Original Article

Indian Journal of Anesthesia and Analgesia
Volume 10 Number 4 October-December 2023
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.10423.2

Comparison of Ultrasound Guided Single Injection Infraclavicular Brachial Plexus Block Using Bupivacaine Alone and Bupivacaine Combined with Dexmedetomidine for Pain Control in Upper Limb Surgeries

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How to cite this article:
Saraswathi Nagappa, Pooja Patil, Mohsina Yasmeen *et al.*/Comparison of Ultrasound Guided Single Injection Infraclavicular Brachial Plexus Block Using Bupivacaine Alone and Bupivacaine Combined with Dexmedetomidine for Pain Control in Upper Limb Surgeries/Indian J Anesth Analg. 2023;10(4) 151-159.

Abstract

Background: Infraclavicular brachial plexus blockade provides anesthesia for surgeries of upper limb. In contrast to interscalene and supraclavicular block, infraclavicular blockade has the advantage of minimal risk to intravertebral, intrathecal or epidural injection, as well as reduced incidence of phrenic nerve and stellate ganglion block.

Aim: To evaluate the effect of dexmedetomidine with bupivacaine on the onset and duration of sensory and motor block and duration of analgesia in infraclavicular blocks.

Methodology: A prospective, double blind, randomized control trial was conducted among 50 patients under going elective surgery of hand, for earm, elbow and distal humerus. Patients were randomly divided into two groups based on random numbers generated by a computer program (www.randomwqqqizer.org). Group A consisted 25 patients received block with bupivacaine + dexmedetomidine Group A and Group B consisted 25 patients received block with bupivacaine + 20 ml normal saline. This study compared Onset and duration of sensory and motor blockade, duration of analgesia, post-operative pain score and hemodynamic parameters between the two groups.

Results: There was significant difference in mean onset of sensory block between two groups, (Group A 9.20 ± 0.98 vs Group B 11.06 ± 1.24 min p value < 0.001. Similarly there was significant difference in mean onset of Motor blockade between two groups (Group A 10.66 ± 1.06 min vs Group B 11.80 ± 1.10 min p value < 0.001). There was a statistically significant longer duration of sensory block (Group A was 8.88 ± 1.04 hrs and in Group B was 7.60 ± 0.78 hrs, p value <0.001), longer duration of motor block (Group A was 7.79 ± 0.82 Hrs vs Group B was 6.62 ± 0.49 hrs p value < 0.001). Statistically significant longer duration of motor block (Group A was 9.78 ± 0.73 vs Group B 6.99 ± 1.10 hrs p value < 0.001.

Conclusion: Dexmedetomidine as an adjuvant hastens the onset and prolongs the duration of both sensory and motor block and has better analgesia when compared to bupivacaine alone.

Keywords: Dexmedetomidine; Upper Limb; Infrac-lavicular.

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Received on: 14.07.2023 **Accepted on:** 29.08.2023

INTRODUCTION

Infraclavicular brachial plexus block is used for surgery of the hand, forearm, elbow and distal humerus.[1] Infraclavicular brachial plexus block has been used less than other approaches because of its fewer uniform landmarks and the necessity of a longer needle, which increases the patient's discomfort. To over come these drawbacks, ultrasound guidance was applied to infraclavicular approach, which has become very easy to perform, as individual nerves of the brachial plexus can be blocked by directing the needle to the nerves with real imaging and prospectively evaluated its feasibility and usefulness.[2] To prolong the duration of anesthesia and to avoid catheter insertion, which is required for prolong surgeries, various adjuvants were added. Dexmedetomidine is a selective alpha 2 (α2) adrenergic agonist with both analgesic and sedative properties that is used as an adjuvant mixed with local anesthetic during regional anesthesia.[3] This study is designed to evaluate the effect of dexmedetomidine with bupivacaine on Onset and duration of sensory and motor block and total duration of analgesia.

