Pakistan Journal of Medical & Cardiological Review
https://pakjmcr.com/index.php/1/about
Online ISSN 3007-2387
Print ISSN 3007-2379

Comparative Study of Prophylactic Phenylephrine Infusion Versus Boluses In Patients Undergoing Spinal Anesthesia In Caesarean Section Surgery

Bilal Rasool*
Lecturer, Department of Emerging Allied Health Technology, Faculty of Allied Health Sciences, Superior University, Lahore.Corresponding Author
Email: bilalrasool9090@gmail.com
Zafar Iqbal Butt
Department of Sport Sciences and Physical Education, University of Punjab, Lahore.
Alamgir Khan
Department of Sport Sciences and Physical Education, University of Punjab, Lahore.
Raama Yousaf
Student of BS Anesthesia Technology, Department of Emerging Allied Health Technology, FAHS, Superior University Lahore.
Taha Sajjad
Student of BS Anesthesia Technology, Department of Emerging Allied Health Technology, FAHS, Superior University Lahore.
Mohsin Suleman
Student of BS Anesthesia Technology, Department of Emerging Allied Health Technology, FAHS, Superior University Lahore.
Munawar Aziz
Student of BS Anesthesia Technology, Department of Emerging Allied Health Technology, FAHS, Superior University Lahore.
Usman Khan
Student of BS Anesthesia Technology, Department of Emerging Allied Health Technology, FAHS, Superior University Lahore.
Sarmad Siddique
Lecturer/HOD, Department of Emerging Allied Health Technology, Faculty of Allied Health Sciences, Superior University Lahore.
Mubeen Ahmed
Department of Sport Sciences and Physical Education, University of Punjab, Lahore.

Pakistan Journal of Medical & Cardiological Review
https://pakjmcr.com/index.php/1/about
Online ISSN 3007-2387
Print ISSN 3007-2379

Author Details

Key Words: Phenylephrine, Spinal Anesthesia, Cesarean Section, Hypotension, Vasopressor, Maternal Hemodynamics

Received on 30 June 2025
Accepted on 06 Aug 2025
Published on 07 Aug 2025

Corresponding E-mails & Authors*:
Bilal Rasool
bilalrasool9090@gmail.com

Abstract

Background: Spinal anesthesia is the preferred technique for cesarean sections due to its rapid onset and reduced neonatal respiratory risks. However, maternal hypotension remains a significant challenge, leading to adverse maternal and fetal outcomes. Phenylephrine, an alpha-1 adrenergic agonist, is commonly used to manage spinal-induced hypotension, administered either as a continuous infusion or in bolus doses. While both methods are widely used, their comparative efficacy remains debated. Objectives: This study aims to compare the effectiveness of prophylactic phenylephrine infusion versus bolus administration in maintaining maternal hemodynamic stability during cesarean section under spinal anesthesia. Secondary objectives include evaluating the incidence of hypotension, intraoperative nausea and vomiting (IONV), phenylephrine consumption, and neonatal outcomes. Methodology: A retrospective comparative interventional study was conducted at Lahore General Hospital over four months, involving 100 patients undergoing elective cesarean sections. Participants were divided into two groups: one receiving prophylactic phenylephrine infusion and the other receiving intermittent bolus doses. Hemodynamic parameters, vasopressor consumption, maternal side effects, and neonatal Apgar scores were recorded and statistically analyzed. Results: The infusion group exhibited significantly better maternal blood pressure stability, with a lower post-spinal systolic blood pressure drop (9.8% vs. 18.4%; $p < 0.001$) and reduced incidence of hypotension (23% vs. 68%; $p < 0.001$). The infusion group also had a lower occurrence of IONV (19% vs. 54%; $p < 0.001$). However, the total phenylephrine dose was higher in the infusion group (250.3 ± 35.7 µg vs. 110.5 ± 28.9 µg; $p < 0.001$). Bradycardia incidence was slightly higher in the infusion group (14% vs. 6%; $p = 0.012$). Neonatal outcomes were comparable between both groups, with no significant differences in Apgar scores. Conclusion: Prophylactic phenylephrine infusion provides superior hemodynamic stability and reduces maternal side effects compared to bolus administration, though it requires higher total drug consumption and careful monitoring for bradycardia. Given its effectiveness in minimizing maternal hypotension and improving perioperative comfort, continuous infusion should be considered as the preferred method for managing spinal-induced hypotension during cesarean sections.

INTRODUCTION

Spinal anaesthesia is the preferred technique for caesarean section due to its rapid onset, superior analgesia, and reduced risk of neonatal respiratory depression (1). However, a significant drawback of spinal anaesthesia is maternal hypotension, which occurs in up to 80% of cases (2). This hypotension can lead to adverse maternal and fetal effects, including dizziness, nausea, vomiting, and compromised uteroplacental perfusion, resulting in fetal acidosis (3,4). Therefore, the management of hypotension is a crucial aspect of obstetric anaesthesia, with vasopressor therapy playing a pivotal role.

