Original Article

Comparison Between 50 Microgram Phenylephrine Bolus and Phenylephrine Infusion in Preventing Hypotension During Spinal Anaesthesia for Cesarean Section

Bharathi S[1], Vandana A Kamble[2], K.G. Shivakumar[3]

[1]Senior Specialist, Fellowship in liver transplant Anaesthesia, Department of Anaesthesia, Aster RV hospital, Bengaluru, Karnataka, India. [2]Assistant Professor, Department of Anaesthesia, K.H.Patil Institute of medical sciences Gadag, Karnataka, India. [3]Assistant Professor, Department of Anaesthesiology, JSS Medical College, JSS Academy of Higher Education & Research (JSS AHER), Sri Shivarathreeshwara Nagar, Mysuru, Karnataka, India

Abstract

Background: Maternal hypotension is a common complication following spinal anaesthesia for cesarean section and may adversely affect both maternal and fetal outcomes. Phenylephrine is the vasopressor of choice for preventing and treating spinal anaesthesia-induced hypotension, but the optimal mode of administration remains uncertain. **Material and Methods:** This quasi-experimental study included 48 ASA II parturients with uncomplicated singleton pregnancies beyond 36 weeks of gestation undergoing elective cesarean section under spinal anaesthesia. Participants were allocated into two groups (n=24 each) using the closed envelope method. Group PB received a 50 µg intravenous phenylephrine bolus, while Group PI received phenylephrine infusion at 20 µg/min immediately after spinal anaesthesia. Maternal heart rate and blood pressure were recorded at predefined intervals until 30 minutes after delivery. Data were analysed using the Student's t-test. **Results:** Baseline demographic characteristics were comparable between the groups. Phenylephrine infusion maintained significantly higher systolic, diastolic, and mean arterial pressures at most observation points ($P<0.05$). Maternal heart rate was significantly lower in the infusion group during the first 11 minutes after spinal anaesthesia. The mean phenylephrine dose administered was 212.50 ± 146.89 µg in Group PB and 500.00 ± 0.00 µg in Group PI ($P<0.001$). Bradycardia requiring atropine occurred in two patients (8.3%) in the infusion group, while nausea and vomiting were comparable between the groups. **Conclusion:** Prophylactic phenylephrine infusion at 20 µg/min provided superior haemodynamic stability compared with intermittent 50 µg bolus administration during cesarean section under spinal anaesthesia, with acceptable maternal adverse effects.

Keywords: Cesarean section; Spinal anaesthesia; Phenylephrine; Maternal hypotension; Phenylephrine infusion; Phenylephrine bolus; Haemodynamic stability.

Received: 05 July 2026 **Revised: 22 July 2026** **Accepted: 06 August 2026** **Published: 07 August 2026**

Introduction

Cesarean section is one of the most commonly performed obstetric procedures worldwide, and spinal anaesthesia is the preferred technique for both elective and emergency cesarean delivery because of its rapid onset, reliable sensory and motor blockade, high success rate, and favourable maternal and neonatal safety profile.[1] Compared with general anaesthesia, spinal anaesthesia allows the mother to remain awake during childbirth, provides effective intraoperative anaesthesia and postoperative analgesia, minimizes fetal exposure to anaesthetic agents, and avoids airway-related complications. However, maternal hypotension remains its most frequent and clinically significant complication.[2] The incidence of spinal anaesthesia-induced hypotension in untreated parturients is approximately 70–80%. It primarily results from sympathetic blockade, leading to arterial and venous vasodilation, reduced systemic vascular resistance, venous pooling, decreased venous return, and reduced cardiac output. Physiological changes during pregnancy, including increased vascular capacitance and aortocaval compression by the gravid uterus, further aggravate the fall in maternal blood pressure following spinal blockade.[3,4] Maternal hypotension is generally defined as a systolic blood pressure below 100 mmHg or a reduction of more than 20% from baseline. Persistent hypotension may cause maternal nausea, vomiting, dizziness, restlessness, and loss of consciousness, while compromised uteroplacental perfusion can result in fetal hypoxia, acidosis, bradycardia, and lower Apgar scores. Therefore, prompt prevention and treatment of hypotension are essential for optimizing maternal and neonatal outcomes.[2,4,5]

Address for correspondence: Dr. K.G. Shivakumar, Assistant Professor, Department of 3Anaesthesiology, JSS Medical College, JSS Academy of Higher Education & Research (JSS AHER), Sri Shivarathreeshwara Nagar, Mysuru, Karnataka, India.

