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ORIGINAL RESEARCH

Butorphanol vs. Tramadol: Adjuvant Effects on Levobupivacaine in PNS-Guided Supraclavicular Brachial Plexus Blocks for Enhanced Postoperative Analgesia

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ABSTRACT

Background and Aims: Supraclavicular brachial plexus blocks are a reliable, minimally invasive option for upper limb surgeries. Adjuvants like butorphanol and tramadol can improve block quality, lower local anesthetic doses, and reduce postoperative analgesic needs. This research study evaluated the effects of incorporating butorphanol compared to tramadol on sensory and motor block characteristics during PNS-guided supraclavicular brachial plexus blocks. **Methods:** This prospective observational study, approved by the IEC, involved 70 adult ASA Physical Status I & II patients (18-65 years) undertaking elective upper limb surgery. Written informed consent was obtained from enrolled subjects. Participants were randomly assigned to two groups: Group A received 0.5% Levobupivacaine (30 ml) with 100 mg Tramadol (32 ml total), while Group B received 0.5% Levobupivacaine (30 ml) with 2 mg Butorphanol (32 ml total). Post-intervention evaluations included sensory and motor block onset and duration, sedation scores, and adverse effects, which were analyzed statistically. **Result:** Group B showed a statistically significant increase in sensory block duration (442.68 ± 52.11 minutes vs. 310.12 ± 78.76 minutes) and postoperative analgesia duration (828 ± 87 minutes vs. 762 ± 52.8 minutes; $P < 0.05$). Onset times for sensory and motor blocks were slightly faster in Group B, but not statistically significant. Group B also demonstrated a longer duration of analgesia (828 ± 87 minutes vs. 762 ± 52.8 minutes; $P = 0.046$). Rescue analgesia needs were slightly reduced in Group B (1.44 ± 0.54 vs. 2.02 ± 0.41; $P = 0.458$). Hemodynamic changes and adverse effects were similar between groups ($P > 0.05$). **Conclusion:** Butorphanol addition to levobupivacaine in supraclavicular brachial plexus blocks significantly extends sensory block and analgesia duration, enhancing pain management and reducing additional analgesic requirements, thus improving patient comfort in upper limb surgeries.

Key words: Brachial Plexus Block, Butorphanol, Levobupivacaine, Peripheral Nerve Stimulation (PNS), Tramadol.

INTRODUCTION

Supraclavicular brachial plexus blocks have become a cornerstone of local anesthesia for patients undergoing upper limb surgeries, offering a dependable alternative to general anesthesia with fewer associated complications. This technique has firmly established itself in anesthesiology due to its benefits, including higher success rates, enhanced safety profiles, cost-effectiveness, reduced hospital stays, and effective postoperative pain management. [1-4]

Recent advancements in peripheral nerve block procedures, such as using peripheral nerve stimulators (PNS), have significantly improved the precision of brachial plexus localization. By delivering a low-intensity electric current through an insulated needle, PNS enables accurate identification and administration of local anesthesia to the targeted nerve. [5-8]

Levobupivacaine, a more recent local anesthetic, is known for its improved safety profile compared to racemic bupivacaine, especially concerning its effects on the cardiovascular and central nervous systems.

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Levobupivacaine's benefits include lower cardiotoxicity, attributed to its reduced affinity for cardiac sodium channels and higher plasma protein binding.[9,10] To further enhance the efficacy of nerve blocks and minimize the need for additional analgesia, various adjuvants have been explored. While many studies have investigated agents such as morphine, buprenorphine, clonidine, and dexamethasone, [11-14] direct comparisons between tramadol and butorphanol as adjuvants to local anesthetics remain limited.

Tramadol, a synthetic analog of codeine, acts on μ-opioid and non-opioid receptors, thereby enhancing the efficacy of local anesthetics and modulating norepinephrine and serotonin reuptake at nerve endings. [15-17] Conversely, butorphanol, a synthetic opioid with κ-receptor agonist activity and partial agonist-antagonist effects at μ-opioid receptors, presents a different mechanism of action.[16,18,19]

The objective of this study is to assess and compare the effectiveness of tramadol and butorphanol when used as adjuvants to levobupivacaine in supraclavicular brachial plexus blocks. We will assess parameters including sensory and motor block onset and duration, postoperative pain relief, Visual Analogue Scale (VAS) scores, the need for additional analgesia, hemodynamic effects, and any adverse reactions associated with each adjuvant.

