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Original Article

Anaesthesia Section

Supraclavicular Brachial Plexus Block: Comparision of Two Different Doses of Dexmedetomidine as an Adjunct to Bupivacaine: A Study

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ABSTRACT

Introduction: Supraclavicular brachial plexus block is commonly performed for upper limb surgeries. A variety of adjuvants are added to the local anaesthetic to fasten the onset and prolong the duration of sensorimotor block.

Aim: To assess the efficacy of two different doses of Dexmeditomidine as an adjuvant in supraclavicular brachial plexus block.

Materials and Methods: This was a prospective randomised study conducted on 99 ASA I and II patients, aged 18-60 years, posted for upper limb surgeries. Patients were randomised into three groups. Group S received 25 mL of 0.5% bupivacaine and 2 mL of NS, Group D20 received 25 mL of 0.5% bupivacaine and 20 µg of Dexmeditomidine in 2 mL NS, Group D40 received 25 mL of 0.5% bupivacaine and 40 µg of Dexmeditomidine in 2 mL NS. Statistical analysis was performed using ANOVA test and Bonferoni's correction for intergroup comparison.

Results: The onset of sensory block was faster in D40 group (8.94±2.99 minutes) compared to D20 (14.55±2.89 minutes) and S group (21.36±4.3 minutes). The onset of motor blockade was 24.55±4.5 minutes in S group, 16.97±16.97 minutes in D20 group and 10.15±2.92 minutes in D40 group. Duration of sensory block was longer in D40 (14.47±0.975 hours) compared to D20 (12.52±1.307 hours) and S group (7.27±1.26 hours). The total mean duration of motor blockade was 6.242±1.22 hours in S group, 11.17±1.254 hours in D20 group and 13.09±1.18 hours in D40 group. The haemodynamic parameters were comparable in all the three groups.

Conclusion: Faster onset, longer duration of sensorimotor blockade and prolonged postoperative analgesia proved Dexmeditomidine was effective when used with bupivacaine as an adjuvant in supraclavicular blocks and the effect is also dose dependent.

Keywords: Haemodynamic stability, Sensorimotor blockade, Ultrasound guided nerve block

INTRODUCTION

Supraclavicular brachial plexus block is the preferred anaesthetic technique for upper limb surgeries which provides complete muscle relaxation, stable intraoperative haemodynamics and smooth transition to postoperative pain relief. Brachial plexus block was first described by Halstead and later improvised by Kulenkempff (the classical supraclavicular approach) and Winnie (the perivascular approach) [1]. The effects of single-injection brachial plexus block dissipate after several hours unmasking the moderate-to-severe pain of the surgical insult. The LA dose can be increased but only to some extent as their therapeutic window is narrow [2]. Thus, the addition of adjuvant not only augments the anaesthetic action of the drug but also reduces the dose required thus improving the safety margin. A variety of perineural adjuvants [3-6] have been tried to hasten the time of onset and prolong the duration of analgesia of nerve blocks with varying degrees of success.

Dexmedetomidine, a newer α_2-adrenoreceptor agonist is a promising adjuvant for local anaesthetics for its sedative, anxiolytic and analgesic properties. Dexmedetomidine as an adjuvant is shown to prolong the duration of block and postoperative analgesia when added to local anaesthetic in various regional blocks [7-9]. The dose of Dexmeditomidine as an adjuvant in supraclavicular blocks vary from 0.1 µg/kg to 1 µg/kg. So considering the average body weight of Indian adults as 70 kg, in this study, we chose the lower possible doses 0.3 µg/kg and 0.6 µg/kg which comes to 20-40 µg.