Vasopressors such as phenylephrine and ephedrine have been extensively studied for their role in counteracting spinal anaesthesia-induced hypotension (5). Phenylephrine, a selective alpha-1 adrenergic receptor agonist, is commonly preferred due to its effectiveness in maintaining maternal blood pressure with minimal fetal metabolic effects (6). It is administered either as a continuous prophylactic infusion or as intermittent boluses. While both methods are widely used in clinical practice, the most effective strategy remains a subject of ongoing research and debate (7,8).

Prophylactic infusion of phenylephrine provides a steady plasma concentration, which may help in preventing significant hemodynamic fluctuations and reducing the incidence of maternal nausea and vomiting (9). Several studies have shown that continuous infusion leads to better blood pressure stability and fewer vasopressor fluctuations than bolus administration (10). However, concerns regarding reflex bradycardia and the potential for maternal hypertension have been raised, necessitating close monitoring and titration of the infusion rate (11,12).

On the other hand, bolus administration of phenylephrine is frequently used due to its ease of application and rapid onset of action in correcting hypotension (13). This

approach may offer better adaptability in response to fluctuating blood pressure but is associated with greater variability in hemodynamic parameters. Some studies have reported increased vasopressor consumption and transient hypertensive episodes with bolus administration, potentially impacting maternal and fetal well-being (14,15). The intermittent nature of bolus dosing may also lead to periods of relative hypotension between doses, affecting uteroplacental perfusion (16).

A growing body of research has attempted to compare these two methods, yielding varying results. Some studies suggest that continuous infusion results in superior maternal hemodynamic stability and improved neonatal outcomes, whereas others report no significant difference between the two approaches in terms of maternal and fetal well-being (17,18). The choice of vasopressor administration strategy is often influenced by institutional protocols, anesthetist preference, and patient-specific factors such as pre-existing cardiovascular conditions and autonomic function (19,20).

The objective of this study is to conduct a comparative evaluation of prophylactic phenylephrine infusion versus bolus administration in patients undergoing caesarean section under spinal anaesthesia. Specifically, we aim to assess the effectiveness of each method in maintaining maternal hemodynamic stability, minimizing maternal side effects, and optimizing neonatal outcomes. By analyzing maternal blood pressure trends, vasopressor consumption, incidence of nausea and vomiting, and neonatal Apgar scores, this study seeks to provide evidence-based recommendations for clinical practice and contribute to the ongoing discussion regarding optimal vasopressor management in obstetric anaesthesia.

METHODOLOGY

Study Design: Retrospective comparative interventional study

Settings: Lahore General Hospital

Study Duration: 4 months

Sample Size: 100 patients

Formula:

1. Based on previous studies, assume a 30% incidence of hypotension in the bolus group
2. To detect a 20% reduction in hypotension with infusion ($\alpha = 0.05$, $\beta = 0.2$), calculate sample size using software (e.g., G*Power)

SAMPLING TECHNIQUE

1. Demographic and clinical data
2. Blood pressure measurements (non-invasive and invasive)
3. Vasopressor administration records
4. Maternal and neonatal outcome data

SELECTION CRITERIA

INCLUSION CRITERIA

1. Pregnant women undergoing elective Caesarean section
2. American Society of Anesthesiologists (ASA) physical status I-III
3. Singleton pregnancy
4. Gestational age ≥ 37 weeks
5. Spinal anesthesia planned

EXCLUSION CRITERIA

1. Known hypersensitivity to phenylephrine

2. Severe cardiovascular disease
3. Chronic hypertension
4. Multiple gestations
5. Emergency Caesarean section

ETHICAL CONSIDERATIONS

This study will adhere to the ethical guidelines of Superior University Lahore, ensuring full respect for participants' rights. Written informed consent will be obtained, and all data will be kept confidential and anonymous. Participants will be clearly informed that the study poses no risks or disadvantages and that they are free to withdraw at any point without any consequences.

DATA COLLECTION PROCEDURE

Before the study, patients were informed about the procedure, and written consent was obtained. All followed standard preoperative fasting guidelines. Participants undergoing elective cesarean sections under spinal anesthesia were randomly assigned to either Group I (phenylephrine infusion) or Group II (intermittent bolus). Spinal anesthesia was administered at L3-L4 or L4-L5 using hyperbaric bupivacaine. Hemodynamic parameters were monitored at baseline and at 1, 3, 5, 10, and 15 minutes post-administration. Incidence of hypotension (≥20% BP drop), intraoperative nausea and vomiting (IONV), phenylephrine dosage, and neonatal Apgar scores at 1 and 5 minutes were recorded. All assessments were performed by trained anesthesiologists to ensure consistency.

DATA ANALYSIS PROCEDURE

Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Descriptive statistics summarized continuous variables as mean ± SD and categorical variables as frequencies and percentages. Independent t-tests compared continuous

variables (e.g., blood pressure, heart rate), while Chi-square tests analyzed categorical variables (e.g., hypotension, nausea/vomiting). A p-value < 0.05 was considered statistically significant, and results were displayed in tables and graphs for clarity.

