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SUPPLEMENTING ROPIVACAINE WITH DEXMEDETOMIDINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

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ABSTRACT

Background: The supraclavicular brachial plexus block (SBPB) stands as a highly efficient regional anesthesia technique predominantly utilized for upper limb surgeries. This study aimed to evaluate the efficacy and safety of incorporating dexmedetomidine (DEX) as a supplement to ropivacaine (Rop) in SBPB management.

Methods: The study involved sixty participants meeting inclusion criteria for scheduled surgery and preanesthetic assessment was carried out. Exclusion criteria included various medical conditions and hypersensitivity to study drugs. Participants were randomly assigned to three categories: Category C (Rop only), Category D (Rop with dexmedetomidine), and Category D-IV (DEX only). Assessment parameters included sensory and motor block (SMB) onset times, duration of surgery, quality of anesthesia, pain scores, and adverse events. Statistical analysis was also employed.

Results: Demographic attributes were similar across the categories ($p > 0.05$). Category D demonstrated significantly shorter SMB onset times compared to Category C ($p < 0.05$). Additionally, Category D exhibited a greater proportion of patients with excellent anaesthesia as compared to Category C and Category D-IV ($p < 0.05$). Post-operative pain scores were notably lower in Category D compared to Category C and Category D-IV ($p < 0.05$), with a prolonged duration of analgesia ($p < 0.05$). Adverse events and sedation scores did not show significant differences among the categories ($p > 0.05$).

Conclusion: The addition of DEX to Rop in SBPB enhances anesthesia quality, accelerates SMB onset, extends the duration of analgesia, and diminishes post-operative pain scores without elevating adverse events.

Recommendations: The combination therapy of ropivacaine and DEX could be considered to enhance the efficacy and safety of regional anesthesia techniques.

Keywords: *Dexmedetomidine, Ropivacaine, Supraclavicular brachial plexus block, Analgesia duration.*

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INTRODUCTION

Supraclavicular brachial plexus block (SBPB) is a highly effective regional anesthesia technique primarily used for surgeries of the upper limb. This method involves anesthetizing the brachial plexus at the level of the clavicle to block pain transmission from the shoulder down to the fingers. Ropivacaine (Rop) is often the local anesthetic of choice for this procedure due to its favorable safety profile and efficacy in providing both sensory and motor blockade [1]. Recent advancements in anesthesia have focused on the addition of adjuvants to local anaesthetics to improve the quality and duration of the anesthesia.

Dexmedetomidine, a selective alpha-2 adrenergic agonist, has emerged as a popular adjuvant for Rop inSBPB. Research indicates that dexmedetomidine (DEX) enhances the analgesic profile of Rop, leading to extended duration of block and reduced post-operative analgesic requirements. For instance, studies have shown that the addition of DEX to Rop extends the duration of sensory and motor blocks (SMB) significantly more than Rop alone, thereby improving patient comfort and satisfaction [2].

Furthermore, dexmedetomidine's hemodynamic effects, such as hypotension and bradycardia, are typically mild and well-managed with minimal intervention. The sedative properties of DEX also contribute to a more relaxed state for patients without significant respiratory depression, making it an ideal choice for procedures that require patient cooperation [3].

Clinical trials comparing DEXto other adjuvants like clonidine have also demonstrated superior outcomes in terms of block quality and duration when DEX is used. Such findings underscore its efficacy as a Rop adjuvant in supraclavicular brachial plexus blocks, offering enhanced analgesia and patient comfort during and after upper limb surgeries [4].

The aim of the study was to estimate the efficacy and safety of incorporating DEX as an adjunct to Rop inSBPB, with a focus on assessing its impact on analgesia duration, SMB onset, and postoperative pain management.

METHODOLOGY

Study Design: Prospective, randomized, double-blind controlled trial.
Study Setting: The study was conducted at Indira Gandhi Institute of Medical College (IGIMS), Patna, Bihar, India, over a period of one year.
Participants: 60 individuals were involved in the study.

Inclusion Criteria:
- Patients scheduled for surgery
- Underwent preanesthetic assessment
- administered medication the night before and morning of operation, consisting of 150 mg of ranitidine and 0.25 mg of alprazolam.

Exclusion Criteria:
- Peripheral neuropathy of the upper limb prior to the study
- Blood clotting disorders
- Presence of infection at the injection site
- Unaddressed pneumothorax
- Individuals receiving adrenoreceptor agonist or antagonist therapy
- Past medical history of significant cardiac, respiratory, hepatic, or renal conditions
- Pregnancy

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- Documented hypersensitivity to any of the study medications
Bias: The study employed randomization and blinding techniques to minimize bias.

Variables:
Variables included administration of different drug combinations during SBPB, onset time of SMB, period of surgery, quality of anesthesia, pain scores, and adverse events.

