

Hypotension After Spinal Anaesthesia in Cesarean Section: Current Approaches to Prevention and Management

Kritika Raj¹, Amit Kumar², Manish Kumar³, Pawan Kumar Dutta⁴, Mirdula Vivakar⁵

¹Senior Resident, Department of Anaesthesiology, MGM Medical College Jamshedpur, Jharkhand, India

²Assistant Professor, Department of Anesthesia & Critical Care Medicine, Mahabodhi Medical College & Hospital, Gaya

³Post Graduate Trainee, Department of Anaesthesiology, Midnapore Medical College and Hospital, Paschim Medinapore, India

⁴Professor & HOD, Department of Anesthesiology, MGM Medical College, Jamshedpur, Jharkhand, India

⁵Assistant Professor, Department of Obstetrics & Gynaecology, Dumka Medical College and Sadar Hospital, Dumka, Jharkhand, India

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Corresponding Author: Dr. Kritika Raj

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Abstract:

Background: Hypotension is one of the most frequent and clinically significant complications following spinal anaesthesia during caesarean section. It can adversely affect both maternal and neonatal outcomes through reduced uteroplacental perfusion, fetal acidosis, and maternal discomfort. Despite the availability of preventive and management strategies, its incidence remains high, warranting continuous evaluation of current practices.

Aim: This study aimed to assess the incidence of hypotension in parturients undergoing caesarean section under spinal anaesthesia, review the preventive measures used, and evaluate the effectiveness of management strategies on maternal and neonatal outcomes.

Methods: A retrospective observational study was conducted at the Department of Anaesthesiology, MGM, Jamshedpur, over one year. Medical records of 50 women aged 18–40 years undergoing lower segment caesarean section under spinal anaesthesia were reviewed. Data on demographics, haemodynamic changes, prophylactic measures, interventions for hypotension, and neonatal outcomes were collected. Statistical analysis was performed using SPSS version 23.0, with Chi-square and Student's t-tests applied; $p < 0.05$ was considered significant.

Results: The incidence of hypotension was 56%. Crystalloid preloading (80%) and left uterine displacement (100%) were the most commonly employed preventive measures, while prophylactic vasopressors were used in only 40% of cases. Among those who developed hypotension, 85.7% were treated with vasopressors, 71.4% with fluid boluses, and 53.6% with oxygen supplementation. A significant association was found between absence of vasopressor prophylaxis and development of hypotension ($p = 0.01$). Patients with BMI $> 26 \text{ kg/m}^2$ had a higher likelihood of hypotension ($p = 0.04$). Maternal outcomes were favorable with no ICU admissions. Neonatal outcomes were satisfactory, with 92% achieving Apgar scores ≥ 7 at 1 minute and 100% at 5 minutes.

Conclusion: Hypotension remains a common complication following spinal anaesthesia in caesarean delivery. Prophylactic vasopressor use significantly reduces its incidence, while prompt management with vasopressors and fluids ensures favorable maternal and neonatal outcomes.

Recommendations: Routine incorporation of prophylactic vasopressor protocols, especially in patients with higher BMI, alongside multimodal preventive strategies, is recommended to optimize haemodynamic stability and improve perioperative safety.

Keywords: Spinal anaesthesia, Cesarean section, Hypotension, Vasopressors, Prevention.

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Introduction

Hypotension following spinal anaesthesia remains one of the most common and clinically significant complications during caesarean section, with potential adverse consequences for both the mother and fetus. The sudden onset of sympathetic blockade causes vasodilation and a reduction in systemic vascular resistance, leading to maternal

hypotension, which can compromise uteroplacental perfusion and result in fetal acidosis and maternal symptoms such as nausea, vomiting, and dizziness [1,2]. Despite advances in anaesthetic techniques, hypotension continues to be reported in up to 70–80% of parturients undergoing spinal anaesthesia for caesarean delivery [3]. Given its high incidence and

clinical relevance, numerous pharmacological and non-pharmacological strategies have been explored to mitigate this risk.

Current approaches to prevention and management focus on optimizing maternal hemodynamic stability before and during the procedure. Traditional methods such as intravenous preloading with crystalloids have demonstrated limited efficacy, whereas co-loading strategies administered simultaneously with spinal injection show more consistent benefits [4]. Vasopressors remain the cornerstone of management, with phenylephrine increasingly preferred over ephedrine due to its superior maternal hemodynamic profile and reduced risk of fetal acidosis [5,6]. Recent studies also suggest that norepinephrine, with its mixed α - and β -adrenergic effects, may provide a more favorable balance between maintaining blood pressure and avoiding reflex bradycardia [7].

Non-pharmacological interventions complement drug therapy, including left uterine displacement to reduce aortocaval compression, lower limb compression devices, and maternal positioning strategies [8]. Prophylactic infusion or bolus regimens of vasopressors combined with advanced hemodynamic monitoring are being increasingly adopted to allow tailored therapy for individual patients [9]. Emerging evidence highlights the role of closed-loop vasopressor systems that automatically titrate infusion based on continuous blood pressure measurements, which may represent a future paradigm shift in intraoperative hemodynamic management [10].