MATERIALS AND METHODS

Patient Selection

This prospective observational research study included 70 subjects, aged 18 to 65 years, of both genders, classified as ASA I or II by the American Society of Anesthesiologists. These patients were scheduled for elective upper limb surgeries during the period from September 2022 to January 2024. Participants were randomly assigned to two groups: Group A (n=35) received 0.5% Levobupivacaine (30 ml) with 100 mg Tramadol (32 ml total volume), and Group B (n=35) received 0.5% Levobupivacaine (30 ml) with 2 mg Butorphanol (32 ml total volume). Approval from the Institutional Ethical Committee (IEC) was obtained, and written informed consent was collected from all participants who met the inclusion criteria, which included individuals aged 18 to 65 years of any gender, classified as ASA physical status I or II, and scheduled for elective upper limb surgeries.

Preoperative Assessment & Procedure Outcome Measures:

Baseline data were gathered using a predefined proforma, and a thorough preoperative evaluation was conducted prior to the scheduled surgery, encompassing the patient's medical history, a full physical examination, airway assessment, ASA classification, and necessary blood tests. Vital signs were monitored, patient consent was confirmed, and the VAS was explained. Patients were instructed to fast overnight. During the procedure, patients were placed supine with the head turned to the opposite side and arms extended towards the opposite knee. The supraclavicular brachial plexus block was carried out using a PNS-guided technique, with the Plexygon set at 2 Hz and 0.40 mA for brachial plexus localization, while maintaining strict aseptic techniques. A 20 G intravenous cannula was inserted into the non-operative arm for dextrose in normal saline administration. Local anesthetic was injected blindly, with incremental doses administered after confirming the absence of blood aspiration. Sensory and motor blocks were assessed every 5 minutes for 30 minutes post-procedure, excluding patients who did not achieve an adequate block within this timeframe. Sensory block was measured with the Hollmen scale (1 = normal sensation, 2 = reduced sensation, 3 = dull touch, 4 = no sensation), motor block with the Bromage scale (0 = full movement, 1 = only finger movement, 2 = no movement), and sedation levels with a four-point scale (0 = fully awake, 1 = drowsy but aware, 2 = asleep but can be woken, 3 = deeply asleep). Pain and analgesia were evaluated with VAS scores recorded at 2, 4, 6, 8, 12, and 24 hours postoperatively, with rescue analgesia (75 mg intravenous diclofenac) provided when VAS ≥ 4. The duration of analgesia was defined as the time until VAS ≥ 4, and the total amount of rescue analgesia administered was recorded. The primary outcome measures were the onset and duration of sensory and motor blocks, as well as the duration of analgesia. Secondary outcomes assessed included hemodynamic changes, respiratory function, sedation levels, adverse effects, and complications such as pneumothorax, hematoma, and postoperative paresthesias.

Statistical Analysis

In this study, the descriptive statistics were represented as Mean ± SD. Normality distribution of data was thoroughly assessed using Shapiro-Wilk test. The Student's t-test was applied for continuous data, while the Mann-Whitney U test was applied for non-normally distributed data. Chi-square tests were applied to categorical variables, and ANOVA was used for data with continuous variables. A p-value of <0.05 was deemed statistically significant. All statistical tests were two-tailed and performed using GraphPad Prism version 9.2 and SPSS (v22, IBM, Chicago).

RESULT

Demographic Characteristics

70 patients in this research study met the inclusion criteria and were enrolled and evaluated. The demographic variables, including age, gender, and ASA physical status distribution, were well-matched between the two groups, with no statistically significance ($p>0.05$). Group A (Tramadol) had an average age of 38.83 ± 14.57 years, while Group B (Butorphanol) had an average age of 41.27 ± 13.52 years. The gender distribution was comparable, with

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Group A consisting of 20 males and 15 females, while Group B included 23 males and 12 females. The distribution of ASA grades was comparable, with Group A consisting of 24 patients classified as Grade I and 11 as Grade II, and Group B comprising 21 Grade I and 14 Grade II patients. The lack of significant differences across these demographic variables suggests that the groups were adequately balanced for comparative analysis, as shown in **Table 1**.