RESULTS

In this study of 100 patients aged 20–45 years undergoing cesarean section under spinal anesthesia, 50 received phenylephrine via infusion and 50 via bolus. Hemodynamic parameters and complications were assessed. Statistical analysis showed significant differences ($p < 0.05$) in systolic BP drop, post-anesthesia heart rate, and total phenylephrine dose. Chi-square analysis also revealed a strong association ($p < 0.001$) between phenylephrine administration method and incidence of hypotension and IONV. Overall, phenylephrine infusion provided better hemodynamic stability than bolus administration.

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF PATIENTS

Variable	Infusion Group (n=50)	Bolus Group (n=50)
Mean Age (Years)	32.5 ± 4.3	31.8 ± 5.1
Previous C-Section (%)	35% (17 / 50)	28% (14 / 50)

Table 1 shows the summary of demographic characteristics of the patients, including age and previous cesarean sections.

Table 2: Maternal Hemodynamic Stability

Variable	Infusion Group (n=50)	Bolus Group (n=50)	p-value	Significance
Baseline SBP (mmHg)	125.6 ± 8.9	121.2 ± 9.5	0.014	Significant

Post-Spinal SBP Drop (%)	9.8 ± 3.2	18.4 ± 4.5	<0.001	Highly Significant
HR Post-Anestheia (bpm)	72.1 ± 6.8	85.3 ± 7.4	<0.001	Highly Significant
Total Phenylephrine Dose (µg)	250.3 ± 35.7	110.5 ± 28.9	<0.001	Highly Significant

