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Clonidine As An Adjunct To Ropivacaine Versus Bupivacaine For Ultrasound Guided Supraclavicular Brachial Plexus Block For Upper Extremity Surgeries: A Comparative Study

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I. Introduction

- Supraclavicular block- often termed the "spinal anaesthesia of the arm" is a reliable alternative to general anaesthesia for upper limb surgery offering stable hemodynamics, strong analgesia, muscle relaxation, and reduced postoperative pain, vasospasm, and edema.
- Ultrasound guidance enhances its safety and accuracy by visualizing anatomical variants, neurovascular structures, and real-time anaesthetic spread - significantly lowering risks of pneumothorax, vascular puncture, and nerve injury.
- Bupivacaine, a long-acting local anaesthetic, delivers prolonged sensory and motor block but carries higher cardiotoxicity risks. Bupivacaine binds to the intracellular portion of sodium channels and blocks sodium influx into nerve cells, which prevents depolarization. Amide group local anaesthetics such as bupivacaine are metabolized primarily in the liver via conjugation with glucuronic acid.
- Ropivacaine is a long-acting amide local anaesthetic with lower lipophilicity, provides greater sensory-motor differentiation and less motor blockade due to selective action on the pain-transmitting Aβ and C nerves rather than Aβ fibres, which are involved in motor function and reduced systemic toxicity.
- Adding Clonidine (an α_2 adrenergic agonist) extends block duration and improves quality by hyperpolarizing nerve membranes (sodium-channel blockade + potassium efflux).
- Our study was undertaken to compare Clonidine as an adjunct to Bupivacaine versus Ropivacaine in Supraclavicular brachial plexus block for upper limb surgeries.

II. Aims And Objectives

Primary objective:

To compare Bupivacaine with Clonidine versus Ropivacaine with Clonidine with regards to characteristics of Supraclavicular brachial plexus block in Upper limb surgeries in terms of onset, duration of sensory/motor blockade and duration of analgesia.

Secondary objective:

To compare the two groups with regards to hemodynamics and any adverse effects.

III. Materials And Methods

Study Design and Setting

A Prospective Randomized controlled double blinded study was conducted on 50 patients aged 18-60 years, classified as ASA I or II undergoing upper limb surgeries under supraclavicular brachial plexus block in Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru, Karnataka between April 2025 and October 2025

Sample Size Estimation

Formula

$$n = \frac{2s_p^{\,2}\left[Z_{1-\alpha/2} + Z_{1-\beta}\right]^2}{\mu_d^2}$$

$$s_p^2 = \frac{s_1^2 + s_2^2}{2}$$

Where,

s_1^2 : Standard deviation in the first group

s_2^2 : Standard deviation in the second group

μ_d^2 : Mean difference between the samples

α : Significance level

1- β : Power

Based on the literature from the previous study done by Kumkum Gupta et al (2014) for the mean difference in the duration of sensory blockade (in mins)
The standard deviation for Ropivacaine with saline group was 25
The standard deviation for Ropivacaine with Clonidine group was 35
Mean difference between samples was 24.5
The Significance level was set at 0.05
The Power of the study was 0.80
The number of samples needed per group will be 24, which will be rounded off to 25 samples.
For 2 groups, the total sample size will be 50 subjects.

Inclusion Criteria

- Patients with American Society of Anesthesiologists (ASA) physical status classes I and II
- Aged between 18 and 60 years of both genders.
- Patients undergoing surgical procedures of forearm or hand under supraclavicular brachial plexus block.
- Hemodynamically stable patients.
- Patients willing to give informed consent.
- Patients with 55-80kg body weight.

Exclusion Criteria

- Patients with significant history of neurological, psychiatric and neuromuscular diseases, alcohol and or drug abuse, diabetes mellitus, renal disorders, liver diseases.
- Contraindications for a supraclavicular block such as local infection at the site, bleeding disorders/anticoagulant therapy.
- History of brachial plexus injury.
- Allergy to the study drugs.
- Patients taking other medications with α-adrenergic blocking effect.