Block Characteristics and Analgesia Duration

The onset times for both sensory and motor blocks were marginally longer in Group A (Tramadol) than in Group B (Butorphanol), but these differences were not statistically significant ($p>0.05$). Specifically, the mean onset time for sensory block was 10.8 ± 1.95 minutes in Group A and 10.3 ± 1.55 minutes in Group B, while the onset time for motor block was 12.9 ± 2.10 minutes in Group A and 12.7 ± 1.84 minutes in Group B. Notably, the duration of the sensory block was significantly longer in Group B, averaging 442.68 ± 52.11 minutes compared to 310.12 ± 78.76 minutes in Group A ($p<0.05$). The duration of the motor block was also longer in Group B, although this difference did not reach statistical significance ($P > 0.05$). Furthermore, the duration of postoperative analgesia was significantly prolonged in Group B, with an average of 828 ± 87 minutes compared to 762 ± 52.8 minutes in Group A ($P = 0.046$). The need for rescue analgesia was clinically lower in Group B (1.44 ± 0.54) compared to Group A (2.02 ± 0.41), although this difference was not statistically significant ($p>0.05$). Hemodynamic parameters and the occurrence of adverse effects were similar between the groups, with no significant differences observed ($p>0.05$), as shown in **Table 2**.

Postoperative Pain and Adverse Effects Assessment

The VAS scores recorded at 6, 8, and 12 hours postoperatively were compared and the findings were not statistically significant between Group A and Group B ($p>0.05$) (**Figure 1**). However, at 24 hours postoperatively, the VAS score in Group B was significantly lower than in Group A ($p=0.003$). Hemodynamic assessments revealed no statistically significant differences between Group A and Group B. Adverse effects were minimal and comparable across both groups, with no significant differences observed in nausea, vomiting, or respiratory depression (Table 3). Sedation levels showed one case in Group A and two cases in Group B, which was statistically insignificant ($p>0.05$).

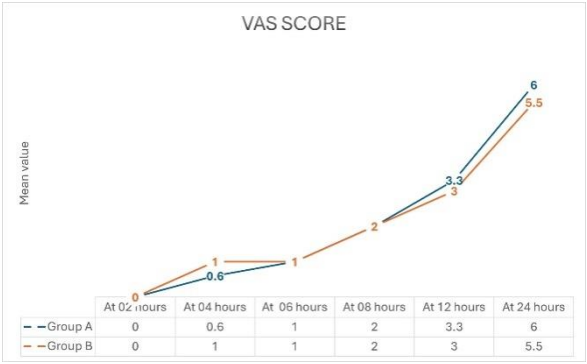

Figure 1: Visual analog scores in two study groups at various time intervals postoperatively

Table 1: The demographic profile of the study subjects

Variable	Group A Tramadol (n=35)	Group B Butorphanol (n=35)	P value
Age	38.83±14.57	41.27±13.52	ns (0.08)
Sex (M: F)	20:15	23:12	ns (0.856)
ASA	Grade I- 24 Grade II-11	Grade I-21 Grade II-14	ns (0.849)
*P< 0.05 considered statistically significant, ns: Statistically non-significant			

Table 2: Perioperative outcomes of the study subjects.

Group	Group A Tramadol (n=35)	Group B Butorphanol (n=35)	P value
Onset of sensory block (min)	10.8±1.95	10.3±1.55	ns (0.611)
Onset of motor block (min)	12.9±2.10	12.7±1.84	ns 0.954
Duration of sensory block (min)	310.12±78.76	442.68±52.11	*** (0.001)**
Duration of motor block (min)	378.46±56.26	436.56±68.68	ns (0.910)
Duration of analgesia (in min)	762 ± 52.8	828 ± 87	*** (0.046)**
Number of rescue analgesia	2.02±0.41	1.44±0.54	ns (0.458)
*P<0.05 significant, ns: Statistically non-significant			

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Table 3: Adverse effects in subgroups.

Adverse effects	Group A Tramadol (n=35)	Group B Butorphanol (n=35)	P value
Nausea and vomiting	0	0	ns
Respiratory depression	0	0	ns
Sedation	1	2	ns
ns: Statistically non-significant			

DISCUSSION

The brachial plexus block is a well-established practice for providing effective analgesia during upper limb surgeries. This method facilitates muscle relaxation, which aids in the alignment of tendons and fracture pieces, reduces postoperative spasms, pain, and swelling by blocking sympathetic nerves on blood vessels, and ultimately enhances postoperative recovery by mitigating the body's stress response to surgery. [20,21]

Levobupivacaine, an S-enantiomer of bupivacaine, is frequently utilized in peripheral nerve blocks due to its superior cardiovascular safety profile and reduced risk of neurological toxicity. [22-24] Combining local analgesics with adjuvant drugs like butorphanol or tramadol can enhance the effectiveness of the block. Specifically, adding 2 mg of butorphanol to bupivacaine has been shown to extend the duration of both sensory and motor blocks and improve postoperative pain relief, without significantly affecting hemodynamic parameters or increasing adverse effects. [2,25,26] Similarly, tramadol (100 mg) has demonstrated efficacy in extending the duration of sensory and motor blocks and accelerating onset times. [27,28]

Our results show that the onset times for sensory and motor blocks were marginally longer in Group A (tramadol) compared to Group B (butorphanol), but these differences were not statistically significant ($P > 0.05$).This result aligns with the studies of Bhavsar et al. (2016) [29] and Vinod et al. (2014), [30] which observed that butorphanol addition resulted in a faster onset of sensory and motor blocks in supraclavicular blocks. Conversely, Khosa et al. (2015) [31] reported a quicker onset with tramadol, which was not replicated in our study.

