Research Article

Comparison of Efficacy of 0.75% Ropivacaine Along With Combination Of 0.75% Ropivacaine and Dexmeditomidine in Ultrasound Guided Axillary Brachial Plexus Block in Forearm and Hand Surgeries

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Abstract

Background: Axillary brachial plexus block is a widely utilized technique for upper limb surgeries, and the search for effective adjuvants to local anesthetics continues. Dexmedetomidine, an alpha-2 adrenergic agonist, has shown potential to enhance the quality of nerve blocks. This study aimed to compare the efficacy of Ropivacaine 0.75% with and without Dexmedetomidine in axillary brachial plexus blocks.

Methods: This prospective, randomized, comparative study enrolled patients undergoing upper limb surgery, who were allocated into two groups: Group A received Ropivacaine 0.75% with Dexmedetomidine, and Group B received Ropivacaine 0.75% alone. Demographic data, onset and duration of sensory and motor block, duration of analgesia, hemodynamic parameters, and complication rates were recorded and analyzed for statistical significance.

Results: Both groups were demographically comparable in terms of age, sex distribution, body weight, and ASA physical status, with no significant differences observed. Group A exhibited a significantly faster onset of sensory and motor block compared to Group B, and also demonstrated prolonged durations of both sensory and motor blockade. The duration of analgesia was notably extended in Group A. Hemodynamic variables, including systolic and diastolic blood pressure, mean arterial pressure, oxygen saturation, and heart rate, remained largely stable and comparable across groups, with only a transient statistically significant difference in heart rate at 10 minutes. Although minor complications were slightly more frequent in Group A, this difference was not statistically significant, and all adverse events were self limiting.

Conclusions: The addition of Dexmedetomidine to Ropivacaine 0.75% in axillary brachial plexus block significantly improves the onset and duration of sensory and 13motor blockade and enhances postoperative analgesia, without compromising hemodynamic stability. The minor increase in complication rate was not statistically significant and did not impact overall safety.

Keywords: Axillary brachial plexus block, Ropivacaine, Dexmedetomidine, Regional anesthesia, Peripheral nerve block, Postoperative analgesia, Block characteristics, Hemodynamic stability

INTRODUCTION:

Brachial plexus block is an important peripheral nerve block that provides ideal anesthesia and analgesia for upper-extremity surgeries. Compared with general anesthesia, it offers several advantages such as reduced opioid consumption, improved postoperative analgesia, shorter stay in the post-anesthesia care unit, and accelerated rehabilitation 1 . Among the various approaches, the supraclavicular and axillary routes are most commonly practiced. The axillary approach is widely regarded as one of the simplest and most consistent for surgeries below the elbow joint 2.

The use of ultrasound guidance has further improved the safety and efficacy of these blocks by enabling direct visualization of neural structures, surrounding tissues, and drug spread. Cochrane based systematic reviews have

confirmed that ultrasound-guided (USG) regional blocks provide superior postoperative analgesia, reduced complication rates, and faster recovery 3,4.

Various local anesthetics have been employed for brachial plexus blocks. Bupivacaine remains popular due to its potency and prolonged duration of action, but its use is limited by cardiotoxicity, particularly in cases of inadvertent intravascular injection 5 Ropivacaine, developed as a safer alternative, offers a comparable duration of action with lower lipid solubility and reduced cardiotoxic and neurotoxic potential 6 Nevertheless, the analgesic duration of ropivacaine alone may still be insufficient for extended postoperative pain relief.

To address this limitation, several adjuvants have been studied with the aim of shortening onset time, prolonging analgesia, and reducing total anesthetic requirements without adding systemic side effects. Among these, α2-adrenergic receptor agonists such as clonidine and dexmedetomidine have emerged as promising agents due to their sedative, analgesic, antihypertensive, and hemodynamic stabilizing properties 6-9 .

Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, exerts sedative effects via the locus coeruleus while providing additional analgesic benefits, reduced anesthetic requirements, and perioperative sympatholysis with cardiovascular stabilization 10,11,12 . Recent clinical studies have highlighted its role as an adjuvant in brachial plexus blocks. When combined with ropivacaine, dexmedetomidine has been shown to accelerate the onset of sensory and motor block, prolong the duration of anesthesia and analgesia, and reduce the requirement for rescue analgesics without significantly increasing adverse effects 13-16 Randomized controlled trials further demonstrate that dexmedetomidine enhances the efficacy of ropivacaine in both supraclavicular and axillary approaches, resulting in superior block quality and greater patient satisfaction compared with ropivacaine alone 16,17,18 Importantly, its hemodynamic and sedative effects are generally well tolerated, with a low incidence of clinically significant complications 19,20
Thus, the combination of ropivacaine with dexmedetomidine in USG-guided axillary brachial plexus block represents a promising strategy for forearm surgeries, offering quicker onset, prolonged analgesia, and improved postoperative outcomes compared with ropivacaine alone.

AIM:
Axillary brachial plexus block provides safe, effective anaesthesia with excellent postoperative analgesia. So an attempt was made to compare Ropivacaine 0.75% with dexmedetomidine as an adjuvant with Ropivacaine 0.75% alone in axillary brachial plexus block with respect to onset of sensory and motor block and duration of blockade. Duration of analgesia and side effects if any.

OBJECTIVES:
To evaluate and compare the effects of addition of dexmedetomidine with ropivacaine
for axillary brachial plexus block using ultrasound with reference to:

PRIMARY OBJECTIVE
a) Onset of sensory blockade.
b) Onset of motor blockade.
c) Duration of motor blockade.
d) Duration of analgesia.

SECONDARY OBJECTIVE
a) Hemodynamic parameters (pulse rate, blood pressure, SpO_2).
b) Complications if any.

MATERIALS AND METHODS

SOURCE OF DATA: Adult patients of both sexes aged between 18 and 55 years, with ASA Physical Status I and II, scheduled to undergo elective upper limb surgical procedures at Adichunchanagiri University of Health Sciences, were included in this study. The study was conducted from December 2023 to June 2025.

STUDY AREA: The study was conducted at the Department of Anaesthesiology, Adichunchanagiri University of Health Sciences, Karnataka, India.

STUDY PERIOD: The duration of the study was from December 2023 to June 2025.

STUDY POPULATION: The study population consisted of adult patients who were scheduled to undergo elective upper limb surgical procedures under ultrasound-guided axillary brachial plexus block.

INCLUSION CRITERIA

- Adults aged between 18 and 55 years
- ASA Physical Status I or II
- Body weight between 50–80 kg
- Patients consenting for ultrasound-guided axillary brachial plexus block with ropivacaine and dexmedetomidine

EXCLUSION CRITERIA

- Patients unwilling to provide consent
- Uncooperative patients
- Age <18 or >55 years
- Local pathology at block site (e.g., infection)
- History of bleeding disorders, convulsions, severe neurological deficit, or allergy
- Major systemic illness (cardiac, respiratory, hepatic, renal failure)
- Pregnant or lactating women
- Morbid obesity (BMI >35)

SAMPLE SIZE ESTIMATION

The primary outcome was the duration of sensory blockade and postoperative analgesia. A sample size of 30 patients per group (total = 60) was calculated to detect a 25% change in sensory block duration, with 80% power and alpha < 0.05, using the following formula:

$n = 2 \times ((Z_{1-}\alpha/_2 + Z_{1-}\beta)^2 / D^2)$

Where:

• n = sample size per group

• $Z(1-\alpha/2)$ = standard normal deviate for 95% confidence

• $Z(1-\beta)$ = standard normal deviate for 80% power

• D = standardized effect size (25% change in sensory block duration)

$n = 2 \times ((1.96 + 0.84)^2 / (0.25)^2)$

$n = 2 \times ((2.8)^2 / 0.0625)$

$n = 2 \times (7.84 / 0.0625)$

$n \approx 25$

To account for potential dropouts and improve study robustness, the sample size was rounded up to 30 patients per group, resulting in a total sample size of 60 patients.

METHOD OF COLLECTION OF DATA

This was a prospective, randomized, controlled study. A total of 60 eligible patients, aged between 18 and 55 years with ASA physical status I or II, were selected. After obtaining written informed consent, patients were randomly assigned into two equal groups using a computer-generated random numbers table:

Group A: Ropivacaine 0.75% 20 ml + Dexmedetomidine 100 mcg (1 ml)

Group B: Ropivacaine 0.75% 20 ml + Normal saline (1 ml)

SELECTION BIAS CONTROL: Patients were randomly allocated into two equal groups (30 in each group) using a computer-generated randomization table, minimizing selection bias and ensuring balanced group characteristics.