METHODOLOGY

Institutional ethics clearance was taken; CTRI number: CTRI/2020/03/023882. This study design was a prospective, double blind, randomized trial carried on 50 patients scheduled for elective surgery of hand, for earm, elbow and distal humerus in our hospital from November 2019 to November 2020. After obtaining written informed consent, patients were randomly allocated to one of the two groups according to a computed randomization list.

All patients underwent pre anesthetic evaluation on the previous day of surgery, kept adequately nil per orally and premedicated with tablet. Ranitidine 150 mg orally on the night before surgery.

A proforma was used to extract and record trial results, which were compared and any differences were resolved by reexamination of the source trials. The data included patient's particulars, indication for surgery, the anesthetic details, intraoperative monitoring and VAS scores. During the pre-anesthetic visit patients were briefed about the procedure and VAS (visual analogue score) scoring system.

Patients scheduled for elective surgery of upper limb were divided into two groups, group A and group B. Monitoring included electrocardiography, plethysmography, non-invasive blood pressure, respiratory rate. Intravenous access was established and an intravenous infusion of normal saline was started. All patients received 1mg midazolam 15 mins before the procedure. Patients were placed supine and their head turned away from the side to be blocked. The linear high frequency probe (5-12 MHz) of an ultrasound machine was positioned in the parasagittal plane near the coracoid process to best visualize a cross sectional view of the axillary artery. Using a 10 cm 22-gauge insulated needle under direct ultrasound guidance, the needle was inserted in plane to the ultrasound probe and redirected inferiorly and slightly medially to achieve median, radial, and ulnar nerve block. Aspiration was performed every 3ml to detect an unintentional intravascular needle placement prior to local anesthetic. The injectable contains either 30ml of 0.33% bupivacaine +1mcg/kg of dexmedetomidine (group-A) 30 ml of 0.33% bupivacaine+placebo (group-B). Any evidence of clinical criteria suggesting local anesthetic toxicity like light headedness, dizziness, tinnitus, disorientation, drowsiness, muscle twitching, convulsion, respiratory depression, CVS depression and collapse, in addition to possible systemic side effects of dexmedetomidine such as bradycardia, hypotension, fainting and somnolence were observed.

An ICB was considered successful when evidence of dermatomes of the brachial plexus (C5–T1) were blocked by the original injection within 30 min. The block was considered incomplete if any supplemental local anesthetic was needed for complete anesthesia and the block was considered to have failed if a supplementary volume did not provide complete anesthesia (after 30 mins. Sensory blockade was assessed every 3 mins and motor block was evaluated every 5 mins within the first 30 mins following completion of drug administration. Sensory block was confirmed by loss to cold sensation using an alcohol swab and pinprick sensation using a 23 gauge needle in all dermatomes of the brachial plexus (C5–T1). Sensory block onset was defined as a decrease of sensation to 25% or less by comparison to the contralateral limb as a reference. Sensory block duration was defined as the time from injection of local anesthetic mixture to complete recovery from cold and pain sensation as tested by an alcohol swab and pinprick, respectively, in all dermatomes of the brachial plexus (C5–T1). Motor blockade was evaluated by the ability to flex the elbow and hand against gravity as follows: grade 1 = ability to flex and extend the forearm; grade 2 = ability to flex or extend only the wrist and fingers; grade 3 = ability

to flex or extend only the fingers; and grade 4 = inability to move the forearm, wrist, and fingers. Onset of motor block was defined as the time from injection of local anesthetic mixture until achieving a reduction in motor power to grade 3 or less. Motor block duration was described as the time from injection of local anesthetic to complete recovery of motor function in all nerve's dermatomes. Sensory and motor blockade duration were assessed every 10 min in the post-operative period. Pain scores were assessed using the VRS (0–10) where pain was evaluated during rest, at 1, 2, 12, 24, 36, and 48 h post-operatively. Duration of analgesia (time interval from completion of local anesthetic administration until first need of rescue analgesia in the form of IV opioids, PCA) and amount of IV opioids consumed during the post-operative 48h were recorded. Any evidence of neurologic, gastrointestinal, and cardiopulmonary complications was also recorded. Primary outcome measures were duration of analgesia while secondary measures were onset and duration of sensory blockade, pain scores, motor blockade onset and duration, narcotic requirements, and evidence of any adverse drug reactions. For statistical analysisdata was entered in Microsoft excel and analyzed by SPSS version 24.0. Data wasanalyzed by descriptive statistics such as mean, median, standard deviation, interquartile range, percentiles, tables and graphs wherever necessary. Student t-test was used to see the significant difference between 2 groups.