IV. Methodology

- After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria were enrolled for the study.
- After pre-anaesthetic evaluation, the study protocol was explained to each patient included in the study and informed consent was obtained.
- Patients included in the study were randomized by a computer generated random number table into 2 groups of 25 patients each. Drugs were prepared by an Anaesthesiologist not a part of this study.
- Patients were kept nil per oral for 8 hours before surgery and an IV access was secured with 18 G cannula, patient was given 500 ml of RL.
- Patients on arrival to Operation theatre were connected to basic standard monitors (Pulsoximeter, NIBP, ECG) and baseline hemodynamic parameters were noted.
- Patients were positioned supine with their head turned contralaterally and the ipsilateral arm gently adducted.
- After sterilizing the skin and ultrasound probe - a high frequency linear transducer was placed horizontally in the supraclavicular fossa behind the mid-clavicle. The brachial plexus appeared as a grape-like cluster of 5–6 hypoechoic circles located lateral and superior to the subclavian artery, between the anterior and middle scalene muscles.
- A 2 mL subcutaneous injection of 2% LIGNOCAINE was administered at the needle insertion site. Under ultrasound guidance, using a 22 G 50 mm hypodermic needle and after confirming negative aspiration, a predetermined study drug was injected around the brachial plexus, with real-time visualization of anesthetic spread in tissue planes.
  Group BC: received Inj. BUPIVACAINE 0.5% 30ml + Inj. Clonidine 1mcg/kg (maximum dose limited to 75 mcg)
  Group RC: received Inj. ROPIVACAINE 0.5% 30ml + Inj. Clonidine 1mcg/kg (maximum dose limited to 75 mcg)
- Intercostobrachial nerve was blocked at axilla with 4 ml of Inj. LIGNOCAINE 2% for tourniquet application.

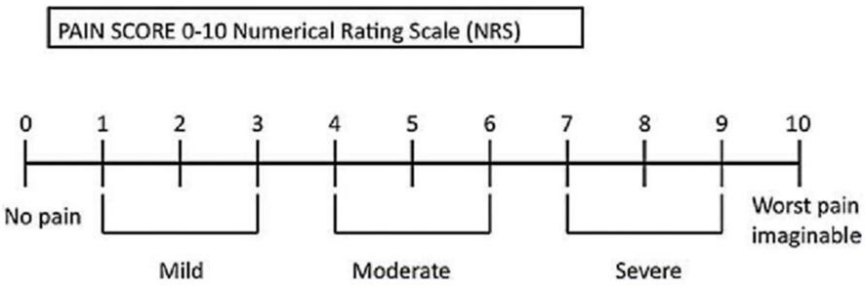
Assessment of parameters:

- The degree of sensory and motor block, and vital parameters of the patient including the heart rate (HR), blood pressure (BP), respiratory rate, and oxygen saturation will be continuously monitored and recorded every 5 min for 30 min initially and later at every 30 min for 6 hrs and every hour upto 12 hrs and every 2 hrs upto 24hrs from the start of the block.

The **Sensory Block** was graded by pinprick in the dermatomal areas C5-T2 as:
0 - Sharp pain
1 - Touch sensation only
2 - No sensation

The **Motor Block** was graded by the Bromage scale as:
0 - Normal motor function
1 - Decreased motor strength with ability to move the fingers only
2 - Complete motor block with inability to move the fingers

- The onset of sensory block is defined as the time elapsed between injection of the drug and complete loss of sensation to pin prick.
- The onset of motor blockade is defined as the time elapsed from injection of the drug to complete motor block.
- Duration of sensory block (the time elapsed between injection of drug and appearance of pain requiring analgesia) and duration of motor block (the time elapsed between injection of the drug and complete return of muscle power) were recorded.
- The duration of analgesia was recorded as the time to when NRS ≥4
- Rescue analgesia in the form of Inj. Diclofenac sodium 1 mg/kg was given by IV infusion.



Ramsay Sedation Score was monitored for 24 hours after administration of the block:
- 1- Anxious and agitated or restless or both
- 2 - Cooperative, oriented, and tranquil
- 3 - Responding to commands only
- 4 - Brisk response to light glabellar tap
- 5 - Sluggish response to light glabellar tap
- 6 - No response to light glabellar tap.

