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COMPARATIVE STUDY BETWEEN LOW DOSE OF HYPERBARIC BUPIVACAINE WITH FENTANYL VERSUS CONVENTIONAL DOSE OF HYPERBARIC BUPIVACAINE IN PATIENTS UNDERGOING CAESAREAN SECTION UNDER SPINAL ANAESTHESIA

Anaesthesiology

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ABSTRACT

Introduction: Spinal anaesthesia is a commonly used technique for caesarean sections. Adding adjuvants to local anaesthetics enhances their efficacy. This study compares the anaesthetic and analgesic effects of low-dose hyperbaric bupivacaine with fentanyl versus conventional-dose hyperbaric bupivacaine. **Methods:** A double-blind, randomized controlled study was conducted on 60 ASA Grade I/II pregnant women undergoing elective caesarean sections at Krishna Mohan Medical College, Mathura, from July 2022 to January 2024. Patients were divided into two groups: Group 1 received 1.5 mL (7.5 mg) of 0.5% hyperbaric bupivacaine plus 0.5 mL (25 µg) fentanyl, and Group 2 received 2 mL (10 mg) of 0.5% hyperbaric bupivacaine alone. Vital parameters, sensory and motor block durations, and complications were assessed. **Results:** Group 1 showed a statistically significant increase in the duration of sensory block and analgesia. Regression of sensory block to T10 was prolonged in Group 1 compared to Group 2. Incidence of hypotension, nausea, and vomiting was lower in Group 1. **Conclusion:** Adding fentanyl to low-dose bupivacaine improves sensory block duration and quality while reducing side effects. This combination is a beneficial modification to standard spinal anaesthesia for caesarean sections.

KEYWORDS

INTRODUCTION

Spinal anaesthesia is the preferred technique for caesarean sections due to its simplicity, rapid onset, and safety profile. While hyperbaric bupivacaine is the commonly used agent, its associated side effects, such as hypotension and delayed recovery, warrant exploration of alternatives. The addition of adjuvants like fentanyl can enhance the quality and duration of the block, reduce drug dosage, and minimize side effects. This study compares low-dose bupivacaine with fentanyl to conventional-dose bupivacaine in terms of efficacy, safety, and patient outcomes.

Spinal anaesthesia works by blocking nerve conduction in the subarachnoid space, providing profound sensory and motor blockade. The use of adjuvants like fentanyl, an opioid agonist, complements the action of local anaesthetics by activating opioid receptors in the spinal cord, which enhances analgesia and reduces side effects. By combining low-dose bupivacaine with fentanyl, we aim to maintain effective anaesthesia while minimizing adverse events.

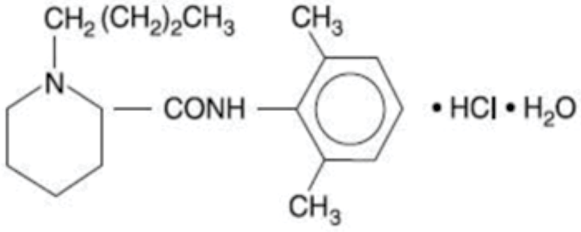

Fig 1. Chemical Structure Of Bupivacaine And Its Enantiomers

The physiological demands of pregnancy and the heightened need for perioperative safety necessitate optimizing anaesthetic techniques for caesarean sections. The balance between effective pain relief, motor recovery, and minimal complications is a priority. This study explores how modifying the conventional approach with the addition of an opioid adjuvant can enhance patient outcomes. Additionally, the study examines the role of adjuvants in mitigating the physiological stresses associated with surgery, including maternal hemodynamic stability and postoperative recovery.

Methods

Study Design

This was a prospective, double-blind, randomized controlled trial designed to compare the anaesthetic and analgesic effects of low-dose bupivacaine with fentanyl versus conventional-dose bupivacaine.

Participants

Sixty ASA Grade I/II pregnant women aged 18 to 35 years and scheduled for elective caesarean sections were enrolled in the study. Inclusion criteria included term gestation, singleton pregnancies, and willingness to participate. Exclusion criteria included patient refusal, coagulopathy, contraindications to spinal anaesthesia, history of drug allergies, and maternal obesity (BMI > 35).

Randomization

Participants were randomly assigned using a computer-generated randomization table into two equal groups:

- **Group 1:** 1.5 mL (7.5 mg) of 0.5% hyperbaric bupivacaine + 0.5 mL (25 µg) fentanyl.
- **Group 2:** 2 mL (10 mg) of 0.5% hyperbaric bupivacaine.

Blinding was maintained by ensuring that the anaesthetic drugs were prepared by an independent investigator not involved in patient care or data collection.

Procedure

After obtaining written informed consent, patients were positioned in the left lateral position, and spinal anaesthesia was administered in the L3-L4 interspace using a 25G Quincke needle. The following standardized protocols were implemented:

1. **Preloading:** All patients received 500 mL of Ringer's lactate intravenously 15 minutes before the procedure to reduce the incidence of hypotension.
2. **Positioning:** Following drug administration, patients were placed in the supine position with a left lateral tilt to prevent aortocaval compression.
3. **Monitoring:** Vital parameters, including blood pressure (BP), heart rate (HR), oxygen saturation (SpO2), and respiratory rate, were continuously monitored.
4. **Block Assessment:** Sensory block levels were assessed using a pinprick method at 2-minute intervals until the block reached T6. Motor block was assessed using the modified Bromage scale.

Outcome Measures

1. **Primary Outcomes:**
   - Duration of sensory block (time to regression to T10).
   - Duration of analgesia (time to first rescue analgesic requirement).
2. **Secondary Outcomes:**
   - Incidence of complications, including hypotension, bradycardia, nausea, vomiting, and pruritus.
   - Hemodynamic stability as reflected by variations in systolic and diastolic blood pressure.

o Quality of motor block recovery.

