Section: Anaesthesiology

Original Research Article

STUDY OF DEXMEDETOMIDINE AND CLONIDINE AS AN ADJUVANT TO ROPIVACAINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB ORTHOPAEDIC SURGERIES IN TERTIARY CARE HOSPITAL: A RANDOMISED CLINICAL TRIAL

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ABSTRACT

Background: Supraclavicular brachial plexus block is a widely used regional anesthesia technique for upper limb surgeries due to its rapid onset and dense blockade. Adding adjuvants like dexmedetomidine or clonidine to local anesthetics enhances block quality and prolongs postoperative analgesia. The present study aimed to compare dexmedetomidine and clonidine as adjuvants to ropivacaine in supraclavicular brachial plexus block for upper limb orthopedic surgeries. **Materials and Methods:** A prospective, randomized, single-blinded trial was conducted on 90 ASA I and II patients aged 18–60 years undergoing upper limb surgeries. Patients were divided into two groups: Group D received 0.5% ropivacaine with dexmedetomidine (1 µg/kg), and Group C received 0.5% ropivacaine with clonidine (1 µg/kg). Supraclavicular brachial plexus block was administered under nerve stimulator guidance. Sensory and motor block characteristics, duration of analgesia, need for rescue analgesia, and hemodynamic parameters were assessed. Statistical analysis was performed using SPSS 24.0. **Result:** Both the groups were comparable demographically. Group D showed significantly faster onset of sensory (8.74 ± 1.38 min) and motor (8.52 ± 1.18 min) blocks compared to Group C (11.26 ± 1.09 min and 11.89 ± 13.30 min, respectively; $p<0.05$). Duration of sensory and motor blocks was also significantly longer in Group D (468.89 ± 37.55 min and 414.89 ± 32.10 min) than in Group C (339.78 ± 34.54 min and 312.67 ± 30.26 min; $p<0.0001$). Group D required significantly less rescue analgesia. Hemodynamic parameters and oxygen saturation were more stable in Group D throughout the perioperative period. **Conclusion:** Dexmedetomidine, as an adjuvant to ropivacaine, provided earlier onset, prolonged duration of anesthesia, better postoperative analgesia, and greater hemodynamic stability than clonidine in supraclavicular brachial plexus blocks for upper limb surgeries.

INTRODUCTION

Upper limb surgeries can be performed using general or regional anesthesia. Nowadays regional anesthesia is increasingly preferred due to its ability to provide effective surgical anesthesia, muscle relaxation, stable hemodynamics, and prolonged postoperative pain relief. It also helps reduce vasospasm through sympathetic blockade and offers benefits such as less sedation, reduced nausea and vomiting, quicker recovery, and smoother transition to postoperative analgesia.[1] Among regional techniques, the brachial plexus block especially the supraclavicular approach is widely used, offering rapid onset, dense, and predictable anesthesia by targeting the nerve supply of the upper extremity at the level of the brachial plexus trunks.[2]

Long-acting local anaesthetics have advantage of longer duration of block and prolonged postoperative analgesia to help reduce postoperative analgesic

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requirement. Ropivacaine, one of the newer long-acting amide local anaesthetics, is the stereo isomer of bupivacaine and has been shown in to be less toxic than bupivacaine when injected intravenously.[3] The addition of an adjuvant to ropivacaine can further have the advantage of prolonging the duration of block and postoperative analgesia as well as decrease the dose of ropivacaine required.[4] Various adjuvants like morphine, fentanyl, sufentanil, dexamethasone, midazolam, ketamine, neostigmine, sodium bicarbonate are added to local anaesthetic agents during regional anaesthesia. Recently, α2-adrenergic receptor agonists like clonidine and dexmedetomidine have gained attention as adjuvants due to their sedative, analgesic, sympatholytic, and cardiovascular stabilizing effects. When combined with local anesthetics, these agents can enhance block quality by prolonging analgesia, likely through local vasoconstriction, C-fiber blockade, or central actions via axonal transport or diffusion along the nerve.[5]