Statistical Analysis

Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

Descriptive Statistics:

Descriptive analysis of all the explanatory and outcome parameters were done using mean and standard deviation for quantitative variables, frequency and proportions for categorical variables.

Inferential Statistics:

Mann Whitney Test, Chi Square Test and Independent Student t Test[Based on Data Distribution] was used to compare the mean age, sex, ASA grading, Vital parameters of the patient including the heart rate (HR), blood pressure (BP), respiratory rate, and oxygen saturation, degree of sensory and motor block and duration of post-operative analgesia (at different time intervals), onset and duration of sensory and motor block between 2 groups.

Chi Square Test was used to compare the block related adverse outcomes between 2 groups.

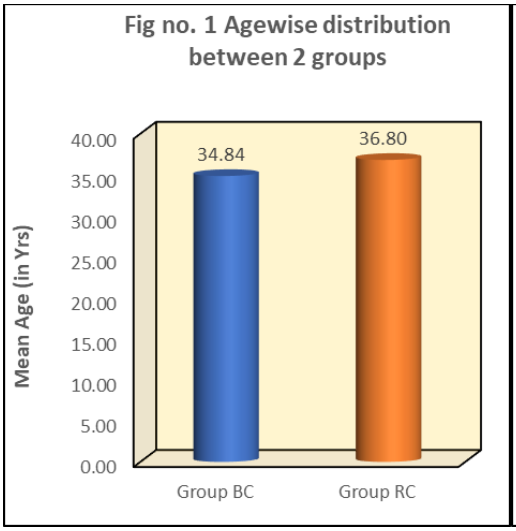
The level of significance was set at $P<0.05$.

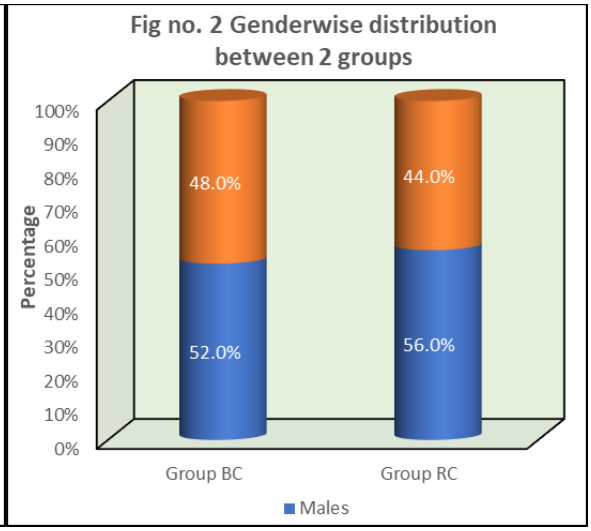
V. Results

The demographic, clinical characteristics and duration of surgery are comparable in both groups as in Table 1.

The age distribution for the Group BC had a mean age of 34.84 ± 7.80 years, whereas the Group RC exhibited a mean age of 36.80 ± 9.16 years. The range of ages in Group BC extended from 24 to 50, while in Group RC, it spanned from 22 to 55. The comparison between the groups suggested no statistically significant difference in age, with a p-value of 0.47. (fig no.1)

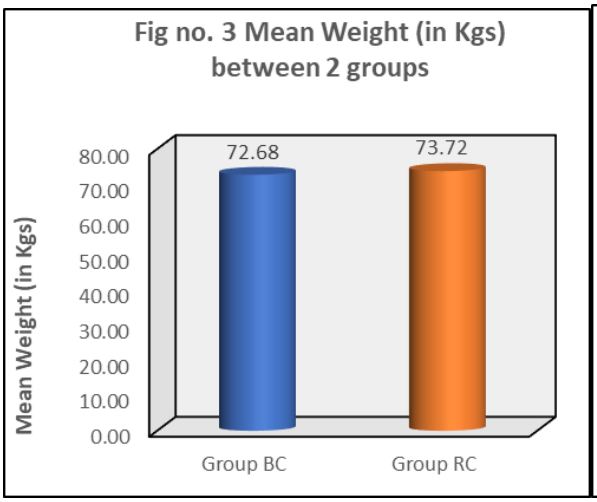
In terms of gender distribution, Group BC consisted of 52.0% males (n = 13) and 48.0% females (n = 12). Similarly, Group RC comprised 56.0% males (n = 14) and 44.0% females (n = 11). The gender distribution between the groups was not statistically significant, as indicated by a p-value of 0.78. (fig no.2)

