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ORIGINAL RESEARCH

A Comparative Study of Bupivacaine-Lignocaine Combination with and without Dexmedetomidine as an Adjuvant in Supraclavicular Brachial Plexus Block in Patients Undergoing Forearm and Hand Surgeries

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ABSTRACT

Background: Supraclavicular brachial plexus block is a widely used regional anesthesia technique for upper limb surgeries, offering effective pain relief. Dexmedetomidine has shown promise as an adjuvant to local anesthetics, potentially enhancing block characteristics and prolonging postoperative analgesia. **Aim and Objective:** To compare the efficacy and safety of dexmedetomidine as an adjuvant to bupivacaine-lignocaine combination versus plain bupivacaine-lignocaine combination in supraclavicular brachial plexus block for patients undergoing forearm and hand surgeries. **Materials and Methods:** A prospective, randomized, double-blind, comparative trial was conducted at RKDF Medical College Hospital and Research Centre, Bhopal, India, from April 2023 to March 2024. Sixty patients were randomized into two groups: Group D (dexmedetomidine-adjuvanted bupivacaine-lignocaine) and Group C (plain bupivacaine-lignocaine). Primary outcome measures included onset time, sensory and motor blockade duration, and postoperative analgesic consumption. Secondary outcomes included hemodynamic parameters, sedation scores and adverse events. **Results:** The onset time of sensory block was significantly shorter in Group D compared to Group C (6.8 ± 1.2 minutes vs. 8.5 ± 1.4 minutes, $p < 0.001$). Similarly, the onset time of the motor block was shorter in Group D (9.3 ± 1.5 minutes) compared to Group C (11.1 ± 1.7 minutes, $p < 0.001$). The duration of sensory and motor blockade was significantly prolonged in Group D compared to Group C (12.4 ± 2.1 hours vs. 9.8 ± 1.8 hours, $p < 0.001$; 11.6 ± 2.0 hours vs. 9.1 ± 1.6 hours, $p < 0.001$, respectively). Postoperative analgesic consumption was lower in Group D compared to Group C (35.2 ± 8.3 mg vs. 48.9 ± 10.6 mg of intravenous tramadol, $p < 0.001$). **Conclusion:** Dexmedetomidine as an adjuvant to bupivacaine-lignocaine combination in supraclavicular brachial plexus block significantly improves block characteristics and postoperative analgesia without increasing adverse events. Integration of dexmedetomidine into perioperative pain management protocols may enhance outcomes in upper limb surgeries.

Keywords: dexmedetomidine, brachial plexus block, regional anesthesia, upper limb surgery, postoperative analgesia.

INTRODUCTION

Regional anesthesia techniques, such as the supraclavicular brachial plexus block, play a crucial role in modern anesthetic practice, offering effective pain relief and minimizing systemic opioid use in upper limb surgeries.[1] Among the various regional anesthesia modalities, the combination of local anesthetics with adjuvants has gained considerable attention for its potential to enhance block

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characteristics, prolong duration, and improve postoperative analgesia.[1, 2]

Dexmedetomidine, a highly selective alpha-2 adrenergic agonist, has emerged as a promising adjuvant in regional anesthesia due to its sedative, analgesic, and sympatholytic properties. When used as an adjunct to local anesthetics, dexmedetomidine has demonstrated dose-dependent prolongation of sensory and motor block duration, along with a reduction in postoperative analgesic requirements and opioid-related side effects.[3, 4]

The supraclavicular approach to brachial plexus block offers several advantages, including reliable block success rates, ease of performance, and a lower risk of phrenic nerve blockade than other techniques.[1] However, achieving optimal block characteristics with a single injection can be challenging, particularly in longer surgical procedures.[3]

In the pursuit of refining regional anesthesia techniques and improving perioperative outcomes, the present study aims to investigate the comparative efficacy and safety of adding dexmedetomidine as an adjuvant to the bupivacaine-lignocaine combination versus using plain bupivacaine-lignocaine combination alone in supraclavicular brachial plexus block. By assessing parameters such as block onset time, duration, sensory and motor block quality, hemodynamic stability, postoperative analgesic consumption, and patient satisfaction, this study provides valuable insights into dexmedetomidine augmentation's potential benefits in upper limb surgeries. The chosen dose of dexmedetomidine was 1 microgram per kilogram, a commonly used dose in similar studies. The findings of this research endeavor aim to contribute to the optimization of perioperative pain management strategies and ultimately enhance the quality of patient care in upper limb surgeries.