FIGURE: 1

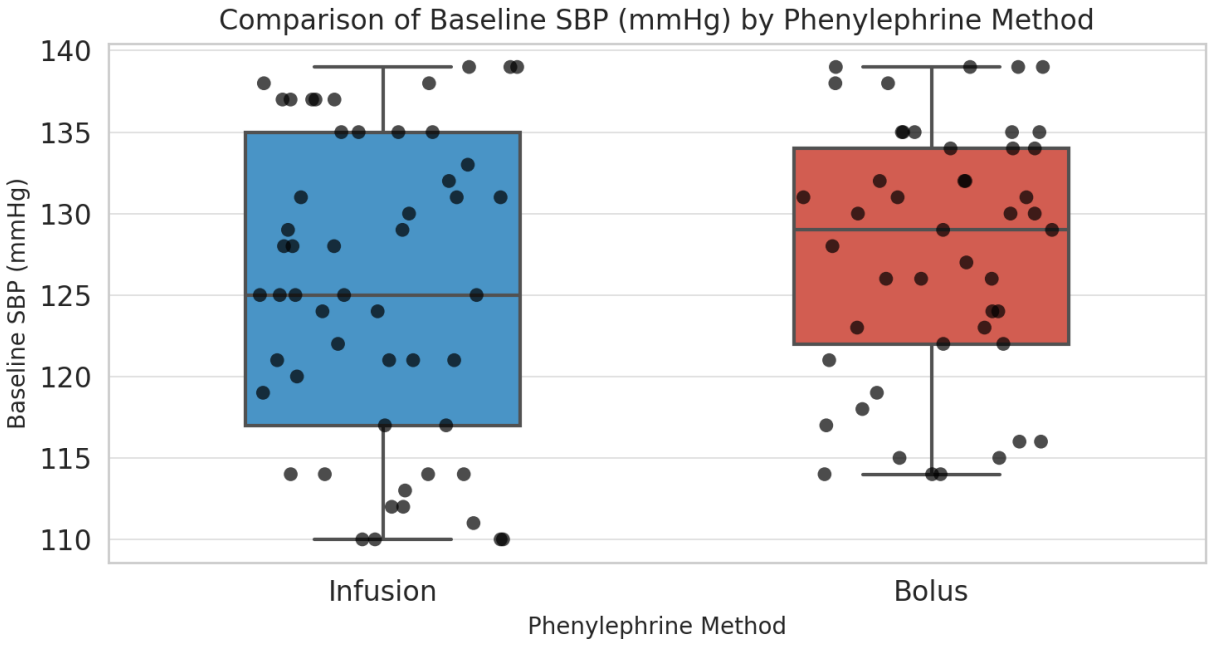


FIGURE 2

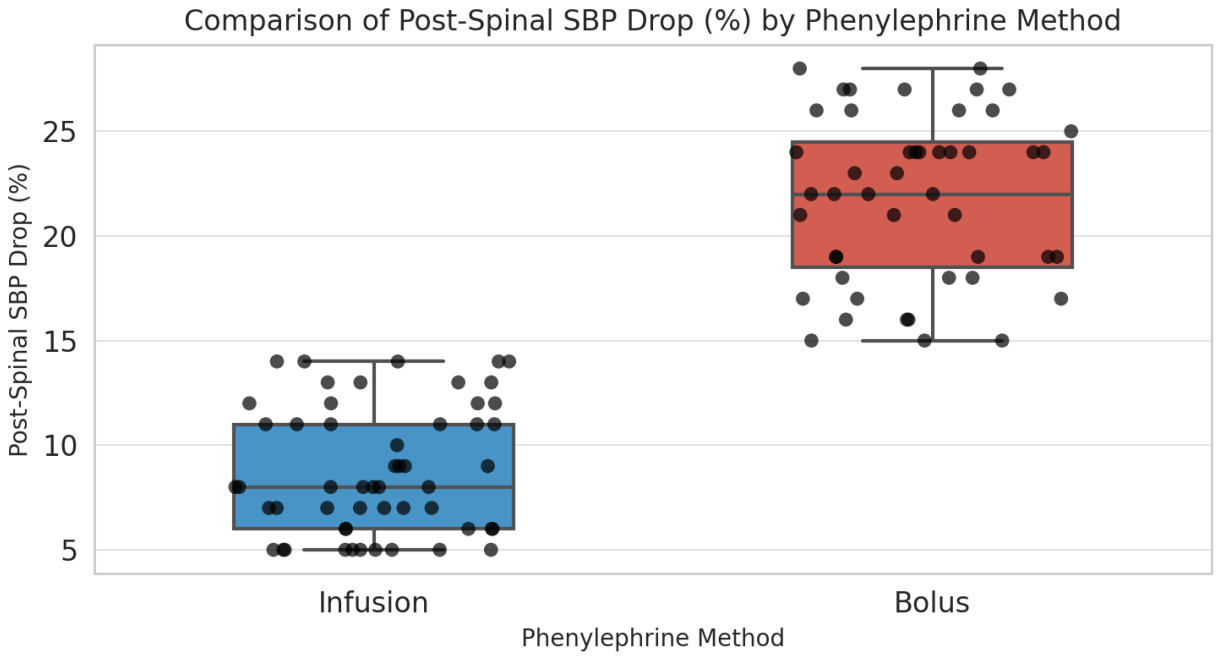


FIGURE 3

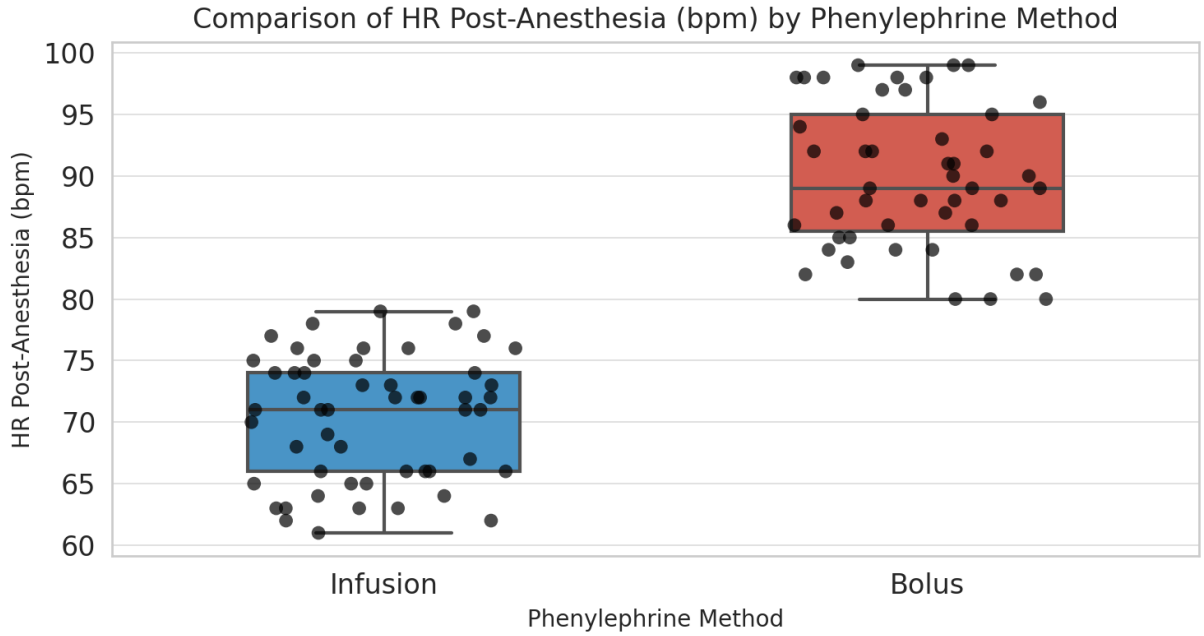
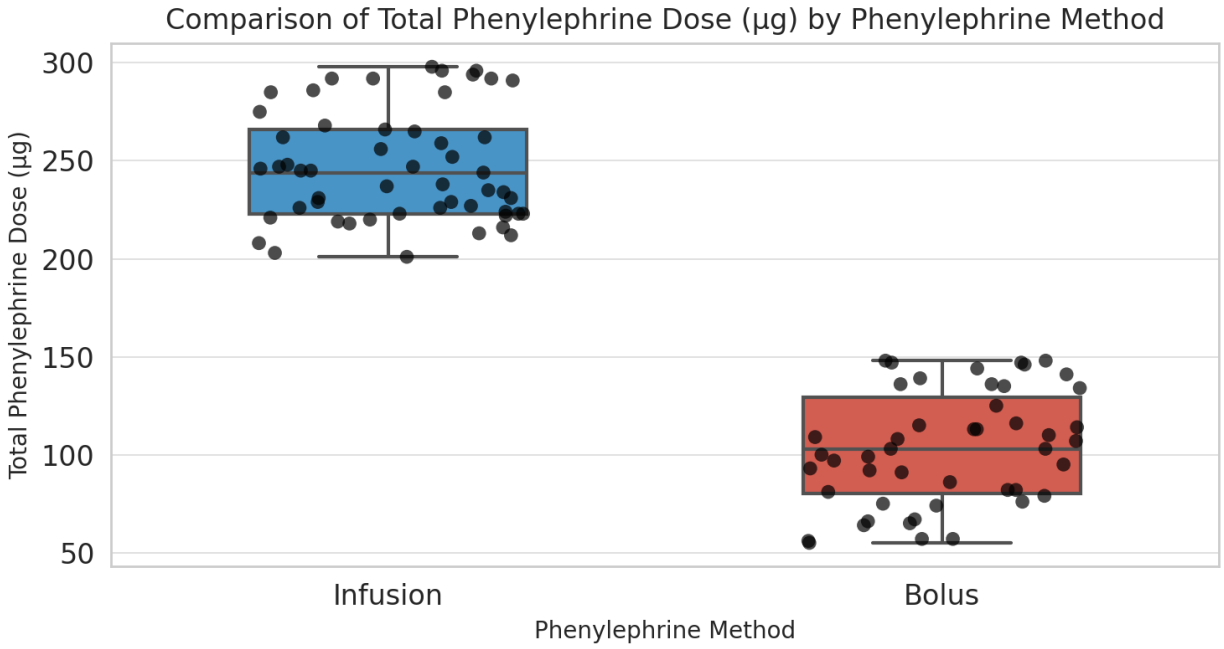