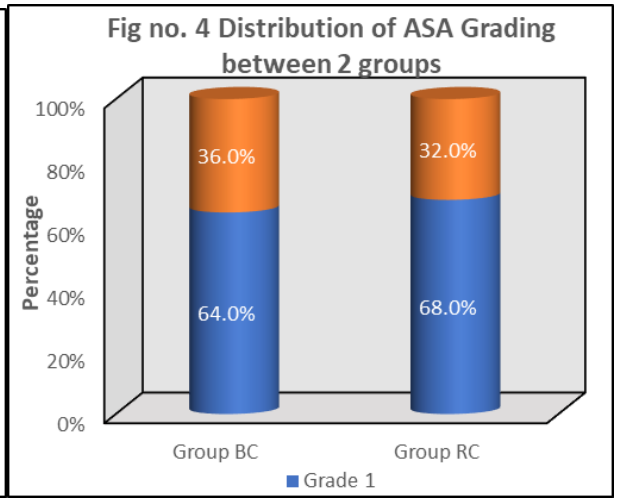




The comparison of mean weight between the two groups was conducted. Group BC had a mean weight of 72.68 ± 5.68 kg, while Group RC exhibited a slightly higher mean weight of 73.72 ± 5.37 kg. The mean difference in weight between the two groups was 1.04 kg. The statistical analysis indicated that this difference was not significant, with a p-value of 0.51. Thus, the weights of the individuals in both groups were comparable. (fig no.3)

The distribution of ASA grading between the two groups was analyzed. In Group BC, 64.0% (n=16) of subjects were classified as ASA Grade 1, while 36.0% (n=9) were ASA Grade 2. In Group RC, 68.0% (n=17) were ASA Grade 1, and 32.0% (n=8) were ASA Grade 2. The comparison showed no statistically significant difference in ASA grading distribution between the groups, with a p-value of 0.77. (fig no.4)





The comparison of mean duration of surgery between the two groups revealed that Group BC had a mean duration of 85.28 ± 8.31 minutes, whereas Group RC had a mean duration of 85.44 ± 6.25 minutes. The mean difference in duration was 0.16 minutes. The statistical analysis showed that this difference was not significant, with a p-value of 0.84. Therefore, the duration of surgery was comparable between the two groups. (fig no.5)

