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COMPARATIVE STUDY OF BUPIVACAINE AND LEVOBUPIVACAINE WITH ADJUVANT BUPRENORPHINE IN ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK IN UPPER LIMB SURGERIES

Anaesthesiology

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ABSTRACT

Background And Aim: Supraclavicular brachial plexus block provides effective analgesia for upper limb surgeries. However, the limited duration of local anaesthetics requires adjuvants to prolong analgesia. Buprenorphine, a partial μ-opioid agonist, is known to enhance analgesic duration. This study compares bupivacaine and levobupivacaine, each combined with buprenorphine, focusing on block characteristics, duration of postoperative analgesia, and associated side effects. **Methods:** This prospective, randomized controlled trial was conducted at JSS Medical College Hospital, Mysuru, with institutional ethical approval. Written informed consent was obtained from all participants. The study was registered at the clinical trial registry of India (CTRI/2024/02/063071). Sixty ASA I–II patients were randomized into two groups: Group I received 30 ml of 0.5% bupivacaine + 150 mcg buprenorphine; Group II received 30 ml of 0.5% levobupivacaine + 150 mcg buprenorphine. Block characteristics were assessed using Hollmen and Modified Bromage scales. Pain was recorded using VAS scores. Statistical analysis included mean, standard deviation, chi-square test. $P < 0.05$ was considered significant. **Results:** Both groups demonstrated comparable efficacy in terms of motor block duration (Group BB: 11.77 ± 1.70, Group LB: 12.03 ± 1.99, $p = 0.579$) and sensory block duration (Group BB: 13.30 ± 1.64, Group LB: 13.77 ± 1.91, $p = 0.314$). Total duration of postoperative analgesia was similar (Group BB: 14.10 ± 1.77, Group LB: 14.17 ± 1.82, $p = 0.886$). Side effects were minimal and comparable **Conclusion:**Both bupivacaine and levobupivacaine, when combined with buprenorphine, provide equivalent block characteristics and analgesic duration in supraclavicular brachial plexus block, with minimal side effects.

KEYWORDS

Bupivacaine, Levobupivacaine, Buprenorphine, Supraclavicular brachial plexus block, ultrasound guidanc

INTRODUCTION

Supra-clavicular brachial plexus block is a widely used regional anesthesia technique for upper limb surgeries, offering advantages like reduced opioid use and improved postoperative analgesia.[1] Both bupivacaine and levobupivacaine, amide-type local anesthetics, are commonly used in SCBPB due to their long-acting effects. Levobupivacaine, being the pure S-enantiomer of bupivacaine, is associated with a better safety profile, especially regarding cardiotoxicity.[2]

However, a key limitation of both agents is their finite duration of postoperative analgesia. To address this, various adjuvants like dexamethasone, clonidine, dexmedetomidine and opioids have been combined with local anesthetics. Buprenorphine, a partial μ-opioid receptor agonist, is of particular interest as it prolongs analgesia with minimal side effects.[1]

Ultrasound guidance enhances the safety and precision of regional blocks by allowing real-time visualization of the nerves and surrounding structures, reducing complication risks and improving block success rates.

Despite prior studies comparing local anesthetics and adjuvants individually, few have directly compared bupivacaine and levobupivacaine combined with buprenorphine in Supra-clavicular brachial plexus block. Therefore, this study aims to evaluate and compare these two combinations in terms of efficacy, duration of analgesia, and safety.

MATERIALS AND METHODS

This prospective, randomized controlled study was conducted in a tertiary hospital after approval of the research ethical committee (clinical trials ID is CTRI/2024/02/063071) and obtaining written informed consent from all the participants.

It included 60 adult patients (ASA physical status I–II) undergoing elective upper limb surgeries under ultrasound-guided supraclavicular brachial plexus block (SCBPB). Inclusion criteria included patients who were above 18 years of age, ASA- PS I and II and who were above 60 kg). Patients' not willing to consent for the procedure, who had local infection/open wound/ distorted anatomy in the affected side of the neck and supraclavicular area due to haematoma/ swelling, with haemodynamic instability, had allergic history to any local anaesthetics, coagulopathy, neuropathy and pregnant patients were excluded from the study.

Randomization

Patients were randomized into two groups (n=30 each) using a computer-generated sequence and sealed opaque envelopes. The anesthesiologist performing the block and the observer assessing outcomes were blinded to group allocation.