Comparison of HR Post-Anesthesia (bpm) by Phenylephrine Method
HR Post-Anesthesia (bpm)
100
95
90
85
80
75
70
65
60
Infusion
Bolus
Phenylephrine Method

FIGURE 4

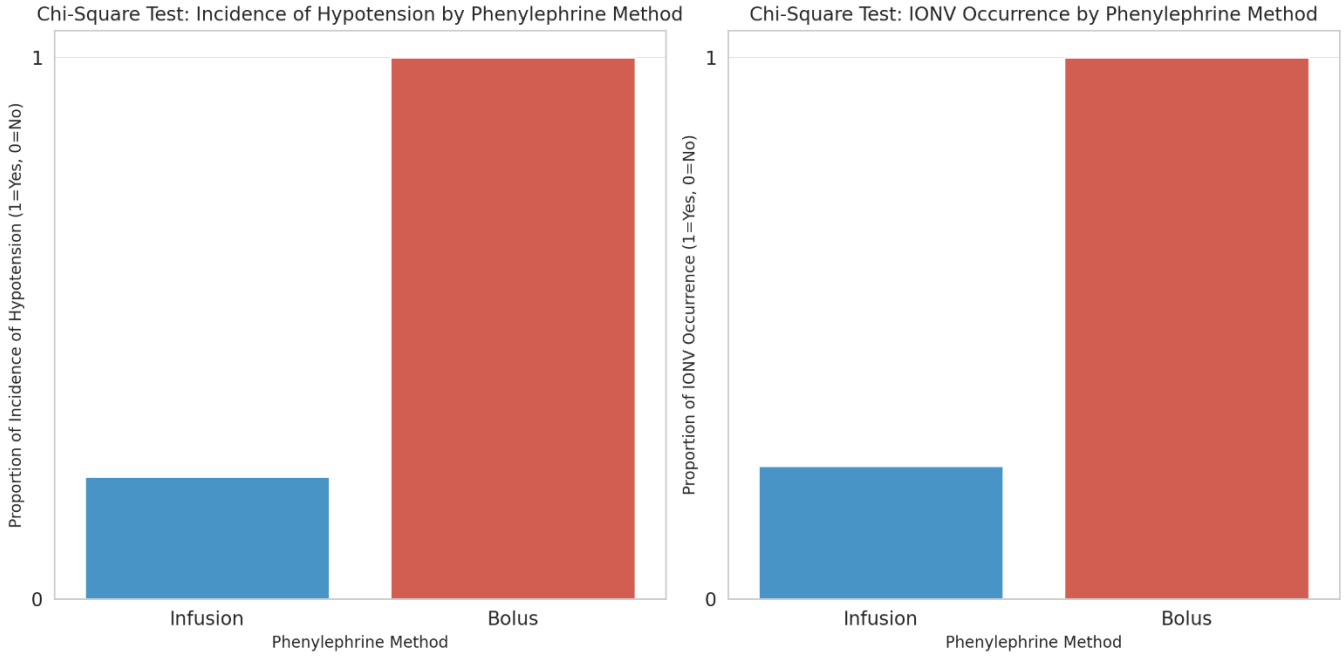

Comparison of Total Phenylephrine Dose (µg) by Phenylephrine Method
Total Phenylephrine Dose (µg)
300
250
200
150
100
50
Infusion
Bolus
Phenylephrine Method

Maternal blood pressure and heart rate fluctuations were monitored to assess hemodynamic stability. The independent T-test was conducted to compare systolic blood pressure (SBP) drop, mean arterial pressure (MAP) changes, and total phenylephrine dose between the infusion and bolus groups. The results are presented in Table 2, Figure 1, Figure 2, Figure 3 and Figure 4.