DOI:
10.21276/amit.2026.v13.i2.917

How to cite this article: Bharathi S, Kamble VA, Shivakumar KG. Comparison Between 50 Microgram Phenylephrine Bolus and Phenylephrine Infusion in Preventing Hypotension During Spinal Anaesthesia for Cesarean Section. Acta Med Int. 2026;13(2):1568-1572.

Several preventive strategies have been investigated, including crystalloid or colloid preloading, co-loading, left uterine displacement, lateral tilt positioning, lower-limb compression, and prophylactic vasopressor administration. Although these non-pharmacological measures may reduce the severity of hypotension, they are insufficient when used alone. Consequently, vasopressors have become the cornerstone of haemodynamic management during cesarean delivery under spinal anaesthesia.[2,4] Among the available vasopressors, phenylephrine is currently recommended as the first-line agent because it effectively maintains maternal blood pressure while providing a more favourable neonatal acid-base status than ephedrine. As a selective α1-adrenergic agonist, phenylephrine increases systemic vascular resistance through arterial and venous vasoconstriction, with minimal placental transfer. However, its use may be associated with reflex bradycardia and reduced maternal cardiac output, making the method of administration clinically important.[6–8] Phenylephrine may be administered either as intermittent intravenous bolus doses or as continuous infusion. A 50-µg intravenous bolus is widely used because it is simple and effective, but repeated boluses may produce fluctuations in blood pressure with alternating hypotension and hypertension. Continuous infusion maintains a steadier plasma concentration, resulting in improved haemodynamic stability, fewer hypotensive episodes, reduced maternal nausea and vomiting, and decreased rescue vasopressor requirements, although it may increase the incidence of reflex bradycardia. Despite several comparative studies, the optimal mode of phenylephrine administration remains uncertain.[4,9,10]

Therefore, the present study was undertaken to compare the efficacy of a 50-µg intravenous phenylephrine bolus with continuous phenylephrine infusion in preventing hypotension during spinal anaesthesia for cesarean section by evaluating maternal haemodynamic stability, vasopressor requirements, maternal adverse effects, and neonatal outcomes.

Materials and Methods

Study Design and Setting: This quasi-experimental study was conducted in the Department of Anaesthesiology at Yenepoya Medical College Hospital, Mangalore. The study included pregnant women admitted for elective lower segment cesarean section (LSCS) under spinal anaesthesia.

Sample Size: The sample size was calculated using G*Power software. A total sample of 48 patients (24 patients in each group) was estimated based on 80% statistical power, a mean difference of 10, an effect size of 0.81, and standard deviations of mean arterial pressure (MAP) of 13.26 and 11.26 reported in the reference study. Following approval from the Institutional Ethics Committee, written informed consent was obtained from all participants before enrolment.

Study Population: Eligible pregnant women scheduled for elective cesarean section under spinal anaesthesia were screened for enrolment. Participants were allocated into two equal groups (n = 24 each) using the closed envelope method.

- Group PB (Phenylephrine Bolus Group): Patients received an intravenous bolus of 50 µg phenylephrine immediately following spinal anaesthesia.
- Group PI (Phenylephrine Infusion Group): Patients received 500 µg phenylephrine diluted in 500 mL of normal saline, administered as a continuous intravenous infusion at 20 µg/min immediately after spinal anaesthesia.

Inclusion Criteria

Patients fulfilling the following criteria were included in the study:

- Pregnant women posted for lower segment cesarean section under spinal anaesthesia.
- Uncomplicated singleton pregnancy beyond 36 weeks of gestation.
- American Society of Anesthesiologists (ASA) physical status II.

