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RESEARCH ARTICLE

Dexmedetomidine Versus Dexamethasone as an Adjuvant in Supraclavicular Brachial Plexus Block: A Comparative Study

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ABSTRACT

Background: Supraclavicular brachial plexus block is widely used for upper limb surgeries because it provides excellent intraoperative anesthesia and prolonged postoperative analgesia. Various adjuvants have been added to local anesthetics to improve block characteristics and prolong analgesic duration. Dexmedetomidine and dexamethasone are among the most commonly used adjuvants in peripheral nerve blocks.

Aim: To compare dexmedetomidine and dexamethasone as adjuvants to bupivacaine in supraclavicular brachial plexus block with respect to onset and duration of sensory and motor blockade, duration of postoperative analgesia, and adverse effects.

Materials and Methods: A prospective randomized comparative study was conducted in the Department of Anaesthesiology at SCB Medical College, Cuttack and SJMCH, Puri over a period of 11 months. A total of 110 patients undergoing elective upper limb surgeries under supraclavicular brachial plexus block were included. Patients were randomly allocated into two groups: Group DEX receiving dexmedetomidine 1 µg/kg with bupivacaine and Group DEXA receiving dexamethasone 8 mg with bupivacaine. Sensory block onset, motor block onset, duration of analgesia, hemodynamic parameters, and complications were evaluated. Statistical analysis was performed using IBM SPSS version 26.0. Independent t-test, Chi-square test, repeated measures ANOVA, and Kaplan–Meier survival analysis were applied. A p-value <0.05 was considered statistically significant.

Results: The onset of sensory block was significantly shorter in Group DEX compared to Group DEXA (8.42 ± 1.64 min vs 10.86 ± 1.88 min; p<0.001). Duration of postoperative analgesia was significantly prolonged in Group DEXA (846.5 ± 92.6 min) compared to Group DEX (768.2 ± 84.3 min; p<0.001). Bradycardia was more common in Group DEX (p=0.048).

Conclusion: Dexmedetomidine provides faster onset of blockade, whereas dexamethasone significantly prolongs postoperative analgesia and duration of blockade when used as adjuvants in supraclavicular brachial plexus block.

Keywords: Dexmedetomidine, Dexamethasone, Supraclavicular brachial plexus block, Peripheral nerve block, Postoperative analgesia, Bupivacaine.

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Introduction

Regional anesthesia has become an important component of modern anesthetic practice because it provides superior perioperative analgesia, decreases opioid consumption, facilitates early mobilization, and improves patient satisfaction following surgery [1]. Supraclavicular brachial plexus block is widely considered one of the most effective approaches for upper limb surgeries because it provides dense anesthesia with rapid onset and reliable surgical conditions [2].

Bupivacaine is commonly used for peripheral nerve blocks because of its long duration of action and favorable sensory blockade profile [3]. However, single-shot brachial plexus block is often limited by relatively shorter postoperative analgesic duration, necessitating the use of adjuvants to enhance block quality and prolong analgesia [4].

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Various adjuvants have been investigated to improve onset time, prolong duration of sensory and motor blockade, and reduce postoperative analgesic requirements [5]. Dexmedetomidine and dexamethasone have emerged as two of the most frequently used adjuvants in peripheral nerve blocks [6].

Dexmedetomidine is a highly selective alpha-2 adrenergic agonist possessing sedative, anxiolytic, sympatholytic, and analgesic properties [7]. It enhances the effects of local anesthetics by inhibiting norepinephrine release and causing hyperpolarization of nerve tissues [8]. Previous studies have demonstrated that dexmedetomidine shortens onset time and prolongs duration of sensory and motor blockade when used in brachial plexus blocks [9].

Dexmedetomidine has also been associated with improved perioperative hemodynamic stability and decreased postoperative analgesic requirements [10]. However, adverse effects such as bradycardia and hypotension remain important concerns during its clinical use [11].

Dexamethasone is another widely used adjuvant in peripheral nerve blocks because of its potent anti-inflammatory and analgesic effects [12]. The proposed mechanisms include suppression of inflammatory mediators, inhibition of ectopic neuronal discharge, and vasoconstrictive action that delays systemic absorption of local anesthetics [13].

