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Original Article

Role of Patient Positioning in Reducing Post-Spinal Hypotension During Surgery

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ABSTRACT

Background: Post-spinal hypotension is a significant complication of spinal anesthesia, driven by sympathetic blockade and reduced venous return, posing substantial risks to vulnerable surgical populations. While pharmacological management remains central, non-pharmacological strategies such as patient positioning have been proposed to mitigate hypotensive events by influencing hemodynamic stability. Objective: This study aimed to evaluate the role of different surgical positions—lateral, sitting, supine, and Trendelenburg—in reducing the incidence of post-spinal hypotension and to explore associated patient and perioperative variables. Methods: A retrospective descriptive cross-sectional analysis was conducted on 300 adult patients undergoing elective surgery under spinal anesthesia across four hospitals in Lahore, Pakistan, over six months. Data included patient demographics, surgical details, intraoperative blood loss, fluid administration, and incidence of hypotension, analyzed using chi-square tests and odds ratios with IBM SPSS software, with significance set at $p < 0.05$. Results: The incidence of hypotension was 38.2% in lateral, 45.5% in sitting, 39.2% in supine, and 44.4% in Trendelenburg positions, with no statistically significant association between surgical position and hypotension ($p = 0.750$). Demographic and perioperative parameters showed minimal intergroup differences. Conclusion: While the lateral position exhibited the lowest hypotension rate, surgical positioning alone did not significantly influence post-spinal hypotension, highlighting the necessity for comprehensive management strategies and individualized patient care, warranting further prospective studies.
Keywords: Spinal Anesthesia, Hypotension, Patient Positioning, Hemodynamic Stability, Surgery, Trendelenburg Position.

INTRODUCTION

Spinal anesthesia has become an essential technique in modern surgical practice due to its efficacy in producing profound regional blockade with minimal systemic side effects, yet it remains associated with significant hemodynamic disturbances such as post-spinal hypotension (PSH), primarily resulting from sympathetic blockade, vasodilation, and decreased venous return (1). PSH is not merely a transient decrease in blood pressure but a serious complication that can lead to organ hypoperfusion, posing particular risks for vulnerable populations including elderly individuals, pregnant women, and patients with cardiovascular comorbidities (2). Pharmacological measures like vasopressors and intravenous fluid administration are conventionally employed to mitigate this complication; however, the role of non-pharmacological interventions, specifically patient positioning, has emerged as a potentially crucial modifiable factor in maintaining hemodynamic stability (3).Different patient positions during and after spinal anesthesia can exert significant influences on the cardiovascular system by altering venous return, cardiac output, and sympathetic nervous system activity, thereby modulating the occurrence and severity of PSH (4). Studies have indicated that the supine position predisposes patients to greater hypotension due to blood pooling in the lower extremities, while positions like lateral decubitus, Trendelenburg tilt, and modified sitting postures have been proposed to improve hemodynamic stability through mechanisms such as limiting the cephalad spread of local anesthetic or enhancing venous return (5,6). However, the evidence regarding the effectiveness of these alternative positions remains inconclusive. For example, Corke et al. observed that left lateral tilt improved maternal and neonatal outcomes during cesarean sections under spinal anesthesia, whereas other investigations reported only modest or negligible benefits from positioning alone (7,8). Furthermore, excessive Trendelenburg positioning, though theoretically beneficial for venous return, carries risks including increased intracranial pressure and compromised respiratory mechanics, underscoring the delicate balance clinicians must achieve (9,10).

Despite numerous studies exploring pharmacological prophylaxis and treatment strategies for PSH, there exists a significant knowledge gap concerning the precise impact of patient positioning on intraoperative hypotension rates across various surgical contexts and patient populations (11). While some research supports lateral or Trendelenburg positioning as protective, others have not demonstrated statistically significant differences in hypotension incidence, leaving clinicians with insufficient guidance to inform evidence-based practice (12,13). Additionally, patient-specific factors such as age, baseline hemodynamics, body habitus, and surgical type may interact with positioning effects, complicating the ability to generalize findings across diverse patient cohorts (14). As pointed out by Smith et al., the heterogeneity in existing studies and the lack of large-scale trials tailored to surgical positioning highlight the urgent need for research that systematically quantifies the relationship between patient positioning and the occurrence of PSH, while accounting for potential confounding factors (15).Given these uncertainties, this study seeks to evaluate whether specific patient positions during surgery influence the incidence of post-spinal hypotension. By retrospectively analyzing data from 300 patients undergoing surgery in various positions—lateral, sitting, supine, and Trendelenburg—this research aims to determine whether positioning independently affects hypotension rates, while considering demographic and perioperative factors such as age, weight, height, blood loss, and fluid administration (16). The study thus addresses a crucial gap in clinical knowledge and aims to contribute evidence-based recommendations for optimizing anesthetic care. Therefore, the objective of this investigation is to examine the role of patient positioning in reducing the incidence of post-spinal hypotension, hypothesizing that certain positions, particularly the lateral decubitus, may offer a protective effect compared to others (17).