Exclusion Criteria

Patients with any of the following conditions were excluded:

- Pregnancy-induced hypertension.
- Diabetes mellitus.
- Cardiovascular disease.
- Fetal abnormalities.
- Failed spinal anaesthesia.
- Contraindications to spinal anaesthesia.

Anaesthetic Technique and Study Procedure: After arrival in the operating theatre, baseline haemodynamic parameters including systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), respiratory rate (RR), and arterial oxygen saturation (SpO_2) were recorded.

All patients were preloaded with Ringer's lactate (10–15 mL/kg) intravenously. Spinal anaesthesia was administered in the left lateral position using a 23-gauge Quincke spinal needle with 2 mL (10 mg) of 0.5% hyperbaric bupivacaine. Following successful intrathecal injection, patients were positioned supine with a 15–20° left lateral tilt using a wedge under the right buttock to minimize aortocaval compression. One minute after the intrathecal injection, patients received the allocated intervention according to their study group. Patients in the PB group received an intravenous 50 µg phenylephrine bolus, whereas patients in the PI group received phenylephrine infusion at 20 µg/min prepared by diluting 500 µg phenylephrine in 500 mL normal saline.Haemodynamic variables (SBP, DBP, MAP, and HR) were recorded every 2 minutes until delivery of the baby and subsequently every 5 minutes for the next 30 minutes, which was considered the study endpoint. Patients were, however, monitored throughout the surgical procedure and during the immediate postoperative period.

Standard Perioperative Management: Persistent hypotension was treated with intravenous ephedrine 6 mg boluses, repeated as required up to a maximum cumulative dose of 30 mg. Bradycardia was managed with intravenous atropine 0.6 mg, while nausea and vomiting were treated with intravenous ondansetron 4 mg.

Outcome Measures: The primary outcome was the maintenance of maternal haemodynamic stability as assessed by changes in systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate following spinal anaesthesia.

Secondary outcomes included the requirement for rescue vasopressor (ephedrine), incidence of bradycardia, nausea and

vomiting, and the need for atropine administration.

Statistical Analysis: The collected data were entered into a spreadsheet and analysed using SPSS. 17statistical software. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparisons between the two study groups were performed using the Student's independent t-test. A P-value <0.05 was considered statistically significant.

Results

A total of 48 parturients undergoing cesarean section under spinal anaesthesia were included in the study, with 24 participants each in the phenylephrine bolus (PB) and phenylephrine infusion (PI) groups. The baseline maternal characteristics were comparable between the two groups [Table 1, Figure 1]. The mean maternal age was 27.00 ± 4.20 years in Group PB and 25.29 ± 4.04 years in Group PI (P=0.158). Similarly, the mean maternal weight was 67.04 ± 6.34 kg in Group PB and 63.29 ± 6.90 kg in Group PI (P=0.056), indicating no statistically significant differences between the groups. Maternal heart rate was comparable at baseline (P=0.231). Following spinal anaesthesia, Group PI demonstrated significantly lower heart rates than Group PB from 1 to 11 minutes (P<0.05 for all comparisons). Thereafter, heart rate differences between the groups were not statistically significant at 16, 21, 26, and 31 minutes (P>0.05) [Table 2, Figure 2]. Baseline systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were similar in both groups (P>0.05). After spinal anaesthesia, Group PI maintained significantly higher SBP than Group PB at nearly all measured time points from 1 to 31 minutes, except at baseline [Table 3]. DBP was also significantly higher in Group PI at 5, 7, 16, 21, and 26 minutes (P<0.05), whereas differences at 1, 3, 9, 11, and 31 minutes were not statistically significant. Likewise, MAP was significantly better maintained in Group PI at 3, 5, 7, 9, 16, 21, 26, and 31 minutes (P<0.05), demonstrating superior haemodynamic stability with prophylactic phenylephrine infusion [Table 3]. The total phenylephrine consumption was significantly higher in Group PI than in Group PB (500.00 ± 0.00 µg vs. 212.50 ± 146.89 µg, P<0.001) [Table 4]. Maternal adverse effects were comparable between the groups (Table 5, Figure 3). Bradycardia requiring atropine occurred only in Group PI (8.3%), whereas nausea and vomiting occurred in 12.5% of Group PB and 16.7% of Group PI; neither difference was statistically significant. All patients in Group PB (100%) required additional rescue phenylephrine boluses, whereas none in Group PI required supplemental vasopressor administration (P<0.001). Bradycardia requiring atropine occurred in two patients (8.3%) in Group PI and in none in Group PB (P=0.149). Similarly, ondansetron-requiring nausea and vomiting occurred in 12.5% of Group PB and 16.7% of Group PI without a significant difference (P=0.684) [Table 6].