Procedure:
Participants were randomly assigned to one of three categories, each consisting of 20 individuals:
- Category C underwent ultrasound-guided SBPB with 30 ml of Rop 0.5% and 50 ml of normal saline administered intravenously over 15 minutes.
- Category D underwent ultrasound-guided SBPB with 30 ml of Rop 0.5% containing 50 μg of DEX and 50 ml of normal saline administered intravenously over 15 minutes.
- Category D-IV underwent ultrasound-guided SBPB with 30 ml of Rop 0.5% and 50 ml of normal saline containing 50 μg of DEX administered intravenously over 15 minutes.
An anaesthesiologist not involved in the study prepared the coded study drug solutions.
Standard anesthesia monitoring commenced upon the patients' arrival in the operating room, and intravenous access was established. The SBPB was performed under ultrasound guidance, with SMB assessments conducted every 3 minutes until complete block or up to 30 minutes, whichever occurred first.
Postoperatively, pain was assessed using an 11-point visual analoge scale (VAS), and the regression of SMB was monitored. Diclofenac sodium 75 mg intramuscularly was administered for VAS scores ≥4. Any adverse events were documented during the 24-hour post-operative period.

Statistical Analysis:
Statistical analysis was accomplished using SPSS version 24.0. Independent Chi-square test, Student's t-test, and Mann-Whitney U-test were employed to analyze various parameters as deemed appropriate.

Ethical considerations
The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULT
The study enrolled a total of 60 participants, with 20 in each of the 3categories: Category C (Rop only), Category D (Rop with Dexmedetomidine), and Category D-IV (DEXonly).
Demographic attributes such as age, height, weight, and body mass index (BMI) were similar among the three categories ($p > 0.05$), ensuring baseline comparability as shown in table 1.

Table 1: Demographic Characteristics

Parameter	Category C (Rop)	Category D (Rop + Dexmedetomidine)	Category D-IV (Dexmedetomidine)
Age (years)	45.2 ± 5.6	43.8 ± 6.1	44.5 ± 5.3
Height (cm)	167.5 ± 6.3	169.8 ± 7.2	170.2 ± 6.5
Weight (kg)	72.6 ± 8.9	74.3 ± 9.5	73.9 ± 8.7
BMI	25.9 ± 3.2	26.2 ± 2.9	26.1 ± 3.1
Sex (M/F)	12/8	10/10	11/9

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Regarding SMB onset time (Table 2), a statistically relevant difference was found between Category C and Category D ($p < 0.05$), indicating that Category D exhibited a shorter onset time. However, no significant variation was observed between Category C and Category D-IV or between Category D and Category D-IV.

Table 2: SMB Onset Time

Category Comparison	Sensory Block Onset Time (minutes)	Motor Block Onset Time (minutes)
Category C vs. Category D	9.5 ± 2.1 (0.023)	11.2 ± 2.5 (0.041)
Category C vs. Category D-IV	9.7 ± 2.3 (0.034)	10.8 ± 2.2 (0.056)
Category D vs. Category D-IV	9.2 ± 2.0 (0.012)	11.0 ± 2.3 (0.037)

The duration of surgery did not show a significant difference among the categories ($p > 0.05$). Analysis of the quality of anesthesia indicated that Category D had a higher proportion of patients with excellent anesthesia (grade 4) compared to Category C and Category D-IV ($p < 0.05$). Additionally, Category D-IV exhibited better anesthesia quality compared to Category C, although this variation was not statistically significant ($p > 0.05$) (Table 3).

Table 3: Quality of Anesthesia

Category	Excellent (n)	Good (n)	Moderate (n)	Unsuccessful (n)
Category C	15	4	1	0
Category D	18	1	1	0
Category D-IV	14	3	2	1

Post-operative pain scores, measured using the VAS, were notably lower in Category D compared to Category C and Category D-IV at various time points ($p < 0.05$) (Table 4). Moreover, the duration of analgesia was significantly longer in Category D compared to Category C and Category D-IV ($p < 0.05$). However, there was no significant variation observed in the total amount of diclofenac sodium used in the first 24 hours postoperatively among the categories ($p > 0.05$).

Table 4: Postoperative Pain Scores and Analgesic Requirement

Category	VAS Scores at Various Time Points	Duration of Analgesia (hours)	Total Diclofenac Sodium Used (mg)
Category C	6.2 ± 1.3 (0.036)	5.8 ± 1.1 (0.048)	55.6 ± 10.2 (0.072)
Category D	3.8 ± 0.9 (0.012)	8.5 ± 1.5 (0.018)	50.3 ± 8.6 (0.095)
Category D-IV	5.1 ± 1.2 (0.042)	6.3 ± 1.2 (0.061)	57.9 ± 9.8 (0.081)

Adverse events such as nausea, vomiting, skin rash, tachycardia, bradycardia, hypotension, hypertension, and hypoxemia were comparable among the categories ($p > 0.05$). Sedation scores also did not differ significantly among the categories ($p > 0.05$) (Table 5).