Clonidine, an α2-adrenergic receptor agonist, has potent central and peripheral antinociceptive properties. Alpha 2 adrenoceptors are located on primary afferent terminals implicated in analgesia. It supports the analgesic action at peripheral sites.[6]

Dexmedetomidine, the next recent highly potent alpha-2 agonist, is also a sedative, anxiolytic and analgesic similar to clonidine. The peculiar features of dexmedetomidine are its high selectivity for alpha-2 receptors and its ability to produce sedation and analgesia while still maintaining patient arousability and respiratory function. Animal and human studies have shown safety and efficacy of adding dexmedetomidine to local anaesthetics in various regional anaesthetic procedures, such as subarachnoid, epidural, and caudal injections, yet other investigations have reported reduced or negative analgesic effects when using dexmedetomidine.[7,8]

So, the present randomised controlled trial has been undertaken in order to assess and compare the analgesic effect between dexmedetomidine and clonidine as an adjuvant to ropivacaine in supraclavicular brachial plexus block for upper limb orthopaedic surgeries.

MATERIALS AND METHODS

After obtaining Institutional ethical committee approval and written informed consent from all the patients, this prospective, randomized, single blinded trial was conducted in the Department of Anesthesiology at Tertiary care hospital during a period of one and half year from 1st Jan 2019 - 30 June 2020. A total 90 patients of either sex, age between 18 to 60 years, ASA grade I and II who were posted for upper extremity orthopaedic surgeries were included in the study. Patients with ASA grade III or IV, those who refused participation, individuals with coagulopathy or on anticoagulant therapy, central or peripheral neuropathies, local skin infections at the injection site, pregnant or lactating women, patients with known hypersensitivity to study drugs, those with severe cardiopulmonary disorders, pneumothorax, chest injuries, phrenic nerve block, or diagnosed personality disorders were excluded from the study.

Selected patients were randomly divided into two groups as odd & even according to their number while inclusion in the study. The two groups were:

- Group D: Dexmedetomidine 1μg/kg added to ropivacaine 0.5% (all odd no. patient)
- Group C: Clonidine 1μg/kg added to ropivacaine 0.5% (all even no. patient)

The preoperative investigations included hemoglobin percentage (Hb%), total count (TC), differential count (DC), bleeding time (BT), and clotting time (CT), along with urine routine examination. Blood sugar levels (RBS), blood urea, and serum creatinine were assessed. Additional tests included chest X-ray, electrocardiogram (ECG), and screening for HIV and HBsAg to rule out infectious risks. Intravenous access was secured using a 20-gauge IV cannula on the contralateral upper limb under strict aseptic precautions.

Intraoperative monitoring was performed using a multipara monitor along with non-invasive blood pressure monitoring using a sphygmomanometer placed on the contralateral upper limb. The patient was positioned supine with arms by the side and head turned slightly to the opposite side. Following aseptic preparation, the interscalene groove and mid-point of the clavicle were identified. A skin wheal was raised 1.5 to 2.0 cm cephaloposterior to the mid-clavicular point near the subclavian artery pulsation. A 22G, 5 cm needle attached to a 20 ml syringe was inserted at this site, directed caudad, slightly medial and posterior, until paraesthesia was elicited or the first rib was contacted. If the rib was encountered first, the needle was redirected over it until paraesthesia occurred in the hand or arm. After confirming negative aspiration for blood, the study drug was injected. Patients were monitored for 24 hours postoperatively. Sensory block was assessed using spirit-soaked cotton over C4 to T2 dermatomes, while motor block was evaluated by the patient's ability to adduct the shoulder and flex the forearm against gravity.