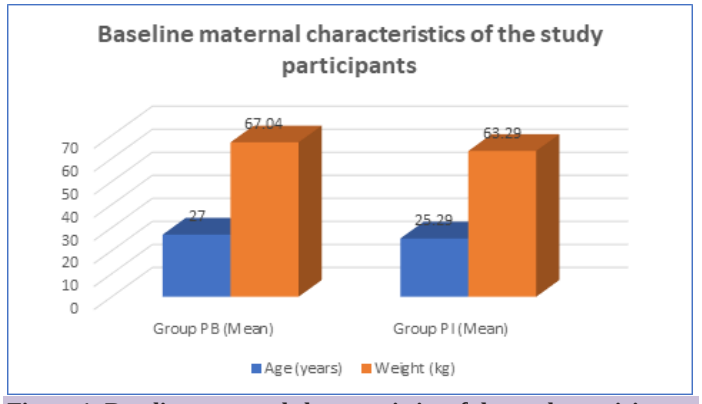

Figure 1: Baseline maternal characteristics of the study participants

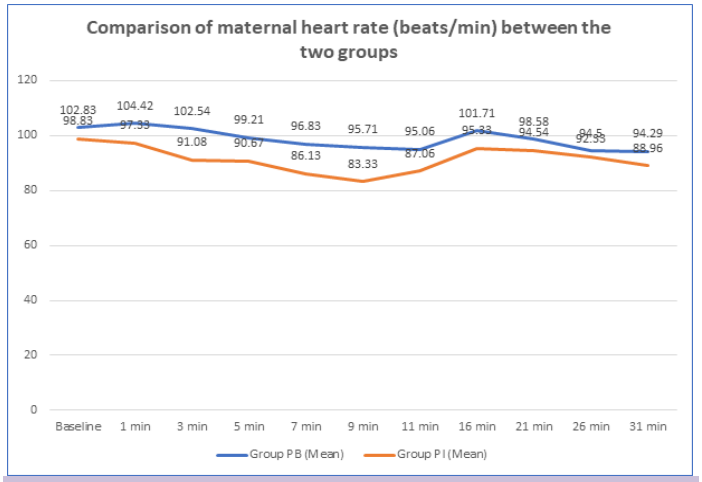

Figure 2: Comparison of maternal heart rate (beats/min) between the two groups.

Table 1: Baseline maternal characteristics of the study participants

Variable	Group PB (n=24)	Group PI (n=24)	P value
Age (years), mean ± SD	27.00 ± 4.20	25.29 ± 4.04	0.158
Weight (kg), mean ± SD	67.04 ± 6.34	63.29 ± 6.90	0.056

Table 2: Comparison of maternal heart rate (beats/min) between the two groups

Time point	Group PB (Mean ± SD)	Group PI (Mean ± SD)	P value
Baseline	102.83 ± 10.97	98.83 ± 11.84	0.231
1 min	104.42 ± 12.01	97.33 ± 10.82	0.037*
3 min	102.54 ± 14.23	91.08 ± 9.23	0.002*
5 min	99.21 ± 13.17	90.67 ± 11.06	0.019*
7 min	96.83 ± 12.37	86.13 ± 12.30	0.004*
9 min	95.71 ± 10.55	83.33 ± 13.74	0.001*
11 min	95.06 ± 10.37	87.06 ± 7.04	0.013*
16 min	101.71 ± 10.56	95.33 ± 16.96	0.125

21 min	98.58 ± 9.38	94.54 ± 16.50	0.304
26 min	94.50 ± 9.90	92.33 ± 13.68	0.533
31 min	94.29 ± 11.03	88.96 ± 13.09	0.134

*P<0.05 statistically significant.

