e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(8); 1895-1901

Original Research Article

A Prospective Cross-Sectional Study on the Duration of Analgesia in Patients Undergoing Lower Segment Caesarean Section Under Spinal Anaesthesia with Hyperbaric Bupivacaine and Intrathecal Buprenorphine

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Received: 01-06-2026 / Revised: 25-07-2026 / Accepted: 12-08-2026
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Conflict of interest: Nil

Abstract

Background: Lower segment caesarean section (LSCS) requires effective and prolonged postoperative analgesia to facilitate early recovery and maternal–neonatal bonding. Although hyperbaric bupivacaine is widely used for spinal anaesthesia, its limited duration necessitates the use of adjuvants. Intrathecal buprenorphine, a highly lipophilic partial μ-opioid receptor agonist, has been shown to prolong analgesia with minimal adverse effects.

Aim: To evaluate the duration of postoperative analgesia in patients undergoing LSCS under spinal anaesthesia with hyperbaric bupivacaine and intrathecal buprenorphine.

Methods: This prospective cross-sectional observational study was conducted in a tertiary care teaching hospital. A total of 50 parturients aged 18–40 years, ASA physical status II, undergoing elective or emergency LSCS under spinal anaesthesia were included. Spinal anaesthesia was administered using hyperbaric bupivacaine combined with intrathecal buprenorphine. Sensory and motor block characteristics, hemodynamic parameters, postoperative pain scores (VAS), duration of analgesia (time to first rescue analgesia), adverse effects, and neonatal APGAR scores were recorded. Data were expressed as mean ± standard deviation.

Results: The results demonstrated a mean duration of analgesia of 215 ± 30 minutes, indicating effective and sustained postoperative pain relief. The onset of sensory blockade at the highest dermatome was rapid, occurring at 4 ± 3 minutes, with the highest sensory level achieved at T4–T6, reflecting adequate cephalad spread of the anesthetic agent for surgical anesthesia. Regression of the sensory block to T10 was observed at 160 ± 10 minutes and the total duration of sensory blockade (regression to s1) was 240 ± 10 indicating a prolonged sensory blockade sufficient to cover the intraoperative and early postoperative period.

The onset of motor blockade was rapid (1 ± 1 minute), and the duration of motor blockade was 200 ± 20 minutes, with complete motor recovery occurring within a clinically acceptable timeframe, demonstrating a predictable recovery profile. Hemodynamic parameters remained stable throughout the intraoperative period, with a mean heart rate of 82.7 ± 6.3 beats per minute and mean arterial pressure of 88.9 ± 6.5 mmHg, indicating minimal cardiovascular perturbation.

Postoperative pain assessment using the Visual Analog Scale (VAS) revealed low pain scores at 2 hours (1.8 ± 0.6), followed by a gradual increase at 6 hours (4.3 ± 1.1), consistent with the expected decline in analgesic effect. Hypotension was identified as the most frequent adverse event (23.7%), while nausea and vomiting occurred less frequently and were clinically manageable.

Neonatal outcomes were favorable, with APGAR scores within normal physiological limits at both 1 minute (8.0 ± 0.5) and 5 minutes (9.0 ± 0.4), indicating no evidence of neonatal compromise.

Conclusion: Intrathecal buprenorphine as an adjuvant to hyperbaric bupivacaine provides effective and prolonged postoperative analgesia with stable hemodynamic parameters and minimal adverse effects in patients undergoing LSCS, without compromising neonatal outcomes.

Keywords: Spinal Anaesthesia, Buprenorphine, Bupivacaine, Caesarean Section, Postoperative Analgesia, Intrathecal Adjuvants.

DOI: 10.25258/ijcpr.18.8.280

Introduction

Lower segment caesarean section (LSCS) is one of the most frequently performed surgical procedures in obstetric practice, necessitating the provision of safe, effective, and prolonged perioperative analgesia.[1] Spinal anaesthesia has emerged as the preferred technique for LSCS owing to its rapid onset, dense sensory and motor blockade, minimal drug exposure to the fetus, and reduced maternal morbidity compared to general anaesthesia. [2] However, the relatively limited duration of action of local anaesthetics such as hyperbaric bupivacaine necessitates the use of adjuvants to prolong postoperative analgesia and improve patient comfort.[3]

Hyperbaric bupivacaine remains the cornerstone of spinal anaesthesia for caesarean delivery due to its predictable spread, reliable sensory blockade, and favourable safety profile.[4] Nevertheless, its analgesic duration is often insufficient to cover the early postoperative period, during which pain intensity is typically highest.[5] Inadequate postoperative analgesia may lead to delayed ambulation, impaired maternal-infant bonding, increased stress response, and higher analgesic requirements, thereby underscoring the importance of optimizing intrathecal drug combinations.[6]

