, or infection. Leg elevation utilizes gravitational force to accelerate venous return from the lower extremities to the heart, counteracting the primary mechanism of hypotension, namely vasodilation. As blood vessels dilate, vascular resistance decreases, leading to reduced blood pressure. Because blood pressure is influenced by vascular resistance and cardiac output, interventions that enhance cardiac output are beneficial in restoring blood pressure in post–spinal anesthesia hypotension.

Cardiac output is primarily determined by venous return. The higher the leg elevation angle, the greater the volume of blood redirected by gravity from the lower extremities toward the heart. This increased venous return enhances right ventricular filling, resulting in a larger volume of blood being pumped into the systemic circulation. As more blood is ejected from the heart, the maximum pressure generated during systole increases, thereby elevating systolic blood pressure. This physiological mechanism is consistent with the findings of the present study, which showed that 45° leg elevation is more effective than 30°.

This study has certain limitations. Environmental temperature could not be controlled, and fluctuations in ambient temperature may influence respondents' blood pressure. Additionally, the study focused solely on blood pressure changes induced by leg elevation in post–spinal anesthesia hypotensive patients; therefore, conclusions are limited to the data analyzed and may not fully represent other hemodynamic variables or clinical contexts.

CONCLUSION

The 45° leg elevation intervention administered for 10 minutes was shown to be more effective in increasing blood pressure among post–spinal anesthesia hypotensive patients. This effect occurs because a higher elevation angle allows a greater volume of blood to be redirected by gravitational force toward the heart, thereby enhancing venous return and increasing systolic blood pressure. Future studies are encouraged to expand this research by examining additional influencing factors such as body temperature and intravenous fluid infusion rate.

Ethical consideration, competing interest and source of funding

-This study adhered to ethical principles for human research and received ethical approval under registration number No. 072.1/EA.KEPK-17/35.07.208/2023, confirming that the research met all ethical feasibility requirements.
-There is no conflict of interest related to this research.
-Source of funding is authors.

REFERENCES

1. Mustopa M. Pemberian rebusan jahe dan daun peppermint efektif dalam pencegahan nausea pada pasien post operasi dengan anestesi spinal di ruang bedah: Giving decoction of ginger and peppermint leaves is effective in prevention of nausea in postoperative patients. J Interprofesi Kesehat Indones. 2022;1(4):141–8.
2. Arif SK, Setiawan I. Perbandingan efek kecepatan injeksi 0,4 ml/dtk dan 0,2 ml/dtk prosedur anestesi spinal terhadap kejadian hipotensi pada seksio sesaria. JAI (Jurnal Anestesiol Indones). 2015;7(2):79-88.
3. Purnawan IK, Sukarja IM, Winarta IW. Pengaruh elevasi kaki terhadap kestabilan tekanan darah pada pasien dengan spinal anestesi. Community Publ Nurs. 2017;5(2):67–72.
4. Pramono A. Buku kuliah anestesi. Jakarta: EGC; 2015.
5. Bolcal Çalışır F, Urfalıoğlu A, Yücel N, Öksüz H, Öksüz G, Doğaner A, et al. Impact of leg elevation added to a 15° left lateral incline on maternal hypotension and neonatal outcomes in cesarean section: A randomized clinical study. J Surg Med. 2019;3(9):689–93.
6. Hasanin A, Mokhtar AM, Badawy AA, Fouad R. Post-spinal anesthesia hypotension during cesarean delivery: A review article. Egypt J Anaesth. 2017;33(2):189–93.
7. Rustini R, Fuadi I, Surahman E. Insidensi dan faktor risiko hipotensi pada pasien yang menjalani seksio sesarea dengan anestesi spinal di Rumah Sakit Dr. Hasan Sadikin Bandung. J Anestesi Perioper. 2016;4(1):42–9.
8. Tanambel P, Kumaat L, Lalenoh D. Profil penurunan tekanan darah (hipotensi) pada pasien sectio caesarea yang diberikan anestesi spinal dengan menggunakan bupivakain. e-CliniC. 2017;5(1):172-8.
9. Ferré F, Martin C, Bosch L, Kurrek M, Lairez O, Minville V. Control of spinal anesthesia-induced hypotension in adults. Local and Regional Anesthesia. 2020 Jun 3:39-46.
10. Peng J, Long S, Feng L. Deep vein thrombosis prevention in acute ischemic stroke patients with lower limb paralysis: A narrative review. Journal of Clinical Medicine. 2026 Mar 10;15(6):2091.
11. Hasanin A, Aiyad A, Elsakka A, Kamel A, Fouad R, Osman M, et al. Leg elevation decreases the incidence of post-spinal hypotension in cesarean section: A randomized controlled trial. BMC Anesthesiol. 2017;17(1):779–86.
12. Sukmaningtyas W, Suryani RL. Pemberian ondansetron dalam mencegah kejadian hipotensi pasca induksi spinal anestesi: Tinjauan literatur. In: Seminar Nasional Penelitian dan Pengabdian Kepada Masyarakat. 2021. p. 1468–74.
13. Sukarja IM. Elevasi kaki efektif menjaga kestabilan tekanan darah pada pasien dengan spinal anestesi. J Gema Keperawatan. 2015;8(1):16–9.
14. Drury ER, Wu J, Gigliotti JC, Le TH. Sex differences in blood pressure regulation and hypertension: renal, hemodynamic, and hormonal mechanisms. Physiological Reviews. 2024 Jan 1;104(1):199-251.
15. Hofhuizen C, Lemson J, Snoeck M, Scheffer GJ. Spinal anesthesia-induced hypotension is caused by a decrease in stroke volume in elderly patients. Local and Regional Anesthesia. 2019 Mar 4:19-26.
16. Peate I. The circulatory system. British Journal of Healthcare Assistants. 2020 Dec 2;14(11):548-53.
17. Oliver J. Diastol dan sistol. J Chem Inf Model. 2013;53(9):1689–99.
18. Marhaendra YA, Basyar E, Adrianto AA. Pengaruh letak tensimeter terhadap hasil pengukuran tekanan darah. Diponegoro University; 2016.
19. Kharisna D, Dewi WN, Lestari W. Efektifitas konsumsi jus mentimun terhadap penurunan tekanan darah pada pasien hipertensi. J Ners Indones. 2012;2(2):124–31.
20. Octavirani DIP, Murdiyanto J. Pengaruh elevasi kaki terhadap kestabilan tekanan darah pada pasien sectio caesarea dengan spinal anestesi. J Kesehat Kusuma Husada. 2023;1(1):73–81.