Sample size was calculated on basis of previous study by Armani S Ammar *et al.*,[3] the onset of sensory block with bupivacaine was 19.4+/-2.8 (min) and with bupivacaine and dexmedetomidine was 13.2+/-2.1 (min). Considering the minimum expected difference in two groups in the onset of sensory block of 2 min (d)

$$N=2\ (Z\alpha+Z1\text{-}\beta)\ 2\sigma2/d2$$

Where

Zα = standard table value for 95% confidence interval = 1.9

Z1-β = standard table value for 80% power = 0.84

σ = s tandard deviation = 2.45

d = difference between two mean = 2 mins

Sample size n=23.52=24 in each group.

- Total sample size is 50.
- Group A-Bupivacaine 0.33% 30ml + 1mcg/kg of dexmedetomidine (Dexmedetomidine group).
- Group B-Bupivacaine 0.33% 30ml + placebo group (Bupivacaine group).

RESULTS

The demographic profile about age, weight gender, ASA grade, and duration of surgery in the two groups were comparable. Totally 50 patients were enrolled for the study, In Group A, majority of subjects were in the age group 31 to 40 years and 41 to 50 years (32% respectively). In Group B, majority of subjects were in the age group 41 to 50 years (44%). Mean age in Group A was 37.80 ± 10.59 years and in Group B was 39.80 ± 9.40 years. There was no significant difference in age distribution between two groups. Fig. 1 There was no significant difference in mean height, weight and BMI between two groups. (Table 1)

In Group A, 44% were females and 56% were

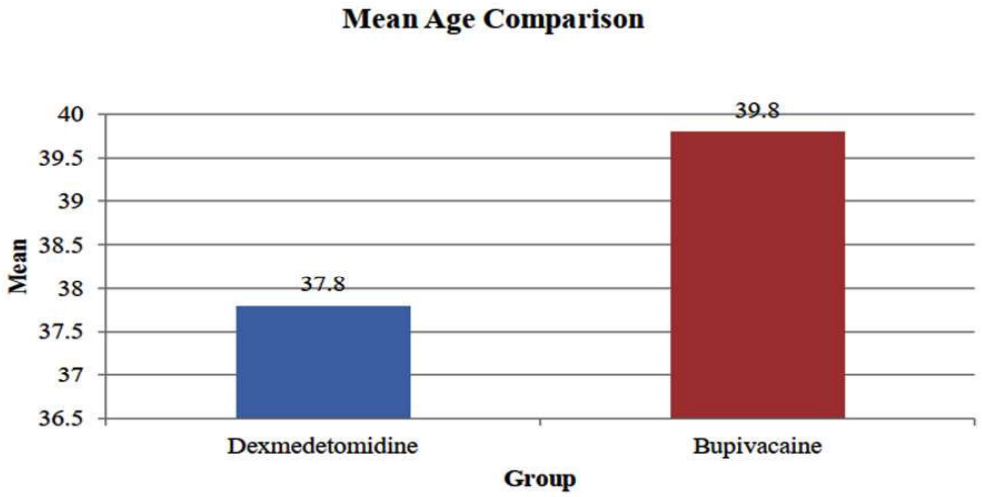

Fig. 1: Bar Diagram Showing Mean Age comparison between two groups

Mean age in Group A was 37.80 ± 10.59 years and in Group B was 39.80 ± 9.40 years. There was no significant difference in mean age between two groups.