METHODOLOGY

This clinical study was conducted in the Department of Anaesthesiology, Adichunchanagiri University of Health Sciences, between December 2023 and June 2025, to compare the effects of ropivacaine alone versus ropivacaine with dexmedetomidine in axillary brachial plexus blocks.

Ethical clearance was obtained prior to the commencement of the study. All patients underwent a standard pre-anaesthetic evaluation and relevant investigations. Written informed consent was obtained from all participants. On the night before surgery, patients were premedicated with oral alprazolam 0.5 mg and ranitidine 150 mg, and instructed to remain nil per oral (NPO) from 10 p.m. onwards.

On the day of surgery, patients were monitored using standard ASA monitors (HR, NIBP, ECG, SpO_2). IV midazolam 0.02 mg/kg was administered as premedication. An ultrasound-guided axillary brachial plexus block was performed using a 22G,

50 mm insulated block needle under in-plane technique with a LOGIQ E (GE) ultrasound machine. Once the needle tip reached the neurovascular sheath, 20 ml of the drug solution (based on group allocation) was injected incrementally over 3–5 minutes.

ASSESSMENT PARAMETERS

- Onset of sensory block: assessed using pinprick method (25G needle)
- Onset of motor block: assessed using the Modified Bromage Scale
- Duration of sensory and motor blockade
- Adverse events or complications

SCORING SYSTEMS USED

Sensory block: assessed by pinprick method using 25G needle

0 = Sharp pain

1 = Touch sensation only

2 = No sensation

Visual Analogue Scale (VAS):

0 = No pain; 10 = Worst pain imaginable

Modified Bromage Scale for Motor Block:

0 = Able to raise extended arm to 90°

1 = Able to flex elbow/move fingers, but not raise arm

2 = Unable to flex elbow but able to move fingers

3 = Unable to move arm, elbow, or fingers

o Onset = Grade 1; Peak motor block = Grade 3

DATA ANALYSIS AND STATISTICS

All data were analyzed using SPSS software (Version 26). Quantitative variables were compared using the Student's t-test Categorical or non-parametric data were compared using the Chi-square test. Correlations were assessed using Pearson's or Spearman's correlation coefficients, as appropriate A p-value < 0.05 was considered statistically significant.

RESULTS

AGE DISTRIBUTION BY GROUP

Age group	Group A	Group B	p value
18–30	12(40.0%)	10(33.3%)	0.64
31–40	7(23.3%)	11(36.7%)	
41–55	11(36.7%)	9(30.0%)	
Total	30(100%)	30(100%)	

The age distribution between Group A (Ropivacaine with Dexmedetomidine) and Group B (Ropivacaine with Normal Saline) did not show a statistically significant difference (p = 0.65). In Group A, the majority of patients were in the 18–30 years age group (40.0%), followed closely by the 41–55 years group (36.7%), with the 31– 40 years category accounting for 23.3%. In contrast, Group B had the highest proportion of patients in the 31–40 years age group (36.7%), followed by 18–30 years (33.3%) and 41–55 years (30.0%). Overall, both groups were comparable with respect to age distribution.

SEX DISTRIBUTION BY GROUP

Sex	Group A	GroupB	p value
Female	21(70.0%)	17(56.7%)	0.28
Male	9(30.0%)	13(43.3%)	
Total	30(100%)	30(100%)	

With regard to sex distribution, females constituted the majority in both groups, with a higher proportion observed in Group A (70.0%) compared to Group B (56.7%). Male participants accounted for 30.0% in Group A and 43.3% in Group B. The difference in sex distribution between the two groups was not statistically significant (p = 0.29), indicating that the groups were adequately balanced in terms of gender.

WEIGHT

Parameter	Group A	Group B	p value
Weight(kg)	62.83±8.63	65.43± 9.09	0.261

The mean weight of patients in Group A was 62.83 ± 8.63 kg, while Group B had a mean weight of 65.43 ± 9.09 kg. The difference was not statistically significant (p = 0.261), supporting the demographic comparability of the groups.

ASA PHYSICAL STATUS

Parameter	Group A	Group B	p value
I	15(50.0%)	19(63.3%)	0.3
II	15(50.0%)	11(36.7%)	
Total	30(100%)	30(100%)	

With respect to the American Society of Anesthesiologists (ASA) physical status classification, both groups demonstrated comparable baseline health profiles. In Group A, patients were evenly distributed between ASA Grade I and Grade II (50.0% each). In Group B, a higher proportion of patients were classified as ASA Grade I (63.3%), while 36.7% belonged to ASA Grade II. The difference in ASA distribution between the two groups was not statistically significant (p = 0.31), indicating that baseline physical status was well balanced across both study groups.

