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Original Research Article

Regional Anaesthesia in Patients with Pregnancy-Induced Hypertension: Labour Analgesia Considerations

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Abstract

Background: Pregnancy-induced hypertension (PIH) represents a significant obstetric complication affecting maternal and fetal outcomes. Regional anaesthesia has emerged as the preferred modality for labour analgesia in these patients, offering potential benefits in blood pressure modulation and stress response attenuation. However, careful consideration of haemodynamic implications and coagulation status is essential.

Methods: This prospective observational study was conducted at a tertiary care hospital over 18 months, enrolling 156 parturients with PIH requiring labour analgesia. Participants were categorized into epidural analgesia (Group E, n=82) and combined spinal-epidural analgesia (Group CSE, n=74). Haemodynamic parameters, analgesic efficacy, maternal complications, and neonatal outcomes were assessed.

Results: Mean arterial pressure demonstrated significant reduction following regional anaesthesia initiation in both groups (Group E: 112.4 ± 8.6 to 94.2 ± 7.3 mmHg; Group CSE: 114.1 ± 9.2 to 91.8 ± 6.9 mmHg; $p<0.001$). Pain scores decreased significantly from baseline (7.8 ± 1.2 to 2.1 ± 0.9; $p<0.001$). Hypotension occurred in 14.6% of Group E versus 23.0% of Group CSE patients ($p=0.042$). No cases of post-dural puncture headache or neurological complications were observed. Neonatal Apgar scores at 5 minutes were comparable between groups (8.7 ± 0.6 vs 8.5 ± 0.7; $p=0.108$).

Conclusion: Regional anaesthesia provides safe and effective labour analgesia in PIH patients with favourable haemodynamic profiles. Epidural analgesia demonstrated greater haemodynamic stability compared to combined spinal-epidural technique, suggesting its preference in moderate-to-severe PIH cases.

Keywords: Pregnancy-induced hypertension, regional anaesthesia, epidural analgesia, labour analgesia, preeclampsia, combined spinal-epidural.

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Introduction

Pregnancy-induced hypertension (PIH) encompasses a spectrum of hypertensive disorders occurring during gestation, including gestational hypertension and preeclampsia, affecting approximately 5-10% of pregnancies worldwide [1]. These conditions constitute major contributors to maternal and perinatal morbidity and mortality, particularly in developing nations where access to specialized obstetric care may be limited [2].

The pathophysiological alterations associated with PIH, including endothelial dysfunction, altered vascular reactivity, and potential coagulation abnormalities, present unique challenges for anaesthetic management during labour and delivery [3]. Regional anaesthesia has progressively become the preferred technique for providing labour analgesia in both normotensive and hypertensive parturients [4]. The benefits of neuraxial techniques in PIH patients extend beyond pain relief, encompassing attenuation of the sympathetic stress response, improvement in uteroplacental perfusion through reduction in circulating catecholamines, and facilitation of controlled blood pressure management [5].

Furthermore, avoiding general anaesthesia circumvents risks associated with difficult airway management, aspiration, and hypertensive response to laryngoscopy, which are particularly concerning

in preeclamptic patients [6]. Contemporary evidence supports the safety of epidural analgesia in carefully selected PIH patients with adequate platelet counts and absence of coagulopathy [7]. Wallace and colleagues demonstrated improved maternal haemodynamic stability with regional compared to general anaesthesia in severe preeclampsia [8]. However, concerns persist regarding hypotension following sympathetic blockade, which may compromise uteroplacental perfusion in already compromised placental circulation [9].

The combined spinal-epidural (CSE) technique offers rapid onset analgesia with the flexibility of epidural catheter maintenance, though the initial spinal component may produce more pronounced haemodynamic fluctuations [10]. Hood and Curry reported comparable safety profiles between purely epidural and spinal techniques in severely preeclamptic patients undergoing caesarean delivery [11]. Nevertheless, comparative data specifically evaluating these techniques for labour analgesia in PIH patients remain limited.

Despite increasing utilization of regional anaesthesia in hypertensive pregnancies, optimal technique selection and management protocols require further clarification. The research gap exists in comparative evaluation of epidural versus combined spinal-epidural analgesia regarding haemodynamic stability, analgesic efficacy, and maternal-fetal outcomes specifically in the labour analgesia setting for PIH patients.