- **Group BB**: 30 ml of 0.5% bupivacaine + 150 mcg buprenorphine
- **Group LB**: 30 ml of 0.5% levobupivacaine + 150 mcg buprenorphine

Preoperative Assessment

Preanesthetic evaluation included thorough history, physical examination, and routine investigation. Patients were instructed to fast and educated about the Visual Analog Scale (VAS) for pain assessment.

Procedure

On the day of surgery, baseline vitals were recorded. IV access was secured in the non-operative arm. All patients received IV midazolam (0.03–0.04 mg/kg) as premedication and supplemental oxygen at 4 L/min via Hudson's mask.

A high-frequency linear ultrasound probe was placed over the supraclavicular area to identify the brachial plexus lateral to the subclavian artery using color Doppler. Under strict aseptic precautions, local infiltration with 2–3 ml of 2% lignocaine was given. Using an in-plane technique, a needle was advanced toward the plexus, and after negative aspiration, the study drug was injected under direct vision, ensuring circumferential spread around the plexus.

Outcome Measured

- **Sensory Block:** Onset and duration assessed using the Hollmen scale over the C5–T1 dermatomes
- **Motor Block:** Onset and duration evaluated using Modified Bromage scale for the upper limb
- **VAS:** Measured at 2, 4, 6, 12 and 24 hours postoperatively
- **Adverse Effects:** Hypotension, bradycardia, nausea, vomiting, respiratory depression

Definitions

- **Onset Time:** Time from injection to sensory score 2 (Hollmen) or motor score 4 (Modified Bromage)
- **Duration Of Block:** Time from complete block to regression (score < 4 for sensory; score = 1 for motor)
- **Duration Of Analgesia:** Time from block completion to first VAS score ≥ 4

Statistical Methods

Sample size calculation was based on an estimated effect size of 0.84, with 90% power and 5% alpha error. Data were analyzed using SPSS

v23. Chi-square/Fisher's exact test was used for categorical data. A p-value < 0.05 was considered statistically significant.

RESULT

Demographic Characteristics

Demographic Characteristics were comparable between the groups.

Table 1 : Demographic Characteristics Between Both Groups

Variable	Category	Group BB (n=30)	Group LB (n=30)	p-value
Mean Age (years)		36.3 ± 12.7	37.6 ± 13.1	0.697
Gender	Female	13 (56.5%)	10 (43.5%)	0.426
	Male	17 (45.9%)	20 (54.1%)	
Mean BMI (kg/m²)		28.1 ± 2.79	28.2 ± 2.00	0.845
Mean Duration of surgery (min)		157 ± 65.6	168.7 ± 69.3	0.506

Sensory And Motor Block Characteristics

Group BB showed a faster onset of sensory block (11.87 ± 1.74 min) than Group LB (13.65 ± 2.93 min), p = 0.006. Similarly, time to peak sensory block was significantly shorter in BB (15.23 ± 1.89 min) vs LB (17.73 ± 3.55 min), p = 0.001.

Motor block onset and peak times were statistically comparable. Duration of sensory and motor blocks did not differ significantly between groups.

Table 2: Sensory And Motor Block Onset Between The Two Groups

Parameter	Group BB (Mean ± SD, min)	Group LB (Mean ± SD, min)	p-value
Sensory block onset	11.87 ± 1.74	13.65 ± 2.93	**0.006**
Time to peak sensory	15.23 ± 1.89	17.73 ± 3.55	0.001
Motor block onset	15.03 ± 2.25	15.63 ± 2.81	0.365
Time to peak motor	20.03 ± 3.05	21.33 ± 3.40	0.124

Duration Of Sensory Block, Motor Block, And Postoperative Analgesia

The mean duration of sensory block was 13.30 ± 1.64 hours in Group BB and 13.77 ± 1.91 hours in Group LB (p = 0.314). Similarly, motor block duration was 11.77 ± 1.70 hours in Group BB and 12.03 ± 1.99 hours in Group LB (p = 0.579). Postoperative analgesia duration was comparable between the groups: 14.10 ± 1.77 hours for Group BB and 14.17 ± 1.82 hours for Group LB (p = 0.886).

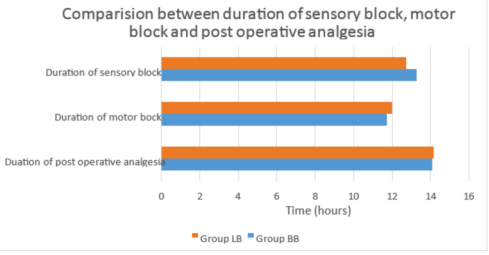

Fig 1 : Comparison between duration of sensory block, motor block and postoperative analgesia between both groups

Hemodynamic Parameters

Throughout the intraoperative and postoperative monitoring periods, hemodynamic stability was well maintained in both groups. There was no significant difference between pulse rate, blood pressure and oxygen saturation between both groups.

