Section: Anaesthesiology

Original Research Article

A COMPARATIVE STUDY OF HYPERBARIC INJ. BUPIVACAINE (0.5%) WITH HYPERBARIC INJ. LEVOBUPIVACAINE (0.5%) FOR SPINAL ANAESTHESIA IN CESAREAN SECTION

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ABSTRACT

Background: Spinal anaesthesia remains the preferred choice for cesarean section due to its rapid onset and superior maternal and fetal outcomes. Bupivacaine is the most widely used local anaesthetic; however, its adverse hemodynamic effects have led to increasing interest in safer alternatives like Levobupivacaine. **Aim:** To compare the clinical efficacy of 0.5% hyperbaric Bupivacaine and 0.5% hyperbaric Levobupivacaine in cesarean section with respect to sensory and motor blockade, duration of analgesia, hemodynamic parameters, and complications. **Materials and Methods:** This prospective, randomized, double-blinded study included 100 ASA II and III parturients scheduled for elective cesarean section. Group B received 10 mg of 0.5% hyperbaric Bupivacaine and Group L received 10 mg of 0.5% hyperbaric Levobupivacaine intrathecally. The onset and duration of sensory and motor block, intraoperative hemodynamic changes, and adverse effects were recorded and analyzed using standard statistical tests. **Results:** Both drugs achieved effective spinal anaesthesia. Bupivacaine had a significantly faster motor block onset and longer sensory and motor block duration ($p < 0.001$). Levobupivacaine was associated with significantly greater hemodynamic stability and a lower incidence of side effects such as hypotension, bradycardia, and nausea. **Conclusion:** Levobupivacaine is a safer and clinically effective alternative to Bupivacaine for spinal anaesthesia in cesarean sections, offering enhanced hemodynamic stability and quicker recovery without compromising anaesthetic efficacy.

INTRODUCTION

Spinal anaesthesia is widely recognized as the preferred technique for lower segment cesarean section (LSCS) due to its rapid onset, simplicity, minimal drug exposure to the fetus, and reduced maternal morbidity. Among the various local anaesthetics used intrathecally, Bupivacaine has long been the gold standard due to its potent sensory and motor blocking capabilities. However, its well-known cardiotoxicity, especially at higher plasma levels or in case of inadvertent intravascular injection, has prompted the development of safer alternatives such as Levobupivacaine.[1]

Levobupivacaine, the S-enantiomer of racemic Bupivacaine, is pharmacologically similar in terms of its anaesthetic properties but exhibits reduced affinity for cardiac sodium channels, rendering it less cardiotoxic.[2] This makes it a promising agent for regional anaesthesia in obstetric patients, where maternal and fetal safety are of paramount concern. Hyperbaric formulations of both drugs further allow better control of drug spread within the cerebrospinal fluid (CSF), enhancing consistency of block height and duration.[3]

Several studies have compared these agents in terms of sensory and motor block characteristics. Bupivacaine has been found to produce dense motor blockade and prolonged anaesthesia, which may not always be necessary or desirable in ambulatory or obstetric settings. Levobupivacaine, on the other hand, is associated with a more favourable profile due to its shorter motor block duration and faster recovery, while maintaining adequate sensory block and postoperative analgesia.[4,5]

Hemodynamic stability is another vital aspect in obstetric anaesthesia. Pregnant women are especially sensitive to hypotension resulting from sympathetic blockade, which can compromise uteroplacental perfusion and fetal oxygenation. Recent data suggests

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that Levobupivacaine may induce less profound hypotension and bradycardia compared to Bupivacaine, potentially enhancing maternal safety.[6,7]

Analgesia duration is also an important consideration. Bupivacaine is known for prolonged postoperative pain relief, but the recovery of motor function is delayed, sometimes affecting early ambulation. Levobupivacaine offers a more balanced profile, with comparable analgesia duration but faster motor recovery—highly beneficial for early maternal-infant bonding and breastfeeding.[8]

The choice between these two agents is further influenced by the incidence of side effects such as nausea, hypotension, shivering, and pruritus. While both are generally well-tolerated, subtle differences in adverse event profiles have been reported and merit clinical evaluation.[9]

Given the increasing use of Levobupivacaine in regional anaesthesia and the ongoing reliance on Bupivacaine as a benchmark, it becomes essential to compare these agents head-to-head in cesarean sections. This study aims to assess their efficacy in terms of sensory and motor blockade, duration of analgesia, hemodynamic parameters, and associated complications, providing a clearer guide for anaesthetic decision-making in obstetric practice.[10]

MATERIALS AND METHODS

After obtaining approval from the Institutional Ethical Committee, this prospective, randomized, double-blinded clinical study was conducted in a tertiary care teaching hospital. The study included 100 parturients of ASA physical status II and III, aged between 18 and 40 years, scheduled for elective lower segment cesarean section under spinal anaesthesia. Written informed consent was obtained from all participants after explaining the procedure in detail.

