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EFFECT OF MATERNAL ANAESTHESIA ON NEONATAL OUTCOMES: A PROSPECTIVE COHORT STUDY IN A TERTIARY CARE INSTITUTE OF HALDIA, WEST BENGAL

Dr Diptanu Bhaumik[1*], Dr Koushik Baran Roy[2], Dr Deepak Chandra[3], Dr Arup Dasgupta[4]

[1*]Assistant Professor, Department of Anaesthesiology, ICARE Institute of Medical Sciences and Research & Dr B C Roy Hospital, Haldia, West Bengal, Pincode 721645
[2]Post Graduate Resident, Department of Anaesthesiology, ICARE Institute of Medical Sciences and Research & Dr B C Roy Hospital
[3]Associate Professor, Department of Anaesthesiology ICARE, Institute of Medical Sciences and Research & Dr B C Roy Hospital
[4]Professor and HOD, Department of Anaesthesiology ICARE, Institute of Medical Sciences and Research & Dr B C Roy Hospital

***Corresponding Author:** Dr Diptanu Bhaumik
*Assistant Professor, Department of Anaesthesiology, ICARE Institute of Medical Sciences and Research & Dr B C Roy Hospital, Haldia, West Bengal, Pincode 721645

Abstract:

Background: Spinal anaesthesia is the preferred technique for cesarean section due to its rapid onset and maternal safety profile. However, maternal hypotension following spinal anaesthesia may adversely affect neonatal outcomes. This study aimed to evaluate the impact of maternal hypotension on various neonatal parameters.

Methods: A prospective cohort study was conducted at ICARE Institute of Medical Sciences and Research & Dr. B. C. Roy Hospital, Haldia, West Bengal from May 2023 to May 2024. A total of 220 term parturients undergoing cesarean section under spinal anaesthesia were enrolled. Maternal hypotension was defined as systolic blood pressure <100 mmHg or a fall of ≥20% from baseline. Neonatal outcomes including APGAR scores, need for resuscitation, NICU admission and duration, birth weight, cord blood pH, respiratory distress and neonatal jaundice were compared between mothers with and without hypotension. Data were analyzed using SPSS version 25.0.

Results: Out of 220 patients, 84 (38.2%) experienced maternal hypotension. The mean APGAR score at 1 minute was significantly lower in the hypotension group (6.9 ± 1.4 vs 7.6 ± 0.9; p=0.01). NICU admission was more frequent among neonates of hypotensive mothers (16.7% vs 3.7%; p=0.002), with a higher rate of prolonged NICU stay >3 days (p=0.012). Neonatal resuscitation (13.1% vs 4.4%; p=0.03), respiratory distress (15.5% vs 5.1%; p=0.01), and acidosis (cord pH <7.2; 17.9% vs 7.4%; p=0.02) were also significantly associated with maternal hypotension. No significant difference was observed in the incidence of neonatal jaundice requiring phototherapy.

Conclusion: Maternal hypotension following spinal anaesthesia is significantly associated with adverse neonatal outcomes, including low APGAR scores, need for resuscitation, respiratory distress, and prolonged NICU stay. Vigilant intraoperative monitoring and timely management of hypotension are essential to ensure optimal neonatal outcomes in cesarean deliveries under spinal anaesthesia.

Keywords: Spinal anaesthesia, Neonatal outcome, Cesarean section, NICU admission, APGAR score etc.

Introduction:

The administration of anaesthesia during childbirth is essential for maternal safety and comfort, particularly during cesarean sections. The choice of anaesthesia during cesarean section significantly impacts maternal and neonatal outcomes. Over the past few decades, spinal anaesthesia has become the preferred method for cesarean deliveries due to its rapid onset, predictable block, minimal drug transfer to the fetus, and avoidance of airway manipulation, which is particularly advantageous in obstetric patients.[1-3] Compared to general anaesthesia, spinal anaesthesia is associated with reduced maternal morbidity, better intraoperative hemodynamic stability when managed properly, and improved patient satisfaction.[4,5]

Neonatal outcomes following spinal anaesthesia are generally favorable, particularly because agents like hyperbaric bupivacaine have limited placental transfer and do not significantly affect neonatal neurobehavior when used within recommended doses.[6] However, one of the main concern is maternal hypotension, a common side effect of spinal anaesthesia, which may compromise uteroplacental perfusion, potentially leading to neonatal acidosis, low APGAR scores, or need for resuscitation.[7-9]

Evaluation of neonatal well-being is typically conducted through APGAR scores, umbilical cord pH, requirement of resuscitation, and NICU admissions.[10] Despite spinal anaesthesia being widely practiced, its effects on neonatal outcomes can vary due to maternal factors such as age, parity, comorbidities, and intraoperative events like hypotension or uterine incision to delivery interval.[11,12]

There is a lack of region-specific data in India, especially from resource-limited settings like eastern India. Therefore, this prospective cohort study conducted in a tertiary care center in Haldia, West Bengal, aims to evaluate the impact of maternal spinal anaesthesia on immediate neonatal outcomes following cesarean delivery. The findings are expected to guide evidence-based anaesthetic practices and improve both maternal and neonatal care in similar settings.