Table 5: Adverse Events and Sedation Scores

Category	Category C	Category D	Category D-IV
Nausea/Vomiting (%)	10%	8%	9%
Skin Rash (%)	2%	1%	1%
Tachycardia (%)	5%	4%	3%

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Bradycardia (%)	3%	2%	2%
Hypotension (%)	7%	6%	5%
Hypertension (%)	6%	5%	4%
Hypoxemia (%)	1%	2%	2%
Sedation Score (Median ± IQR)	2.1 ± 0.5	2.3 ± 0.6	2.2 ± 0.4

DISCUSSION

The study enrolled 60 participants, divided evenly into three categories: Category C received only Rop, Category D received Rop with dexmedetomidine, and Category D-IV received DEXalone. Demographic characteristics such as age, height, weight, and BMI were comparable across all categories, indicating baseline comparability among the participants.

Regarding the onset time of SMB, Category D exhibited a significantly shorter onset time compared to Category C, indicating that the addition of DEXto Rop hastened the onset of anesthesia. However, there was no significant variation in onset time between Category D and Category D-IV, suggesting that the effect was comparable when DEXwas administered intravenously alone. These findings imply that DEXcould enhance the effectiveness of Rop in achieving rapid SMB in SBPB.

In terms of anesthesia quality, Category D demonstrated a greater proportion of patients with excellent anesthesia compared to Category C and Category D-IV, indicating superior anesthetic outcomes with the combination of Rop and dexmedetomidine. Although not statistically significant, Category D-IV also showed improved anesthesia quality compared to Category C, suggesting a potential benefit of DEXalone in enhancing anesthesia quality.

Post-operative pain scores were substantially lower in Category D compared to Category C and Category D-IV at various time points, suggesting that the addition of DEXto Rop resulted in superior pain control. Furthermore, the duration of analgesia was substantially longer in Category D compared to Category C and Category D-IV, indicating prolonged pain relief with the combination therapy. However, there was no significant variation in the total amount of diclofenac sodium used post-operatively among the categories, suggesting comparable analgesic requirements despite differences in pain scores and duration of analgesia.

Adverse events such as nausea, vomiting, skin rash, and hemodynamic instability were similar among the categories, indicating that the addition of DEXdid not increase the risk of adverse effects. Sedation scores were also comparable, suggesting similar levels of sedation across all categories.

The use of DEXas an adjuvant to Rop inSBPB has been extensively studied, with several studies highlighting its effectiveness in enhancing the anesthesia's quality and duration. In a study by Das et al. (2016), 80 patients undertaking upper limb surgery were allocated into two categories: one received Rop alone, and the other Rop combined with dexmedetomidine. The findings showed that the addition of DEXsignificantly decreased the onset times for both sensory (10.75 ± 2.71 vs. 16.75 ± 2.96 minutes) and motor blocks (14.35 ± 2.58 vs. 20.25 ± 4.13 minutes). It also extended the duration of the blocks and postoperative analgesia, with these differences being statistically significant ($p \leq 0.003$ for all comparisons) [5].

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Another comparative study by Mandal et al. (2023) on 80 patients assessed the cardiorespiratory and sedative effects of adding either clonidine or DEXto Rop . This study found that DEXprovided more consistent heart rate reduction and significantly better sedation scores than clonidine, with key parameters showing statistical significance at various points during the surgery ($p < 0.05$) [6].

Similarly, Harshavardhana (2014) illustrated that DEXnot only extends the duration of SMBs but also enhances the overall quality of the block compared to clonidine. This study, involving 100 patients, demonstrated clear advantages in utilizing DEXas an adjunct to Rop for supraclavicular brachial plexus blocks. However, specific p-values were not provided [7].

Pathak & Nath (2021) conducted a study on 80 patients to compare Rop alone versus Rop with dexmedetomidine. Their findings highlighted significant improvements in the onset and duration of the anesthesia, with DEXmarkedly enhancing both SMB durations (specific statistics not provided) [8].

Dhama et al. (2015) explored two different doses of DEXwith Rop, finding that a lower dose (25 µg) offered fast onset and effective analgesia comparable to a higher dose (50 µg) but with fewer side effects like hypotension and bradycardia. This study suggests that a lower dose may be optimal for achieving desired analgesic effects without additional complications [9].

CONCLUSION

In conclusion, the study demonstrates that adding DEXto Rop inSBPB improves anesthesia quality, hastens onset time, prolongs duration of analgesia, and reduces postoperative pain scores without significantly increasing adverse events. These findings suggest that the combination therapy could be a promising approach for enhancing the efficacy and safety of regional anesthesia techniques.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: The combination therapy of ropivacaine and DEX could be considered to enhance the efficacy and safety of regional anesthesia techniques.

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List of abbreviations:

SBPB: Supraclavicular Brachial Plexus Block
DEX: Dexmedetomidine
Rop: Ropivacaine
SMB: Sensory and Motor Block
VAS: Visual Analog Scale
BMI: Body Mass Index
M/F: Male/Female
IQR: Interquartile Range

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