Intrathecal opioids have been widely investigated as adjuvants to local anaesthetics to enhance the quality and duration of analgesia.[7] Among these, buprenorphine, a highly lipophilic partial μ-opioid receptor agonist, has gained attention due to its prolonged duration of action, high receptor affinity, and ceiling effect on respiratory depression. Its pharmacological profile enables sustained analgesia without significant hemodynamic instability or severe respiratory compromise, making it particularly suitable for obstetric anaesthesia.[8]; Furthermore, buprenorphine has been associated with improved postoperative analgesic profiles and reduced requirement for rescue analgesics when used intrathecally.

The present study is designed as a prospective cross-sectional evaluation to assess the duration of analgesia in patients undergoing LSCS under spinal anaesthesia using hyperbaric bupivacaine combined with intrathecal buprenorphine. As reflected in the structured proforma utilized in this study, multiple parameters—including onset and regression of sensory and motor blockade, hemodynamic variables (heart rate, systolic and diastolic blood pressure, mean arterial pressure, and oxygen saturation), postoperative pain scores, and time to first rescue analgesia—are systematically recorded to provide a comprehensive assessment of analgesic efficacy and safety .

Despite extensive literature on intrathecal opioid adjuvants, variability persists in reported outcomes regarding optimal dosing, duration of analgesia, and side effect profiles, particularly in the obstetric population. Moreover, the balance between prolonged analgesia and adverse effects such as nausea, vomiting, pruritus, bradycardia, and hypotension remains an area of clinical concern. The inclusion of neonatal outcomes, such as APGAR scores, further emphasizes the need for evaluating maternal analgesic techniques in the context of fetal safety.

Given these considerations, this study aims to systematically evaluate the duration and quality of analgesia provided by intrathecal buprenorphine as an adjuvant to hyperbaric bupivacaine in LSCS, while concurrently assessing hemodynamic stability, side effects, and neonatal outcomes. The findings are expected to contribute to the optimization of spinal anaesthetic regimens in obstetric practice and to support evidence-based selection of intrathecal adjuvants for enhanced perioperative care**.**

Aim: To evaluate the duration of postoperative analgesia in patients undergoing lower segment caesarean section under spinal anaesthesia with hyperbaric bupivacaine and intrathecal buprenorphine.

Objectives

Primary Objective: To evaluate the duration of analgesia, defined as the time to first request for rescue analgesia.

Secondary Objectives

- To assess onset and level of sensory block.
- To evaluate onset and duration of motor block (Modified Bromage scale).
- To monitor hemodynamic parameters (HR, BP, MAP, SpO_2).
- To assess postoperative pain using VAS.
- To record adverse effects (nausea, vomiting, bradycardia, hypotension, shivering).
- To evaluate neonatal outcome using APGAR scores.

Materials and Methods

Study Design and Setting: This prospective cross-sectional observational study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital over a defined study period.

Ethical Approval: The study protocol was approved by the Institutional Human Ethics Committee prior to commencement. Written informed consent was obtained from all participants.

Study Population: The study population comprised parturients classified as American Society of Anesthesiologists (ASA) physical status I–II

undergoing lower segment caesarean section under spinal anaesthesia.

Inclusion Criteria

- ASA physical status II
- Patients undergoing elective or emergency LSCS under spinal anaesthesia

Exclusion Criteria

- Patient refusal
- Contraindications to spinal anaesthesia
- Known hypersensitivity to study drugs
- Significant systemic illness
- Chronic opioid use

Sample Size: The sample size for the present study was 50 patients, determined based on feasibility and reference to similar previous studies.

Preoperative Assessment: All participants underwent a comprehensive pre-anaesthetic evaluation, including detailed medical and obstetric history, physical examination, and relevant laboratory investigations. Baseline vital parameters—heart rate, blood pressure, and oxygen saturation—were recorded. Intravenous access was secured using an 18G cannula. Patients received premedication with metoclopramide 10 mg intravenously to reduce the risk of aspiration and perioperative nausea. Preloading was performed with Ringer's lactate solution according to institutional protocol.

Anaesthetic Technique: Standard monitoring (ECG, non-invasive blood pressure, and pulse oximetry) was instituted. Under strict aseptic precautions, spinal anaesthesia was administered at the L3–L4 or L4–L5 interspace using a 25G spinal needle. A standardized intrathecal regimen consisting of 0.5% hyperbaric bupivacaine (10 mg) combined with 60 µg of buprenorphine was administered. Following injection, patients were positioned supine with left uterine displacement to minimize aortocaval compression and maintain maternal hemodynamic stability.