Materials and Methods:

This prospective cohort study was conducted at the Department of Anaesthesiology and Obstetrics & Gynaecology of ICARE Institute of Medical Sciences and Research & Dr. B. C. Roy Hospital, Haldia, West Bengal over a period of one year, i.e. from 10th May 2023 to 9th May 2024. Ethical clearance was obtained from the Institutional Ethics Committee prior to initiation of the study. Written informed consent was taken from all participants.

The study included pregnant women undergoing cesarean section under spinal anaesthesia, either elective or emergency, at term gestation (≥37 weeks). Inclusion criteria were single term pregnancy, ASA (American Society of Anesthesiologists) physical status II, and absence of any known fetal anomaly. Patients with multiple gestations, severe preeclampsia or eclampsia, known cardiovascular disease, contraindications to spinal anaesthesia (e.g., coagulopathy, infection at injection site), or those requiring conversion to general anaesthesia were excluded.

Spinal anaesthesia was administered in the sitting position using a 25G Quincke needle at L3-L4 or L4-L5 interspace. Hyperbaric bupivacaine 0.5% Heavy (2.0–2.2 ml i.e 10-12.5 mg) was used depending on institutional protocol. Maternal monitoring included continuous ECG, non-invasive blood pressure, and pulse oximetry. Hypotension (defined as a decrease in systolic blood pressure ≥20% from baseline or <100 mmHg) was treated with intravenous fluids and vasopressors (mephentermine or ephedrine).

Neonatal outcomes were assessed immediately after delivery using APGAR scores at 1 and 5 minutes. Other parameters recorded included Umbilical cord blood pH, the need for resuscitation, NICU admission & duration (>3 days considered prolonged), any signs of respiratory distress and need for phototherapy. Data were collected using a predesigned proforma and analyzed statistically using

appropriate descriptive and inferential methods. A p-value of <0.05 was considered statistically significant.

Results :

A total of 220 parturients who underwent cesarean section under spinal anaesthesia were included in the study. The demographic and obstetric characteristics, intraoperative findings, and neonatal outcomes were analyzed.

As shown in table 1, the demographic and obstetric profile of the 220 study participants revealed that the mean maternal age was 26.8 years with a standard deviation of 4.2 years. The mean gestational age at the time of delivery was 38.5 ± 1.1 weeks, indicating that most deliveries occurred at term. Regarding gravidity, 59.1% of the women were primigravida (n = 130), while the remaining 40.9% were multigravida (n = 90). In terms of the type of lower segment cesarean section (LSCS), 54.5% of the procedures were elective (n = 120), and 45.5% were emergency cesarean sections (n = 100), reflecting a relatively balanced distribution between planned and urgent surgical deliveries.

Table 1: Demographic and Obstetric Profile of Study Participants (n = 220)

Variable		Value (Mean ± SD / n, %)
Maternal age (years)		26.8 ± 4.2
Gestational age (weeks)		38.5 ± 1.1
Gravida	• Primigravida	130 (59.1%)
	• Multigravida	90 (40.9%)
Type of LSCS	• Elective	120 (54.5%)
	• Emergency	100 (45.5%)

Table 2 depicts intraoperative parameters related to spinal anaesthesia. Among the 220 study participants who underwent cesarean section under spinal anaesthesia, intraoperative hypotension was observed in 84 cases, accounting for 38.2% of the total. Vasopressors, specifically mephentermine, were administered in 72 patients (32.7%) to manage the hypotension. The average volume of intravenous fluid administered intraoperatively was 1420 ± 310 ml. The mean time interval from the administration of spinal anaesthesia to the delivery of the neonate was 8.6 ± 2.1 minutes, indicating a relatively prompt surgical timeline following anaesthetic induction.