Several studies have shown that dexamethasone significantly prolongs postoperative analgesia and duration of blockade without increasing neurotoxicity [14]. However, comparative evidence regarding dexmedetomidine and dexamethasone in supraclavicular brachial plexus block remains limited in the Indian population. Therefore, the present study was undertaken to compare dexmedetomidine and dexamethasone as adjuvants to bupivacaine in ultrasound-guided supraclavicular brachial plexus block.

Materials And Methods

Study Design

Prospective randomized comparative study.

Study Duration

11 months.

Study Place

Department of Anaesthesiology, SCB Medical College, Cuttack and SJMCH, Puri.

Sample Size

A total of 110 patients were included in the study.

Inclusion Criteria

- Age between 18 and 65 years
- ASA physical status I and II
- Elective upper limb surgeries
- Written informed consent

Exclusion Criteria

- Allergy to study drugs
- Coagulopathy
- Infection at puncture site
- Severe hepatic or renal disease
- Pregnancy
- Pre-existing neuropathy

Group Allocation

Group DEX (n=55)

Received 28 mL of 0.5% bupivacaine with dexmedetomidine 1 µg/kg.

Group DEXA (n=55)

Received 28 mL of 0.5% bupivacaine with dexamethasone 8 mg.

Parameters Assessed

- Onset of sensory block
- Onset of motor block
- Duration of sensory block
- Duration of motor block
- Duration of postoperative analgesia
- VAS score
- Hemodynamic parameters
- Adverse effects

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0. Independent t-test, Chi-square test, repeated measures ANOVA, and Kaplan–Meier survival analysis were applied. A p-value <0.05 was considered statistically significant.

Ethical Consideration

Institutional Ethics Committee approval was obtained before commencement of the study, and written informed consent was obtained from all patients.

Results

A total of 110 patients undergoing elective upper limb surgeries under ultrasound-guided supraclavicular brachial plexus block were included in the study. Patients were randomly divided into two equal groups comprising 55 patients each. Group DEX received dexmedetomidine as

an adjuvant to bupivacaine, while Group DEXA received dexamethasone with bupivacaine. The demographic variables were comparable between both groups, and no statistically significant difference was observed with respect to age, gender, body weight, or ASA physical status.

Demographic Characteristics of Study Population

The mean age in Group DEX was 41.6 ± 12.4 years, while in Group DEXA it was 42.8 ± 11.7 years. Male predominance was observed in both groups. Statistical analysis revealed no significant intergroup difference in baseline demographic parameters ($p>0.05$), indicating adequate comparability between the study groups.

The demographic characteristics were comparable between the two groups as shown in Table 1 and Figure 1.

Block Characteristics

The onset of sensory blockade was significantly faster in Group DEX compared to Group DEXA. Mean sensory block onset time was 8.42 ± 1.64 minutes in Group DEX and 10.86 ± 1.88 minutes in Group DEXA ($p<0.001$). Similarly, onset of motor blockade was significantly earlier in Group DEX.

However, the duration of sensory block, motor block, and postoperative analgesia was significantly prolonged in Group DEXA compared to Group DEX ($p<0.05$). These findings suggest that dexmedetomidine provides faster onset whereas dexamethasone offers prolonged analgesic duration.

The comparison of block characteristics between the study groups is shown in Table 2 and Figure 2.

Hemodynamic Parameters

Hemodynamic parameters including heart rate and mean arterial pressure were monitored intraoperatively and postoperatively. Baseline heart rate values were comparable between the two groups. However, Group DEX demonstrated significantly lower heart rate values during the intraoperative period at 15, 30, and 60 minutes compared to Group DEXA.

Despite statistically significant reductions, the heart rate remained within clinically acceptable limits and did not require pharmacological intervention in most patients.

A statistically significant reduction in intraoperative heart rate was observed in Group DEX as shown in Table 3 and Figure 3.