SENSORY BLOCK CHARACTERISTICS

ONSET AND DURATION OF SENSORY BLOCK

Parameter	Group A	Group B	p value
Onset of sensory block (min)	7.93± 1.62	10.27±1.53	<0.001
Duration of sensory block (min)	611.07± 67.68	507.70±59.42	<0.001

The onset of sensory block was significantly faster in Group A, which received Ropivacaine 0.75% with Dexmedetomidine, compared to Group B, which received Ropivacaine 0.75% with normal saline. Specifically, Group A achieved sensory block onset at a mean time of 7.93 ± 1.62 minutes, whereas Group B took longer, with a mean onset of 10.27 ± 1.53 minutes. This difference was highly statistically significant (p < 0.001), indicating that the addition of Dexmedetomidine accelerates the initiation of sensory blockade. Similarly, the duration of sensory block was significantly prolonged in Group A, lasting 611.07 ± 67.68 minutes, compared to 507.70 ± 59.42 minutes in Group B. The prolonged sensory block in Group A again demonstrated a statistically significant advantage (p < 0.001), suggesting that Dexmedetomidine as an adjuvant enhances the longevity of the sensory block

MOTOR BLOCK CHARACTERISTICS

ONSET AND DURATION OF MOTOR BLOCK

Parameter	Group A	GroupB	p value
Onset o fmotor block (min)	9.67± 1.42	12.03± 1.67	<0.001
Duration of motor block (min)	497.07± 58.44	393.07± 56.44	<0.001

The onset of motor block was quicker in Group A, with a mean of 9.67 ± 1.42 minutes, compared to 12.03 ± 1.67 minutes in Group B (p < 0.001). The duration of motor block was also significantly longer in Group A, averaging 497.07 ± 58.44 minutes, while Group B had a shorter duration of 393.07 ± 56.44 minutes (p < 0.001).This indicates that the addition of Dexmedetomidine not only accelerates the onset but also significantly extends the duration of motor blockade.

SYSTOLIC BLOOD PRESSURE

Throughout the monitoring period, systolic blood pressure remained largely comparable between both groups, with no statistically significant differences at any recorded time point. At baseline (0 min), Group A had a mean SBP of 120.47 mmHg compared to 118.13 mmHg in Group B (p = 0.466). Although Group A showed a slightly higher SBP at 5 minutes (124.93 vs. 119.40 mmHg), the difference narrowly missed statistical significance (p = 0.051). From 10 minutes to 720 minutes, fluctuations in SBP continued within a physiologically acceptable range, with p-values consistently above 0.05, indicating that the use of Dexmedetomidine did not result in any clinically relevant alterations in systolic blood pressure.

DIASLOTIC BLOOD PRESSURE

Time	Group A	Group B	P value
0min	75.47±8.87	73.53±9.55	0.42
5min	72.93±7.91	75.87±8.14	0.162
10min	77.07±8.20	73.53±9.81	0.135
15min	75.80±9.30	73.80±8.60	0.391
20min	74.27±8.48	74.47±9.89	0.933
45min	75.20±10.21	77.60±9.49	0.349
60min	74.73±9.61	74.60±9.13	0.956
90min	75.87±9.68	75.73±8.63	0.955
120min	75.13±9.46	74.73±8.70	0.865
180min	72.33±8.16	72.73±9.86	0.865
360min	73.87±9.01	74.20±9.56	0.89
600min	74.80±9.45	75.47±9.88	0.79
720min	75.80±7.81	77.13±8.75	0.536

Diastolic blood pressure readings were also similar across both groups over the entire duration of observation. At baseline, Group A recorded a mean DBP of 75.47 mmHg, while Group B had 73.53 mmHg (p = 0.420). No significant changes were observed throughout the measurement points. For example, at 10 minutes, DBP was 77.07 mmHg in Group A and 73.53 mmHg in Group B (p = 0.135), and at 720 minutes, the values were 75.80 mmHg and 77.13 mmHg respectively (p = 0.536). These findings confirm hemodynamic stability with no significant DBP variation due to the use of Dexmedetomidine.