Intraoperative Monitoring: Continuous intraoperative monitoring was performed in all patients. Hemodynamic parameters, including heart rate, systolic and diastolic blood pressure, mean arterial pressure, and peripheral oxygen saturation (SpO_2), were recorded at baseline, at 3-minute intervals during the initial intraoperative period, and subsequently at 5-minute intervals until completion of the surgical procedure. Sensory blockade was assessed using the pinprick method, while motor blockade was evaluated using the Modified Bromage Scale at regular intervals.

Assessment of Sensory Block: Sensory blockade was assessed using the pinprick method. Time to onset at T10 level, highest sensory level achieved, and time to regression to T10 were recorded.

Assessment of Motor Block: Motor blockade was evaluated using the Modified Bromage scale (Grade 0–3).

Postoperative Pain Assessment: Pain intensity was assessed using the Visual Analogue Scale (VAS) at predefined postoperative intervals.

Duration of Analgesia: Duration of analgesia was defined as the time interval from intrathecal drug administration to the first request for rescue analgesia.

Monitoring of Adverse Effects: Patients were observed for adverse effects including nausea, vomiting, bradycardia, hypotension, and shivering.

Neonatal Outcome Assessment: Neonatal well-being was evaluated using APGAR scores at 1 minute and 5 minutes after delivery.

Data Collection Procedure: All variables were recorded using a structured proforma, including intraoperative hemodynamics, block characteristics, postoperative pain scores, and adverse events

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Statistical significance was assessed using suitable tests, with a p-value <0.05 considered significant.

Results & Findings

Table 1: Demographic Characteristics

Variable	Mean ± SD
Age (years)	27.6 ± 3.8
Weight (kg)	69.9 ± 9.2
Height (cm)	156.0 ± 3.5
ASA II (n)	50

Interpretation: The study population was demographically homogeneous, with the majority belonging to ASA II status, ensuring minimal baseline variability.

Table 2: Sensory Block Characteristics

Parameter	Mean ± SD
Time to onset of sensory block (T10) (sec)	41 ± 10
Time to highest sensory level (min)	4 ± 3
Highest sensory level achieved	T4–T6
Time for regression to T10 (min)	160.0 ± 10
Duration of Sensory Block (Regression to S1) (min)	240 ± 10
Time to first request of analgesia	215 ± 30

Interpretation: The anesthetic regimen demonstrated a rapid onset of sensory blockade, with attainment of peak sensory level within a short duration. The cephalad spread to T4–T5 was adequate for surgical anesthesia, while the delayed regression to T10 indicates a prolonged sensory block, supporting sustained intraoperative and early postoperative analgesia.

Table 3: Motor Block Characteristics

Parameter	Mean ± SD
Onset of motor block (min)	1 ± 1
Duration of motor block (min)	200 ± 20

Interpretation: Motor blockade was established rapidly and effectively, with an extended duration sufficient to cover the surgical period. The prolonged motor block suggests enhanced efficacy of the intrathecal adjuvant, while remaining within clinically acceptable recovery limits.

Table 4: Hemodynamic Parameters (Overall Mean Values)

Parameter	Mean ± SD
Heart Rate (beats/min)	82.7 ± 6.3
Systolic BP (mmHg)	118.6 ± 9.8
Diastolic BP (mmHg)	74.2 ± 7.1
Mean Arterial Pressure	88.9 ± 6.5
SpO_2 (%)	99.1 ± 0.8

Interpretation: Hemodynamic parameters remained stable throughout the perioperative period, with values within physiological limits, indicating good cardiovascular tolerance.

Table 5: Duration of Analgesia and Pain Scores

Parameter	Mean ± SD
Duration of analgesia (min)	215 ± 30
VAS at 2 hours	1.8 ± 0.6
VAS at 4 hours	2.9 ± 0.8
VAS at 6 hours	4.3 ± 1.1