Postoperative Pain Assessment

Postoperative pain was assessed using the Visual Analogue Scale (VAS). Mean VAS scores at 2 hours postoperatively

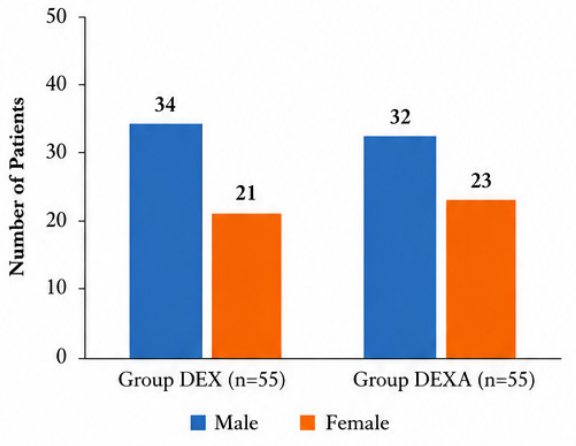

Figure 1: Gender Distribution Between Study Groups

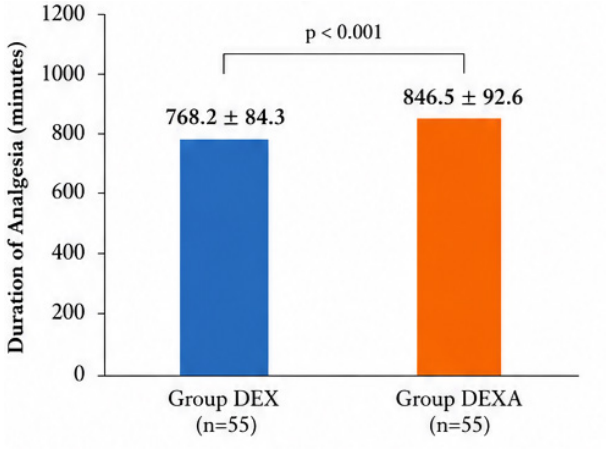

Figure 2: Comparison of Duration of Analgesia Between Groups

Table 1: Demographic Profile of Patients

Parameter	*Group DEX (n=55)*	*Group DEXA (n=55)*	*Statistical Value*	*p-value*
Mean age (years)	41.6 ± 12.4	42.8 ± 11.7	t = 0.51	0.612
Male/Female	34/21	32/23	$\chi^2 = 0.15$	0.702
Mean weight (kg)	63.4 ± 8.6	64.1 ± 9.2	t = 0.40	0.688
ASA I/II	36/19	33/22	$\chi^2 = 0.35$	0.554

Table 2: Comparison of Sensory and Motor Block Parameters

Parameter	*Group DEX*	*Group DEXA*	*t-value*	*p-value*
Sensory block onset (min)	8.42 ± 1.64	10.86 ± 1.88	7.26	<0.001
Motor block onset (min)	11.18 ± 2.02	13.34 ± 2.26	5.29	<0.001
Duration of sensory block (min)	721.4 ± 80.6	812.5 ± 88.2	5.64	<0.001
Duration of motor block (min)	645.6 ± 72.1	712.8 ± 76.4	3.17	0.002
Duration of analgesia (min)	768.2 ± 84.3	846.5 ± 92.6	4.62	<0.001

Table 3: Comparison of Mean Heart Rate Between Groups

Time Interval	*Group DEX*	*Group DEXA*	*t-value*	*p-value*
Baseline	82.4 ± 8.6	81.8 ± 7.9	0.34	0.734
15 min	76.2 ± 7.1	80.6 ± 6.8	2.93	0.004
30 min	74.4 ± 6.8	79.8 ± 7.2	3.42	0.001
60 min	75.1 ± 7.2	80.1 ± 6.9	3.18	0.002