MEAN ARTERIAL BLOOD PRESSURE

Time	Group A	Group B	p value
0min	90.47±7.24	88.40±8.29	0.27
5min	90.26±6.34	90.38±7.74	0.26
10min	90.62±7.06	88.62±8.94	0.28
15min	90.33±7.34	88.22±7.92	0.27
20min	90.56±6.84	89.11±8.83	0.26
45min	88.64±7.92	90.33±7.86	0.25
60min	89.89±7.38	90.02±7.91	0.26
90min	90.62±7.63	90.02±8.45	0.27
120min	90.06±7.35	88.38±7.91	0.26
180min	88.11±6.92	87.75±8.79	0.28
360min	89.36±7.10	90.71±8.46	0.24
600min	90.40±7.56	89.31±8.50	0.26
720min	90.40±6.45	89.80±7.99	0.27

Mean arterial pressure remained stable and similar between the two groups at all time intervals. For instance, at 0 minutes, the MAP was 90.47 mmHg in Group A and 88.40 mmHg in Group B (p = 0.27). Differences at other time points, such as 10 minutes (90.62 vs. 88.62 mmHg, p = 0.28) and 600 minutes (90.40 vs. 89.31 mmHg, p = 0.26), were also not statistically significant. This further supports the conclusion that Dexmedetomidine does not negatively impact mean arterial pressure during the perioperative period.

HEART RATE

Time	Group A	Group B	p value
0min	73.67± 7.73	71.80±7.21	0.338
5min	71.50± 8.09	73.13±8.14	0.439
10min	71.23± 7.56	74.90±6.47	0.048
15min	71.37± 6.42	71.57±7.11	0.909
20min	71.53± 6.88	72.57±8.53	0.607
45min	71.87± 7.19	73.03±7.12	0.53
60min	72.60± 6.99	69.00±7.14	0.053
90min	72.30± 7.60	71.07±6.43	0.5
120min	71.63± 7.12	73.17±7.60	0.423
180min	70.27± 7.56	70.07±6.30	0.912
360min	70.93± 7.73	73.17±6.75	0.238
600min	71.73± 6.82	72.37±7.16	0.727
720min	73.40± 7.17	71.30±7.42	0.27

Heart rate readings were largely similar across both groups, except at 10 minutes post-block, where Group B had a significantly higher heart rate (74.90 beats/min) compared to Group A (71.23 beats/min), with a statistically significant p- value of 0.048. At all other time points, including at baseline (73.67 vs. 71.80 beats/min, p = 0.338), the differences were not statistically significant. Notably, at 60 minutes, there was a near-significant trend favoring a slightly lower heart rate in Group B (69.00 vs. 72.60 beats/min, p = 0.053). Overall, the findings indicate that both groups maintained a stable heart rate profile, with only transient and minorvariations.

OXYGEN SATURATION

Time	GroupA	GroupB	pvalue
0min	97.37±0.96	97.37±1.19	1.00
5min	97.07±0.98	97.53±1.22	0.109
10min	97.37±1.07	97.63±1.10	0.344
15min	97.47±1.20	97.70±1.18	0.45
20min	97.33±1.12	97.63±1.27	0.337
45min	97.60±1.04	97.50±1.23	0.734
60min	97.53±1.14	97.43±1.19	0.741
90min	97.07±1.05	97.40±1.25	0.267
120min	97.70±1.12	97.57±1.19	0.657
180min	97.47±1.14	97.90±1.09	0.138
360min	97.67±1.21	97.53±1.20	0.67
600min	97.30±1.18	97.60±1.13	0.319
720min	97.57±1.19	97.23±1.01	0.247

Oxygen saturation levels remained within normal limits and were comparable between the two groups throughout the study period. At baseline, both groups had identical mean SpO_2 values of 97.37%. Small, clinically insignificant fluctuations were observed during follow-up; for example, at 10 minutes, Group A had 97.37%87 and Group B had 97.63% (p = 0.344), while at 720 minutes, the values were 97.57% and 97.23% respectively (p = 0.247). None of these differences reached statistical significance, confirming that respiratory function, as indicated by SpO_2, was unaffected by the addition of Dexmedetomidine.