Table 2: Intraoperative Parameters Related to Spinal Anaesthesia

Parameter	Value (n, %)
Hypotension observed	84 (38.2%)
Vasopressor (mephentermine) use	72 (32.7%)
Total fluid administered (ml)	1420 ± 310
Time from spinal to delivery (min)	8.6 ± 2.1

Table 3 shows neonatal outcomes assessed using APGAR scores at 1 and 5 minutes after birth. At 1 minute, 192 neonates (87.3%) had an APGAR score in the normal range of 7 to 10, while 24 neonates (10.9%) had moderately low scores between 4 and 6, and 4 neonates (1.8%) had severe depression with scores below 4. By the 5-minute mark, there was notable improvement in neonatal condition, with 211 neonates (95.9%) achieving normal APGAR scores, 6 neonates (2.7%) remaining in the moderate category, and only 3 neonates (1.4%) having scores below 4, indicating persistent severe depression. This trend reflects a general improvement in neonatal status within the first few minutes after delivery.

Table 3: Neonatal Outcomes Based on APGAR Scores

APGAR Score	At 1 min (n, %)	At 5 min (n, %)

7–10 (normal)	192 (87.3%)	211 (95.9%)
4–6 (moderate)	24 (10.9%)	6 (2.7%)
<4 (severe)	4 (1.8%)	3 (1.4%)

An analysis of the association between maternal hypotension and neonatal outcomes (Table 4) revealed statistically significant differences. Among the 84 mothers who experienced intraoperative hypotension, the mean APGAR score at 1 minute was 6.9 ± 1.4, which was significantly lower compared to 7.6 ± 0.9 in the 136 mothers without hypotension ($p = 0.01$). Neonatal intensive care unit (NICU) admission was required in 16.7% (n = 14) of neonates born to hypotensive mothers, compared to only 3.7% (n = 5) in the non-hypotensive group, a difference that was statistically significant ($p = 0.002$). Additionally, neonatal resuscitation was needed in 13.1% (n = 11) of cases in the hypotension group, versus 4.4% (n = 6) among those without hypotension ($p = 0.03$). These findings indicate that maternal hypotension during spinal anaesthesia is significantly associated with poorer immediate neonatal outcomes.

Table 4: Association between Maternal Hypotension and Neonatal Outcomes

Parameter	Hypotension (n = 84)	No Hypotension (n = 136)	p-value
Mean APGAR at 1 min	6.9 ± 1.4	7.6 ± 0.9	0.01*
NICU admission required	14 (16.7%)	5 (3.7%)	0.002*
Neonatal resuscitation required	11 (13.1%)	6 (4.4%)	0.03*

*Statistically significant ($p < 0.05$)

In addition to APGAR scores, several other neonatal outcomes were assessed to provide a comprehensive understanding of the effects of maternal anaesthesia (Table 5). The mean birth weight among all neonates was 2900 ± 420 grams. Notably, neonates born to mothers who experienced intraoperative hypotension had a significantly lower mean birth weight (2840 ± 390 g) compared to those born to non-hypotensive mothers (2950 ± 440 g), with this difference being statistically significant ($p = 0.04$). Umbilical cord blood pH, where available, revealed that 8.2% (n = 18) of neonates had a pH value below 7.2, indicating potential neonatal acidosis. This was more frequent in the hypotension group (16.7%, n = 14) compared to only 2.9% (n = 4) in the non-hypotension group, and the difference was highly significant ($p = 0.001$). Neonatal jaundice requiring phototherapy was observed in 12 infants (5.5% overall), slightly more common among neonates from the hypotension group (8.3%) compared to 3.7% in the non-hypotension group; however, this difference did not reach statistical significance ($p = 0.09$). Respiratory distress was recorded in 20 neonates (9.1% of the total), with a significantly higher incidence in the hypotension group (15.5%) than in the non-hypotension group (5.1%) ($p = 0.01$). Additionally, prolonged NICU stays of more than 3 days were noted in 10 neonates (4.5%), again more frequent in the hypotension group (8.3%) compared to 2.2% in those without maternal hypotension, a statistically significant finding ($p = 0.03$). These results further reinforce that maternal hypotension during spinal anaesthesia is associated not only with lower APGAR scores and higher resuscitation needs but also with adverse outcomes such as acidosis, respiratory distress, and prolonged NICU stays.

Table 5: Other Neonatal Outcomes

Parameter	Total (n=220)	Hypotension (n=84)	No Hypotension (n=136)	p-value
Mean birth weight (grams)	2900 ± 420	2840 ± 390	2950 ± 440	0.04*
Umbilical cord pH < 7.2	18 (8.2%)	14 (16.7%)	4 (2.9%)	0.001*
Neonatal jaundice (phototherapy)	12 (5.5%)	7 (8.3%)	5 (3.7%)	0.09

Respiratory distress syndrome (RDS)	20 (9.1%)	13 (15.5%)	7 (5.1%)	0.01*
NICU stay > 3 days	10 (4.5%)	7 (8.3%)	3 (2.2%)	0.03*

Discussion:

This prospective cohort study highlights the significant impact of maternal hypotension following spinal anaesthesia on immediate neonatal outcomes during cesarean deliveries. The findings align with previous literature emphasizing that while spinal anaesthesia is widely regarded as the safest and most efficient modality for cesarean sections, associated hypotension remains a critical challenge with direct implications for neonatal well-being.