MATERIALS AND METHODS

This descriptive cross-sectional study was designed to evaluate the role of patient positioning in reducing the incidence of post-spinal hypotension during surgery, based on the rationale that non-pharmacological strategies such as surgical positioning may offer a practical means of stabilizing hemodynamics without relying solely on pharmacological interventions (1,2). The study was conducted retrospectively at four tertiary-care hospitals in Lahore, Pakistan—Mayo Hospital, Shaikh Zayed Hospital, Jinnah Hospital, and Masood Hospital—over a six-month period, enabling the inclusion of a diverse patient population undergoing surgical procedures under spinal anesthesia during this time frame. Ethical approval for the study was secured from the institutional review boards of all participating hospitals prior to data collection, ensuring adherence to the principles of the Declaration of Helsinki, and confidentiality of patient records was strictly maintained throughout the analysis process (3).

Participants were eligible for inclusion if they were adult patients aged between 18 and 80 years who were scheduled for elective surgical procedures under spinal anesthesia and classified as American Society of Anesthesiologists (ASA) physical status I to III, thereby representing a range of low to moderate perioperative risk profiles (4). Exclusion criteria were rigorously applied and consisted of patients who were hemodynamically unstable preoperatively, individuals with contraindications to spinal anesthesia such as coagulopathies or localized infection at the puncture site, and patients with known hypersensitivity to local anesthetic agents, to minimize confounding variables related to pre-existing instability or procedural risks (5). Eligible patients were selected using a convenient sampling technique based on available surgical records, which, while practical for retrospective analyses, carries the potential for selection bias due to non-random sampling (6). The total sample size of 300 patients was calculated using the formula $n = (Z^2 \times p \times (1-p)) / E^2$, assuming a hypothesized proportion of post-spinal hypotension informed by prior literature and a margin of error suitable for detecting meaningful differences between groups (7).

Data were retrieved systematically from medical records, anesthesia charts, and perioperative monitoring logs by trained research personnel, ensuring consistency and minimizing the risk of transcription errors. Information collected included demographic variables such as age, gender, weight, height, and ASA classification; surgical details such as type and duration of the procedure; and perioperative clinical outcomes including the occurrence and severity of post-spinal hypotension, intraoperative blood loss, and the total volume of intravenous fluids administered. Post-spinal hypotension was operationally defined as a decrease in systolic blood pressure of more than 20% from baseline or an absolute systolic pressure below 90 mmHg after administration of spinal anesthesia, with further categorization of severity based on the extent of the blood pressure drop and the need for vasopressor therapy (8).

Efforts to reduce bias included using predefined operational definitions for all variables and cross-verifying data entries by two independent reviewers. Potential confounding factors such as patient age, baseline hemodynamic status, and surgery type were recorded for subsequent statistical adjustment where necessary. Data integrity was maintained by employing rigorous data entry protocols, including double-checking digital records and utilizing locked databases with restricted access to prevent unauthorized alterations.

Statistical analyses were conducted using IBM SPSS Statistics, applying descriptive statistics to summarize continuous variables as means and standard deviations, while categorical variables were reported as frequencies and percentages. Associations between patient positioning and the incidence of post-spinal hypotension were evaluated using the Chi-square test for categorical comparisons, and Student's t-test for analyzing differences in continuous variables across groups. The significance level was set at $p < 0.05$. Missing data were assessed for randomness, and any incomplete entries were excluded listwise, given the retrospective nature of the data collection and the inability to re-contact patients for clarification. Although the primary focus was on overall associations, subgroup analyses were performed to explore trends in hypotension rates across different positions while adjusting for potential confounders through stratification based on demographic and surgical variables where data permitted (9).

RESULTS

Analysis of 300 patients undergoing surgery under spinal anesthesia revealed that the overall incidence of post-spinal hypotension varied modestly across surgical positions but without reaching statistical significance ($\chi^2 = 1.21$, $p = 0.750$). The lateral position demonstrated the lowest hypotension rate, with 26 out of 68 patients affected (38.2%). In comparison, the sitting position had the highest observed rate, with hypotension occurring in 35 of 77 patients (45.5%). The supine and Trendelenburg positions showed intermediate rates of 39.2% (29 of 74 patients) and 44.4% (36 of 81 patients), respectively. When using the lateral position as the reference, the odds of developing hypotension were higher in other positions but not significantly so, with odds ratios of 1.35 (95% CI: 0.68–2.68) for sitting, 1.04 (95% CI: 0.51–2.16) for supine, and 1.28 (95% CI: 0.65–2.53) for Trendelenburg.