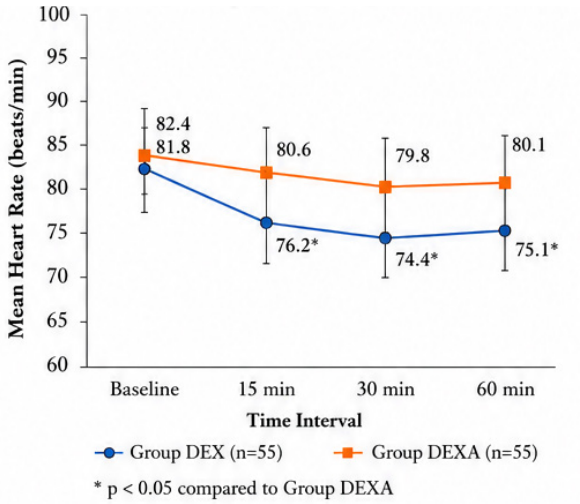

Figure 3: Mean Heart Rate Trend Between Groups

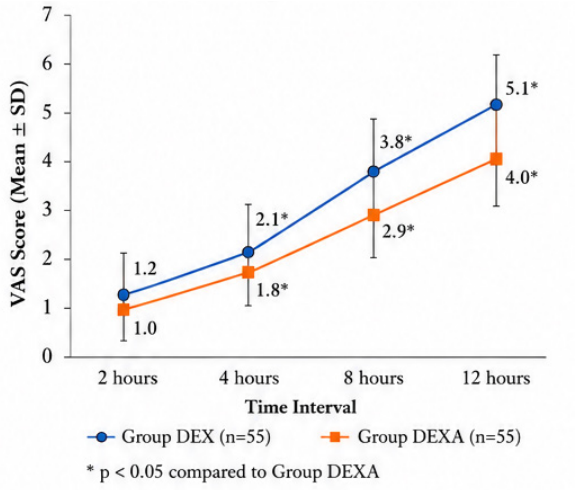

Figure 4: Comparison of Postoperative VAS Scores Between Groups

were comparable between both groups. However, significantly lower VAS scores were observed in Group DEXA at 4, 8, and 12 hours postoperatively, indicating prolonged analgesic efficacy with dexamethasone.

Postoperative VAS score comparison between the groups is shown in Table 4 and Figure 4.

Requirement of Rescue Analgesia

The mean time to first rescue analgesic requirement was significantly prolonged in Group DEXA compared to Group DEX. Patients receiving dexamethasone required rescue analgesia much later than those receiving dexmedetomidine. Time to first rescue analgesia was significantly prolonged in Group DEXA as shown in Table 5 and Figure 5.

Adverse Effects

Adverse effects observed during the study included bradycardia, hypotension, nausea/vomiting, and sedation. Bradycardia was significantly more common in Group DEX compared to Group DEXA (p=0.048). No cases of respiratory depression, pneumothorax, local anesthetic toxicity, or neurological deficits were observed in either group.

Table 4: Comparison of Postoperative VAS Scores

Time interval	*Group DEX*	*Group DEXA*	*t-value*	*p-value*
2 hours	1.2 ± 0.6	1.0 ± 0.4	1.76	0.081
4 hours	2.1 ± 0.8	1.8 ± 0.7	1.99	0.048
8 hours	3.8 ± 1.0	2.9 ± 0.9	4.97	<0.001
12 hours	5.1 ± 1.2	4.0 ± 1.1	5.01	<0.001

Table 5: Time to First Rescue Analgesia

Parameter	*Group DEX*	*Group DEXA*	*t-value*	*p-value*
Time to first rescue analgesia (min)	768.2 ± 84.3	846.5 ± 92.6	4.62	<0.001