Table 1: Mean Height, Weight and BMI Comparison between two groups

	Group				P Value
	Dexmedetomidine		Bupivacaine		
	Mean	SD	Mean	SD	
Height	1.59	.06	1.60	.07	0.748
Weight	61.76	6.62	60.20	5.61	0.373
BMI	24.23	1.73	23.48	2.10	0.176

There was no significant difference in mean height, weight and BMI between two groups

males and in Group B, 56% were females and 44% were males. There was no significant difference in sex distribution between two groups Fig. 2. Mean Duration of surgery in Group A, was 100.80 ± 23.26 min and in Group B was 98.40 ± 25.28 min. There was no significant difference in duration of surgery between two groups. (Table 2)

Table 2: Mean Duration of Surgery in mins Comparison between two groups

	Group				P Value
	Dexmedetomidine		Bupivacaine		
	Mean	SD	Mean	SD	
Duration of surgery in mins	100.8	23.26	98.4	25.28	0.728

Mean Duration of surgery in Group A, was 100.80 ± 23.26 min and in Group B was 98.40 ± 25.28. There was no significant difference in duration of surgery between two groups.

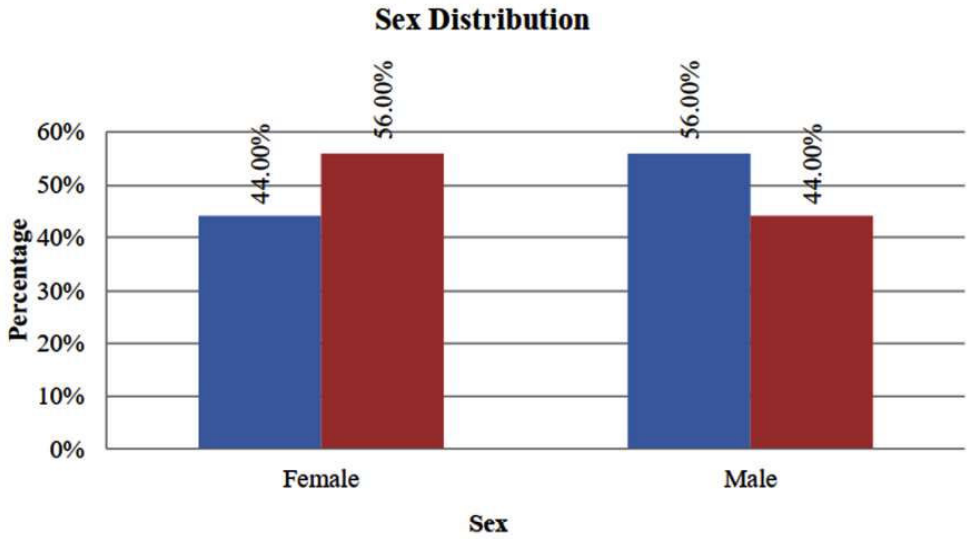

Fig. 2: Bar Diagram Showing Sex Distribution between two groups

χ 2 =0.720, df = 1, p = 0.396

In Group A, 44% were females and 56% were males and in Group B, 56% were females and 44% were males. There was no significant difference in sex distribution between two groups.

There was significant difference in mean onset of sensory block between two groups, (Group A 9.20 ± 0.98 vs Group B 11.06 ± 1.24 min p value < 0.001*. Table 3. Similarly there was significant difference in mean onset of Motor block between two groups (Group A 10.66 ± 1.06 min vs Group B 11.80 ± 1.10 min p value < 0.001)*. Table 3 There was a statistically significant longer duration of sensory block (Group A was 8.88 ± 1.04 hrs and in Group B was 7.60 ± 0.78 hrs, p value < 0.001*) Fig. 3, longer duration of motor block (Group A was 7.79 ± 0.82 Hrs vs Group B was 6.62 ± 0.49 hrs p value < 0.001)

Fig. 3. Statistically significant longer duration of motor block (Group A was 9.78 ± 0.73 vs Group B 6.99 ± 1.10 hrs p value < 0.001*. (Table 4)

In this study there was significant difference in mean Heart rate between two groups at 135 min and 150 min and at immediate post-op, 1 hr, 3 hrs and 12 hrs post-op. At other interval there was no significant difference in mean HR between two groups Fig. 4.