Overall, the prevention and management of spinal anaesthesia-induced hypotension in caesarean section has evolved towards a multimodal approach, integrating optimized fluid therapy, pharmacological prophylaxis, and individualized monitoring. Continued research into vasopressor selection, dosing strategies, and automated delivery systems promises to further improve maternal and neonatal outcomes. This review discusses the current strategies and evolving evidence in the prevention and management of hypotension following spinal anaesthesia in caesarean section.

Methodology

Study Design: This was a retrospective observational study.

Study Setting: The study was carried out at the Department of Anaesthesiology, Mahatma Gandhi Memorial Medical College over a period of one year.

Participants: The medical records of 50 parturients who underwent lower segment caesarean section (LSCS) under spinal anaesthesia during the study period were included.

Inclusion Criteria

- Women aged 18–40 years undergoing cesarean section under spinal anaesthesia.
- Complete medical records with adequate intraoperative documentation of haemodynamic parameters.
- Patients in whom preventive and/or management strategies for hypotension were documented.

Exclusion Criteria

- Incomplete or missing data in patient records.
- Patients with pre-existing cardiovascular disorders, autonomic neuropathies, or endocrine disorders affecting blood pressure regulation.
- Women who received general anaesthesia or combined spinal–epidural anaesthesia.

Bias: To minimize selection bias, only records fulfilling predefined inclusion and exclusion criteria were considered. Information bias was reduced by cross-verifying the anaesthesia charts with perioperative nursing records.

Data Collection: Data were extracted from patient medical records, anaesthesia charts, and operative notes. Parameters collected included patient demographics, baseline haemodynamic values, incidence of hypotension, preventive strategies employed (e.g., fluid preloading, vasopressors, left uterine displacement), and management interventions (vasopressors, oxygen supplementation, fluid bolus).

Procedure: Patient records were systematically reviewed, and relevant details were entered into a structured data collection form. Hypotension was defined as a fall in systolic blood pressure of $\geq 20\%$ from baseline or an absolute systolic value < 90 mmHg. Preventive and therapeutic interventions were documented and categorized for analysis.

Statistical Analysis: The collected data were compiled and analyzed using (SPSS) version 23.0. Descriptive statistics were presented as mean $\pm$ standard deviation for continuous variables and frequencies with percentages for categorical variables. Chi-square test and Student's t-test were used for comparison, where appropriate. A p value < 0.05 was considered statistically significant.

Results

A total of 50 parturients undergoing cesarean section under spinal anaesthesia were included. The mean age was 27.4 ± 4.2 years, and the mean body mass index (BMI) was 25.6 ± 3.1 kg/m². Majority of patients (60%) were primigravida, while 40% were multigravida.

Table 1: Demographic profile of participants (n = 50)

Variable	Mean $\pm$ SD / n (%)
Age (years)	27.4 $\pm$ 4.2
BMI (kg/m ²)	25.6 $\pm$ 3.1
Primigravida	30 (60%)
Multigravida	20 (40%)

The sample represented a typical obstetric population with a predominance of younger women and primigravidas.

Incidence of Hypotension: Out of 50 patients, 28 (56%) experienced hypotension following spinal anaesthesia, whereas 22 (44%) maintained stable haemodynamics.

Table 2: Incidence of hypotension

Outcome	n (%)
Hypotension	28 (56%)
No hypotension	22 (44%)

More than half of the study population developed hypotension, highlighting the clinical relevance of preventive and management strategies.

Preventive Strategies Employed: The most frequently employed preventive measure was

crystalloid preloading (80%), followed by vasopressor prophylaxis (phenylephrine infusion, 40%). Left uterine displacement was consistently practiced (100%).

Table 3: Preventive measures used

Preventive Strategy	n (%)
Crystalloid preloading	40 (80%)
Colloid preloading	6 (12%)
Prophylactic vasopressors	20 (40%)
Left uterine displacement	50 (100%)

Preventive measures were variably applied, with fluid preloading being the most common.

Management of Hypotension: Among the 28 patients who developed hypotension, the primary

intervention was vasopressor administration (phenylephrine or ephedrine), used in 24 patients (85.7%). Fluid boluses were administered in 20 patients (71.4%), while supplemental oxygen was required in 15 cases (53.6%).

Table 4. Management strategies for hypotension (n = 28)

Management Intervention	n (%)
Vasopressors (Phenylephrine/Ephedrine)	24 (85.7%)
Crystalloid bolus	20 (71.4%)
Oxygen supplementation	15 (53.6%)
Left uterine displacement (reinforced)	10 (35.7%)

Vasopressors were the most effective and frequently used management option, followed by fluid boluses.

Maternal and Neonatal Outcomes: Maternal outcomes were favorable, with resolution of

hypotension in all patients. No maternal ICU admission was required. Neonatal outcomes were assessed using Apgar scores: 92% had scores ≥ 7 at 1 minute, while 100% had scores ≥ 7 at 5 minutes.