The parturients were randomly assigned into two groups of 50 each using a computer-generated randomization chart. Group B received 10 mg of 0.5% hyperbaric Bupivacaine (2 mL), and Group L received 10 mg of 0.5% hyperbaric Levobupivacaine (2 mL) administered intrathecally.

Inclusion criteria consisted of parturients aged 18 to 40 years, with ASA grade II or III, undergoing elective cesarean section. Exclusion criteria included parturients with contraindications to spinal anaesthesia, known allergy to local anaesthetics, emergency cesarean sections, spinal deformities, objection to spinal technique, and height less than 150 cm or more than 170 cm.

All patients underwent a thorough preoperative evaluation including detailed history, general and systemic examination, airway assessment, and laboratory investigations. They were instructed to maintain fasting for six hours prior to surgery.

On the day of surgery, intravenous access was secured in all patients, and standard monitors including non-invasive blood pressure, electrocardiogram, and pulse oximeter were attached. Baseline parameters were recorded. Intravenous Ringer lactate was infused at 10 mL/kg. Premedication included Inj. Ondansetron 4 mg IV and Inj. Glycopyrrolate 0.2 mg IV administered slowly.

The patients were then positioned in the left lateral posture. Under strict aseptic precautions, subarachnoid block was performed at the L3–L4 interspace using a 25G Quincke spinal needle. After confirming free flow of cerebrospinal fluid, the study drug was injected over a period of 10 seconds. The patient was then turned supine and supplemental oxygen at 4 L/min was provided via face mask. Following delivery, intravenous oxytocin 20 units diluted in 500 mL of normal saline was administered.

Sensory block was assessed by bilateral loss of pinprick sensation using a 20-gauge needle at specific dermatomal levels. Assessment was done every two minutes for the first ten minutes, then every ten minutes until regression to the L1 level. Motor block was assessed using the Modified Bromage Scale, where score 0 indicated no block, score 1 indicated hip block only, score 2 involved hip and knee, and score 3 indicated complete motor block including the ankle.

The onset of sensory block was defined as the time from intrathecal injection to loss of pinprick sensation at the T10 dermatome. The onset of motor block was defined as the time from injection to achievement of a Bromage score of 3. Two-segment regression time was measured as the duration between achieving the maximum sensory block and regression by two dermatomes.

Bromage score was recorded every minute until reaching score 3, and subsequently every 15 minutes until full motor recovery to score 0. The duration of sensory block was defined as the time from drug administration until regression to L1, and the duration of motor block was measured as the time until the Bromage score returned to zero.

Hemodynamic parameters including systolic and diastolic blood pressure, heart rate, and SpO_2 were recorded at baseline, then every five minutes for the first ten minutes, and every ten minutes thereafter until the end of surgery.

Statistical analysis was carried out using SPSS version 20. Descriptive statistics were used to summarize patient profiles and clinical variables. Categorical variables were compared using the Chi-square test with contingency tables. Continuous variables were analyzed using Student's t-test. Data was expressed as mean ± standard deviation, median (range), or number of patients as appropriate. A p-value less than 0.05 was considered statistically significant

RESULTS

Table 1 shows the demographic comparison between the two groups. The mean age, weight, and height of

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patients in both Group B (Bupivacaine) and Group L (Levobupivacaine) were statistically comparable, with no significant differences observed ($p > 0.05$). This ensures that baseline characteristics were evenly distributed, and the groups were homogenous for analysis.

Table 2 presents the onset time for both sensory and motor blockade. While the onset of sensory block was similar in both groups, the onset of motor block was significantly faster in the Bupivacaine group compared to the Levobupivacaine group ($p < 0.001$), indicating a more rapid neuromuscular effect with Bupivacaine.

Table 3 details the duration of sensory and motor blockade. Both durations were significantly longer in the Bupivacaine group than in the Levobupivacaine group ($p < 0.001$), suggesting that Bupivacaine provides a more prolonged anaesthetic effect. However, this could be a drawback in settings where early ambulation is preferred.

Table 4 compares intraoperative hemodynamic parameters between the two groups. Patients in the Levobupivacaine group maintained better systolic and diastolic blood pressure and had a slightly higher heart rate compared to those in the Bupivacaine group, with all differences being statistically significant. This indicates that Levobupivacaine offers greater hemodynamic stability during spinal anaesthesia.