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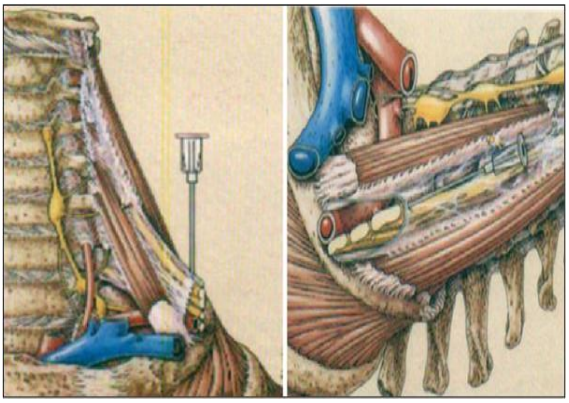

Figure 1: Needle entry in relation to subclavian artery

Patients on adrenoreceptor agonists or antagonists, those with known hypersensitivity to local anesthetics, bleeding disorders, uncontrolled diabetes, pre-existing peripheral neuropathy, or who were pregnant were excluded from the study. A thorough preoperative evaluation and routine investigations were conducted, and patients were kept nil per oral for 6–8 hours before surgery. Informed written consent was obtained after explaining the procedure. Premedication included IV ranitidine (0.25 mg/kg) and ondansetron (0.1 mg/kg). On entering the operation theatre, standard monitors were applied (HR, NIBP, SpO_2, ECG) and baseline vitals recorded. An IV line was secured in the unaffected limb and Ringer's lactate infusion started. All patients received a supraclavicular brachial plexus block administered by an experienced anesthesiologist, different from the assessor, ensuring a double-blinded design. Neural localization was achieved using a nerve stimulator with a 22G, 50 mm Stimuplex needle. Following negative aspiration, 20 mL of 0.5% ropivacaine combined with either dexmedetomidine or clonidine was injected, followed by a 3-minute massage to aid drug distribution. Sensory block was assessed every minute using the pinprick method in dermatomes corresponding to the median, radial, ulnar, and musculocutaneous nerves. Onset of sensory block was defined as the appearance of dull sensation to pinprick in any of the mentioned nerve distributions. Sensory block was graded as follows: Grade 0 – sharp pinprick sensation felt; Grade 1 – dull sensation indicating analgesia; and Grade 2 – no sensation, indicating complete anesthesia. Motor block was assessed by the same observer every minute after drug injection until complete blockade was achieved. The onset of motor block was defined as achieving Grade 1, while peak motor block corresponded to Grade 2, based on a modified Bromage scale for the upper extremity: Grade 0 – full flexion and extension of the elbow, wrist, and fingers; Grade 1 – decreased motor strength with finger movement only; and Grade 2 – complete motor block with no finger movement. The block was considered incomplete if any nerve (median, radial, ulnar, or musculocutaneous) remained unanesthetized after 30 minutes; such patients were supplemented with intravenous fentanyl (1 µg/kg) and midazolam (0.02 mg/kg). If more than one nerve remained unaffected, the block was considered failed and general anesthesia was administered. Hemodynamic parameters, including heart rate, blood pressure, and oxygen saturation, were monitored every 30 minutes intraoperatively and hourly postoperatively.

Sedation of the patients was assessed using the Ramsay Sedation Score. At the end of the procedure, the quality of operative conditions was evaluated using a numeric scale: Grade 4 (Excellent) – no complaint from the patient; Grade 3 (Good) – minor complaint with no need for supplemental analgesics; Grade 2 (Moderate) – complaints requiring supplemental analgesia; and Grade 1 (Unsuccessful) – general anesthesia administered. Intraoperative and postoperative assessments were conducted by an anesthesiologist blinded to the drug used. Postoperative pain was assessed using a Numeric Rating Scale (NRS) from 0 to 10, recorded every 60 minutes until a score of 5 was reached. Rescue analgesia in the form of intramuscular diclofenac sodium (1.5 mg/kg) was administered at an NRS of 5, and the time of administration was noted. All patients were monitored for side effects such as nausea, vomiting, dry mouth, and complications including pneumothorax, hematoma, local anesthetic toxicity, and post-block neuropathy during the intra- and postoperative periods. The duration of sensory block was defined as the time from completion of local anesthetic administration to the return of full sensation in all nerve distributions. The duration of motor block was defined as the time from drug administration to the full recovery of motor function in the hand and forearm.