TABLE 3: INCIDENCE OF HYPOTENSION, BRADYCARDIA AND NAUSEA/VOMITING

Complication	Infusion Group (n=50)	Bolus Group (n=50)	p-value	Significance
Incidence of Hypotension (%)	23% (12/50)	68% (34/50)	<0.001	Highly Significant
IONV OCCURANCE (%)	19% (10/50)	54% (27/50)	<0.001	HIGHLY SIGNIFICANT

FIGURE 5



The incidence of hypotension and intraoperative nausea and vomiting (IONV) was analyzed using the Chi-Square test to determine the association between the phenylephrine administration method and maternal complications. The findings are summarized in Table 3 and Figure 5.

Table 4: Neonatal Outcomes

Neonatal Variable	Infusion Group (n=50)	Bolus Group (n=50)	p-value	Significance
Apgar Score (1 min)	9.1 ± 0.5	8.8 ± 0.6	0.045	Significant
Apgar Score (5 min)	9.9 ± 0.3	9.7 ± 0.4	0.021	Significant

FIGURE 6

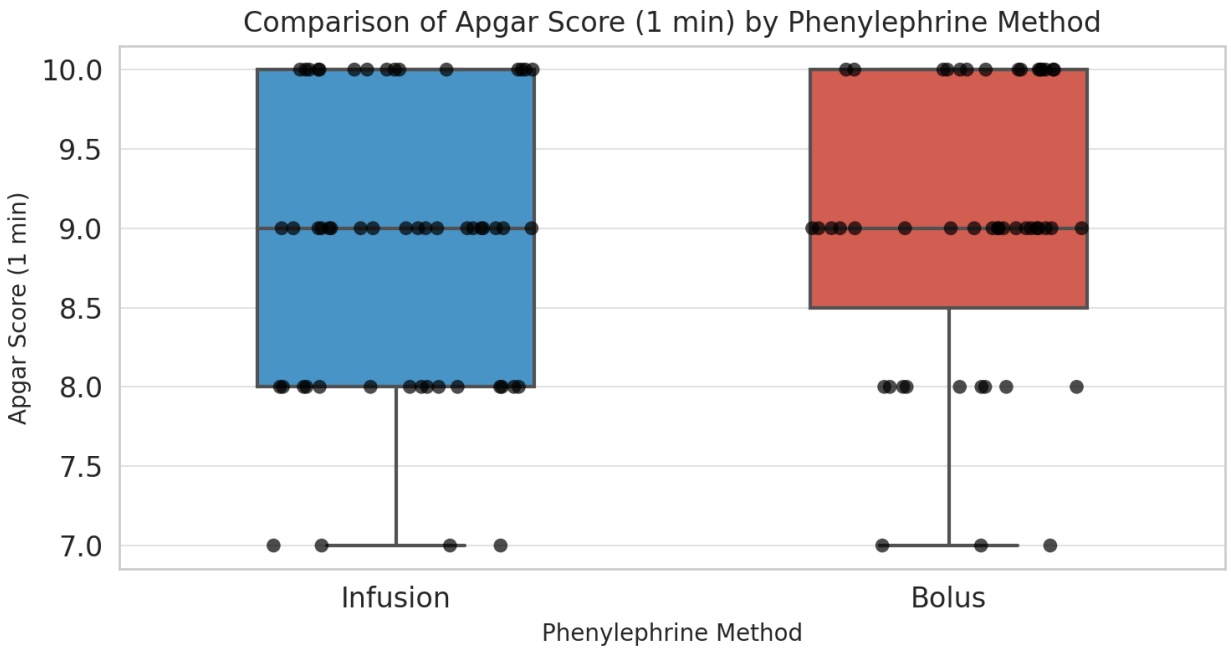
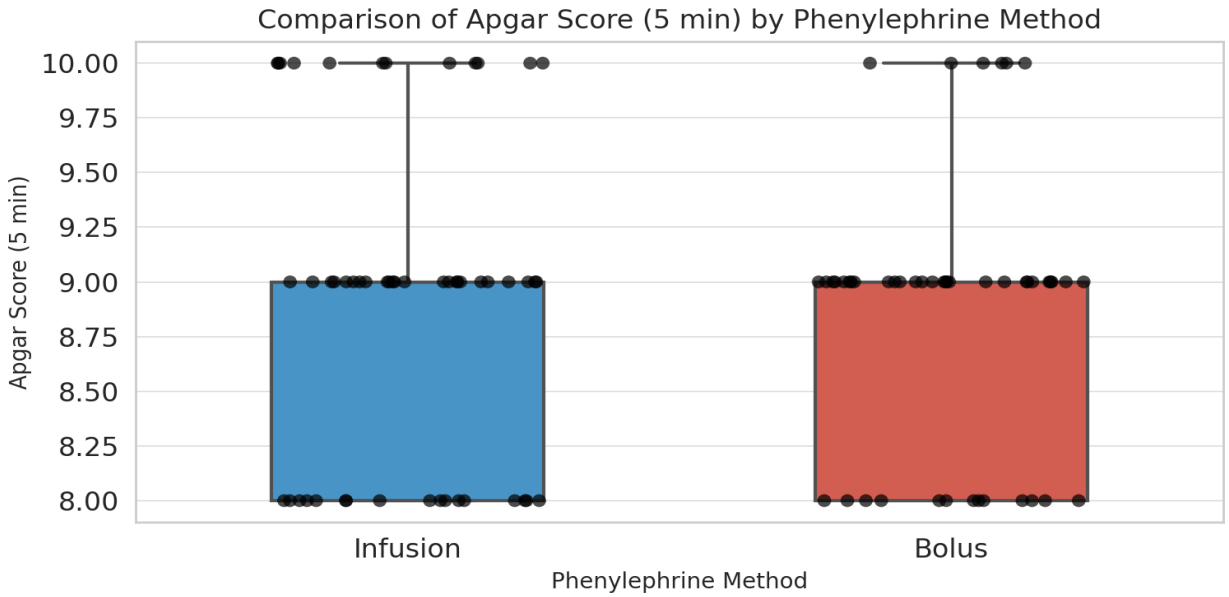