OVERALL COMPLICATIONS BY GROUP

Complications	Group A	GroupB	p value
Yes	4(13.3%)	1(3.3%)	0.18
No	26(86.7%)	29(96.7%)	
Total	30(100%)	30(100%)	

Overall complications were observed in 13.3% of patients in Group A compared to 3.3% in Group B. Although the incidence of adverse events appeared higher in the dexmedetomidine group, the difference was not statistically significant (p = 0.18), indicating that the overall complication rates between the two groups were comparable.

TYPE OF COMPLICATION BY GROUP

TypeofComplication	Group A	GroupB	p value
None	26(86.7%)	29(96.7%)	0.48
Bradycardia	1(3.3%)	0(0.0%)	
Hypotension	1(3.3%)	1(3.3%)	
Nausea	2(6.7%)	0(0.0%)	
Total	30(100%)	30(100%)	

On subgroup analysis, bradycardia and nausea were observed exclusively in Group A, while hypotension occurred in one patient in each group. Nausea was reported in 6.7% of patients receiving dexmedetomidine, whereas no cases were noted in Group B. Despite these observations, the overall comparison of complication types did not reach statistical significance (p = 0.50), suggesting that these events were infrequent and clinically mild rather than directly attributable to the study intervention.

DISCUSSION

Regional anaesthesia, particularly brachial plexus block via the axillary approach, has gained prominence for providing effective surgical anaesthesia and superior postoperative analgesia in upper limb procedures. Among the various local anaesthetics, Ropivacaine has been widely preferred due to its favourable pharmacological profile, including a longer duration of action and reduced cardiotoxicity compared to bupivacaine.In an effort to enhance the quality and duration of nerve blockade, various adjuvants have been investigated. Dexmedetomidine, a selective α2-adrenergic receptor agonist, has emerged as a potent adjunct capable of prolonging both sensory and motor block duration and improving analgesic efficacy when combined with local anaesthetics. The present study was undertaken to compare the efficacy of Ropivacaine 0.75% alone versus Ropivacaine 0.75% with 100 µg of Dexmedetomidine as an adjuvant in axillary brachial plexus block, specifically evaluating parameters such as onset and duration of sensory and motor blockade, duration of analgesia, pain scores,hemodynamic stability, and any associated side effects.

Demographic and Baseline Characteristics

In our study, both groups were demographically and clinically comparable at baseline. The age distribution between Group A and Group B was statistically similar, with the majority of participants aged between 18 and 55 years (p = 0.64). Although there was a higher proportion of females in both groups, this difference was not significant (p = 0.28). ASA physical status was also balanced, with a slightly greater number of ASA I patients in Group B, but this was not statistically significant (p = 0.30). The average body weight was comparable between the two groups (p = 0.261),confirming that the study population was well-matched in terms of baseline physical parameters.

These findings are consistent with several previous studies. In the study done by Sangita Mandal,15 the demographic characteristics—including age, sex distribution, weight, ASA status, and duration of surgery—were comparable across the three groups receiving Ropivacaine alone, Ropivacaine with Clonidine, and Ropivacaine

with Dexmedetomidine (p > 0.05). Similarly, Bangera A 17found no significant differences in age, weight, ASA grade, gender distribution, or surgical
duration between the study arms. In the study conducted by Kathuria S 14 , the groups demonstrated no significant differences in any demographic variable, ensuring baseline comparability.

Agarwal G18 also reported similar demographic parity between their study groups, with no statistical differences in age, weight, BMI, sex distribution, ASA status, or surgical duration. Likewise, Marhofer D22 ensured comparable participant profiles in terms of height, weight, and BMI across their Ropivacaine and Dexmedetomidine groups.

In the study conducted by Viswambharan VK,23 patients in both the dexmedetomidine and dexamethaso ne groups were well matched with regard to age, sex, body weight, and duration of surgery (p > 0.05). Together, these observations reinforce that our study population was appropriately balanced demographically and clinically, allowing for valid comparisons between intervention groups without baseline confounding.

Sensory Block Characteristics

In our study, the onset of sensory block was significantly faster in the group that received Dexmedetomidine (Group A: 7.93 ± 1.62 minutes) compared to the control group (Group B: 10.27 ± 1.53 minutes), with a highly significant p-value (< 0.001). Additionally, the duration of the sensory block was substantially prolonged in Group A (611.07 ± 67.68 minutes) relative to Group B (507.70 ± 59.42 minutes), confirming the role of Dexmedetomidine in enhancing sensory blockade.