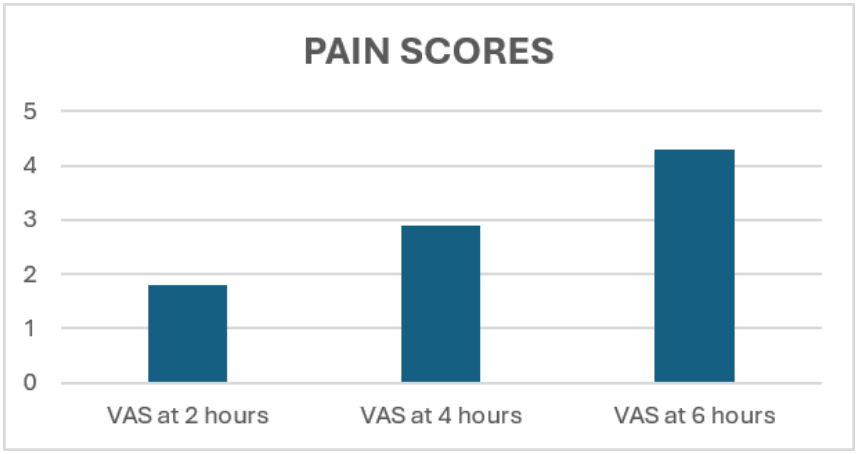

Figure 1: Pain Scores

Interpretation: The duration of analgesia was prolonged, approaching approximately 5 hours, with low VAS scores in the early postoperative period, demonstrating effective pain control.

Table 6: Adverse Effects

Side Effect	Frequency (n)	Percentage (%)
Hypotension	18	23.7%
Nausea	4	5.3%
Vomiting	3	3.9%
Shivering	6	7.9%

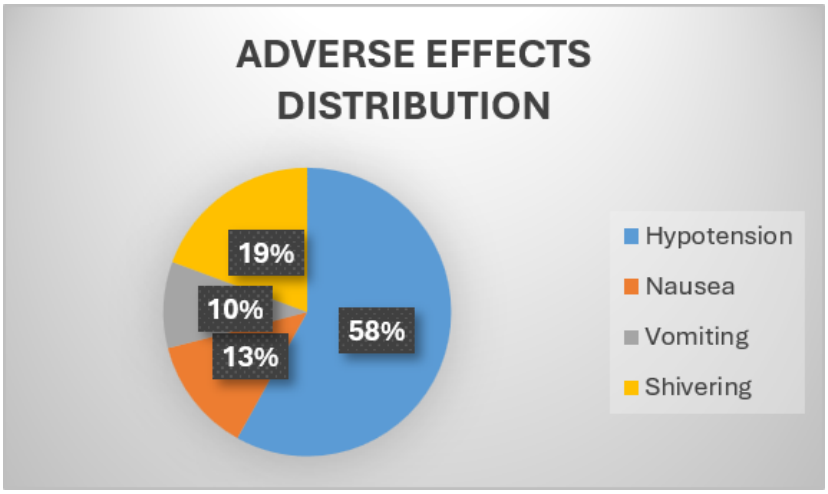

Figure 2: Adverse Effects

Interpretation: Adverse effects were infrequent and clinically manageable, with hypotension being the most commonly observed complication.

Table 7: Neonatal Outcome

Parameter	Mean ± SD
APGAR (1 min)	8.0 ± 0.5
APGAR (5 min)	9.0 ± 0.4

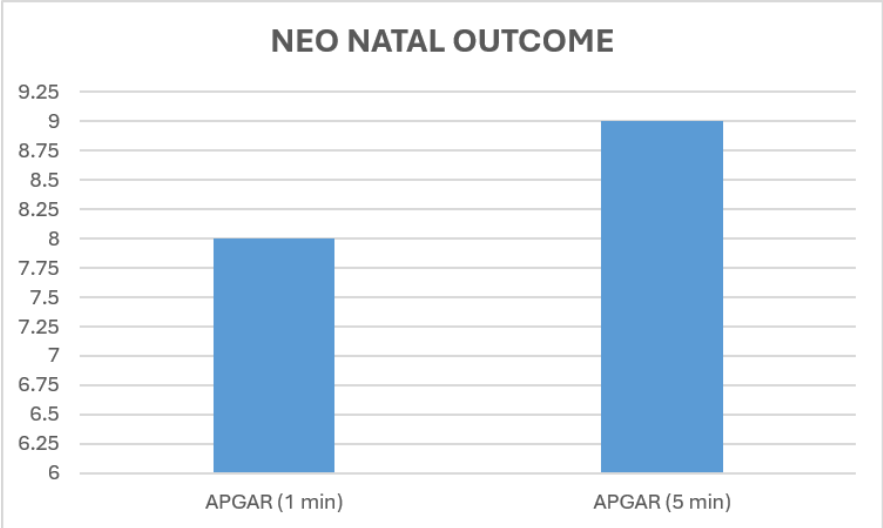

Figure 3: Neonatal Outcome

Interpretation: Neonatal outcomes were within normal physiological limits, indicating no detrimental effects of the anaesthetic regimen on neonatal well-being.