These findings suggest that no single position conferred a statistically significant protective effect against post-spinal hypotension.The mean age of patients varied modestly across groups, with those in the sitting position being oldest at 51.7 ± 17.3 years (95% CI: 47.3–

56.1), while the lateral group was youngest, averaging 46.9 ± 19.2 years (95% CI: 42.0–51.8). Patients in the supine and positions exhibited intermediate mean ages of 48.9 ± 17.4 years (95% CI: 44.5–53.3) and 50.3 ± 17.0 years (95% CI: 46.1–54.5), respectively. However, these differences were not statistically significant, as pairwise comparisons with the lateral group yielded p-values ranging from 0.118 to 0.658, suggesting age distribution was largely comparable across surgical positions.Regarding body weight, patients in the lateral and supine groups shared the highest average weight of 84.4 kg, with standard deviations of 22.6 kg and 20.1 kg, respectively

Table 1. Incidence of Post-Spinal Hypotension by Surgical Position

Surgical Position	Hypotension Cases (n)	Total (n)	Hypotension (%)	Odds Ratio vs (95% CI)	p-value
Lateral	26	68	38.2	Reference	—
Sitting	35	77	45.5	1.35 (0.68 – 2.68)	0.750
Supine	29	74	39.2	1.04 (0.51 – 2.16)	0.750
Trendelenburg	36	81	44.4	1.28 (0.65 – 2.53)	0.750

Table 2. Age Distribution by Surgical Position

Surgical Position	Mean Age (years) ± SD	95% CI for Mean Age	p-value (vs Lateral)
Lateral	46.9 ± 19.2	42.0 – 51.8	—
Sitting	51.7 ± 17.3	47.3 – 56.1	0.118
Supine	48.9 ± 17.4	44.5 – 53.3	0.658
Trendelenburg	50.3 ± 17.0	46.1 – 54.5	0.303

Table 3. Weight Distribution by Surgical Position

Surgical Position	Mean Weight (kg) ± SD	95% CI for Mean Weight	p-value
Lateral	84.4 ± 22.6	78.6 – 90.2	—
Sitting	83.8 ± 22.5	78.3 – 89.3	0.885
Supine	84.4 ± 20.1	79.4 – 89.4	1.000
Trendelenburg	81.7 ± 19.5	76.9 – 86.5	0.493

Table 4. Height Distribution by Surgical Position

Surgical Position	Mean Height (cm) ± SD	95% CI for Mean Height	p-value
Lateral	174.5 ± 13.3	170.8 – 178.2	—
Sitting	173.7 ± 14.1	169.7 – 177.7	0.768
Supine	175.2 ± 15.2	171.0 – 179.4	0.772
Trendelenburg	174.7 ± 14.5	170.6 – 178.8	0.953

Table 5. Intraoperative Blood Loss by Surgical Position

Surgical Position	Mean Blood Loss (mL) ± SD	95% CI for Mean Blood Loss	p-value
Lateral	278.0 ± 122.5	246.9 – 309.1	—
Sitting	280.5 ± 126.0	247.2 – 313.8	0.893
Supine	268.3 ± 137.5	232.7 – 303.9	0.648
Trendelenburg	285.7 ± 139.5	249.5 – 321.9	0.677

Table 6. Total Fluids Administered by Surgical Position

Surgical Position	Mean Fluids Administered (mL) ± SD	95% CI for Mean Fluids	p-value
Lateral	1579.0 ± 616.3	1411.0 – 1747.0	—
Sitting	1456.3 ± 515.5	1304.3 – 1608.3	0.184
Supine	1503.1 ± 567.9	1342.6 – 1663.6	0.379
Trendelenburg	1539.8 ± 550.9	1383.8 – 1695.8	0.755

The sitting group exhibited a slightly lower mean weight of 83.8 ± 22.5 kg, while the Trendelenburg group showed the lowest average at 81.7 ± 19.5 kg. None of these differences reached statistical significance, as all pairwise comparisons with the lateral group revealed p-values exceeding 0.49. The 95% confidence intervals overlapped substantially across all groups, indicating relatively uniform weight distributions.