Table 3: Mean Onset of Sensory Block and Motor Block in mins Comparison between two groups

	Group				P Value
	Dexmedetomidine		Bupivacaine		
	Mean	SD	Mean	SD	
Onset of sensory block (mins)	9.20	0.98	11.06	1.24	<0.001*
Onset of motor blolck (mins)	10.66	1.06	11.80	1.10	<0.001*

Mean Onset of sensory block in Group A was 9.20 ± 0.98 min and in Group B was 11.06 ± 1.24 min. There was significant difference in onset of sensory block between two groups.

Similarly mean Onset of Motor block in Group A was 10.66 ± 1.06 min and in Group B was 11.80 ± 1.10 min. There was significant difference in onset of Motor block between two groups.

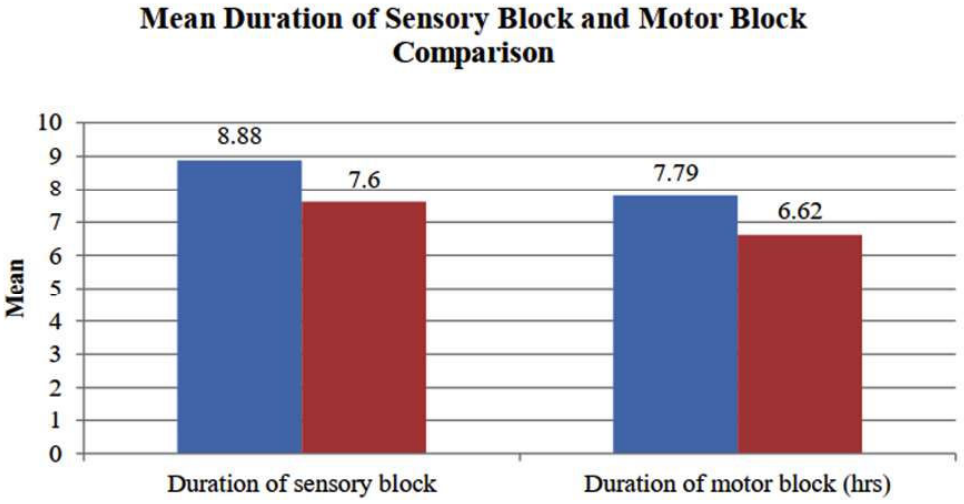

Fig. 3: Bar Diagram Showing Mean Duration of Sensory Block and Motor Block in hrs Comparison between two groups

Mean Duration of sensory block in Group A was 8.88 ± 1.04 hrs and in Group B was 7.60 ± 0.78 hrs. There was significant difference in Duration of sensory block between two groups.

Similarly mean Duration of Motor block in Group A was 7.79 ± 0.82 hrs and in Group B was 6.62 ± 0.49 hrs. There was significant difference in Duration of Motor block between two groups.

Table 4: Mean Duration of Analgesia in hrs Comparison between two groups

	Group				P Value
	Dexmedetomidine		Bupivacaine		
	Mean	SD	Mean	SD	
Duration of Analgesia (hrs)	9.78	0.73	6.99	1.1	<0.001*

Table 4: Mean Duration of Analgesia in hrs Comparison between two groups

Mean Duration of analgesia in Group A was 9.78 ± 0.73 hrs and in Group B was 6.99 ± 1.10 hrs. There was significant difference in Duration of Duration of analgesia between two groups.