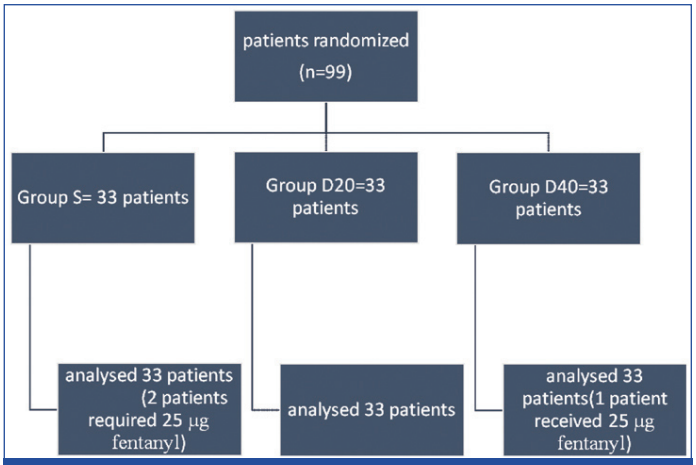
The present study was conducted with the aim of assessing the efficacy adding dexmedetomidine, at two doses of 20 µg and 40 µg, added to 0.5% bupivacaine, in patients posted for upper limb surgeries under supraclavicular brachial plexus block. The secondary outcomes measured were the onset and duration of sensorimotor blockade, haemodynamic variables and adverse events.

MATERIALS AND METHODS

After approval from the hospital ethical committee (CTRI NO:2014/10/007755) and with patients written consent, 99 American Society of Anaesthesiologists (ASA) physical Status I and II patients, aged 18-60 years, undergoing upper limb surgeries under supraclavicular brachial plexus block, were enrolled in this prospective, randomised controlled study. Patients with diabetes, peripheral neuropathy, with known allergy to local anaesthetics, coagulopathy, infection at the site of block, pregnancy, and patients on beta blockers were excluded from the study.

Assuming, a 45 minutes difference in prolongation of sensory analgesia and taking the power of study at 90% by keeping Type I error (α=0.05) and Type II error (β=0.1), the sample size was calculated as 30 patients in each group. We enrolled 33 patients in each group for the better validation of study results. Patients were randomly allocated by computer generated randomization number into 3 groups. Single blinding was done to avoid bias. The participants were unaware of the group to which they are allocated.

D20 Group: Patients received 25 mL of 0.5% bupivacaine with 20 µg of Dexmeditomidine in 2 mL of NS (total volume 27 mL) D40 Group: Patients received 25 mL of 0.5% bupivacaine with 40 µg of Dexmeditomidine in 2 mL of NS (total volume 27 mL) and S Group: Patients received 25 mL of 0.5% bupivacaine with 2 mL of NS (total volume 27 mL) [Table/Fig-1]. There were no drop outs from the study.



[Table/Fig-1]: Consort diagram showing the number of patients included and analysed.

After connecting the patients to pre induction monitors, an 18G cannula was secured and oxygen was delivered through the face mask. Under aseptic precautions, supraclavicular brachial plexus block was performed using a B Braun simuplex needle under ultrasound guidance with a linear probe with a frequency of 6-13 Hz and the study drug was deposited into the brachial plexus sheath. Sensory block was assessed by pin prick method every five minutes after drug injections at the dermatomes corresponding to median, radial, ulnar and musculocutaneous nerves. Sensory block was considered complete when the patient experienced complete loss of sensation to pin prick. **Sensory block** was graded using a three-point scale: Grade 0- sharp pain felt; Grade 1- moderate analgesia, dull pain felt; Grade 2- good analgesia, no sensation. Assessment of motor block was carried out using the three-point scale every five minutes till complete motor blockade was achieved. **Motor blockade** was assessed using a modified Bromage scale for upper extremities on a three-point scale [10]: Grade 0– normal motor function with full flexion and extension of elbow, wrist and fingers; Grade 1– decreased motor strength with ability to move fingers only; Grade 2– complete motor blockade with inability to move fingers too. When a patient experienced pain in the segments supplied by median, radial, ulnar or the musculocutaneous nerves even after 30 minutes, the block was considered incomplete and supplemented by IV Fentanyl 1 µg/kg and Midazolam 0.04 µg/kg. The block was considered to be a failed block if more than one nerve remained unaffected, in which case general anaesthesia was given and the patient was excluded from the study. Parameters observed were: Duration of sensory blockade and motor blockade (time from local anaesthetic administration to complete recovery of sensory and motor functions), duration of analgesia (time from administration of supraclavicular block to time of first request to analgesics). Rescue analgesics (inj. Tramadol 1-2 mg/kg) was given if Visual Analog Scale was more than 3. Total requirement of tramadol in the first hour was also noted. Patient was observed for any side effects like postoperative nausea and vomiting, bradycardia, hypotension, pruritus, respiratory depression or local anaesthetic toxicity.