Complication Management
- Hypotension was treated with incremental doses of ephedrine (5-10 mg IV).
- Bradycardia was managed with atropine (0.6 mg IV).
- Pruritus was treated with antihistamines if required.
- Nausea and Vomiting were managed with ondansetron (4 mg IV).

Statistical Analysis
Data were analyzed using SPSS software version 25. Continuous variables were expressed as mean ± standard deviation and compared using independent t-tests. Categorical variables were expressed as percentages and analyzed using chi-square tests. A p-value <0.05 was considered statistically significant.

RESULTS
Demographics
Baseline characteristics, including age, height, weight, and gestational age, were similar between the two groups ($p > 0.05$), ensuring comparability and minimizing confounding variables.

Table 1: Demographic Data

Parameter	Group 1 (n=30)	Group 2 (n=30)	p-value
Age (years)	28.5 ± 4.2	29.2 ± 3.8	0.58
Height (cm)	160 ± 6	159 ± 5	0.67
Weight (kg)	65.4 ± 8.3	66.1 ± 7.9	0.72

Sensory and Motor Block
- Sensory Block: Regression to T10 was significantly longer in Group 1 (185 ± 20 min) compared to Group 2 (120 ± 15 min; $p < 0.01$). This prolonged duration underscores the efficacy of adding fentanyl.
- Motor Block: No significant difference in the duration of motor block was observed between the groups ($p > 0.05$), indicating that fentanyl does not adversely affect motor recovery.

Table 2. Block Characteristics

Parameter	Group 1 (n=30)	Group 2 (n=30)	p-value
Sensory block duration	185 ± 20 min	120 ± 15 min	<0.01
Motor block duration	140 ± 10 min	135 ± 12 min	0.30
Time to rescue analgesia	240 ± 30 min	160 ± 25 min	<0.01

Analgesia
- Time to first rescue analgesia was significantly longer in Group 1 (240 ± 30 min) than in Group 2 (160 ± 25 min; $p < 0.01$), demonstrating superior analgesic efficacy.

Hemodynamic Stability and Complications
- Hypotension: Incidence was lower in Group 1 (15%) compared to Group 2 (35%; $p < 0.05$), reflecting improved hemodynamic stability.
- Nausea and Vomiting: Reported in 10% of Group 1 and 25% of Group 2 patients ($p < 0.05$).
- Pruritus: Mild pruritus was observed in 10% of Group 1 patients but resolved spontaneously without intervention.
- Bradycardia: Incidence was comparable between the groups ($p > 0.05$).

DISCUSSION
The objective of our study was to compare the effects of intrathecally administered low-dose hyperbaric bupivacaine combined with fentanyl versus a conventional high dose of hyperbaric bupivacaine on anaesthesia quality, hemodynamic stability, and postoperative analgesia in parturients undergoing elective caesarean sections. The results showed that the combination of low-dose bupivacaine with fentanyl provided satisfactory anaesthesia and extended postoperative analgesia with reduced side effects compared to the conventional high-dose bupivacaine.

Key Findings
1. Sensory and Motor Blockade:
- The onset of motor and sensory blockade was comparable in both groups. However, the regression of sensory block to T10 and the duration of sensory blockade were significantly longer in the low-dose bupivacaine with fentanyl group (Group 1) compared to the high-dose bupivacaine group (Group 2). This observation aligns with findings from Mahdy et al., who reported satisfactory anaesthesia with a 10 mg dose of hyperbaric bupivacaine but noted increased efficacy with additives[1,2].

2. Hemodynamic Stability:
- Group 1 demonstrated better hemodynamic stability with fewer incidences of hypotension and bradycardia compared to Group 2. This is consistent with Kiran et al., who found lower doses of bupivacaine minimized hypotension and bradycardia without compromising anaesthesia quality[1].

3. Postoperative Analgesia:
- Group 1 showed a prolonged duration of analgesia and a delayed requirement for rescue analgesia, highlighting the efficacy of fentanyl as an adjuvant. Similar results were reported by Jaishri Bogra et al., who concluded that the combination of fentanyl and bupivacaine extended postoperative analgesia and reduced visceral pain[3,4].

4. Side Effects:
- Side effects such as nausea, vomiting, and pruritus were less frequent in Group 1, corroborating studies by Sheikh et al. and Venkata et al., who emphasized the stability and reduced side effects provided by fentanyl combinations[5].

Comparison with Literature
The study's findings are in agreement with several previous investigations that advocate for the addition of fentanyl to bupivacaine for enhanced analgesic and anaesthetic effects. Studies such as those by Veena Chatrath et al. and Yesuf et al. further validate the prolonged analgesic duration and hemodynamic stability achieved through this combination[6,7].

Clinical Implications
The use of low-dose hyperbaric bupivacaine with fentanyl offers a viable alternative to conventional higher doses of bupivacaine for caesarean sections. This combination reduces complications like hypotension and extends analgesia, enhancing maternal and neonatal outcomes. Given the minimal side effects and improved patient comfort, this approach could be considered a standard in clinical practice for spinal anaesthesia in caesarean sections.

Limitations and Recommendations
While the study's sample size was adequate, future research with larger cohorts could provide more robust conclusions. Additionally, the long-term maternal and neonatal outcomes associated with these anaesthesia protocols warrant further investigation.

CONCLUSION
our study supports the use of low-dose hyperbaric bupivacaine combined with fentanyl as an effective and safer alternative to conventional high-dose bupivacaine for caesarean sections, offering superior hemodynamic stability, prolonged analgesia, and reduced side effects.

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