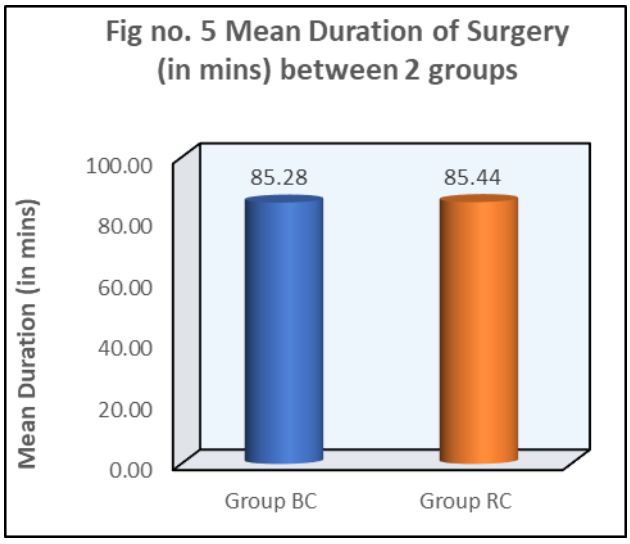


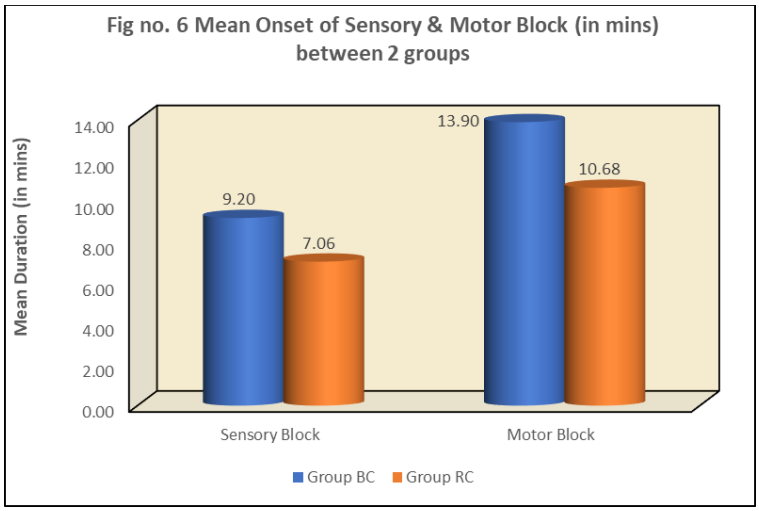
Table 1. Demographic and clinical characteristics of the study groups

Characteristics	Group RC	Group BC	p-value	Significant
Age in years(Mean±SD)	36.80 ± 9.16	34.84 ± 7.80	0.47	No
Weight in kg(Mean±SD)	73.72 ± 5.37	72.68 ± 5.68	0.51	No
Sex (male:female)	14:11	13:12	0.78	No
ASA PS I (n, %)	17(68%)	16(64%)	0.77	No
ASA PS II (n, %)	8(32%)	9(36%)		
Duration of Surgery in minutes (Mean±SD)	85.44 ± 6.25	85.28 ± 8.31	0.84	No

The comparison of block characteristics between the two groups is as in Table 2.

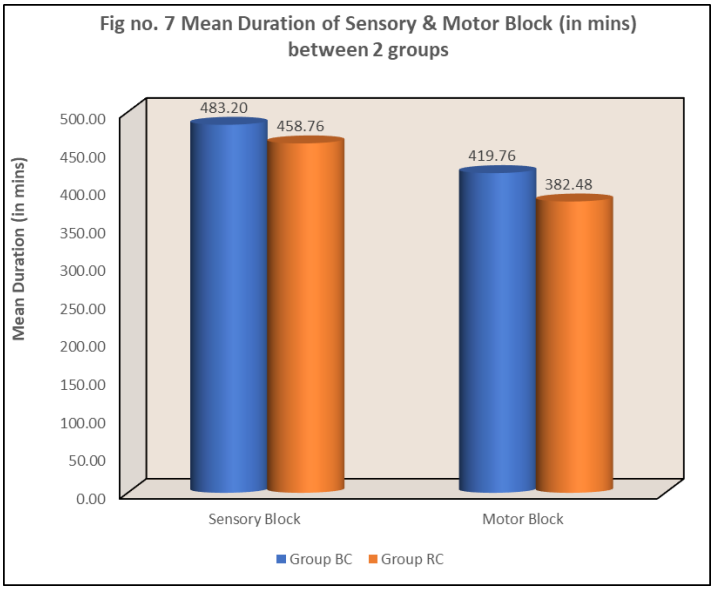
The comparison of the onset of sensory block between the two groups showed that Group BC had a mean onset time of 9.20 ± 1.12 minutes, whereas Group RC had a mean time of 7.06 ± 0.74 minutes. The mean difference was 2.14 minutes, and this difference was statistically significant with a p-value of less than 0.001.

Similarly, the onset of motor block in Group BC was observed at a mean of 13.90 ± 1.65 minutes, compared to 10.68 ± 1.05 minutes in Group RC. The mean difference was 3.22 minutes, which was also statistically significant with a p-value of less than 0.001. These findings indicated that both sensory and motor blocks occurred earlier in Group RC compared to Group BC. (fig no.6)



The comparison of the mean duration of sensory block between the two groups indicated that Group BC experienced a longer sensory block lasting 483.20 ± 21.82 minutes, whereas Group RC had a mean duration of 458.76 ± 21.26 minutes. The mean difference was 24.44 minutes, and this difference was statistically significant with a p-value of less than 0.001.