The duration of anesthesia observed in our study corroborates with Stoelting and Hiller's (2006) findings of 6–12 hours for levobupivacaine.[32] Notably, Group B (butorphanol) exhibited a significantly prolonged duration of sensory block compared to Group A (tramadol), while the motor block duration was similar across both groups. This is consistent with the research by Mir and Hamid (2007)[33] and Bhavsar et al. (2016),[29] which found that butorphanol extended the duration of both sensory and motor blocks. However, the studies by Alemanno et al. (2012)[34] and Madhusudhana et al. (2011)[35] indicated that tramadol also extended anesthesia duration, aligning with our findings on the motor block duration.

Regarding brachial plexus analgesia duration, our research highlighted a significant extension with butorphanol compared to tramadol ($P < 0.05$). This supports findings from Kumari et al. (2019) [2], Acharya et al. (2014) [18], and Bhavsar et al. (2016) [29], who observed similar benefits of butorphanol in prolonging analgesia duration. Khosa et al. (2015) [31], Madhusudhana et al. (2011) [35], and Akhtar et al. (2015) [36] also reported that tramadol extended pain relief duration, in agreement with our results.

The requirement for additional pain relief was comparable between groups ($P = 0.458$), which aligns with Khosa et al.'s (2015) [31] findings that combining tramadol with local analgesics did not significantly reduce the need for extra doses. In contrast, Wajima et al. (1995) [37] found that butorphanol required fewer additional analgesia doses compared to intravenous butorphanol.

VAS scores showed a significant reduction in Group B (butorphanol) compared to Group A (tramadol) at 24 hours ($P = 0.003$). This finding is consistent with Wajima et al.'s (1995) [37] observation of lower VAS scores in the butorphanol group at multiple postoperative intervals. Similarly, Khosa and Madhusudhana (2011), [31,35] and Bharathi et al. (2019) [26] reported reduced VAS scores with tramadol and butorphanol addition. Bharathi et al. (2019) [26] noted that higher doses of butorphanol enhanced blockade duration and pain relief, though it also increased sedation rates.

Our study found no significant difference in sedation levels or hemodynamic parameters between groups, aligning with the findings of Bhatia et al. (2017) who highlighted butorphanol's efficacy without adverse hemodynamic effects. [38]

This study's primary limitations include the relatively small sample size and the lack of a placebo or control group. Nonetheless, our findings indicate that both tramadol and butorphanol significantly enhance the quality and duration of supraclavicular brachial plexus blocks, with butorphanol offering superior analgesia duration and a decreased need for additional pain relief. To address these limitations and further our understanding, ongoing research within our department is exploring the long-term effects of adjuvants in supraclavicular blocks, with a particular focus on pain relief extending beyond the immediate postoperative period.[15,16]

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CONCLUSION

In this study, the addition of Butorphanol (2 mg) to 0.5% Levobupivacaine (30 ml) for supraclavicular brachial plexus blocks demonstrated a notable enhancement in the duration of sensory and postoperative analgesia compared to Tramadol (100 mg). Although the onset times for sensory and motor blocks were comparable between the two adjuvants, Butorphanol significantly extended both sensory block duration and overall postoperative pain relief, evidenced by longer analgesia and lower Visual Analog Scale (VAS) scores at 24 hours postoperatively. These findings indicate that Butorphanol is a more effective adjuvant for prolonging the duration of analgesia in supraclavicular brachial plexus blocks, without adversely affecting hemodynamic stability or increasing sedation. The results support the use of Butorphanol as a preferred option for enhancing postoperative pain management in upper limb surgeries.

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None.

Conflicts of interest/Competing interests

The authors declare that they have no conflict of interest.

Ethical Approval

The institutional ethical committee clearance was obtained prior to the conduct of the study. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committees, as well as the 1964 Helsinki Declaration and its subsequent amendments or comparable ethical standards.

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