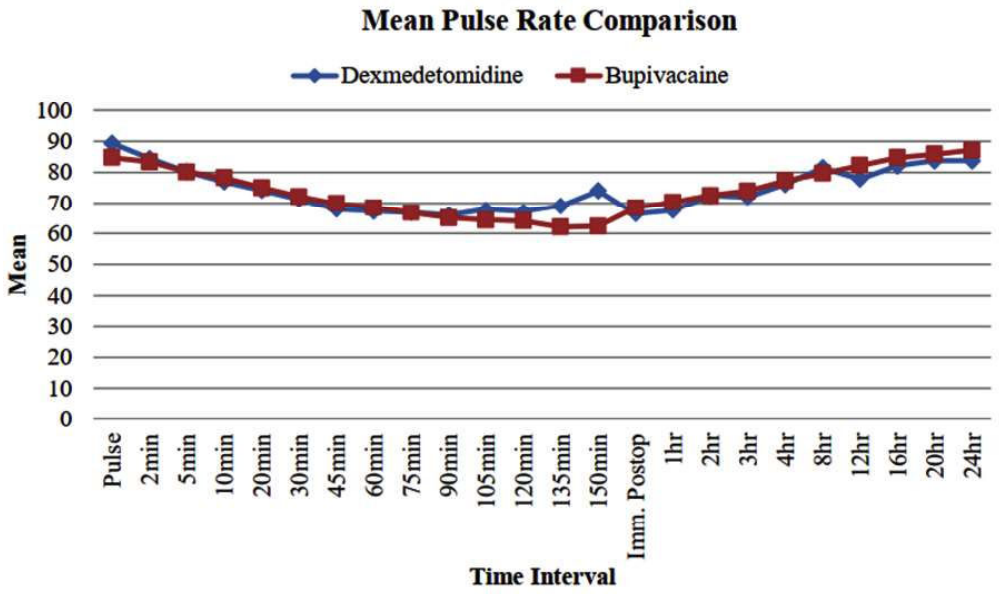

Fig. 4: Line Diagram Showing Mean Heart Beat Comparison between two groups at different intervals of follow ups

There was significant difference in mean Heart rate between two groups at 135 min and 150 min and at immediate post op, 1 hr, 3 hr and 12 hr post op. At other interval there was no significant difference in mean HR between two groups.

There was significant difference in VAS Score between two Groups at 6 hrs (Group A, 100% had score of 2 vs Group B, 40% had score of 2 and 60% had score of 4). Table 5

There was significant difference in mean SBP between two groups at immediate post-op, 1 hrs and 2 hrs post-op. At other intervals there was no significant difference in mean SBP between two Groups. There was significant difference in mean DBP between two Groups at 2 min, 135 min, immediate post-op, 1hr, 3 hr, 20 hr and 24 hrs Post-op. At other intervals there was no significant difference in mean DBP between two groups. And there was significant difference in mean MAP between two groups at immediate Post-op, 1 hr, 2 hr, 20 hr and 24 hr. At other intervals there was no significant difference in mean MAP between two groups. Fig. 5 There was significant difference in Ramsay sedation score at 30 min and 180 min between two groups. At these intervals Group A had higher RSS score compared to Group B. Table 6

Table 5: VAS Score Distribution between two groups at different intervals of follow ups

VAS Score		Group				Chi Square
		Dexmedetomidine		Bupivacaine		
		Count	%	Count	%	
Immediate Post-operative	0	25	100.00%	25	100.00%	-
1 hr	0	25	100.00%	25	100.00%	-
2 hrs	0	25	100.00%	25	100.00%	-
6 hrs	2	25	100.00%	10	40.00%	χ 2 =21.429 , df = 1, p= < 0.001*
	4	0	0.00%	15	60.00%	
12 hrs	4	19	76.00%	0	0.00%	χ 2 =32 , df = 2, p = <0.001*
	6	6	24.00%	18	72.00%	
	8	0	0.00%	7	28.00%	
24 hrs	6	13	52.00%	11	44.00%	χ 2 =0.321 , df = 1, p =0.571
	8	12	48.00%	14	56.00%	

There was significant difference in VAS Score between two groups at 6 hrs. At 6 hrs in Group A, 100% had score of 2 were as in Group B, 40% had score of 2 and 60% had score of 4.