Table 3: Comparison of maternal blood pressure (SBP, DBP and MAP) between the two groups

Time	SBP (PB)	SBP (PI)	P value	DBP (PB)	DBP (PI)	P value	MAP (PB)	MAP (PI)	P value
Baseline	120.17±10.09	120.13±8.55	0.988	75.29±8.55	75.75±5.84	0.829	90.79±7.60	90.46±6.18	0.868
1 min	109.71±11.54	117.54±10.26	0.017*	69.92±8.40	71.71±9.31	0.487	83.08±8.59	86.67±8.71	0.158
3 min	100.58±13.38	113.63±13.99	0.002*	64.08±14.99	65.88±10.75	0.636	76.38±12.81	83.00±9.10	0.045*
5 min	94.71±12.65	115.21±11.61	<0.001*	57.54±12.24	66.50±9.71	0.007*	70.46±11.83	83.00±10.28	<0.001*
7 min	97.71±10.73	115.83±10.65	<0.001*	59.21±8.61	67.38±11.19	0.007*	71.92±8.74	83.46±8.95	<0.001*
9 min	98.08±12.00	114.33±16.53	<0.001*	60.96±11.59	66.71±14.85	0.142	72.50±10.83	81.63±14.46	0.017*
11 min	95.29±14.22	108.59±12.55	0.007*	58.94±12.17	63.06±11.50	0.318	70.82±12.95	79.24±11.92	0.058
16 min	95.83±10.79	113.92±14.12	<0.001*	54.79±9.89	66.58±12.68	0.001*	68.04±9.21	81.13±12.61	<0.001*
21 min	95.54±11.09	114.33±15.75	<0.001*	54.63±9.69	62.00±12.83	0.030*	67.33±9.80	79.21±12.57	0.001*
26 min	97.46±12.47	113.25±12.41	<0.001*	54.38±10.83	64.17±9.62	0.002*	68.63±10.61	79.17±9.51	0.001*
31 min	100.17±13.24	112.29±14.59	0.004*	59.79±10.65	63.83±12.62	0.237	72.21±10.88	79.71±11.66	0.026*

*P<0.05 statistically significant.

Table 4: Total phenylephrine consumption in the two groups

Group	Mean dose (µg) ± SD	P value
Group PB	212.50 ± 146.89	<0.001
Group PI	500.00 ± 0.00	

Table 5: Maternal adverse effects

Adverse effect	Group PB (n=24)	Group PI (n=24)	P value
Bradycardia requiring atropine	0	2 (8.3%)	NS
Nausea and vomiting	3 (12.5%)	4 (16.7%)	NS

NS = Not statistically significant.

Table 6: Rescue interventions and maternal adverse events

Variable	Group PB (n=24)	Group PI (n=24)	P value
Total phenylephrine administered (µg), mean ± SD	212.50 ± 146.89	500.00 ± 0.00	<0.001
Patients requiring additional phenylephrine boluses, n (%)	24 (100.0)	0 (0.0)	<0.001
Bradycardia requiring atropine, n (%)	0 (0.0)	2 (8.3)	0.149*
Nausea and vomiting requiring ondansetron, n (%)	3 (12.5)	4 (16.7)	0.684*

*Fisher's exact test.