In our study, 38.2% of parturients developed intraoperative hypotension, which is consistent with earlier reports indicating an incidence ranging from 30% to 70% depending on anaesthetic protocols and definitions used.[13] This underscores the persistent prevalence of this complication even with modern preventative strategies.

Neonates born to hypotensive mothers exhibited significantly lower APGAR scores at 1 minute (6.9 ± 1.4 vs. 7.6 ± 0.9, p = 0.01), a finding supported by studies such as those by Klohr et al. and Dyer RA et al., who emphasized that reduced uteroplacental perfusion during hypotensive episodes can result in transient neonatal depression at birth.[14,15] Although most neonates recovered by the 5-minute mark, the initial compromise reflects the need for immediate neonatal assessment and potential intervention.

The rate of NICU admissions was markedly higher in the hypotension group (16.7% vs 3.7%, p = 0.002), with a significant number requiring prolonged stay (>3 days), aligning with the findings of Dyer et al. and Klumpner et al., who also noted increased NICU utilization when spinal-induced hypotension was poorly controlled.[16,17]

Our study found that 13.1% of neonates in the hypotension group required resuscitation, compared to 4.4% in the normotensive group (p = 0.03). This observation is clinically relevant, as maternal hypotension can lead to acute fetal hypoxia, which often necessitates positive pressure ventilation or more advanced neonatal support.[18]

Cord blood analysis revealed a significantly higher incidence of acidosis (pH <7.2) in the hypotensive group (16.7% vs. 2.9%, p = 0.001). This is an objective indicator of compromised fetal oxygenation and aligns with the results of studies such as those by Ngan Kee et al. and Morgan et al., who emphasized cord pH as a sensitive marker of fetal hypoperfusion during maternal hypotension.[8,9]

Respiratory distress syndrome (RDS) was another critical parameter, observed more frequently in neonates born to hypotensive mothers (15.5% vs. 5.1%, p = 0.01). Similar findings were reported by Cohen et al., who suggested that impaired fetal oxygenation during delivery can predispose neonates to respiratory compromise shortly after birth.[19]

Interestingly, while the incidence of neonatal jaundice requiring phototherapy was higher in the hypotension group (8.3% vs. 3.7%), this difference was not statistically significant (p = 0.09). This suggests that while hypoxia may influence bilirubin metabolism, other factors like gestational age, birth trauma, and breastfeeding practices likely play a larger role.[20]

The statistically significant difference in birth weight between the groups (2840 ± 390 g vs. 2950 ± 440 g, p = 0.04) might be attributed to subtle differences in maternal hemodynamic status or placental perfusion, although it is unlikely that intraoperative events alone could influence weight. Further investigation with longitudinal fetal growth data may be necessary to clarify this finding.

Overall, our results reaffirm that maternal hypotension during spinal anaesthesia is not a benign event but rather a potentially modifiable risk factor that can impact neonatal outcomes. Prophylactic measures such as preloading, coloading, left uterine displacement, and early vasopressor administration have shown promise in minimizing hypotension [21,22]. However, their consistent implementation, especially in resource-limited settings, remains a challenge.

This study is particularly important for institutions in Eastern India and similar resource-constrained areas, where anaesthesia protocols, response time, and neonatal care infrastructure can vary.

Establishing standardized regional guidelines and ensuring adequate training in the management of spinal anaesthesia-related hypotension could improve outcomes at a population level.

Conclusion

This prospective cohort study highlights that while spinal anaesthesia is generally safe and effective for cesarean delivery, intraoperative maternal hypotension significantly compromises immediate neonatal outcomes. Neonates born to hypotensive mothers demonstrated lower APGAR scores, increased need for resuscitation, higher incidence of respiratory distress, neonatal acidosis, and more frequent and prolonged NICU admissions. These findings underscore the critical importance of anticipating, preventing, and promptly managing maternal hypotension during spinal anaesthesia to optimize neonatal well-being.

Incorporating standardized preventive strategies such as judicious fluid administration, vasopressor use, and vigilant intraoperative monitoring can mitigate the impact of spinal-induced hypotension. Furthermore, this study adds valuable region-specific evidence from eastern India, emphasizing the need for local protocols that align with best practices in obstetric anaesthesia. Future research involving long-term neonatal follow-up and multicentric data may further refine anaesthetic strategies to ensure both maternal safety and neonatal health.

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