Statistical Analysis

Statistical analysis was carried out using data collected through a structured proforma, which was entered into MS Excel and analyzed using SPSS version 24.0 (IBM, USA). Qualitative data were expressed as percentages and proportions, while quantitative data were presented as mean and standard deviation. The association between qualitative variables was analyzed using the Chi-square or Fisher's exact test. Paired t-test was used to compare mean values within the same group, and unpaired t-test was used for comparison between two groups. One-way ANOVA was applied for comparisons among multiple groups. Descriptive statistics included mean, standard deviation, and standard error of mean. A p-value <0.05 was considered statistically significant, and p-value <0.001 was considered highly significant.

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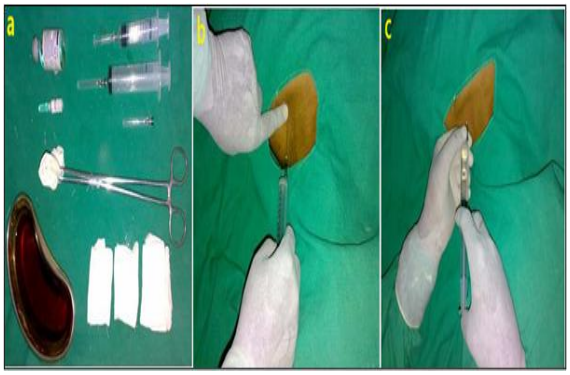

Figure 2: a) Sterile tray containing drugs and equipments; b) Needle entry 1 cm cephalo-posterior to subclavian artery pulsation; c) Test drug injected after negative aspiration for blood

RESULTS

[Table 1] shows the demographic profile of patients in both groups. Most patients in both groups were in the 31–40 years age group, with 26.7% in Group C and 42.2% in Group D. Group D had a higher proportion of females (77.8%) compared to Group C (60%). In terms of ASA classification, more patients in Group D were ASA I (77.8%) compared to Group C (53.3%). The mean age of patients in Group C was 40.04 ± 13.34 years, and in Group D, it was 37.24 ± 10.93 years. This difference was not statistically significant (p=0.279). The mean duration of surgery was 82 ± 16.87 minutes in Group C and 75.33 ± 17.40 minutes in Group D, (p=0.068).

The onset of both sensory and motor blocks was significantly faster in Group D (8.74 ± 1.38 minutes and 8.52 ± 1.18 minutes, respectively) compared to Group C (11.26 ± 1.09 minutes and 11.89 ± 13.30 minutes), with p-values of 0.0001 and 0.04. The duration of both sensory and motor blocks was significantly longer in Group D (468.89 ± 37.55 minutes and 414.89 ± 32.10 minutes, respectively) than in Group C (339.78 ± 34.54 minutes and 312.67 ± 30.26 minutes), with highly significant p-values (0.0001), [Table 2].

Additionally, the need for rescue analgesia was significantly less in Group D (1.07 ± 0.25) compared to Group C (2.02 ± 0.58), also with a highly significant p-value (0.0001), [Table 2].

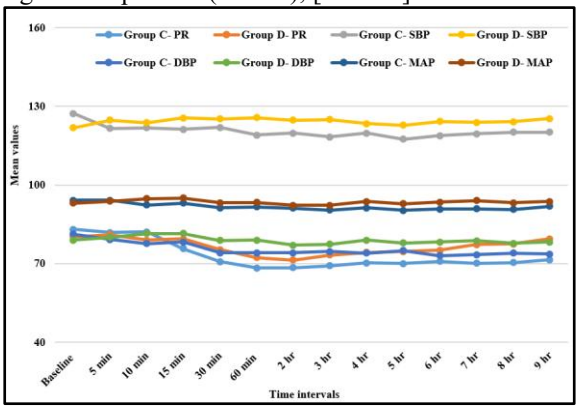

Figure 3: Comparison of hemodynamic parameters between Group C and Group D

When comparing haemodynamic parameters between the two groups, it was observed that from 10 minutes onwards till 9 hours, the mean pulse rate, diastolic blood pressure (DBP), and mean arterial pressure (MAP), and from 5 minutes onwards for systolic blood pressure (SBP), were significantly more stable and closer to normal values in Group D (Dexmedetomidine) compared to Group C (Clonidine), with all differences being statistically significant (p<0.05). This indicates better haemodynamic stability in the dexmedetomidine group, [Figure 3].