MATERIALS AND METHODS

This study was designed as a prospective, randomized, double-blind, comparative trial conducted at RKDF Medical College Hospital and Research Centre, Bhopal, Madhya Pradesh, India, from April 2023 to March 2024.

Ethical Considerations

Ethical approval for the study protocol was obtained from the Institutional Ethics Committee of RKDF Medical College Hospital and Research Centre prior to the commencement of the study. After explaining the nature and purpose of the study, potential risks, and benefits, informed consent was obtained from all participants.

Study Population

Patients aged 18 to 65 years undergoing elective forearm and hand surgeries under supraclavicular brachial plexus block were eligible for inclusion in the study. Patients with contraindications to regional anesthesia, known allergies to study medications, preexisting neurological deficits, coagulopathy, or psychiatric disorders were excluded.

Sample Size Calculation

A sample size of 60 patients was calculated using a power analysis with an estimated effect size of 0.5, alpha error of 0.05, and power of 80%. Patients were randomized into two groups using computer-generated random numbers to receive either the bupivacaine-lignocaine combination with dexmedetomidine (Group D) or the plain bupivacaine-lignocaine combination (Group C).

Intervention

Patients in Group Dwas given 15ml of 0.5% bupivacaine + 10ml of 2% Lignocaine + 1 μg/kg of dexmedetomidine diluted with normal Saline to make total volume 30 ml.Patients in Group C will receive 15ml of 0.5% Bupivacaine + 10ml of 2% Lignocaine + 5 ml Normal Saline.Both patients and the attending anesthesiologist responsible for perioperative management were blinded to the group allocation. Dexmedetomidine and normal saline were prepared by an independent anesthesiologist not involved in patient care, ensuring double-blinding.

Outcome Measures

The primary outcome measures included the onset time of sensory and motor blockade, duration of sensory and motor blockade, and postoperative analgesic consumption. Secondary outcome measures comprised hemodynamic parameters (heart rate, systolic and diastolic blood pressure), sedation scores, adverse events (hypotension, bradycardia, respiratory depression), and patient satisfaction scores.

Data Collection and Statistical Analysis

Training research personnel collected and recorded data on demographic characteristics, surgical details, perioperative parameters, and outcome measures. As applicable, statistical analysis was performed using appropriate tests, including the independent t-test, Mann-Whitney U test, chi-square test, and Fisher's exact test. A p-value less than 0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics

Sixty patients scheduled for elective forearm and hand surgeries were enrolled in the study and randomized into two groups: Group D (n=30) receiving dexmedetomidine-adjuvanted bupivacaine-lignocaine combination, and Group C (n=30) receiving plain bupivacaine-lignocaine combination. The demographic and clinical characteristics of the study population were comparable between the two groups (Table 1).

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Table 1: Demographic and Clinical Characteristics

Characteristics	Group D	Group C	P value
Age (years), mean ± SD	42.5 ± 10.3	41.8 ± 9.7	0.778
Gender (Male/Female)	18/12	17/13	0.589
Body Mass Index (kg/m²)	24.9 ± 3.1	25.3 ± 2.8	0.982
ASA Physical Status (I/II)	22/8	23/7	0.884

Primary Outcome Measures

Onset Time of Sensory Block: The onset time of sensory block was significantly shorter in Group D compared to Group C (6.8 ± 1.2 minutes vs. 8.5 ± 1.4 minutes, $p < 0.001$).

Onset Time of Motor Block: Similarly, the onset time of motor block was significantly shorter in Group D compared to Group C (9.3 ± 1.5 minutes vs. 11.1 ± 1.7 minutes, $p < 0.001$).

Duration of Sensory Block: The duration of sensory block was significantly prolonged in Group D compared to Group C (12.4 ± 2.1 hours vs. 9.8 ± 1.8 hours, $p < 0.001$).

Duration of Motor Block: The duration of the motor block was also significantly prolonged in Group D compared to Group C (11.6 ± 2.0 hours vs. 9.1 ± 1.6 hours, $p < 0.001$).

Postoperative Analgesic Consumption: Patients in Group D required significantly lower postoperative analgesic consumption compared to Group C (mean ± SD: 35.2 ± 8.3 mg vs. 48.9 ± 10.6 mg of intravenous tramadol, $p < 0.001$).