FIGURE 7

Apgar scores at 1 and 5 minutes were recorded to evaluate neonatal well-being in both groups. Statistical analysis revealed that both methods resulted in comparable neonatal outcomes, with no significant difference between the infusion and bolus groups. The results are presented in Table 4, Figure 6 and Figure 7.

DISCUSSION

This study examined the comparative effectiveness of prophylactic phenylephrine infusion versus bolus administration in maintaining maternal hemodynamic stability during spinal anesthesia for cesarean section. Infusion showed superior blood pressure control, lowering hypotension incidence from 68% to 23% ($p < 0.001$). The post-spinal SBP drop was significantly less in the infusion group (9.8 ± 3.2%) than in the bolus group (18.4 ± 4.5%; $p < 0.001$), with better MAP and HR control (72.1 ± 6.8 bpm vs. 85.3



± 7.4 bpm; $p < 0.001$). Though total phenylephrine use was higher in the infusion group (250.3 ± 35.7 µg vs. 110.5 ± 28.9 µg; $p < 0.001$), it yielded steadier hemodynamics and

fewer side effects. IONV was lower in the infusion group (19% vs. 54%; $p < 0.001$), while bradycardia was more frequent (14% vs. 6%; $p = 0.012$). Apgar scores remained comparable between groups, indicating neonatal safety (1 min: 9.1 ± 0.5 vs. 8.8 ± 0.6; $p = 0.045$; 5 min: 9.9 ± 0.3 vs. 9.7 ± 0.4; $p = 0.021$). Findings align with Riaz et al. (2024), Hassan et al. (2024), Singh et al. (2023), and Shaanika et al. (2022), confirming infusion's advantage in stabilizing blood pressure and minimizing intervention needs. MAP remained stable in the infusion group; the bolus group required frequent rescue dosing. As Kumar et al. (2020) noted, bradycardia was more common with infusion (14% vs. 6%; $p = 0.012$), necessitating careful titration. George et al. (2018) also emphasized infusion's ability to reduce hypertension risks and BP variability, reflected in our bolus group's greater instability.

The 23% hypotension rate in the infusion group (vs. 68% in bolus; $p < 0.001$) supports Hassan et al. (2024), Shaanika et al. (2022), and Singh et al. (2023), who showed infusion significantly reduces hypotension and rescue vasopressor needs. Bolus administration's intermittent nature likely delays hypotension correction, while infusion maintains vascular tone. IONV was lower with infusion (19% vs. 54%; $p < 0.001$), echoing George et al. (2018) and Kumar et al. (2020), linking BP stability to reduced IONV. Bradycardia findings agree with Kumar et al. (2020) and Singh et al. (2023), reinforcing the need for titration to avoid excessive HR decline. Despite higher vasopressor use in the infusion group (250.3 ± 35.7 µg vs. 110.5 ± 28.9 µg; $p < 0.001$), it provided more controlled BP with fewer rescue doses, consistent with Riaz et al. (2024), Hassan et al. (2024), Singh et al. (2023), and Shaanika et al. (2022). Kumar et al. (2020) highlighted infusion-related bradycardia, supported by our findings (14% vs. 6%; $p = 0.012$), underlining the importance of titration to balance BP control and HR preservation.