Similarly, for the motor block, Group BC showed a mean duration of 419.76 ± 27.11 minutes, compared to 382.48 ± 17.32 minutes in Group RC. The mean difference of 37.28 minutes was also statistically significant with a p-value of less than 0.001. These results suggested that both sensory and motor blocks lasted significantly longer in Group BC than in Group RC. (fig no.7)



The comparison of the mean duration of analgesia between the two groups revealed that Group BC experienced an average of 607.12 ± 40.04 minutes of analgesia, whereas Group RC had an average duration of 588.36 ± 13.71 minutes. The mean difference was 18.76 minutes, which was statistically significant with a p-value of 0.03. This indicated that Group BC had a significantly longer duration of analgesia compared to Group RC. (fig no.8)

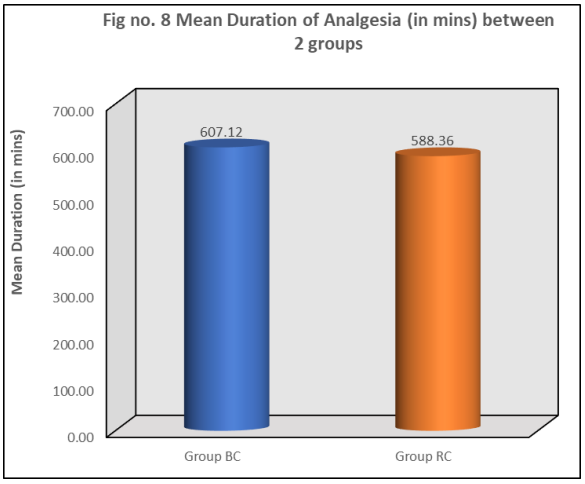
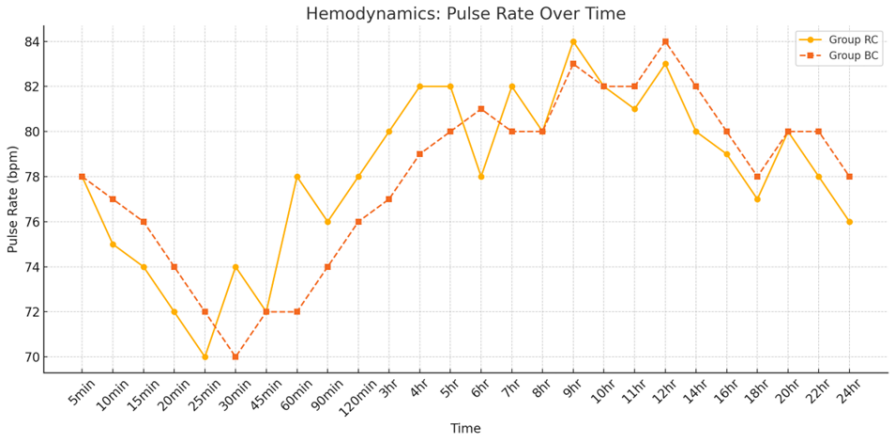
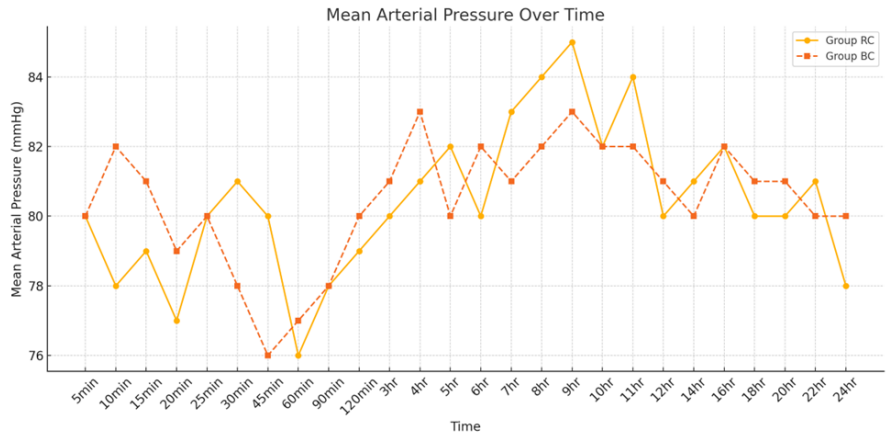