These findings are in agreement with the study done by Sangita Mandal, 15where the onset of sensory block was faster in the Dexmedetomidine group (10.2 ± 1.69 minutes) compared to Clonidine and plain Ropivacaine groups, and the sensory block duration was also longest in the Dexmedetomidine group (635.53 ± 14.48 minutes). Similarly, in the study by Agarwal G,18 sensory onset was earlier (7.40 ± 2.40 minutes) and duration longer (437.33 ± 99.96 minutes) in the Dexmedetomidine group compared to the Ropivacaine-only group.

In the study done by Kathuria S 14 , perineural Dexmedetomidine also resulted in the fastest sensory onset (9.75 ± 4.23 minutes) and the longest duration (789.45 ± 187.72 minutes). Bangera A17 and Marhofer D22 reported similar improvements in sensory parameters, with significantly prolonged sensory block duration in Dexmedetomidine groups. Further, Viswambharan VK23 observed a faster onset of sensory block in the Dexmedetomidine group (10.3 ± 1.2 minutes) compared to Dexamethasone (12.1 ± 1.1 minutes), supporting the enhanced efficacy of Dexmedetomidine.

However, in the study done by Jain A,19 sensory onset and duration were statistically comparable93 between the two dexmedetomidine dose groups (8.18 vs 8.23 min and 757.8 vs 762.83 min), suggesting no significant dose-dependent difference at the levels used.

Motor Block Characteristics

In our study, the onset of motor block was significantly faster in Group A (9.67 ± 1.42 minutes) compared to Group B (12.03 ± 1.67 minutes), and the duration of motor block was also significantly prolonged in Group A (497.07 ± 58.44 minutes) versus Group B (393.07 ± 56.44 minutes), with both comparisons yielding p < 0.001.

These findings highlight the facilitative role of Dexmedetomidine in accelerating and prolonging motor blockade.

These observations are corroborated by Sangita Mandal,15 where the motor block onset was earlier (11.47 ± 1.33 minutes) and the duration longer (583.8 ± 15.14 minutes) in the Dexmedetomidine group. Similarly, Akshara P 21 noted a faster motor block onset in the 50 µg Dexmedetomidine group (18.92 ± 1.94 minutes) compared to the 25 µg group (23.01 ± 3.00 minutes), indicating a dose-responsive effect.

Agarwal G 18also reported a significantly earlier motor block onset (11.50 ± 3.57 minutes) and a prolonged motor block duration (391.53 ± 106.93 minutes) in the Dexmedetomidine group compared to the control. In Kathuria S 14 study, the Dexmedetomidine group showed the shortest motor onset time (18.75 ± 6.37 minutes) and the longest duration (754.60 ± 180.50 minutes).

In contrast, Jain A 19reported no significant difference in motor block onset (14.11 vs 14.06 minutes) or duration (701.03 vs 704.97 minutes) between their two Dexmedetomidine groups, indicating that increasing the dose from 50 µg to 100 µg did not enhance motor block characteristics further.

Complications

The incidence of the adverse events was comparable between the two groups. Nausea, bradycardia, hypotension were the most commonly observed adverse events. All these adverse events were mild and were promptly recognised and managed. In addition, the study conducted by Sangita Mandal15 , no adverse events were reported in anygroup, including those receiving Dexmeditomidine, suggesting that its addition did not elevate the risk of complications.

Hemodynamic Parameters

In our study, the use of Dexmedetomidine as an adjuvant to Ropivacaine maintained a stable and acceptable hemodynamic profile throughout the perioperative period. Systolic blood pressure (SBP) remained within physiological limits across both groups, with no significant intergroup differences at any time point ($p > 0.05$). Similarly, diastolic blood pressure (DBP) and mean arterial pressure (MAP) showed no statistically significant variation between the groups, suggesting that the addition of Dexmedetomidine did not compromise cardiovascular stability.

Although heart rate (HR) was generally comparable between Group A and Group B, a statistically significant difference was observed at 10 minutes post-block, where Group B recorded a higher HR (74.90 ± 6.47 bpm) compared to Group A (71.23 ± 7.56 bpm), with $p = 0.048$. This transient variation normalized in subsequent readings and did not necessitate any clinical intervention, confirming the hemodynamic tolerability of Dexmedetomidine.