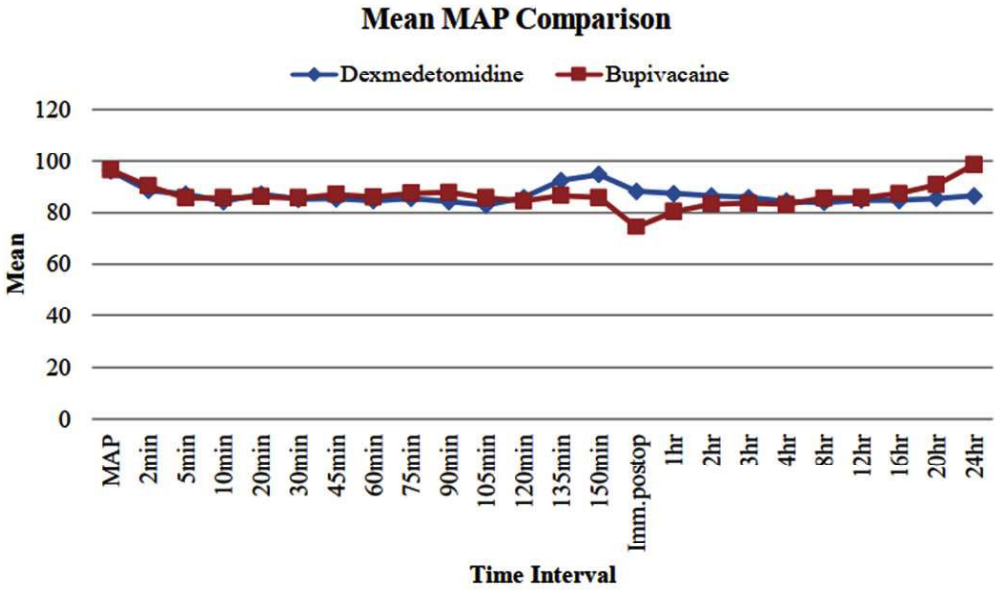

Fig. 5: Line Diagram Showing Mean MAP Comparison between two groups at different intervals of follow ups

There was significant difference in mean MAP between two groups at immediate Post-op, 1 hr, 2 hr, 20 hr and 24 hr. At other intervals there was no significant difference in mean MAP between two groups.

Table 6: Ramsay Sedation Score Distribution between two groups at different intervals of follow ups

Ramsay Sedation Score		Group				Chi Square
		Dexmedetomidine		Bupivacaine		
		Count	%	Count	%	
2 minutes	1	10	40.00%	9	36.00%	$\chi 2 = 0.085$, df = 1, p = 0.771
	2	15	60.00%	16	64.00%	
5 minutes	1	3	12.00%	3	12.00%	$\chi 2 = 0$, df = 1, p = 1.000
	2	22	88.00%	22	88.00%	
10 minutes	2	16	64.00%	16	64.00%	$\chi 2 = 0.000$, df = 1, p = 1.000
	3	9	36.00%	9	36.00%	
20 minutes	2	14	56.00%	14	56.00%	$\chi 2 = 0.000$, df = 1, p = 1.000
	3	11	44.00%	11	44.00%	
30 minutes	1	5	20.00%	0	0.00%	$\chi 2 = 5.556$, df = 1, p = 0.018*
	2	20	80.00%	25	100.00%	
45 minutes	1	1	4.00%	0	0.00%	$\chi 2 = 1.02$, df = 1, p = 0.312
	2	24	96.00%	25	100.00%	
60 minutes	1	3	12.00%	0	0.00%	$\chi 2 = 3.191$, df = 1, p = 0.074
	2	22	88.00%	25	100.00%	
75 minutes	1	2	8.00%	0	0.00%	$\chi 2 = 2.083$, df = 1, p = 0.149
	2	23	92.00%	25	100.00%	
90 minutes	1	3	12.00%	2	8.00%	$\chi 2 = 0.222$, df = 1, p = 0.637
	2	22	88.00%	23	92.00%	
105 minutes	1	2	8.00%	0	0.00%	$\chi 2 = 2.091$, df = 2, p =0.352
	2	15	60.00%	16	64.00%	
	3	8	32.00%	9	36.00%	

table cont....

