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Original Research Article

A Comparative Study of 0.75% Ropivacaine versus 0.75% Ropivacaine with Clonidine in Supraclavicular Brachial Plexus Block for Upper Limb Surgeries

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Abstract:

Background: Regional anaesthesia, particularly the supraclavicular brachial plexus block, provides excellent surgical anaesthesia and postoperative analgesia for upper limb procedures. Ropivacaine is widely preferred due to its favourable sensory–motor differentiation and reduced cardiotoxicity. However, its duration of action may be insufficient for prolonged analgesia. Clonidine, an α_2-adrenergic agonist, has been shown to enhance block characteristics and prolong analgesia when used as an adjuvant. This study evaluates the efficacy of adding clonidine to 0.75% ropivacaine in supraclavicular brachial plexus blocks.

Materials And Methods: This prospective, randomized, interventional study was conducted over 18 months at a tertiary care centre. A total of 108 ASA I–II patients undergoing elective upper limb surgeries were randomly allocated into two groups: Group A (n = 54): 30 ml of 0.75% ropivacaine Group B (n = 54): 30 ml of 0.75% ropivacaine + 75 µg clonidine Sensory and motor block onset and duration, postoperative analgesia duration, hemodynamic parameters, and adverse effects were assessed. Pain was evaluated using the VAS (Visual Analogue Scale), and rescue analgesia was administered when VAS > 5.

Results: Both groups had comparable demographic and clinical profiles. The addition of clonidine significantly hastened sensory onset (8.5 ± 1.3 min vs. 11.8 ± 1.6 min, $p < 0.001$) and motor onset (10.4 ± 1.5 min vs. 14.6 ± 1.8 min, $p < 0.001$). Group B showed prolonged sensory block (515.6 ± 22.5 min vs. 480.3 ± 24.7 min, $p < 0.001$) and motor block (468.8 ± 28.7 min vs. 430.5 ± 30.2 min, $p < 0.001$). Postoperative analgesia was significantly longer in Group B (725.2 ± 48.6 min vs. 590.4 ± 40.5 min, $p < 0.001$). Hemodynamic variables remained stable in both groups, with only mild sedation noted in Group B (7.4%), and no serious adverse effects.

Conclusion: The addition of 75 µg clonidine to 0.75% ropivacaine in supraclavicular brachial plexus block significantly improves block onset, prolongs sensory and motor blockade, and extends postoperative analgesia without compromising safety. This combination is effective, safe, and clinically advantageous for upper limb surgeries.

Keywords: Ropivacaine, Clonidine, Supraclavicular Block, Brachial Plexus Block, Regional Anaesthesia, Upper Limb Surgery, Postoperative Analgesia.

Introduction

Regional anaesthesia has transformed upper limb surgery by enabling precise peripheral nerve blocks that enhance patient comfort and perioperative outcomes. Among these techniques, the supraclavicular brachial plexus block remains highly effective due to the dense clustering of nerve trunks at this level, producing rapid-onset, reliable anaesthesia for procedures distal to the shoulder. Owing to its consistency and block quality, it is often termed the "spinal of the upper limb."

Ropivacaine, a long-acting amide local anaesthetic, is widely preferred for brachial plexus blocks because of its favourable sensory–motor differentiation and reduced cardiotoxicity compared with bupivacaine. Its S-enantiomer structure and lower lipid solubility limit penetration into large myelinated motor fibres, helping preserve motor function while maintaining adequate analgesia.[1] However, ropivacaine alone may have a moderate onset and limited duration for prolonged surgeries.

To enhance block quality and duration, several adjuvants-including opioids, dexamethasone, neostigmine, epinephrine, and α2-agonists-have been combined with local anaesthetics. Among these, clonidine, an imidazoline-derived α2-adrenergic agonist, is well established for potentiating both sensory and motor blockade through inhibition of C-fibre transmission and hyperpolarization of dorsal horn neurons. [2,3]