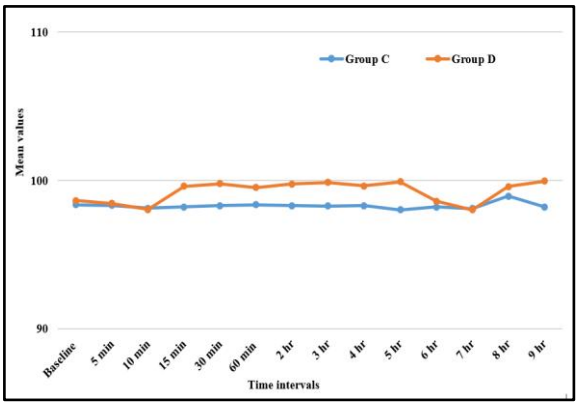

Figure 4: Comparison of SPO2 between Group C and Group D

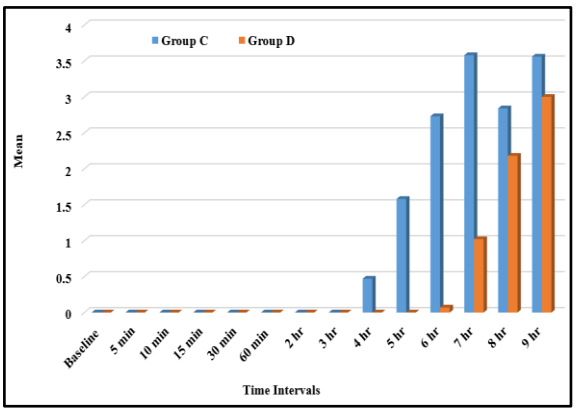

Figure 5: Comparison of VAS score between Group C and Group D

When compared mean SPO2 between two groups from 15 minutes onwards till 9 hours, the difference was found to be statistically significant (p<0.05). It means SPO2 was more in Group D as compared with Group C, [Figure 4].

When we compared mean VAS score between two groups from 4 hours onwards till 9 hours, the difference was found to be statistically significant (p<0.05). It means Vas score was more improved in Group D as compared with Group C, [Figure 5].

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Table 1: Demographic profile of the patients

Demographic profile		Group C	Group D
Age group in years	<20	04 (8.9%)	01 (2.2%)
	21-30	08 (17.8%)	13 (28.9%)
	31-40	12 (26.7%)	19 (42.2%)
	41-50	10 (22.2%)	06 (13.3%)
	51-60	09 (20.0%)	04 (8.9%)
	>60	02 (4.4%)	02 (4.4%)
Gender	Male	18 (40.0%)	10 (22.2%)
	Female	27 (60.0%)	35 (77.8%)
ASA type	I	24 (53.3%)	35 (77.8%)
	II	21 (46.7%)	10 (22.2%)

Table 2: Comparison of supraclavicular brachial plexus block characteristics and duration of rescue analgesia between Group C and Group D

Characteristics	Group C	Group D	P value
Sensory block onset	11.26 ± 1.09	8.74 ± 1.38	0.0001
Motor block onset	11.89 ± 13.30	8.52 ± 1.18	0.04
Sensory block duration	339.78 ± 34.54	468.89 ± 37.55	0.0001
Motor block duration	312.67 ± 30.26	414.89 ± 32.10	0.0001
Rescue Analgesia	2.02 ± 0.58	1.07 ± 0.25	0.0001

DISCUSSION

Brachial plexus blockade, particularly through the supraclavicular approach, remains a cornerstone technique in regional anesthesia, offering effective anesthesia and analgesia for upper limb surgeries while minimizing systemic effects, promoting early ambulation, and reducing hospital stays. Although long-acting local anesthetics like ropivacaine provide extended postoperative pain relief, their duration is often insufficient to completely avoid the need for opioids. In this context, various adjuvants have been investigated to prolong the analgesic effect and improve block quality. Our study compared clonidine and dexmedetomidine as adjuvants to ropivacaine in supraclavicular brachial plexus blocks.

