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Original Research Article

Hemodynamic Changes After Spinal Anesthesia in Cesarean Section: A Prospective Observational Study

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Abstract

Background: Spinal anesthesia is the preferred anesthetic technique for cesarean section because of its rapid onset, effective sensory blockade, and minimal fetal drug exposure. However, post-spinal hypotension remains the most common complication and may adversely affect both maternal comfort and uteroplacental perfusion.
Aim: To determine the incidence of post-spinal hypotension and identify associated risk factors in patients undergoing cesarean section.
Methodology: This prospective observational study was conducted on 90 patients undergoing elective or emergency cesarean section under spinal anesthesia. Maternal demographics, obstetric variables, baseline hemodynamic parameters, sensory block level, intraoperative management, and neonatal outcomes were recorded. Hypotension was defined as a fall in systolic blood pressure ≥20% from baseline or an absolute systolic blood pressure <90 mmHg. Statistical analysis was performed to identify factors associated with post-spinal hypotension.
Results: Post-spinal hypotension occurred in 64.4% of patients, most commonly within the first 10 minutes following spinal anesthesia. Higher body mass index, lower baseline systolic blood pressure, higher sensory block level (≥T4), primigravida status, and emergency cesarean section were significantly associated with hypotension. Vasopressor support was required in the majority of affected patients. Conclusion: Post-spinal hypotension remains a frequent and clinically significant complication during cesarean section under spinal anesthesia. Early identification of high-risk patients and timely preventive strategies are essential to improve maternal and neonatal outcomes.
Keywords: Spinal Anesthesia, Hypotension, Cesarean Section, Patients, Obstetric Anesthesia.
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Introduction

Spinal anesthesia is widely accepted as the anesthetic technique of choice for cesarean section due to its rapid onset, dense neural blockade, avoidance of airway manipulation, and favorable maternal–fetal safety profile [1]. Despite these advantages, post-spinal hypotension remains the most frequently encountered complication, with reported incidence ranging from 60% to 80% in the absence of prophylactic measures [2,3].

The pathophysiology of post-spinal hypotension is multifactorial. Sympathetic blockade following spinal anesthesia leads to peripheral vasodilation and reduced systemic vascular resistance. In pregnancy, these effects are exacerbated by aortocaval compression caused by the gravid uterus, resulting in reduced venous return and cardiac output [4]. Pregnancy-related physiological changes such as increased sensitivity to local anesthetics and altered autonomic tone further predispose patients to hypotension [5].

Maternal hypotension may manifest as nausea, vomiting, dizziness, and altered consciousness, while severe or prolonged hypotension can compromise uteroplacental perfusion, leading to fetal hypoxia, acidosis, and low Apgar scores [6,7].

Although preventive strategies such as fluid loading, left uterine displacement, and vasopressor administration have been advocated, hypotension continues to occur frequently in routine obstetric anesthesia practice [8].

Identifying patient- and anesthesia-related risk factors is therefore essential for targeted prevention and improved perioperative management. This

study was undertaken to evaluate the incidence of post-spinal hypotension and analyze the associated risk factors in patients undergoing cesarean section under spinal anesthesia.

Methodology

Study Design and Setting: A prospective observational study was conducted in the Department of Anesthesiology at a tertiary care hospital.

Sample Size Calculation: Sample size was calculated using the formula for the estimation of proportion:

$$n=Z^2\times p\times q/d^2$$

Where Z = 1.96 (95% confidence interval), p = 70% (expected incidence based on previous studies [2,3]), $q = 100 - p$, and d = 10% allowable error.

The calculated sample size was 81. Considering possible dropouts, 90 patients were included.

Study Population: Patients aged 18–40 years, ASA physical status II, undergoing elective or emergency cesarean section under spinal anesthesia were enrolled.

Inclusion Criteria

- Term singleton pregnancy
- Cesarean section under spinal anesthesia

Exclusion Criteria

- Hypertensive disorders of pregnancy
- Cardiac disease
- Contraindications to spinal anesthesia
- Conversion to general anesthesia

Anesthetic Technique: Spinal anesthesia was administered in the sitting position using hyperbaric bupivacaine. Patients were positioned supine with left uterine displacement. Standard monitoring included non-invasive blood pressure, heart rate, and oxygen saturation.

Definition of Hypotension: Post-spinal hypotension was defined as a decrease in systolic blood pressure ≥20% from baseline or an absolute systolic blood pressure <90 mmHg [9].

Data Collection: Data were collected using a pre-designed and pre-tested structured questionnaire. Relevant maternal demographic details, obstetric history, baseline clinical parameters, intraoperative findings, and neonatal outcomes were recorded for each participant at the time of surgery. The questionnaire was filled by the investigator based on patient interview and clinical records.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 26. Continuous variables were expressed as mean ± standard deviation, and categorical variables were summarized as frequency and percentage.

The association between post-spinal hypotension and study variables was assessed using appropriate statistical methods based on the type and distribution of data. A p-value < 0.05 was considered statistically significant.

Results

A total of 90 patients undergoing cesarean section under spinal anesthesia were included in the final analysis. Table 1 summarises the baseline demographic and obstetric profile of the study participants. The mean age of parturients was 26.8 ± 4.2 years, and the mean body mass index was 24.9 ± 3.1 kg/m². Most women were multigravida (57.8%), while 42.2% were primigravida. Elective cesarean sections constituted 60% of cases, whereas 40% were performed as emergency procedures. The mean baseline systolic blood pressure was 118.6 ± 9.4 mmHg, indicating hemodynamic stability prior to spinal anesthesia.