The analysis of patient height demonstrated minimal variation between groups. Patients in the supine position were tallest on average, with a mean height of 175.2 ± 15.2 cm (95% CI: 171.0–179.4), while those in the sitting position were shortest at 173.7 ± 14.1 cm (95% CI: 169.7–177.7). The lateral and Trendelenburg groups showed mean heights of 174.5 ± 13.3 cm and 174.7 ± 14.5 cm, respectively. Statistical comparisons indicated no significant differences in height across positions, with p-values ranging from 0.768 to 0.953. Mean intraoperative blood loss also varied slightly between positions. The Trendelenburg group recorded the highest average blood loss of 285.7 ± 139.5 mL (95% CI: 249.5–321.9), closely followed by the sitting position with 280.5 ± 126.0 mL (95% CI: 247.2–313.8) and the lateral position with 278.0 ± 122.5 mL (95% CI: 246.9–309.1). The supine group exhibited the lowest mean blood loss at 268.3 ± 137.5 mL (95% CI: 232.7–303.9). However, these differences were not statistically significant, with all p-values relative to the lateral group exceeding

0.64.The volume of total fluids administered intraoperatively showed modest differences among groups. Patients positioned laterally received the highest mean fluid volume of 1579.0 ± 616.3 mL (95% CI: 1411.0–1747.0), whereas those in the sitting group received the lowest average at 1456.3 ± 515.5 mL (95% CI: 1304.3–1608.3). Supine and Trendelenburg patients received intermediate volumes of 1503.1 ± 567.9 mL and 1539.8 ± 550.9 mL, respectively. None of these differences reached statistical significance, as all p-values were above 0.18, reflecting relatively consistent fluid management across surgical positions. Collectively, while some trends suggested a marginally lower hypotension rate in the lateral position and slightly different perioperative parameters among groups, none of the observed differences in hypotension incidence, demographic characteristics, blood loss, or fluid administration achieved statistical significance. These findings imply that surgical positioning alone may not exert a decisive influence on the development of post-spinal hypotension in this patient cohort.

Figure 1 Perioperative Blood Loss, Fluid Use, and Hypotension by Surgical Position

The figure represents blood loss and total fluids administered across surgical positions with corresponding hypotension rates as a clinical backdrop. The teal line indicates blood loss, ranging narrowly from 268.3 mL in supine to 285.7 mL in Trendelenburg, while orange scatter points display mean fluid volumes from 1456.3 mL in sitting to 1579.0 mL in lateral. Green bars illustrate hypotension rates, highlighting that higher fluid administration in the lateral group does not correspond to the lowest hypotension rate, and elevated rates persist in sitting (45.5%) and Trendelenburg (44.4%) positions despite differences in perioperative management. This visual demonstrates that increased perioperative fluids do not proportionally decrease hypotension risk, emphasizing the need for more nuanced preventive strategies in clinical practice.

DISCUSSION

The present study sought to elucidate the influence of patient positioning on the incidence of post-spinal hypotension, revealing that while the lateral position demonstrated the lowest rate of hypotension at 38.2%, the observed differences across surgical positions were not statistically significant, with an overall chi-square p-value of 0.750. This aligns with certain prior investigations suggesting that although positioning may modulate hemodynamics to some extent, it does not universally confer protection against hypotension in all patient groups (1,2). Carpenter et al. initially emphasized that spinal anesthesia-induced hypotension is a multifactorial phenomenon influenced by autonomic blockade, patient age, and baseline hemodynamics rather than positioning alone (3). Similarly, Hartmann et al. underscored that while certain positions like the lateral decubitus may reduce cephalad spread of local anesthetics, their protective effects are inconsistent across diverse patient populations (4). Our findings corroborate these observations by demonstrating that even though lateral positioning appeared favorable, it did not achieve statistically significant superiority over sitting, supine, or Trendelenburg positions in reducing hypotension risk.

Conversely, some studies have reported positioning as a crucial determinant of hemodynamic stability. Corke et al. and Buggy et al. documented significant benefits of lateral or tilted positions in obstetric populations, where aortocaval compression contributes prominently to hypotension during cesarean sections, indicating the physiological context is critical in modulating positioning effects (5,6). Additionally, Tverdal et al. observed improved cardiac output with mild Trendelenburg positioning, albeit with caution due to potential respiratory compromise, a nuance absent in our general surgical cohort (7). The lack of significant difference in our study might stem from the heterogeneous patient characteristics, diverse surgical types, and differences in anesthetic techniques, suggesting that the magnitude of positioning effects may be diluted in a mixed surgical population compared to more uniform cohorts like obstetric patients (8).Mechanistically, the relationship between positioning and hypotension after spinal anesthesia reflects the interplay of gravitational effects on venous return, the distribution of local anesthetic within the cerebrospinal fluid, and autonomic nervous system responses (9). The sitting position, for instance, has been shown to facilitate a more restricted spread of the anesthetic, potentially minimizing high sympathetic blockade but paradoxically increasing hypotension risk due to gravitational pooling in the lower extremities, particularly during transitions from sitting to supine after the block (10,11).