For statistical analysis, data were collected and entered in MS Excel 2010. Statistical analysis was performed using SPSS software 18 (SPSS, Inc., Chicago, IL, USA). Interval data are expressed as mean and standard deviation. Statistical analysis was done using ANOVA test and intergroup comparison was done with Bonferoni's correction. The p-value <0.05% was considered significant.

RESULTS

The average age of the patients was 34.67 years, the youngest being 19 years and oldest being 49 years. The average weight of the patients was 69.18 kg, ranging from 42 kg to 89 kg. The baseline haemodynamic parameters such as heart rate, blood pressure were comparable in all the three groups [Table/Fig-2,3].

	S group	D20 group	D40 group	
Age (years)	34.67±10.463	35.55±13.889	34.73±8.289	p=0.010
Weight (kg)	69.18±8.199	63.52±14.142	66.64±13.617	p=0.177
Gender (M/F)	28/5	24/9	25/8	p=0.468

[Table/Fig-2]: Demographic variables.

Variable	S group	D20 group	D40 group	
Pre op HR	80.24 (10.494)	78.36 (14.084)	80.39 (11.051)	p=0.746
Pre op SBP	127.39 (13.313)	126.55 (16.914)	131.18 (16.183)	p=0.438
Pre op DBP	80.03 (8.600)	81.55 (9.563)	85.70 (10.221)	p=0.47

[Table/Fig-3]: Preoperative haemodynamics.

Among the three groups, the onset of sensorimotor blockade was faster in D40 group when compared to D20 and S group. Inter group comparison by Bonferoni's correction showed a faster onset in D20 group than S group. The duration of sensory blockade and motor blockade was also longer in D40 than in D20 and S groups [Table/Fig-4].

Variable	Sensory block onset (min)	Motor block onset (min)	Duration of sensory block (hours)	Duration of motor block (hours)
D40 group	8.94±2.9	10.15±2.92	14.47±0.97	13.09±1.182
D20 group	14.55±2.89	16.97±4.6	12.51±1.3	11.16±1.25
S group	21.36±4.37	24.55±4.5	7.27±1.2	6.24±1.22

[Table/Fig-4]: Outcome variables.

There was no statistically significant difference in the intraoperative haemodynamics such as mean heart rate and blood pressure at 5, 10, 15,20,25, 30,45,60,75,90,105 and 120 minutes among the three groups. A p-value of <0.05 was considered significant [Table/Fig-5-8].

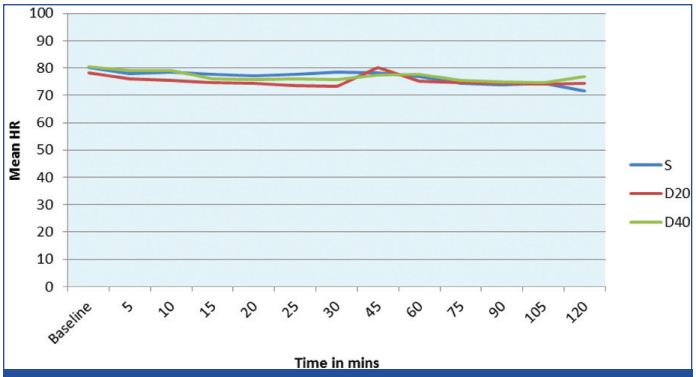
Time (minutes)	Study groups			p-value
	S group	D 20	D 40	
	(Mean±SD)	(Mean±SD)	(Mean±SD)	
5	77.94±9.536	75.8±13.984	79.18±10.457	0.501
10	78.45±9.028	75.52±13.148	78.94±9.028	0.369
15	77.73±8.966	74.64±13.642	76.12±10.136	0.529
20	77.2±8.264	74.24±13.304	75.82±8.988	0.514
25	77.2±8.264	73.42±13.777	75.82±8.988	0.268
30	78.42±11.355	73.18±13.742	75.73±8.776	0.184
45	78.12±9.720	80.15±9.230	77.39±9.497	0.475
60	76.73±10.757	75.24±9.953	77.64±9.813	0.888
75	74.27±10.147	74.73±8.719	75.39±9.287	0.630
90	73.76±9.763	74.42±8.804	74.88±9.086	0.884
105	74.48±12.647	74.00±8.500	74.41±9.883	0.952
120	71.67±9.252	74.24±10.871	76.76±11.667	0.157