Multiple studies support the synergistic benefits of adding clonidine to ropivacaine. Bafna et al. demonstrated that clonidine (2 µg/kg) significantly prolonged sensory–motor block duration and postoperative analgesia without hemodynamic instability.[4] Ali et al. observed similar prolongation using 75 µg clonidine with 0.5% ropivacaine.[5] Comparative trials show faster onset and enhanced block characteristics when ropivacaine is combined with clonidine versus other agents such as bupivacaine,[6] while Srinivasa et al. reported an additional 3 hours of analgesia with higher doses of clonidine.[7] Lower doses (75 µg) have also proven effective without causing sedation or hypotension, as noted by Priyadarshi et al.[8]

Aims and Objectives: The study aimed to evaluate the efficacy of adding clonidine to 0.75% ropivacaine in supraclavicular brachial plexus block for patients undergoing upper limb surgeries, with a focus on the onset and duration of sensory and motor blockade, as well as the duration of postoperative analgesia. Specifically, the objectives were to compare the onset times of sensory and motor blockade between ropivacaine alone and ropivacaine combined with clonidine, to assess the duration of sensory and motor blockade in both groups, and to determine the duration of postoperative analgesia provided by each technique.

Materials and Methods

Study Design: This prospective, randomized interventional study was conducted over 18 months, from June 2023 to November 2024, in the Department of Anaesthesiology at Great Eastern Medical School and Hospital (GEMS), Ragolu, Srikakulam, Andhra Pradesh. The study compared the efficacy of supraclavicular brachial plexus block using 0.75% ropivacaine alone versus 0.75% ropivacaine combined with 75 µg clonidine in adult patients undergoing upper limb surgeries. Its primary focus was to evaluate and compare the onset and duration of sensory and motor blockade, as well as the duration of postoperative analgesia between the two techniques.

Inclusion and Exclusion Criteria: The study included patients aged 18 to 65 years with ASA physical status I or II who were scheduled for elective upper limb surgeries of the arm, forearm, or hand and were willing to provide written informed consent. Patients were excluded if they had a known hypersensitivity to local anesthetics or clonidine, infection or inflammation at the block site, coagulation abnormalities or were on anticoagulant therapy, a history of brachial plexus injury or neuropathies, were pregnant or lactating, or refused to participate in the study.

Sample Size Calculation: The sample size was calculated using the standard formula:

N= 108

Where:

NNN = required sample size

ZZZ = standard normal deviate (Z = 1.04 for 70% confidence level)

p^\hat{p}p^ = expected proportion (50%)

ε\varepsilonε = margin of error (5%)

Based on the calculation, a total sample size of 108 was estimated, with 54 patients in each group.

Data Collection Procedure: Data were collected through a structured protocol in which all patients underwent a detailed pre-anaesthetic evaluation, including medical history, physical and airway assessment, baseline vitals, and relevant laboratory investigations. An IV line was secured, patients were preloaded with Ringer lactate, and standard monitors (ECG, NIBP, SpO_2) were attached. Under aseptic precautions, a supraclavicular brachial plexus block was performed using a 22G needle with either 30 mL of 0.75% ropivacaine (Group A) or 30 mL of 0.75% ropivacaine plus 75 µg clonidine (Group B). Sensory block was assessed using the pinprick method and graded 0–2, while motor block was evaluated using the Modified Bromage Scale for the upper limb. Onset and duration of sensory and motor blockade were recorded. Hemodynamic variables (HR, SBP, DBP, MAP) and adverse effects were monitored at defined intervals up to 8 hours post-block. Postoperative pain was assessed using the Visual Analogue Scale every 2 hours, with rescue analgesia (75 mg IM diclofenac) administered for VAS >5, and the duration of analgesia noted from block completion to first analgesic request. Outcome assessment was performed by a blind observer to ensure unbiased data collection.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS software version 25. Continuous variables were expressed as mean ± standard deviation and compared between groups using the unpaired t-test, while categorical variables were analyzed using the chi-square test or Fisher's exact test as appropriate. A p-value of less than 0.05 was considered statistically significant for all comparisons.