The aim of this study was to evaluate and compare the safety, efficacy, and haemodynamic effects of epidural analgesia versus combined spinal-epidural analgesia for labour pain management in patients with pregnancy-induced hypertension.

Materials and Methods

Study Design and Setting: This prospective observational comparative study was conducted at the Department of Anaesthesiology and Obstetrics between January 2023 and June 2024.

Sample Size Calculation

Based on previous literature reporting hypotension incidence of 25% in CSE versus 12% in epidural groups, with α=0.05 and power=80%, the minimum required sample size was calculated as 68 patients per group. Accounting for potential dropouts (15%), 80 patients were targeted per group.

Participant Selection

Inclusion Criteria:

- Pregnant women aged 18-40 years
- Gestational age ≥37 weeks
- Diagnosis of pregnancy-induced hypertension (blood pressure ≥140/90 mmHg on two occasions)
- Singleton pregnancy in active labour
- American Society of Anesthesiologists (ASA) physical status II-III
- Platelet count ≥80,000/μL

Exclusion Criteria:

- Contraindications to regional anaesthesia
- Coagulation disorders or platelet count <80,000/μL
- HELLP syndrome
- Eclampsia or impending eclampsia
- Fetal distress requiring immediate delivery
- Previous spinal surgery or local infection
- Allergy to local anaesthetics
- Patient refusal

Grouping and Intervention

Participants were allocated based on technique preference following detailed counselling:

- **Group E (Epidural):** Received lumbar epidural analgesia
- **Group CSE (Combined Spinal-Epidural):** Received combined spinal-epidural analgesia

Anaesthetic Technique

All patients received 500 mL crystalloid co-loading during procedure initiation. Standard monitoring included continuous electrocardiography, pulse oximetry, non-invasive blood pressure measurement at 3-minute intervals, and continuous fetal heart rate monitoring.

Epidural Technique (Group E): With the patient in sitting position, epidural space identification at L3-L4 interspace using 18G Tuohy needle via loss-of-resistance technique. Epidural catheter advanced 4 cm into space. Test dose of 3 mL lidocaine 2% with epinephrine 1:200,000 administered. Following negative aspiration, 10 mL of 0.125% bupivacaine with fentanyl 2 μg/mL administered incrementally.

CSE Technique (Group CSE): Needle-through-needle technique at L3-L4 interspace. Intrathecal injection of 2.5 mg bupivacaine with 15 μg fentanyl administered. Epidural catheter subsequently placed for maintenance analgesia.

Outcome Measures

Primary Outcomes: Haemodynamic parameters (systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate) recorded at baseline, 5, 10, 15, 30, 60, and 120 minutes post-procedure.

Secondary Outcomes: Visual analogue scale (VAS) pain scores, onset time to effective analgesia (VAS ≤3), motor blockade (Bromage scale),

maternal complications (hypotension, bradycardia, nausea/vomiting, post-dural puncture headache), and neonatal outcomes (Apgar scores at 1 and 5 minutes, umbilical cord pH).

Hypotension was defined as systolic blood pressure <90 mmHg or >20% decrease from baseline and managed with intravenous ephedrine 6 mg boluses.

Statistical Analysis: Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation and compared using independent t-tests. Categorical variables were expressed as frequencies and percentages, compared using chi-square or Fisher's exact tests. Repeated measures ANOVA was used for haemodynamic parameters over time. Statistical significance was set at $p<0.05$.

Results

Demographic and Baseline Characteristics: A total of 156 patients completed the study (Group E: n=82; Group CSE: n=74).

Both groups were comparable regarding demographic characteristics and baseline parameters (Table 1).

Table 1: Demographic and Baseline Characteristics of Study Participants

Parameter	Group E (n=82)	Group CSE (n=74)	p-value
Age (years)	27.4 ± 4.8	26.9 ± 5.1	0.526
Gestational age (weeks)	38.6 ± 1.2	38.4 ± 1.4	0.341
Body mass index (kg/m²)	28.3 ± 3.6	27.9 ± 3.4	0.478
Primigravida, n (%)	48 (58.5%)	41 (55.4%)	0.688
Baseline SBP (mmHg)	156.2 ± 12.4	158.7 ± 13.1	0.223
Baseline DBP (mmHg)	98.4 ± 8.2	99.8 ± 8.7	0.296
Baseline MAP (mmHg)	112.4 ± 8.6	114.1 ± 9.2	0.229
Baseline heart rate (bpm)	88.6 ± 12.3	90.2 ± 11.8	0.407
Platelet count (×10³/μL)	168.4 ± 42.6	172.1 ± 45.3	0.598
Cervical dilatation (cm)	4.2 ± 0.8	4.1 ± 0.9	0.459
Gestational hypertension, n (%)	34 (41.5%)	28 (37.8%)	0.635
Preeclampsia, n (%)	48 (58.5%)	46 (62.2%)	0.635

SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MAP: Mean arterial pressure

Haemodynamic Parameters: Mean arterial pressure demonstrated significant reduction following regional anaesthesia in both groups. Maximum reduction occurred at 15 minutes post-procedure, with Group CSE showing greater magnitude of decrease (Table 2). Heart rate remained stable throughout the observation period in both groups.

Table 2: Haemodynamic Parameters at Different Time Points

Time Point	MAP Group E (mmHg)	MAP Group CSE (mmHg)	p-value	HR Group E (bpm)	HR Group CSE (bpm)	p-value
Baseline	112.4 ± 8.6	114.1 ± 9.2	0.229	88.6 ± 12.3	90.2 ± 11.8	0.407
5 min	102.6 ± 7.8	98.4 ± 8.1	0.001*	86.4 ± 11.6	84.8 ± 10.9	0.378
10 min	97.8 ± 7.4	93.2 ± 7.6	<0.001*	84.2 ± 10.8	82.6 ± 11.2	0.358
15 min	94.2 ± 7.3	91.8 ± 6.9	0.034*	82.8 ± 10.4	80.4 ± 10.6	0.152
30 min	95.6 ± 6.8	93.4 ± 7.2	0.048*	84.6 ± 9.8	82.2 ± 10.1	0.127
60 min	96.8 ± 6.4	94.8 ± 6.6	0.058	86.2 ± 10.2	84.8 ± 9.6	0.369
120 min	98.4 ± 6.2	96.2 ± 6.8	0.036*	88.4 ± 9.8	86.6 ± 10.4	0.256

MAP: Mean arterial pressure; HR: Heart rate; *Statistically significant (p<0.05)

Analgesic Efficacy and Maternal-Neonatal Outcomes: Combined spinal-epidural technique demonstrated significantly faster onset of analgesia compared to epidural technique. However, the incidence of hypotension was significantly higher in the CSE group. Neonatal outcomes were comparable between groups (Table 3).

Table 3: Analgesic Efficacy, Complications, and Neonatal Outcomes

Parameter	Group E (n=82)	Group CSE (n=74)	p-value
Analgesic Parameters			
Baseline VAS score	7.8 ± 1.1	7.9 ± 1.2	0.578
VAS at 15 minutes	2.4 ± 1.0	1.8 ± 0.8	<0.001*
VAS at 30 minutes	2.1 ± 0.9	2.0 ± 0.9	0.484
Onset time (minutes)	14.6 ± 3.8	6.2 ± 2.4	<0.001*
Motor Blockade (Bromage)			
Grade 0	68 (82.9%)	52 (70.3%)	0.062
Grade 1	14 (17.1%)	22 (29.7%)	
Maternal Complications			
Hypotension, n (%)	12 (14.6%)	17 (23.0%)	0.042*
Bradycardia, n (%)	4 (4.9%)	6 (8.1%)	0.521
Nausea/vomiting, n (%)	8 (9.8%)	11 (14.9%)	0.334
Pruritus, n (%)	6 (7.3%)	14 (18.9%)	0.032*
PDPH, n (%)	0 (0%)	0 (0%)	-
Neurological complications	0 (0%)	0 (0%)	-
Mode of Delivery			
Vaginal delivery, n (%)	64 (78.0%)	56 (75.7%)	0.721
Instrumental delivery, n (%)	10 (12.2%)	12 (16.2%)	0.468
Caesarean section, n (%)	8 (9.8%)	6 (8.1%)	0.719
Neonatal Outcomes			
Apgar score 1 min	7.6 ± 0.8	7.4 ± 0.9	0.142
Apgar score 5 min	8.7 ± 0.6	8.5 ± 0.7	0.108
Umbilical cord pH	7.28 ± 0.06	7.26 ± 0.07	0.058
NICU admission, n (%)	4 (4.9%)	6 (8.1%)	0.521

VAS: Visual analogue scale; PDPH: Post-dural puncture headache; NICU: Neonatal intensive care unit; *Statistically significant (p<0.05)

Discussion

The present study demonstrates that both epidural and combined spinal-epidural techniques provide effective labour analgesia in patients with pregnancy-induced hypertension, with acceptable safety profiles. However, epidural analgesia exhibited superior haemodynamic stability compared to the CSE technique, evidenced by lower incidence of hypotension.