In present randomized clinical trial involving 90 patients (45 in each group), we found no significant difference in demographic variables such as age and sex between the groups, ensuring comparability which is comparable with the previous studies.[9-12]

The onset of both sensory and motor blockades was significantly faster in the dexmedetomidine group (Group D) compared to the clonidine group (Group C). The mean onset time for sensory blockade in Group D was 8.74±1.38 minutes, while it was 11.26±1.09 minutes in Group C. Similarly, motor block onset occurred earlier in Group D (8.52±1.18 minutes) than in Group C (11.89±13.30 minutes), with both differences being statistically significant ($p<0.05$). These findings are consistent with previous studies by Kirubahar et al,[11] and Hosalli et al,[12] highlighting dexmedetomidine's faster onset properties.

Furthermore, the duration of sensory and motor blockade was significantly longer in the dexmedetomidine group. The mean duration of sensory block in Group D was 468.89±37.55 minutes versus 339.78±34.54 minutes in Group C. Similarly, motor block lasted 414.89±32.10 minutes in Group D compared to 312.67±30.26 minutes in Group C. These results comparable with the findings of Kirubahar et al,[11] Hosalli et al,[12] Swami SS et al,[13] and Tripathi A et al,[14] they also reported superior block duration and analgesia with dexmedetomidine. However, El-Hennawy et al,[15] reported no significant difference in block duration between dexmedetomidine and clonidine when used with bupivacaine in pediatric caudal blocks, suggesting that the clinical effects may vary based on patient population and technique.

The superior efficacy of dexmedetomidine can be attributed to its high α2-adrenergic receptor selectivity approximately eight times greater than clonidine leading to enhanced analgesic and sedative effects. The mechanisms of α2-agonist-mediated analgesia are both central and peripheral. Peripherally, they inhibit norepinephrine release and exert direct inhibitory effects on nerve conduction. Centrally, they act on the dorsal horn by suppressing substance P release and activating receptors in the locus coeruleus, enhancing sedation and analgesia.[16]

Additionally, haemodynamic parameters including SBP, DBP, MAP, pulse rate, and SpO_2 remained more stable in the dexmedetomidine group compared to the clonidine group, with statistically significant differences ($p<0.05$). This suggests a more favorable cardiovascular profile of dexmedetomidine during intraoperative and postoperative periods. These findings are in agreement with studies by Kirubahar et al,[11] and Hosalli et al,[12] supporting the better haemodynamic stability associated with dexmedetomidine.

Overall, our study demonstrates that dexmedetomidine is a more effective adjuvant to ropivacaine than clonidine in terms of faster onset, longer duration of sensory and motor block, better analgesia, and improved haemodynamic stability during supraclavicular brachial plexus block.

CONCLUSION

The present study concludes that dexmedetomidine, when used as an adjuvant to ropivacaine in

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supraclavicular brachial plexus block, provides significant advantages over clonidine. Patients in the dexmedetomidine group (Group D) experienced an earlier onset of both sensory and motor blockade, along with a significantly prolonged duration of anesthesia compared to the clonidine group (Group C). Additionally, the duration before requiring rescue analgesia was longer in Group D, indicating better and sustained postoperative pain relief. Furthermore, haemodynamic parameters remained more stable and closer to normal in Group D, demonstrating superior cardiovascular tolerance. Overall, dexmedetomidine proved to be a more effective and reliable adjuvant than clonidine for enhancing the quality and duration of regional anesthesia in upper limb orthopedic surgeries.

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