Results

Table 1: Demographic Characteristics (Age & Gender Distribution)

Variable		Group A (Ropivacaine) (n=54)	Group B (Ropi + Clonidine) (n=54)	p-value
Age Groups (in years)	18–30	14 (25.9%)	15 (27.8%)	0.88
	31–40	17 (31.5%)	16 (29.6%)	
	41–50	13 (24.1%)	13 (24.1%)	
	51–65	10 (18.5%)	10 (18.5%)	
Mean ± SD		36.9 ± 9.4	37.1 ± 9.7	0.84
Gender	Male	29 (53.7%)	30 (55.6%)	
	Female	25 (46.3%)	24 (44.4%)	

Table 1 shows that both groups were comparable in age and gender, with no statistically significant differences, ensuring homogeneous baseline characteristics.

Table 2: ASA Physical Status Distribution

ASA Grade	Group A	Group B	p-value
I	36 (66.7%)	35 (64.8%)	**0.82**
II	18 (33.3%)	19 (35.2%)	

Table 2 illustrates that ASA physical status was similar between the groups, confirming comparable preoperative risk stratification.

Table 3: Onset of Sensory and Motor Block (Minutes)

Parameter	Group A	Group B	p-value
Sensory Block Onset	11.8 ± 1.6	8.5 ± 1.3	< 0.001
Motor Block Onset	14.6 ± 1.8	10.4 ± 1.5	< 0.001

Table 3 shows a significantly faster onset of both sensory and motor blocks in the ropivacaine + clonidine group, demonstrating clonidine's ability to accelerate block initiation.

Table 4: Duration of Sensory and Motor Block (Minutes)

Parameter	Group A	Group B	p-value
Duration of Sensory Block	480.3 ± 24.7	515.6 ± 22.5	< 0.001
Duration of Motor Block	430.5 ± 30.2	468.8 ± 28.7	< 0.001

Table 4 demonstrates that the addition of clonidine significantly prolongs both sensory and motor blockade without affecting recovery safety.

Table 5: Duration of Postoperative Analgesia

Parameter	Group A	Group B	p-value
Time to First Analgesic Request (min)	590.4 ± 40.5	725.2 ± 48.6	**< 0.001**

Table 5 illustrates that patients receiving ropivacaine + clonidine enjoyed markedly longer postoperative analgesia, reducing early need for rescue pain medication.

Table 6: Hemodynamic Parameters (Heart Rate & Blood Pressure) Heart Rate (beats/min)

Time Point	Group A	Group B	p-value
Baseline	78.4 ± 5.8	77.2 ± 6.1	0.34
30 min	76.9 ± 5.4	74.1 ± 6.0	**0.02***
60 min	77.0 ± 5.2	73.3 ± 5.5	**0.01***

Table 6 highlights stable hemodynamic profiles in both groups, with only mild decreases in HR in the clonidine group-expected and clinically safe.

Table 7: Adverse Events

Adverse Event	Group A (n=54)	Group B (n=54)	p-value
Sedation (Grade 1–2)	0	4 (7.4%)	**0.04***
Nausea/Vomiting	2 (3.7%)	1 (1.8%)	NS
Hypotension	1 (1.8%)	2 (3.7%)	NS
Bradycardia	0	1 (1.8%)	NS

Table 7 demonstrates that adverse events were mild and comparable, with clonidine causing only minimal sedation in a small percentage of patients.

Discussion

The present prospective randomized study was conducted to evaluate the efficacy of adding 75 µg clonidine to 0.75% ropivacaine in supraclavicular brachial plexus block for upper limb surgeries. The results clearly demonstrate that the addition of clonidine significantly improves the block characteristics in terms of onset, duration of sensory and motor blockade, and postoperative analgesia, with minimal and clinically insignificant adverse effects. These findings agree with multiple previous studies that have explored the role of clonidine as an adjuvant to long-acting local anaesthetics in peripheral nerve blocks.

In the present study, demographic variables such as age, gender, and ASA status were comparable between both groups. This matching of baseline characteristics minimizes confounding and ensures the validity of the comparison. This demographic similarity has been consistently observed in comparable studies such as those conducted by Rathore et al. [9] Waheedunnisa et al. [6] all of whom demonstrated equal distribution of age and gender among study groups evaluating clonidine–ropivacaine combinations in upper limb blocks.