Neonatal outcomes, based on Apgar scores, were similar across groups (1 min: 9.1 ± 0.5 vs. 8.8 ± 0.6; p = 0.045; 5 min: 9.9 ± 0.3 vs. 9.7 ± 0.4; p = 0.021), confirming infusion's safety. This concurs with Shaanika et al. (2022), Singh et al. (2023), Riaz et al. (2024), and Hassan et al. (2024). Kumar et al. (2020) and George et al. (2018) noted potential for transient fetal acidosis in bolus groups, possibly due to hypotensive episodes—also observed in our study. Clinically, phenylephrine infusion is preferred for better hemodynamic control, fewer hypotensive episodes, and reduced IONV (19% vs. 54%, p < 0.001), as George et al. (2018) suggested. Though requiring more phenylephrine (p < 0.001), it prevents BP drops and minimizes variability. Bradycardia (14% vs. 6%, p = 0.012) underscores the need for close monitoring and dose adjustment, as Kumar et al. (2020) advised. Neonatal outcomes remained unaffected, affirming safety (Riaz et al., 2024; Shaanika et al., 2022). Limitations include single-center design and short-term outcome focus. Multicenter trials and studies evaluating long-term maternal and neonatal outcomes, as well as additional fetal health parameters like blood gas analysis, are recommended to enhance understanding of phenylephrine's broader impact.

CONCLUSION

This study demonstrated that prophylactic phenylephrine infusion is more effective than bolus administration in maintaining maternal hemodynamic stability during cesarean section under spinal anesthesia. The infusion method significantly reduced the incidence of hypotension and intraoperative nausea and vomiting (IONV), contributing to better maternal comfort and perioperative outcomes. Although total phenylephrine consumption was higher in the infusion group, it ensured more consistent blood pressure control with fewer rescue boluses. However, the increased bradycardia risk

highlights the need for dose titration and monitoring. Importantly, neonatal outcomes (Apgar scores) remained comparable, indicating phenylephrine infusion is safe and effective for optimizing maternal and fetal well-being. Based on these findings, it should be considered the preferred approach in managing spinal-induced hypotension during cesarean sections, with appropriate side effect mitigation.

REFERENCES

Alday Muñoz et al. (2011) observational trial comparing ephedrine vs phenylephrine by bolus and infusion to prevent hypotension

Anesthesia & Analgesia (2024) discussion on phenylephrine bolus vs infusion efficacy across multiple trials

Ansari et al. (2011) comparison between two phenylephrine infusion rates with moderate co-loading for prevention of spinal anesthesia-induced hypotension

BMC Anesthesiology (2022): RCT comparing norepinephrine versus phenylephrine infusion specifically in twin pregnancies under spinal anesthesia

BMC Anesthesiology RCT that reports neonatal outcomes and twin pregnancy data with vasopressor infusions

Carrollová et al. (2019) narrative review: general versus spinal anesthesia in cesarean sections and their hemodynamic implications

das Neves et al. (2010) study on therapeutic vs prophylactic phenylephrine dosing in elective cesarean section

Doherty et al. (2012) RCT comparing fixed-rate infusion vs bolus phenylephrine, assessing maternal cardiac output and hemodynamic outcomes

Doherty et al.'s (2012) detailed hemodynamic assessment under different phenylephrine regimens

Ferré et al. (2020) review of spinal anesthesia-induced hypotension control strategies in adults during cesarean section

Kamal et al. (2025) study comparing norepinephrine vs phenylephrine boluses in emergency cesarean section hypotension prevention

Kinsella et al. consensus statement collaborators on vasopressor use in obstetric spinal-induced hypotension

Kwon et al. large retrospective ACS-NSQIP data investigating perioperative hyperglycemia and surgical outcomes, including hypotension patterns

Meta-analysis comparing norepinephrine vs phenylephrine for prevention of hypotension in spinal anesthesia for cesarean section

Meta-analysis of phenylephrine vs norepinephrine effects on neonatal acid-base balance and Apgar scores

Observational study by Osmani et al. comparing Apgar and maternal outcomes between phenylephrine and noradrenaline boluses

Osmani et al. (2022) observational study comparing phenylephrine vs noradrenaline bolus for hemodynamic stability in elective cesarean delivery

Review by Jee and Sung (2023) systematic methodology overview on RCT inclusion criteria comparing phenylephrine and norepinephrine

Samarah et al. (2020) RCT on ondansetron prior to spinal anesthesia's hemodynamic effects in elective cesarean section

Singh et al. (2023) RCT comparing phenylephrine infusion vs bolus in cesarean delivery under spinal anesthesia

Systematic review and meta-analysis comparing phenylephrine infusion vs bolus regimens in cesarean delivery, demonstrating significant reduction in predelivery hypotension with infusion

Theodoraki et al. (2020) RCT comparing fixed-rate norepinephrine vs phenylephrine infusion to prevent hypotension during cesarean section

Theodoraki et al.'s double-blinded RCT demonstrating noninferiority of norepinephrine infusion compared to phenylephrine in cesarean delivery

Turkish Journal of Anaesthesiology and Reanimation (2022): RCT comparing prophylactic phenylephrine infusion vs norepinephrine infusion

Van de Velde (2019) commentary on low-dose spinal anesthesia to prevent spinal-induced hypotension in cesarean delivery