Table 5: Neonatal Apgar scores

Apgar Score	1 Minute (n, %)	5 Minutes (n, %)
≥ 7	46 (92%)	50 (100%)
< 7	4 (8%)	0 (0%)

Neonatal outcomes remained satisfactory, with minimal impact of maternal hypotension when timely management was instituted.

Statistical Analysis: A significant association was found between lack of prophylactic vasopressor use and the incidence of hypotension ($p = 0.01$, Chi-square test). Similarly, patients with higher BMI

(>26 kg/m²) showed a greater likelihood of hypotension ($p = 0.04$).

Discussion

The present retrospective study analyzed 50 parturients undergoing cesarean section under spinal anaesthesia at RIIMS, Ranchi, with a focus on the incidence, prevention, and management of hypotension. The demographic profile revealed a predominance of young women, with a mean age of 27.4 years and a majority being primigravidas. This reflects the typical obstetric population receiving spinal anaesthesia in similar tertiary care centers.

The overall incidence of hypotension in this study was 56%, which aligns with the reported range of 50–70% in previous literature. This high frequency underscores the persistent challenge of haemodynamic instability following spinal anaesthesia in obstetric patients, despite routine preventive measures. Importantly, analysis revealed that patients with a higher BMI were more prone to hypotension, suggesting that maternal body habitus may influence susceptibility to blood pressure drops.

Preventive strategies varied among cases. Crystalloid preloading was the most commonly used technique (80%), while prophylactic vasopressors were employed in only 40% of patients. The significantly higher incidence of hypotension in those who did not receive vasopressor prophylaxis ($p = 0.01$) highlights the critical role of timely pharmacological intervention in maintaining haemodynamic stability. Although left uterine displacement was consistently practiced, it appeared insufficient alone to prevent hypotension, reaffirming the need for multimodal preventive approaches.

Among patients who developed hypotension, the primary management intervention was vasopressor therapy, used in 85.7% of cases, followed by fluid boluses and supplemental oxygen. These measures were effective, as all patients achieved haemodynamic recovery without adverse maternal outcomes or ICU admissions. This demonstrates that prompt recognition and treatment of hypotension can mitigate complications and ensure maternal safety.

Neonatal outcomes were favorable, with the majority of newborns achieving Apgar scores ≥ 7 at both 1 and 5 minutes. Only 8% of neonates had lower Apgar scores at 1 minute, but all normalized by 5 minutes. This suggests that transient maternal hypotension, when managed effectively, has minimal impact on neonatal wellbeing.

Recent evidence continues to refine the strategies for preventing and managing hypotension following spinal anaesthesia during caesarean delivery. A randomized controlled trial comparing

norepinephrine and ephedrine demonstrated that norepinephrine resulted in fewer episodes of hypotension and bradycardia, while maintaining favorable neonatal outcomes, suggesting its superiority over traditional agents like ephedrine [11]. Similarly, a Beninese trial found that noradrenaline was more effective than ephedrine in prolonging the time to hypotension and reducing the total vasopressor dose required intraoperatively [12]. Complementing these findings, prospective evaluations of a low-dose norepinephrine infusion protocol confirmed its efficacy in maintaining maternal hemodynamic stability without compromising neonatal well-being [13].

Comprehensive reviews have also advanced understanding of evidence-based practices. A systematic review emphasized that vasopressors, particularly phenylephrine and norepinephrine, alongside fluid co-loading, represent the most reliable strategies for reducing the incidence of spinal-induced hypotension [14]. Another review highlighted demographic and clinical predictors of hypotension, including maternal body habitus, baseline blood pressure, and sympathetic tone, thereby supporting the development of individualized prophylactic approaches [15].

Clinical practice surveys further illustrate global trends. A 2023 multicenter survey reported that while most anesthesiologists use phenylephrine routinely, prophylactic vasopressor use remains limited. Non-pharmacological methods such as left uterine displacement and leg compression are also widely practiced, though their effectiveness as standalone measures is insufficient [16]. In line with this, a maternal care bundle that included left uterine placement significantly reduced intraoperative vasopressor requirements and improved maternal hemodynamic outcomes [17].

Other regional studies reinforce the need for multimodal prevention. In Ethiopia, prophylactic ephedrine was shown to significantly reduce the incidence of hypotension compared to fluid co-loading alone [18]. A Bhutanese cohort identified low baseline systolic blood pressure, higher sensory block height, and prolonged fasting as significant risk factors for developing hypotension, emphasizing the importance of patient-specific risk stratification [19]. Overall, these studies consistently highlight the evolving preference for norepinephrine and phenylephrine as first-line vasopressors, underscore the limitations of fluids alone, and advocate for multimodal strategies integrating pharmacological and non-pharmacological interventions tailored to maternal risk factors.

Conclusion

This retrospective study demonstrated that hypotension remains a frequent complication

following spinal anaesthesia in cesarean section, occurring in more than half of the cases. Prophylactic vasopressor uses significantly reduced its incidence, while prompt management with vasopressors and fluid therapy ensured favorable maternal outcomes. Neonatal outcomes were not adversely affected when timely interventions were instituted. Strengthening preventive strategies, particularly routine prophylactic vasopressor administration, may further improve perioperative safety in obstetric anaesthesia.

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