[Table/Fig-5]: Comparison of mean heart rate among the three groups.

No patients required tramadol for pain relief in the first hour. There was no incidence of postoperative nausea and vomiting, hypotension, bradycardia, pruritus, respiratory depression or local anaesthetic toxicity.

DISCUSSION

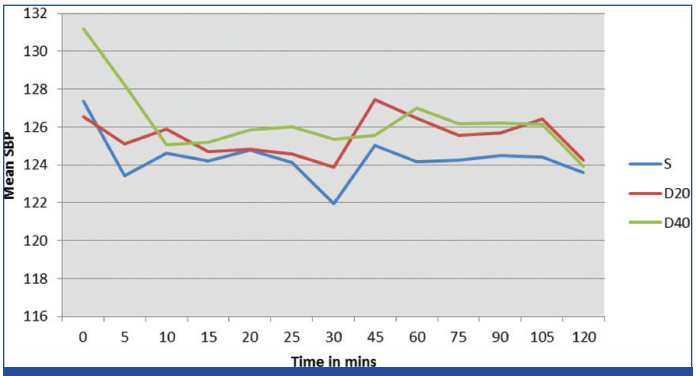
Brachial plexus block is a preferred anaesthetic technique for forearm and hand pathologies. Although peripheral nerve stimulator was considered gold standard to locate the peripheral nerves, the introduction of ultrasound guided nerve blocks had gained immense popularity and interest [11]. Among all the adjuvants, α_2 agonist has shown a promising effect in quickening the onset of blockade



[Table/Fig-6]: Comparison of mean heart rate among the three groups.
p-value <0.05 is considered statistically significant

Time (minutes)	Study groups			p-value
	S group	D20	D 40	
	(Mean±SD)	(Mean±SD)	(Mean±SD)	
5	123.42±15.900	125.12±17.453	128.24±16.047	0.487
10	124.64±13.397	125.06±15.939	125.06±15.939	0.947
15	124.21±13.131	124.70±17.191	124.70±17.191	0.966
20	124.79±12.789	124.82±17.218	125.85±14.759	0.948
25	124.15±14.036	124.58±17.086	126.03±14.306	0.871
30	123.88±19.705	125.36±15.781	123.74±17.226	0.729
45	125.03±12.496	127.45±16.943	125.55±11.958	0.760
60	124.18±12.413	126.45±16.000	127 .00±12.867	0.682
75	124.27±12.598	125.55±15.863	126.18±12.131	0.846
90	124.27±12.598	125.55±15.863	125.55±15.863	0.846
105	124.42±12.199	124.42±12.199	126.42±15.732	0.819
120	123.58±15.264	124.27±19.504	123.92±13.724	0.985

[Table/Fig-7]: Comparison of mean systolic blood pressure between the three groups.