Table 1: Baseline Demographic and Obstetric Characteristics

Variable	Value
Age (years)	26.8 ± 4.2
Body mass index (kg/m²)	24.9 ± 3.1
Gestational age (weeks)	38.2 ± 1.1
Primigravida	38 (42.2%)
Multigravida	52 (57.8%)
Elective cesarean section	54 (60.0%)
Emergency cesarean section	36 (40.0%)
Baseline systolic BP (mmHg)	118.6 ± 9.4

Nausea was the most common symptom, reported in 51.7% of hypotensive patients, followed by vomiting in 31.0%. Other symptoms included dizziness (20.7%) and sweating (17.2%). These findings demonstrate the significant impact of hypotension on maternal comfort during cesarean section. An Apgar score of less than 7 at 1 minute was observed in 13.3% of neonates, while only 4.4% had Apgar scores below 7 at 5 minutes.

NICU admission was required in 6.7% of newborns.

Overall, neonatal outcomes were favorable, with most neonates showing rapid post-delivery adaptation despite maternal hypotension.

Table 2: Incidence, Severity, and Timing of Post-Spinal Hypotension

Parameter	Frequency (%)
Hypotension present	58 (64.4%)
Mild hypotension	26 (44.8%)
Moderate hypotension	20 (34.5%)
Severe hypotension	12 (20.7%)
Onset within 0–5 min	28 (48.3%)
Onset within 6–10 min	22 (37.9%)
Onset > 10 min	8 (13.8%)

Table 3: Intraoperative Characteristics

Variable	Frequency (%)
Sensory block ≥ T4	50 (55.6%)
Vasopressor requirement	46 (79.3%)
Mephentermine use	32 (69.6%)
Phenylephrine use	14 (30.4%)
Bradycardia episodes	18 (20.0%)

Table 4: Association of Risk Factors with Post-Spinal Hypotension

Variable	Hypotension Present	Hypotension Absent	p-value
BMI ≥ 25 kg/m²	36 (78.3%)	10 (21.7%)	< 0.05
Baseline SBP < 120 mmHg	42 (72.4%)	16 (27.6%)	< 0.05
Sensory block ≥ T4	40 (80.0%)	10 (20.0%)	< 0.001
Emergency cesarean section	30 (83.3%)	6 (16.7%)	< 0.01
Primigravida	28 (73.7%)	10 (26.3%)	< 0.05

Table 4 analyzes the association between selected maternal and anesthetic variables and the occurrence of post-spinal hypotension. A significantly higher incidence of hypotension was observed in parturients with BMI ≥25 kg/m² (78.3%), baseline systolic blood pressure <120 mmHg (72.4%), sensory block level ≥T4 (80.0%), emergency cesarean section (83.3%), and primigravida status (73.7%). All these associations were statistically significant ($p < 0.05$), indicating their strong predictive value for post-spinal hypotension.

Discussion

The present study demonstrated an incidence of post-spinal hypotension of 64.4%, which is comparable to previously reported rates of 60–80% in patients undergoing cesarean section under spinal anesthesia [2,3,10]. Carpenter et al. reported hypotension in approximately 75% of patients, while Rout et al. observed an incidence of nearly 70%, reinforcing that hypotension remains common despite improved anesthetic techniques [2,3].

In our study, nearly half of the hypotensive episodes occurred within the first 5 minutes after spinal anesthesia. Similar observations were made by Ngan Kee et al., who reported that most episodes occur within 5–7 minutes, corresponding to the peak sympathetic blockade phase [11]. This highlights the critical need for close hemodynamic monitoring immediately after intrathecal drug administration.

Higher sensory block levels (≥ T4) were significantly associated with hypotension in the present study, with 80.0% of such patients developing hypotension. Dyer et al. and Bajwa et al. similarly reported higher incidence and severity of hypotension with higher sensory block levels due to extensive sympathetic blockade [12,13].

Increased body mass index was another significant risk factor. In our study, 78.3% of patients with BMI ≥ 25 kg/m² developed hypotension. Lee et al. reported comparable findings, attributing the increased risk to greater cephalad spread of intrathecal local anesthetic and reduced cerebrospinal fluid volume in obese patients [14].

Baseline systolic blood pressure also influenced the incidence of hypotension. Patients with baseline SBP < 120 mmHg had a hypotension incidence of 72.4%, consistent with observations by Klöhr et al., who identified lower baseline blood pressure as an independent predictor of spinal-induced hypotension [15].

Emergency cesarean sections showed a higher incidence of hypotension (83.3%) compared with elective procedures. Mercier et al. similarly reported increased hypotension in emergency cases, likely due to inadequate pre-operative optimization

and heightened maternal stress [16]. Primigravida status was also associated with higher hypotension rates (73.7%), a finding supported by earlier studies suggesting increased sympathetic responsiveness and anxiety in primigravida patients [17].

Vasopressor support was required in 79.3% of hypotensive patients in our study, which aligns with previous reports where vasopressor use exceeded 70% among affected patients [11]. Maternal symptoms such as nausea and vomiting were more frequent in hypotensive patients, corroborating the established association between hypotension and intraoperative discomfort [6,7]. Neonatal outcomes were largely satisfactory, although a small proportion required NICU admission, consistent with earlier studies linking maternal hypotension with transient neonatal compromise [7,16].

Conclusion

Post-spinal hypotension is a frequent and clinically significant complication in patients undergoing cesarean section under spinal anesthesia. Higher body mass index, lower baseline systolic blood pressure, higher sensory block level, primigravida status, and emergency cesarean section are important risk factors. Anticipation of these factors and timely preventive strategies can significantly improve maternal comfort and neonatal outcomes.

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