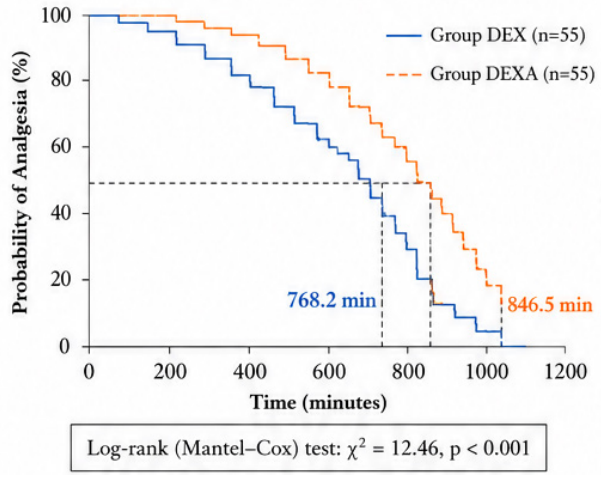

Figure 5: Kaplan–Meier Curve Showing Duration of Analgesia

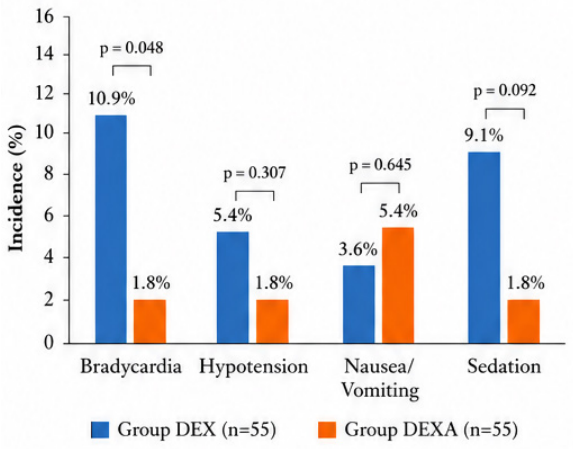

Figure 6: Incidence of Adverse Effects Between Groups

The incidence of adverse effects between the groups is summarized in Table 6.

Overall Statistical Summary

The present study demonstrated that dexmedetomidine significantly hastened onset of sensory and motor blockade, whereas dexamethasone significantly prolonged duration of sensory block, motor block, and postoperative analgesia. Although bradycardia was more frequently observed with dexmedetomidine, no major complications occurred in either group.

Discussion

The present study demonstrated that dexmedetomidine significantly shortened onset time of sensory and motor blockade, whereas dexamethasone significantly prolonged postoperative analgesia and duration of blockade. Similar findings were reported by Marhofer et al., who observed prolonged peripheral nerve blockade with dexmedetomidine as an adjuvant to ropivacaine [15].

In the current study, onset of sensory blockade was significantly faster in the dexmedetomidine group. Abdallah and Brull also demonstrated that alpha-2 agonists improve onset characteristics and enhance quality of peripheral nerve blocks [16].

The prolonged duration of postoperative analgesia observed with dexamethasone in the present study is consistent with findings reported by Albrecht et al., who concluded that dexamethasone significantly prolongs analgesia when used as a perineural adjunct [17].

Hussain et al. demonstrated that dexamethasone provides superior analgesic duration compared to several other adjuvants used in peripheral nerve blocks [18]. Similar observations were reported by Verma et al., who found significantly prolonged analgesia with dexamethasone compared to dexmedetomidine in supraclavicular brachial plexus block [19].

Table 6: Complications Observed in Study Groups

Complication	*Group DEX (n=55)*	*Group DEXA (n=55)*	*χ^2 value*	*p-value*
Bradycardia	6 (10.9%)	1 (1.8%)	3.91	0.048
Hypotension	3 (5.4%)	1 (1.8%)	1.04	0.307
Nausea/Vomiting	2 (3.6%)	3 (5.4%)	0.21	0.645
Sedation	5 (9.1%)	1 (1.8%)	2.84	0.092
Respiratory depression	0	0	—	—

The present study also showed lower postoperative VAS scores in the dexamethasone group during the later postoperative period. Hassan et al. similarly observed improved postoperative pain control with dexamethasone as an adjuvant [20].

Hemodynamic parameters remained stable in both groups, although bradycardia was more common in patients receiving dexmedetomidine. This finding correlates with the sympatholytic effects of dexmedetomidine described by Kehlet and Wilmore in multimodal perioperative analgesia studies [21].

The incidence of adverse effects in the present study was minimal and comparable with previous investigations. Choi et al. demonstrated that dexamethasone can safely prolong analgesia without increasing major neurological complications [22].

The absence of severe complications such as respiratory depression or pneumothorax in the present study may be attributed to the use of ultrasound guidance. Liu et al. reported similar safety outcomes with ultrasound-guided peripheral nerve blocks using adjuvants [23].

Schnabel et al. conducted a meta-analysis and concluded that dexmedetomidine effectively prolongs peripheral nerve blockade but may increase incidence of bradycardia and sedation [24]. The present study findings are in agreement with these observations.

Hussain et al. in a recent network meta-analysis suggested that individualized selection of adjuvants based on surgical duration and postoperative analgesic requirements may improve clinical outcomes [25]. The present study supports this approach, with dexmedetomidine providing rapid onset and dexamethasone offering prolonged analgesia.

Conclusion

Both dexmedetomidine and dexamethasone are effective adjuvants to bupivacaine in supraclavicular brachial plexus block. Dexmedetomidine provides significantly faster onset of sensory and motor blockade, whereas dexamethasone significantly prolongs duration of postoperative analgesia and blockade. Selection of adjuvant should be individualized according to surgical and postoperative analgesic requirements.

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