[Table/Fig-8]: Comparison of mean systolic blood pressure between the three groups.
p-value<0.05 is considered statistically significant

and prolonging the block [12]. There have been four proposed mechanism of action of α_2 agonist on the peripheral nerve. They are centrally mediated analgesia, α_2 mediated vasoconstrictive effects, attenuation of inflammatory response and direct action on peripheral nerves [5]. Dalle C et al., had proposed that α_2 agonists, by enhancing activity dependent hyperpolarization generated by Na/K pump during repetitive stimulation, increases the threshold for initiating action potential causing blockade of conduction [13]. Kosugi T et al., in their study found Dexmeditomidine in high concentrations, inhibit CAPs in frog sciatic nerves without $\alpha_2$adrenoreceptor activation. Also, Dexmeditomidine decreased the peak amplitude of CAPs reversibly and in a concentration dependent manner. Their action was not antagonized with α_2 adrenoreceptor antagonist like Yohimbine and Atipamezole [14]. In a randomized double blind controlled study done by Swami SS et al., on 60 ASA I and II patients posted for upper limb surgeries, Dexmeditomidine at 1 µg/kg enhanced the duration of analgesia when compared to clonidine at 1 µg/kg. The time for rescue analgesia was also prolonged in the Dexmeditomidine group [12].

Onset of Sensorimotor Blockade

In our study, sensory blockade was assessed by loss of pin prick sensation. Among the three groups, D40 group where 40 µg of Dexmeditomidine had a faster onset of sensory blockade (8.99 min) when compared to D20 group where 20 µg of Dexmeditomidine was used (14.55 minutes) and S group where saline was used (21.36 minutes). Intergroup comparison between D40 and D20 showed a faster onset of sensory block in D40 group then D20 group. Motor blockade was assessed by modified bromage scale every five minutes. The onset of motor blockade was 24.55 minutes, 16.97 minutes and 10.15 minutes in S group, D20 group and D40 groups respectively. In the study conducted by Nallam SR et al., where two doses of Dexmeditomidine 50 µg/kg and 100 µg/kg were added to Levobupivacaine also showed higher doses of Dexmeditomidine hastens the onset of sensorimotor blockade [15]. Kaygusuz K et al., in his study had used Dexmeditomidine in the dose of 1 µg/kg as an adjuvant to Levobupivacaine to shorten the onset of sensorimotor blockade [16]. We conclude that the onset of sensorimotor blockade was faster when Dexmeditomidine was used as an adjuvant and it was dose dependent.

Duration of Sensorimotor Blockade and Analgesia

We observed that the total duration of effective sensory blockade in D40, D20 and S group were 14.47 hours, 12.52 hours and 7.27 hours, respectively. Also, the total duration of motor blockade lasted for 13 hours in D40 groups compared to 11 hours in D20 groups and 6 hours in S group. Increasing the dose of Dexmeditomidine from 20 µg to 40 µg had not only fastened the onset of sensorimotor blockade but also resulted in a longer pain free period. Agarwal S et al., had concluded in their study that Dexmeditomidine as an adjuvant to bupivacaine in brachial plexus block prolongs the duration of sensorimotor blockade and analgesia thereby [17]. Kathuria et al., in his study proved that the actions of Dexmeditomidine were probably local than central [18].

Haemodynamic Changes

In our study, the intraoperative haemodynamic parameters like heart rate, blood pressure were recorded and analysed. All the three groups showed a stable haemodynamics and there was no incidence of bradycardia or hypotension in any of the three groups. Agarwal S et al., also had observed that there was no incidence of bradycardia or hypotension when he compared Dexmeditomidine at a dose of 100 µg was used as an adjuvant to 0.375% bupivacaine in supraclavicular brachial plexus block [17]. In another study conducted by Zhang Y et al., Dexmeditomidine as an adjuvant to ropivacaine in axillary brachial plexus block in doses of 100 µg had shown bradycardia and hypotension. This could have been because of the relatively larger doses of Dexmeditomidine [7].

CONCLUSION

From the results of the present study, we conclude that 40 µg of Dexmeditomidine produces a faster onset of blockade and prolongs the duration of postoperative analgesia compared to 20 µg of Dexmeditomidine without any side effects.

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