Adverse Effects

No significant adverse effects such as hypotension, bradycardia, nausea, vomiting, pruritus, or respiratory depression were observed in either group.

DISCUSSION

Regional anesthesia, particularly supraclavicular brachial plexus block, is a well-established technique providing both intraoperative anesthesia and prolonged postoperative analgesia in upper limb surgeries.

Both groups were comparable with respect to demographic data

The present study observed a significantly faster onset of sensory block in the bupivacaine (11.9±1.7 min) group compared to levobupivacaine (13.7+2.9min) (**p=0.006**) and the time to achieve peak sensory block was similarly shorter with Bupivacaine (15.2±1.9 vs 17.7±3.5 minutes, **p=0.001**). This finding aligns with Patel et al., who noted earlier onset with bupivacaine compared to ropivacaine (17.7 + 2.35min vs 22.13+ 3.05 min).[5] However, other studies, including Pedro et al. and Deshpande et al. (6.13min vs 7.59 min),[3,4] have reported faster onset with levobupivacaine in certain settings. These discrepancies may result from differences in study methodology, assessment criteria for sensory onset, and block techniques.

In contrast to sensory block, motor block onset was similar between both groups, with no statistically significant difference. These outcomes partially support previous conclusions by Pedro et al., who likewise reported comparable motor block latency with levobupivacaine and racemic bupivacaine.[3] In Pedro's 2009 trial, both agents produced motor blockade of similar timing and quality, which is in line with our observation. While our results showed no difference, this contrasts with some authors (e.g., Patel et al.) who found racemic bupivacaine to initiate motor block faster than a pure S-enantiomer alternative (25.43 ± 2.22 min vs 27.90 ± 1.88 min), though those comparisons involved ropivacaine rather than levobupivacaine.[5]

Both sensory and motor block durations were comparable across groups. Our findings align with previous research by Pedro et al., who concluded that levobupivacaine's anaesthetic efficacy and block duration are similar to that of racemic bupivacaine. In contrast, Deshpande et al. reported a sensory block duration of 17.3 hours with levobupivacaine vs. 14.5 hours with bupivacaine. Motor block duration was also longer with levobupivacaine (17.5 hours) vs. bupivacaine (15.0 hours) [4]. Cline et al. found a similar trend, with levobupivacaine producing sensory block for 13.85 hours vs. 10.7 hours for ropivacaine; motor block lasted 17.45 hours with levobupivacaine.[7]

Postoperative analgesia duration was prolonged and similar in both groups (~14 hours). These outcomes align with previous research by Cenk Ilham et al. and others who found no difference in time to first analgesic request between 0.5% bupivacaine and 0.5% levobupivacaine blocks (reporting ~14–17 hours in both) [7]. Deshpande et al. observed postoperative analgesia duration of 17.47 hours for levobupivacaine and 15 hours for bupivacaine.[4] Lisinnantti et al. found similar durations across bupivacaine (17.8 h), levobupivacaine (17.1 h), and ropivacaine (15 h), though the difference was not statistically significant.[6]

Both groups showed stable hemodynamic profiles, with no significant intergroup differences in heart rate, blood pressure, or oxygen saturation. No adverse cardiac or neurologic events were seen. This is in line with findings from Pedro et al. and Ture et al.,[8] where both agents were shown to be hemodynamically safe when used in regional blocks.

No significant adverse effects such as hypotension, bradycardia, nausea, vomiting, pruritus, or respiratory depression were seen in either group.

Limitations

Limitations include a small sample size (60 patients) and restriction to ASA I–II patients, limiting applicability to high-risk populations.

CONCLUSION

Both bupivacaine and levobupivacaine, when combined with buprenorphine, provide effective and comparable surgical anesthesia and postoperative analgesia in ultrasound-guided supraclavicular brachial plexus blocks. While bupivacaine offers a marginally faster sensory onset, levobupivacaine presents a safer alternative without sacrificing efficacy. Buprenorphine serves as an effective adjunct to both agents, enhancing postoperative pain control. Notably, buprenorphine's role as an adjuvant remains underutilized in some centers despite evidence supporting its effectiveness in prolonging analgesia without increasing side effects. Our study reinforces its utility in brachial plexus blocks

The choice between bupivacaine and levobupivacaine should thus be guided by patient comorbidities and institutional preferences rather than efficacy concerns alone.

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