Table 2: Block characteristics

Variables	Group RC (Mean ± SD)	Group BC (Mean ± SD)	p-value	Significant
Onset of Sensory block (minutes)	**7.06 ± 0.74**	9.20 ± 1.12	<0.001	**Yes**
Onset of Motor block (minutes)	**10.68 ± 1.05**	13.90 ± 1.65	<0.001	**Yes**
Duration of Sensory block (minutes)	458.76 ± 21.26	**483.20 ± 21.82**	<0.001	**Yes**
Duration of Motor block (minutes)	382.48 ± 17.32	**419.76 ± 27.11**	<0.001	**Yes**
Duration of Analgesia (minutes)	588.36 ± 13.71	**607.12 ± 40.04**	0.03	**Yes**

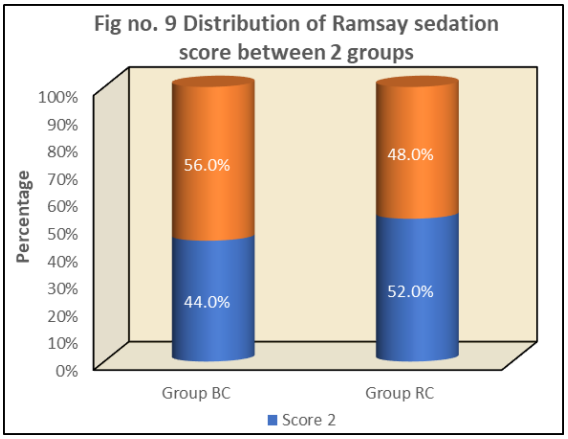
No statistically significant difference was observed in heart rate, blood pressure, and oxygen saturation between the two groups at any time point.





The comparison of Ramsay sedation score and Adverse effects between the two groups is as in Table 3.

The distribution of Ramsay sedation scores between the two groups showed that in Group BC, 44.0% (n=11) of subjects had a score of 2, and 56.0% (n=14) had a score of 3. In Group RC, 52.0% (n=13) of subjects scored 2, while 48.0% (n=12) scored 3. The comparison indicated no statistically significant difference between the groups, with a p-value of 0.57. (fig no.9)



The comparison of adverse effects between the two groups revealed that bradycardia occurred in 20.0% (n=5) of subjects in Group BC and 16.0% (n=4) in Group RC, with no significant difference (p=0.71). (fig no.10)

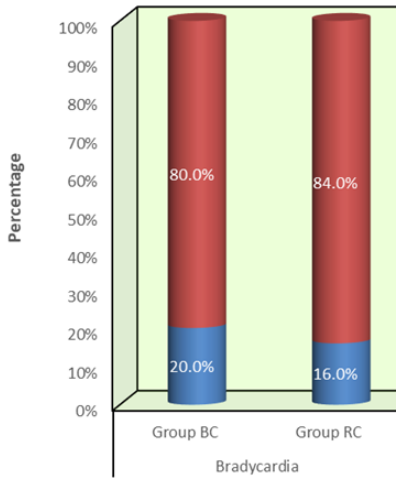


Fig no.10 Distribution of Adverse effects- Bradycardia

The comparison of adverse effects between the two groups revealed that bradycardia (HR<60bpm) occurred in both the groups but was not significant (HR not <50bpm and was not associated with hypotension) and thus were not treated with Atropine.

There were no incidences of hypotension, nausea or vomiting, desaturation (SpO_2 <95%).

Overall, the incidence of adverse effects was comparable between the two groups.