Table 5 summarizes the incidence of common adverse effects. Group B showed higher frequencies of hypotension, bradycardia, nausea, vomiting, and shivering as compared to Group L. This further supports the safer side effect profile of Levobupivacaine in obstetric patients.

Table 1: Comparison of Age, Weight, and Height in Both Groups

Parameter	Group B (Bupivacaine)	Group L (Levobupivacaine)	P-value
Age (years)	26.76 ± 4.32	25.88 ± 3.71	0.32
Weight (kg)	62.58 ± 5.69	61.56 ± 5.89	0.45
Height (cm)	157.58 ± 4.09	158.24 ± 3.84	0.44

Table 2: Onset of Sensory and Motor Block

Parameter	Group B (Bupivacaine)	Group L (Levobupivacaine)	P-value
Onset of sensory block (min)	2.56 ± 0.66	2.70 ± 0.71	0.30
Onset of motor block (min)	3.94 ± 0.62	4.70 ± 0.65	<0.001

Table 3: Duration of Sensory and Motor Block

Parameter	Group B (Bupivacaine)	Group L (Levobupivacaine)	P-value
Duration of sensory block (min)	153.96 ± 12.45	142.08 ± 11.92	<0.001
Duration of motor block (min)	168.68 ± 12.24	144.28 ± 12.42	<0.001

Table 4: Hemodynamic Parameters (Mean Values)

Parameter	Group B (Bupivacaine)	Group L (Levobupivacaine)	P-value
Systolic BP (mmHg)	110.80 ± 6.85	115.16 ± 5.44	0.001
Diastolic BP (mmHg)	74.16 ± 4.77	77.76 ± 5.36	0.001
Heart Rate (bpm)	80.40 ± 4.18	82.84 ± 4.61	0.005

Table 5: Incidence of Adverse Effects

Adverse Effect	Group B (n=50)	Group L (n=50)
Hypotension	10	4
Bradycardia	3	1
Nausea/Vomiting	6	2
Shivering	5	2

DISCUSSION

This study was conducted to compare the clinical efficacy and safety of hyperbaric 0.5% Bupivacaine and hyperbaric 0.5% Levobupivacaine in spinal anaesthesia for elective cesarean sections. The findings confirm that both agents are effective, but Levobupivacaine demonstrates a more favorable profile in terms of hemodynamic stability, motor recovery, and incidence of side effects.

The demographic characteristics such as age, height, and weight were statistically comparable between the two groups, eliminating baseline biases. The onset of sensory block was similar in both groups, consistent with prior studies that have reported comparable time to sensory block for isobaric and hyperbaric formulations of Bupivacaine and Levobupivacaine.[11] However, Bupivacaine exhibited a significantly faster onset of motor block, possibly due to its higher lipid solubility and affinity for neural sodium channels.[12]

A significant difference was observed in the duration of sensory and motor blockade. Bupivacaine produced a longer duration of anaesthesia, as also seen in previous comparative studies.[2,5] While this prolonged effect may be beneficial in some surgical contexts, it can delay early ambulation and increase the risk of urinary retention—less desirable in obstetric patients aiming for early maternal-infant bonding and mobility.[13]

Levobupivacaine demonstrated better hemodynamic stability during surgery. The mean systolic and

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diastolic blood pressures were significantly higher and more stable in Group L compared to Group B. This is in line with the findings of recent trials suggesting that Levobupivacaine causes less sympathetic blockade and hence fewer hemodynamic fluctuations.[14] Stable maternal hemodynamics are particularly important in cesarean sections to ensure consistent uteroplacental perfusion and fetal oxygenation.[11,14]

Moreover, the adverse effect profile was clearly more favorable in the Levobupivacaine group. The Bupivacaine group exhibited higher incidences of hypotension, bradycardia, and nausea/vomiting. These findings are consistent with previous literature that associates Bupivacaine with more pronounced autonomic blockade and related side effects.[4,9] Levobupivacaine's reduced cardiotoxicity and neurotoxicity make it a safer alternative, especially in high-risk obstetric patients.[15]

Importantly, the shorter motor block duration seen with Levobupivacaine supports faster postoperative recovery. This facilitates early breastfeeding and bonding with the newborn, aligning with modern obstetric goals for enhanced maternal satisfaction and reduced hospital stays.[13]

CONCLUSION

Intrathecal administration of both hyperbaric 0.5% Bupivacaine and hyperbaric 0.5% Levobupivacaine provides effective anaesthesia for cesarean section. However, Levobupivacaine offers better hemodynamic stability, fewer side effects, and faster motor recovery. These attributes make it a clinically safer and more efficient alternative to Bupivacaine in obstetric anaesthesia, particularly in patients requiring stable cardiovascular function and early postoperative mobilization.

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