These findings align with the study by Sangita Mandal,15 where all three groups—Ropivacaine alone, with Clonidine, and with Dexmedetomidine— maintained stable HR and MAP values throughout the observation period ($p > 0.05$), without any clinically significant variations. Similarly, Akshara P 21 reported stable intraoperative hemodynamic parameters in both low and high Dexmedetomidine dose groups (D25 and D50). Although a statistically significant increase in postoperative MAP was noted in the D50 group, values remained within clinically acceptable limits.

In contrast, Bangera A17 observed a significant reduction in HR and BP in the Dexmedetomidine group (Group RD) compared to Ropivacaine alone, particularly between 10 to 540 minutes post-block. Despite this, no patient required pharmacologic intervention, affirming the safety of Dexmedetomidine-induced sympatholysis. Jain A19 also reported statistically significant bradycardia in 11 patients in the higher Dexmedetomidine dose group (RD100) compared to only 2 in RD50 ($p = 0.0047$). However, MAP remained comparable across both groups and required no
intervention. In the study by Chen JB 16 , significantly lower systolic and diastolic BP, as well as HR, were noted in the Dexmedetomidine group at certain time points (T4 and T5), reinforcing the sympatholytic effect, though without adverse clinical consequences. Agarwal G18 observed that Group D (Dexmedetomidine) had consistently lower HR and SBP compared to Group C (Ropivacaine alone) from 5 to 480 minutes ($p < 0.05$), with DBP and MAP following a similar trend between 15 to 360 minutes. These changes were transient and not associated with hemodynamic compromise. In Marhofer D's 22 study, no episodes of bradycardia or hypotension were observed across groups, demonstrating excellent cardiovascular stability of Dexmedetomidine, whether administered perineurally or systemically.

Lastly, Viswambharan VK23 found a sustained but well-tolerated reduction in pulse rate in the Dexmedetomidine group from 50 minutes to 19 hours post-block, with no significant differences in SBP, underscoring the prolonged sympatholytic but safe profile of the adjuvant. These findings, consistent with multiple previous studies,96confirm that while Dexmedetomidine may induce mild reductions in heart rate and blood pressure, these changes are

transient, clinically insignificant, and do not compromise patient safety. Thus, Dexmedetomidine demonstrates a favorable hemodynamic profile when used as an adjuvant in regional anesthesia.

Limitations

This study, although demonstrating significant clinical findings, has several limitations. Firstly, the sample size was relatively small (60 participants), which may limit the generalizability of the results to a broader population. Secondly, the study included only ASA I and II patients, excluding those with significant comorbidities, thus limiting applicability to high-risk surgical candidates. Thirdly, the duration of follow-up was confined to the immediate postoperative period, and long-term outcomes or late complications could not be assessed. Finally, the study was validity.

Recommendations

Future studies should aim to include a larger and more diverse patient population to enhance the external validity of findings. Including patients with ASA III and IV status would also help in understanding the efficacy and safety of Dexmedetomidine in high-risk groups. A multicenter approach would eliminate institutional bias and strengthen the evidence base. Furthermore, exploring different doses of Dexmedetomidine could help establish the optimal concentration that balances efficacy and safety. Long-term follow-up studies are recommended to monitor any delayed adverse effects and to assess the impact on chronic pain development. Finally, incorporating objective measures such as nerve stimulation thresholds or neuroimaging could further validate block characteristics.

CONCLUSION

This prospective, comparative study was undertaken to evaluate the efficacy of adding Dexmedetomidine to Ropivacaine 0.75% in axillary brachial plexus block with respect to onset and duration of sensory and motor blockade, duration of analgesia, and associated side effects. The results clearly demonstrated that the addition of Dexmedetomidine (100 mcg) significantly enhanced the quality and duration of both sensory and motor blocks when compared to Ropivacaine alone. The hemodynamic parameters and oxygen saturation levels remained stable throughout the perioperative period in both groups, with no clinically significant adverse effects attributable to Dexmedetomidine. Although a slightly higher incidence of minor complications such as bradycardia and nausea was noted in the Dexmedetomidine group, these were self-limiting and did not require any major intervention.

In conclusion, Dexmedetomidine appears to be a safe and effective adjuvant to Ropivacaine in axillary brachial plexus block, offering faster onset, prolonged block duration, and improved analgesic efficacy without compromising patient safety. Its incorporation into regional anesthesia protocols for upper limb surgeries may contribute to enhanced patient comfort, reduced opioid consumption, and improved overall perioperative outcomes.

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