Table 3: Comparison of Ramsay sedation score and Adverse effects

Variables	Category	Group RC n (%)	Group BC n (%)	p-value	Significant
Bradycardia	Yes	**4(16.0%)**	**5(20.0%)**	0.71	**No**
	No	21(84.0%)	20(80.0%)		
Ramsay sedation score(overall)	Score 2	**13(52.0%)**	**11(44.0%)**	0.57	**No**
	Score 3	**12(48.0%)**	**14(56.0%)**		

VI. Discussion

- In this study, the demographic characteristics - age, gender, weight distribution and also ASA grading distribution were comparable with no statistically significant difference between the two groups : Group BC, which received Inj. Bupivacaine 0.5% with Clonidine, and Group RC, which received Inj. Ropivacaine 0.5% with Clonidine, suggesting similar baseline health conditions across the groups.
- The time of onset of sensory and motor blocks were notably earlier in Group RC (Ropivacaine plus Clonidine), with a p-value of <0.001 indicating that it offers a quicker onset.
- The duration of sensory and motor blocks and also the duration of analgesia were longer, which refers to how long postoperative pain relief lasted, was significantly longer in Group BC receiving Bupivacaine with Clonidine, with a p-value of <0.001 .
- The sedation levels, as measured by Ramsay scores, showed no statistically significant differences, suggesting that both drug combinations produced comparable sedation levels during the perioperative period.
- Safety profiles were also evaluated, focusing on adverse effects such as bradycardia and hypotension. The incidence of these adverse effects was low and did not differ significantly between the groups, indicating that both anaesthetic regimens were safe and well tolerated.
- KN Patil. et al.[3] conducted a study using Clonidine as an adjuvant to ropivacaine-induced supraclavicular brachial plexus block for upper limb surgeries and found that the onset of sensorimotor block was earlier and the duration of both sensory/motor block and analgesia were significantly prolonged by clonidine. And although incidence of hypotension and bradycardia was higher with clonidine, it was not clinically significant.
- Gupta K. et al. [1] conducted a comparative study on 60 patients, using Clonidine as an adjuvant with 0.75% Ropivacaine for ultrasound guided supraclavicular brachial plexus block for upper extremity surgeries under tourniquet and found that post-operative analgesia was prolonged in RC group (mean duration 956 min) as compared with R group (736 min), with no significant difference in the onset of sensory and motor blockade and the occurrence of adverse effects.
- Jayshree. et al.[4] conducted a study comparing Bupivacaine And Addition of Clonidine To Bupivacaine in Supraclavicular Brachial Plexus Nerve Block and found that there was early onset and prolongation of duration of sensory and motor block in the group that received clonidine as an adjunct and there was also decrease in heart rate and systolic blood pressure, higher sedation score and lower analgesic requirement.
- Sirohiya P. et al.[5] conducted a study on 60 patients comparing the effect of bupivacaine and bupivacaine + clonidine combination in supraclavicular brachial plexus block. The time of onset of sensory blockade and motor blockade were reduced and duration of sensory and motor blockade and post operative analgesia were prolonged and a higher Sedation score in the group that received clonidine.
- Modak S. et al.[7] conducted a Comparative study of 0.5% ropivacaine and 0.5% bupivacaine for brachial plexus block by supraclavicular approach for upper limb surgeries and found that Ropivacaine had earlier onset of sensory and motor blockade and a longer duration of sensory and motor blockade compared to bupivacaine.
- Gahlot H. et al.[8] conducted a comparative study between 0.5% Bupivacaine and 0.75% Ropivacaine in USG guided Supraclavicular Brachial Plexus Block and concluded that the onset of sensory and motor blockade was earlier in ropivacaine group, while mean duration of block was significantly longer in bupivacaine group. Our study has shown to have similar results.

VII. Conclusion

- This study found that both, Bupivacaine + Clonidine and Ropivacaine + Clonidine are effective and safe for regional anesthesia.
- Ropivacaine with Clonidine produced a faster onset of both sensory and motor block, whereas Bupivacaine with Clonidine provided a longer duration of block and postoperative analgesia.
- Surgical duration and sedation were similar between groups, and adverse effects, including bradycardia - were infrequent and equivalent in both.
- Thus, Ropivacaine + Clonidine suits situations needing rapid block onset, while Bupivacaine + Clonidine offers prolonged postoperative pain relief.
- The choice should be tailored to clinical needs and patient-specific factors. Both combinations demonstrated favorable safety profiles and are viable options to optimize perioperative pain control and patient comfort.

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