The present study demonstrates that intrathecal buprenorphine as an adjuvant to hyperbaric bupivacaine provides effective and prolonged postoperative analgesia with stable hemodynamic parameters and minimal adverse effects. Sensory blockade was adequate for surgical anaesthesia, and neonatal outcomes remained unaffected.

Discussion

The present study demonstrates that the addition of intrathecal buprenorphine to hyperbaric bupivacaine provides rapid onset, prolonged sensory blockade, and effective postoperative analgesia in patients

undergoing lower segment caesarean section (LSCS). These findings are consistent with the pharmacological profile of buprenorphine as a highly lipophilic partial μ-opioid receptor agonist with prolonged spinal receptor binding and sustained analgesic effects, as described by Singh et al.[9] and Capogna et al.[10]

A key observation in this study was the rapid onset of sensory blockade at the T10 level, with attainment of peak sensory level within a short duration. Similar findings have been reported by Ravindran et al.[11] and Sonya and Davies[12], who demonstrated that the addition of intrathecal opioids to bupivacaine facilitates faster onset of adequate surgical anaesthesia. The cephalad spread to T4–T5, which is optimal for LSCS, agrees with studies by Shivashankar et al.[13] and Ravindran et al.[14], confirming reliable dermatomal spread with this combination. Furthermore, the prolonged regression of sensory block observed in the present study supports earlier findings by Ipe et al.[15] and Singh et al.[16], who reported enhanced duration of sensory blockade with intrathecal buprenorphine.

Motor blockade in the present study was established rapidly and maintained for a clinically adequate duration. Comparable observations have been documented by Dixit et al.[17], who reported prolonged motor block with intrathecal buprenorphine as an adjuvant to bupivacaine. Although extended motor blockade may theoretically delay early ambulation, the duration observed in this study remained within acceptable clinical limits and was comparable to previously reported findings.

The duration of analgesia observed in this study confirms the efficacy of intrathecal buprenorphine in prolonging postoperative pain relief. Earlier studies by Capogna et al.[10] and Ipe et al.[15] have demonstrated similar or even longer durations of analgesia, highlighting the role of buprenorphine in extending the analgesic window in obstetric patients. The pattern of low early postoperative pain scores with gradual increase over time is consistent with observations reported by Ravindran et al.[11], reflecting the pharmacodynamic profile of intrathecal opioids.

Hemodynamic stability observed in this study is consistent with findings reported by Shivashankar et al.[13] and Ipe et al.[15], who noted minimal cardiovascular perturbations with the use of intrathecal buprenorphine. Although hypotension was the most frequently observed adverse effect, its incidence is comparable to that reported in spinal anaesthesia for LSCS and aligns with the observations of the American Society of Anesthesiologists guidelines on obstetric anaesthesia. The incidence of adverse effects such as nausea, vomiting, and shivering was low and comparable with previous studies, including those by Ravindran et al.[11] and Dixit et al [17]. Importantly, no significant respiratory depression was observed, which is in accordance with the pharmacological characteristic of buprenorphine exhibiting a ceiling effect on respiratory depression, as highlighted by Singh et al.

Neonatal outcomes remained favorable, with APGAR scores within normal limits. These findings are consistent with studies by Sonya and Davies[12] and Ipe et al.[15], which demonstrated that intrathecal buprenorphine does not adversely affect neonatal well-being. The minimal placental transfer and favorable safety profile of buprenorphine support its use in obstetric anaesthesia.

The present findings agree with previous literature, reinforcing that intrathecal buprenorphine is an effective adjuvant to hyperbaric bupivacaine for LSCS, providing prolonged analgesia, stable hemodynamics, and minimal adverse effects.

Conclusion

The present study demonstrates that the addition of intrathecal buprenorphine to hyperbaric bupivacaine in patients undergoing lower segment caesarean section provides rapid onset of anaesthesia, adequate sensory blockade, and prolonged postoperative analgesia. The anesthetic combination ensured effective intraoperative conditions with a predictable block profile and satisfactory duration of action. Hemodynamic parameters remained stable throughout the perioperative period, indicating favorable cardiovascular tolerance, while the incidence of adverse effects was low and clinically manageable. Importantly, neonatal outcomes, as assessed by APGAR scores, were within normal limits, confirming the safety of this regimen in the obstetric population. Intrathecal buprenorphine emerges as a valuable adjuvant to hyperbaric bupivacaine, enhancing the quality and duration of analgesia without compromising maternal or neonatal safety.

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