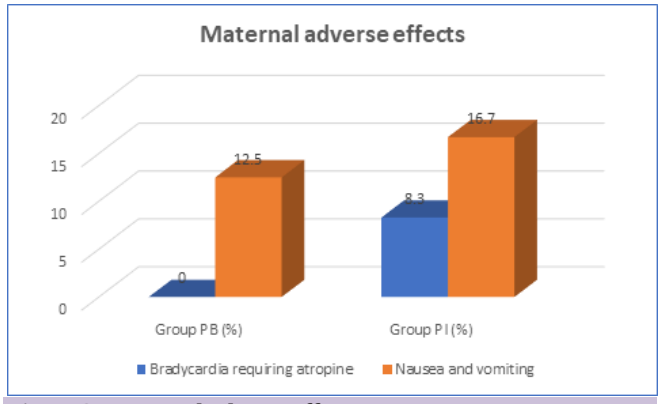

Figure 3: Maternal adverse effects

Discussion

The present quasi-experimental study compared the efficacy of a 50 µg intravenous phenylephrine bolus with prophylactic phenylephrine infusion (20 µg/min) for maintaining maternal haemodynamic stability during cesarean section under spinal anaesthesia. The principal finding was that prophylactic phenylephrine infusion provided significantly better control of systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), although it was associated with a greater reduction in maternal heart rate. Maternal adverse effects were comparable between the two groups.Baseline maternal characteristics were similar, confirming good comparability between the groups. The mean maternal age was 27.00 ± 4.20 years in the bolus group and 25.29 ± 4.04 years in the infusion group (P=0.158), while the mean maternal weight was 67.04 ± 6.34 kg and 63.29 ± 6.90 kg, respectively (P=0.056). These findings are consistent with Bajaj et al,[9] and Ngan Kee et al,[11] who also reported comparable baseline demographic and haemodynamic characteristics between treatment groups. Maternal heart rate was significantly lower in the infusion group during the early intraoperative period, with significant differences observed from 1 to 11 minutes after spinal anaesthesia (P<0.05). Baseline heart rates were 102.83 ± 10.97 bpm in the bolus group and 98.83 ± 11.84 bpm in the infusion group. Similar findings were reported by Bajaj et al,[9] who demonstrated significantly lower heart rates with continuous phenylephrine infusion due to reflex bradycardia. Ngan Kee et al,[11] likewise observed a higher incidence of maternal bradycardia with prophylactic infusion despite superior blood

pressure control. A major finding of the present study was the superior haemodynamic stability achieved with prophylactic phenylephrine infusion. Baseline SBP was comparable between groups (120.17 ± 10.09 vs 120.13 ± 8.55 mmHg; P=0.988). However, after spinal anaesthesia, SBP remained significantly higher in the infusion group. At 5 minutes, SBP was 115.21 ± 11.61 mmHg in the infusion group compared with 94.71 ± 12.65 mmHg in the bolus group (P<0.001). Similarly, MAP at 5 minutes was significantly higher in the infusion group (83.00 ± 10.28 vs 70.46 ± 11.83 mmHg; P<0.001), while DBP also remained significantly better maintained at multiple time points. These observations closely agree with Bajaj et al,[9] who reported substantially fewer episodes of hypotension with phenylephrine infusion, and with Ngan Kee et al,[11] who demonstrated more consistent maintenance of maternal SBP within the target range. Mohta et al,[12] also confirmed that continuous phenylephrine infusion provided tighter blood pressure control than intermittent bolus administration. The mean total phenylephrine dose was 212.50 ± 146.89 µg in the bolus group compared with 500 µg in the infusion group, reflecting the requirement for repeated rescue boluses with intermittent administration. Similar findings were reported by Bajaj et al,[9] and Nikooseresht et al,[13] who showed that prophylactic infusion reduced the need for additional vasopressor doses. Bradycardia requiring atropine occurred in two patients (8.3%) in the infusion group and none in the bolus group, while nausea and vomiting occurred in 12.5% and 16.7% of patients, respectively, without significant differences. Comparable results were reported by Bajaj et al,[9] and Nikooseresht et al,[13] who found improved haemodynamic control with infusion despite a slightly higher incidence of bradycardia and no increase in maternal or neonatal adverse outcomes.