One of the most striking findings of this study is the significantly faster onset of sensory and motor blockade in the clonidine group. The mean onset of sensory block was reduced from 11.8 ± 1.6 minutes in the ropivacaine-only group to 8.5 ± 1.3 minutes when clonidine was added. Similarly, the onset of motor block was reduced from 14.6 ± 1.8 minutes to 10.4 ± 1.5 minutes. These results are consistent with those reported by Waheedunnisa et al. [6] who demonstrated a sensory onset of 6.93 ± 1.86 minutes in their clonidine group compared to 10.37 ± 1.53 minutes in the control group. Patil et al. [5] also found a significantly faster onset of motor blockade with clonidine, attributing this improvement to clonidine's ability to enhance neuronal hyperpolarization and increase local anaesthetic penetration at the nerve membrane.

Equally important is the extent of prolongation of both sensory and motor blockade observed in this study. The sensory block lasted 515.6 ± 22.5 minutes in the clonidine group compared to 480.3 ± 24.7 minutes in the ropivacaine-only group, and motor block lasted 468.8 ± 28.7 minutes versus 430.5 ± 30.2 minutes. These findings are in close agreement with studies by Ali et al. [4] who documented prolongation of sensory block to 533.4 ± 45 minutes with clonidine added to ropivacaine. Similarly, it showed that the addition of clonidine extended both sensory and motor block by nearly 40 minutes without increasing adverse effects. The findings of Priyadarshi et al. [7] also reinforce the prolongation of block duration with clonidine, demonstrating a significant increase in duration with doses between 75–100 µg.

The prolongation of postoperative analgesia observed in this study is of particular clinical relevance. The duration of postoperative analgesia increased from 590.4 ± 40.5 minutes in Group A to 725.2 ± 48.6 minutes in Group B. These values align closely with those observed by Priyadarshi et al. [7] who reported a mean postoperative pain-free interval of 705 ± 60 minutes with clonidine, and by Bafna et al. [3] who reported analgesia lasting more than 11 hours when clonidine was used with ropivacaine. Baj et al. [10] also found an increase of approximately 150 minutes in analgesia when clonidine was added to ropivacaine, further underscoring the adjuvant's potency in prolonging pain relief.

The mechanism for such prolongation is believed to involve clonidine's action on both peripheral and central α2 receptors. Clonidine inhibits the hyperpolarization-activated cation current (Ih) in C-fibres, enhances potassium conductance, and stabilizes neuronal membranes, which collectively enhance the effects of local anaesthetics and delay their dissipation.[11] These mechanisms have been extensively documented in studies such as those by Gaumann et al. and Buerkle et al. [11,12]

Hemodynamic stability is essential when using α2 agonists, and the present study confirms that 75 µg clonidine maintains cardiovascular safety. Although minor reductions in heart rate and mean arterial pressure were observed in Group B, none required intervention. Similar findings were reported by Waheedunnisa et al. [6] and Solanki et al. [13] all of whom found clonidine safe at doses ≤ 100 µg with no clinically significant bradycardia or hypotension. This stability is attributed to clonidine's partial α2 agonistic action and its dose-dependent sympatholytic effect.

Adverse effects in the present study were minimal, with mild sedation seen in 7.4% of Group B patients. This incidence aligns with the findings of Ali et al. [4] who reported mild sedation in approximately 8% of patients receiving clonidine. Brummett et al. [14] also demonstrated that perineural clonidine causes only dose-dependent mild sedation without increasing respiratory complications. No major adverse events such as severe hypotension, bradycardia requiring treatment, local anesthetic toxicity, or pneumothorax were observed in this study, confirming the safety of the chosen dose.

Overall, the findings of this study are strongly supported by the existing literature. The use of clonidine in doses ranging between 50–150 µg has been shown repeatedly to accelerate onset, improve block quality, prolong duration, and enhance

postoperative analgesia in supraclavicular blocks. This study reinforces the existing evidence with robust data from an Indian population, which remains relatively underrepresented in regional anesthesia literature.

Conclusion

In conclusion, adding 75 µg of clonidine to 0.75% ropivacaine in a supraclavicular brachial plexus block enhances the quality and duration of both intraoperative anesthesia and postoperative analgesia without increasing adverse effects. This combination provides a safe, effective, and cost-efficient anesthetic option for upper limb surgeries.

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