In our study, the sitting position exhibited the highest hypotension rate at 45.5%, echoing findings from Nishikawa and Dohi, who linked sitting posture to increased autonomic instability during spinal anesthesia (12). However, these differences did not achieve statistical significance, emphasizing that while positioning may influence physiology, other factors such as intravascular volume status, anesthetic dose, and patient comorbidities likely exert more dominant effects (13). From a clinical perspective, our findings underscore the complexity

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of preventing post-spinal hypotension. While non-pharmacological measures like positioning remain attractive due to their simplicity and cost-effectiveness, the absence of statistically significant differences suggests that relying on positioning alone may not suffice, necessitating a multimodal approach incorporating careful fluid management and vasopressor use (14). This aligns with recommendations from Singh et al., who advocated integrating positioning, vasopressors, and volume therapy to optimize hemodynamic stability, especially in high-risk groups (15). Importantly, our data reinforce the necessity for individualized anesthetic plans, tailored to patient-specific risk factors and procedural contexts rather than adopting a uniform positioning strategy for all patients.A strength of this study lies in its relatively large sample size of 300 patients, which enhances the precision of estimated hypotension rates across positions, contributing valuable real-world data to the ongoing discourse on intraoperative management under spinal anesthesia. The multicenter design further strengthens generalizability by incorporating diverse surgical settings. Nevertheless, several limitations merit consideration. The retrospective nature of data collection introduces inherent risks of incomplete documentation and selection bias, as patient allocation to different positions was not randomized but influenced by surgical requirements or anesthetist preference (16). Additionally, although our sample size was moderate, subgroup comparisons may have been underpowered to detect smaller but clinically meaningful differences, particularly when considering overlapping confidence intervals in our odds ratio estimates. The lack of real-time hemodynamic monitoring data, such as cardiac output measurements, limits mechanistic insights into how positioning influenced intraoperative cardiovascular dynamics. Furthermore, while our inclusion of multiple hospitals increases external validity, the predominance of a single geographical region may constrain broader applicability to different healthcare systems or patient populations.

Future research should aim for prospective, randomized controlled trials focused on homogeneous surgical groups, such as specific orthopedic or obstetric populations, to clarify the true extent of positioning benefits and to explore potential interactions between patient characteristics and positioning effects (17). Investigations incorporating advanced hemodynamic monitoring could elucidate subtle physiological changes attributable to different positions, potentially identifying subgroups that might derive significant benefit from tailored positioning strategies. Moreover, exploring combinations of positioning with adjunctive measures like external compression devices, as shown by Ngan Kee et al. in obstetric contexts, could provide a more robust prophylactic framework against spinal anesthesia-induced hypotension (18). Ultimately, these endeavors may refine perioperative protocols and improve patient safety, advancing our understanding of how to best mitigate the hemodynamic consequences of spinal anesthesia.

In conclusion, while our study suggests a trend toward reduced hypotension with lateral positioning, the absence of statistically significant differences indicates that patient positioning alone may not decisively influence the risk of post-spinal hypotension in mixed surgical populations. A comprehensive, individualized approach that integrates positioning with pharmacologic and fluid management remains essential for optimizing intraoperative hemodynamic stability and ensuring favorable surgical outcomes (19,20).

CONCLUSION

This study investigating the role of patient positioning in reducing post-spinal hypotension during surgery found no statistically significant difference in hypotension incidence among lateral, sitting, supine, and Trendelenburg positions, although the lateral position exhibited the lowest observed rate of 38.2%, suggesting a potential, albeit non-conclusive, protective effect. These findings imply that while surgical positioning may modestly influence hemodynamic outcomes, it alone is unlikely to prevent hypotension, underscoring the need for comprehensive perioperative strategies that integrate individualized positioning with vigilant fluid management and vasopressor therapy to enhance patient safety and surgical outcomes. Clinically, this reinforces the importance of tailoring anesthesia care to patient-specific factors rather than relying on positioning alone, while future research should focus on prospective trials with homogeneous patient groups and advanced hemodynamic monitoring to clarify the precise impact of positioning and guide evidence-based practice in human healthcare.

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