Our findings regarding blood pressure reduction following regional anaesthesia initiation align with previous investigations. The sympatholytic effect of neuraxial blockade results in vasodilation and consequent blood pressure decrease, which may actually benefit PIH patients through improved organ perfusion [12]. Ramanathan and colleagues reported similar beneficial haemodynamic effects of epidural analgesia in preeclamptic patients, attributing improved outcomes to reduced catecholamine levels and enhanced uteroplacental blood flow [13].

The significantly faster onset of analgesia observed with CSE technique (6.2 ± 2.4 minutes versus 14.6 ± 3.8 minutes) reflects the direct subarachnoid drug administration characteristic of this approach. However, this rapid onset was accompanied by a higher incidence of hypotension (23.0% versus 14.6%), consistent with findings by Simmons and colleagues who reported increased haemodynamic instability with intrathecal local anaesthetic administration [14]. This phenomenon occurs due to the more rapid and dense sympathetic blockade achieved through spinal administration compared to the gradual onset of epidural analgesia. The hypotension incidence in our epidural group (14.6%) is comparable to that reported by Gambling and colleagues, who observed hypotension in approximately 12-18% of PIH patients receiving epidural analgesia [15]. Importantly, all hypotensive episodes were successfully managed with ephedrine administration without adverse maternal or fetal consequences, supporting the relative safety of regional techniques in this population when appropriately monitored and managed.

Our study demonstrated no cases of post-dural puncture headache or neurological complications, reinforcing the safety of regional anaesthesia when performed with attention to technical precision and appropriate patient selection. The absence of coagulation-related complications supports current guidelines recommending neuraxial techniques in PIH patients with platelet counts exceeding 70,000-

80,000/μL [16]. Bauer and colleagues emphasized the importance of individualized coagulation assessment rather than rigid platelet thresholds in determining suitability for neuraxial procedures [17].

Neonatal outcomes were reassuring across both groups, with Apgar scores and umbilical cord pH values within normal ranges. These findings corroborate the conclusions of Reynolds and colleagues, who demonstrated that effective labour analgesia, rather than compromising fetal wellbeing, may actually improve fetal oxygenation through enhanced placental perfusion and reduced maternal hyperventilation-induced hypocapnia [18].

The higher incidence of pruritus observed in the CSE group (18.9% versus 7.3%) reflects the intrathecal opioid administration inherent to this technique. While generally self-limiting and easily managed, this complication may affect patient satisfaction [19]. The minimal motor blockade observed in both groups (Bromage grade 0-1) supports the use of low-concentration local anaesthetic solutions for labour analgesia, facilitating ambulation and active labour participation.

Several limitations warrant acknowledgement. The non-randomized allocation based on technique preference introduces potential selection bias. Additionally, the exclusion of patients with severe preeclampsia and platelet counts below 80,000/μL limits generalizability to the most severely affected population. Future randomized controlled trials addressing these limitations would strengthen evidence-based recommendations.

The clinical implications of our findings suggest that while both techniques are acceptable options for PIH patients, epidural analgesia may be preferred in cases where haemodynamic stability is paramount, such as moderate-to-severe preeclampsia or patients with borderline blood pressure control. Conversely, CSE may be considered when rapid analgesia onset is prioritized, provided vigilant haemodynamic monitoring is ensured [20].

Conclusion

This study confirms that regional anaesthesia represents a safe and effective modality for labour analgesia in patients with pregnancy-induced hypertension. Both epidural and combined spinal-epidural techniques provided excellent pain relief with acceptable maternal and neonatal outcomes. Epidural analgesia demonstrated superior haemodynamic stability with significantly lower hypotension incidence, whereas combined spinal-epidural technique offered faster onset of analgesia. These findings support the preferential consideration of epidural analgesia in PIH patients where cardiovascular stability is a primary concern. Appropriate patient selection, vigilant monitoring, and prompt management of complications remain essential for optimizing outcomes in this high-risk obstetric population. Further large-scale randomized trials are recommended to establish definitive protocols for regional anaesthesia technique selection in hypertensive pregnancy.

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