Conclusion

The present study demonstrated that prophylactic phenylephrine infusion at 20 µg/min was more effective than intermittent 50 µg phenylephrine bolus in maintaining maternal systolic, diastolic, and mean arterial blood pressure during cesarean section under spinal anaesthesia. Although the infusion group experienced a greater reduction in maternal heart rate with a small increase in bradycardia, haemodynamic stability was significantly better without an increase in maternal adverse effects. Continuous phenylephrine infusion reduced blood pressure fluctuations and provided more consistent control of spinal anaesthesia-induced hypotension. Therefore, prophylactic phenylephrine infusion may be considered a preferable strategy for preventing maternal hypotension during cesarean delivery under spinal anaesthesia.

Limitations: The present study was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalizability of the findings. Maternal and neonatal outcomes were evaluated only during the intraoperative and immediate postoperative periods without long-term follow-up. Additionally, only one phenylephrine infusion rate and one bolus dose were compared; therefore, the optimal dosing regimen could not be determined.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Birnbach DJ, Bateman BT. Anesthesia for obstetrics. In: Miller RD, editor. Miller's Anesthesia. 7th ed. Philadelphia: Churchill Livingstone; 2010.
2. Mercier FJ, Augè M, Hoffmann C, Fischer C, Le Gouez A. Maternal hypotension during spinal anesthesia for caesarean delivery. Minerva Anestesiol. 2013;79(1):62-73.
3. Lee JE, George RB, Habib AS. Spinal-induced hypotension: incidence, mechanisms, prophylaxis, and management: summarizing 20 years of research. Best Pract Res Clin Anaesthesiol. 2017;31(1):57-68.
4. Šklebar I, Bujas T, Habek D. Spinal anaesthesia-induced hypotension in obstetrics: prevention and therapy. Acta Clin Croat. 2019;58(Suppl 1):90-95.
5. Carvalho B, Dyer RA. Norepinephrine for spinal hypotension during cesarean delivery: another paradigm shift? Anesthesiology. 2015;122(4):728-730.
6. Lee A, Ngan Kee WD, Gin T. A quantitative, systematic review of randomized controlled trials of ephedrine versus phenylephrine for the management of hypotension during spinal anesthesia for cesarean delivery. Anesth Analg. 2002;94(4):920-926.
7. Cooper DW, Carpenter M, Mowbray P, Desira WR, Ryall DM, Kokri MS, et al. Fetal and maternal effects of phenylephrine and ephedrine during spinal anesthesia for cesarean delivery. Anesthesiology. 2002;97(6):1582-1590.
8. Cooper BE. Review and update on inotropes and vasopressors. AACN Adv Crit Care. 2008;19(1):5-13.
9. Bajaj JK, Choudhary M. Study comparing phenylephrine bolus and infusion for maternal hypotension and neonatal outcome during cesarean section under spinal anesthesia. Anesth Essays Res. 2018;12(2):446-451.
10. Sharkey AM, Siddiqui N, Downey K, Ye XY, Guevara J, Carvalho JCA, et al. Comparison of intermittent intravenous boluses of phenylephrine and norepinephrine to prevent and treat spinal-induced hypotension in cesarean deliveries: randomized controlled trial. Anesth Analg. 2019;129(5):1312-1318.
11. Ngan Kee WD, Khaw KS, Ng FF. Comparison of phenylephrine infusion regimens for maintaining maternal blood pressure during spinal anaesthesia for Caesarean section. Br J Anaesth. 2004;92(4):469-474.
12. Mohta M, Aggarwal A, Chilkoti GT, Tyagi A, Sethi AK, Gupta N, et al. Prophylactic phenylephrine boluses versus variable rate infusion during elective cesarean delivery under spinal anesthesia: a randomized double-blind study. Anesth Analg. 2025;141(4):736-739.
13. Nikooseresht M, Seifrabiei MA, Hajian P, Khamooshi S. A clinical trial on the effects of different regimens of phenylephrine on maternal hemodynamic after spinal anesthesia for cesarean section. Anesth Pain Med. 2020;10(4):e58048.