Table 2: Comparison of Primary Outcome Measures

Outcome Measure	Group D	Group C	p-value
Onset Time of Sensory Block (minutes), mean ± SD	6.8 ± 1.2	8.5 ± 1.4	<0.001
Onset Time of Motor Block (minutes), mean ± SD	9.3 ± 1.5	11.1 ± 1.7	<0.001
Duration of Sensory Block (hours), mean ± SD	12.4 ± 2.1	9.8 ± 1.8	<0.001
Duration of Motor Block (hours), mean ± SD	11.6 ± 2.0	9.1 ± 1.6	<0.001
Postoperative Analgesic Consumption (mg), mean ± SD	35.2 ± 8.3	48.9 ± 10.6	<0.001

There were no significant differences in heart rate, systolic blood pressure, and diastolic blood pressure between the two groups at various time points intraoperatively and postoperatively ($p > 0.05$). Sedation scores were similar between Group D and Group C throughout the perioperative period, with no significant differences observed ($p > 0.05$). The incidence of adverse events such as hypotension, bradycardia, and respiratory depression was comparable between the two groups and did not reach statistical significance ($p > 0.05$).

DISCUSSION

Regional anesthesia techniques, such as the supraclavicular brachial plexus block, are integral components of modern anesthesia practice, offering effective pain relief and minimizing systemic opioid use in upper limb surgeries. In this study, we evaluated the efficacy and safety of dexmedetomidine as an adjuvant to the bupivacaine-lignocaine combination compared to plain bupivacaine-lignocaine combination alone in supraclavicular brachial plexus block for patients undergoing forearm and hand surgeries.

Our findings indicate that the addition of dexmedetomidine to the local anesthetic mixture significantly improved various aspects of block characteristics and postoperative analgesia. Specifically, we observed a shorter onset time of sensory and motor block, prolonged duration of sensory and motor blockade, and reduced postoperative analgesic consumption in the dexmedetomidine group compared to the plain bupivacaine-lignocaine group. These results are consistent with previous studies demonstrating the beneficial effects of dexmedetomidine as an adjuvant in regional anesthesia.

The shorter onset time of sensory and motor block observed in the dexmedetomidine group can be attributed to the potentiation of local anesthetic action by dexmedetomidine through its alpha-2 adrenergic agonist activity. This mechanism of action has been described in various studies, including those by Abdallah et al.[1] and Abdallah and Brull[2].

Moreover, our study's prolonged sensory and motor blockade duration corroborates findings from previous investigations evaluating dexmedetomidine's effects on peripheral nerve blocks. Studies by Esmaoglu et al.[3]and Marhofer et al.[4] have reported similar prolongation of block duration with dexmedetomidine augmentation, highlighting its potential to enhance the efficacy of regional anesthesia techniques.

The reduction in postoperative analgesic consumption observed in the dexmedetomidine group is consistent with the analgesic-sparing effects of dexmedetomidine reported in several studies. By attenuating nociceptive input and enhancing the descending inhibitory pathways, dexmedetomidine provides effective postoperative pain relief with a reduced need for opioids, thus minimizing opioid-related adverse effects and facilitating early ambulation and recovery. This is in line with the findings of Memiş et al.[5] and Gupta et al. 6 studies.

Despite the favorable effects of dexmedetomidine augmentation observed in our study, it is essential to consider the potential risks associated with its use,

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including hemodynamic instability (hypotension, bradycardia), respiratory depression, and sedation. However, our study did not observe a significant increase in adverse events between the dexmedetomidine group and the plain bupivacaine-lignocaine group, which is consistent with the safety profile reported in previous literature. This aligns with the findings of studies by Brummett et al.[7]and Chakraborty et al[8].

One limitation of our study is the relatively small sample size, which may limit the generalizability of our findings. The study duration was limited to one year, and longer-term outcomes were not assessed. Future research with larger sample sizes and longer follow-up periods is warranted to validate our study's findings further and elucidate the optimal dosing and administration regimen for dexmedetomidine in regional anesthesia.

CONCLUSION

Our study demonstrates that dexmedetomidine as an adjuvant to the bupivacaine-lignocaine combination in supraclavicular brachial plexus block offers significant advantages in terms of block characteristics and postoperative analgesia compared to plain bupivacaine-lignocaine combination alone. These findings support the integration of dexmedetomidine into perioperative pain management protocols for upper limb surgeries, potentially leading to improved patient outcomes and enhanced satisfaction.

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