120 minutes	1	2	8.00%	0	0.00%	χ 2 =2.085 , df = 2, p = 0.353
	2	13	52.00%	14	56.00%	
	3	10	40.00%	11	44.00%	
135 minutes	1	1	4.00%	0	0.00%	χ 2 =1.02 , df = 1, p = 0.312
	2	24	96.00%	25	100.00%	
150 minutes	2	25	100.00%	25	100.00%	-
165 minutes	2	25	100.00%	25	100.00%	-
180 minutes	1	5	20.00%	0	0.00%	χ 2 =5.556 , df = 1, p = 0.018*
	2	20	80.00%	25	100.00%	

There was significant difference in Ramsay sedation score at 30 min and 180 min between two groups. At these intervals Group A had better RSS score compared to Group B.

DISCUSSION

The purpose of the study was to assess the efficacy of dexmedetomidine along with local anesthetic adjuvants in infraclavicular brachial plexus block. Infraclavicular brachial plexus blockade provides anesthesia for surgeries of upper limb. In contrast to interscalene and supraclavicular blockade, an infraclavicular blockade has advantage of minimal risk of intravertebral, intrathecal or epidural injection as well as reduced incidence of phrenic nerve paralysis or stellate ganglion block. Both the axillary and medial cutaneous nerves are blocked at the level of the cords before they branch from brachial plexus heath.[4,5] Several hypothesized mechanisms of action have been suggested to explain the analgesic effect of dexmedetomidine. Some of these include vasoconstriction around the injection site direct suppression of impulse propagation through neurons as a result of a complex interaction with axonal ion channels or receptors, local release of encephalin like substances a decrease in localized inflammatory mediators and an increase in anti-inflammatory cytokines through an α2 adrenoceptor mediated mechanism.[6] Perineural administration of high-dose dexmedetomidine in combination with bupivacaine enhanced LA blockade in rats without inducing neurotoxicity.[7] Perineural dexmedetomidine as an infraclavicular adjunct is associated with important facilitatory effects regardless of the block level, specifically prolonged sensory and motor block durations, and faster sensory and motor block onset. The analgesic benefits of using dexmedetomidine include prolonged duration of analgesia, reduced post-operative analgesic consumption.[8-10] we did not use lignocaine along with bupivacaine, as it may interfere in assessing sensory and motor block onset. Our Study showed that addition of dexmedetomidine to bupivacaine hadearly onset of sensory and motor block along with prolonged duration of analgesia, similar to previous studies like Alireza Mirkheshti *et al.*,[11] which showed that dexmedetomidine as an adjuvant to local anesthetic had better effects on sensory and motor block duration and motor block onset compared to ketorolac. In Ammar *et al.*[12] study, showed addition of dexmedetomidine with local anesthetichad shorter time of onset for sensory and motor block and longer duration of blockade and lower VRS pain scores. Whereas in F.W. Abdallah *et al.*,[8] a systematic review and meta-analysis on facilitatory effects of perineural dexmedetomidine on neuraxial and peripheral nerve block, concluded that dexmedetomidine is a potential local anesthetic adjuvant that can exhibit a facilitatory effect when administered intrathecally and peripherally as a part of brachial plexus block.

Complication during study, noticed vessel punctures in 2 patients, in Group A. There were no vessel punctures in Group B. No other complications were noted in either group.

Limitation of the study was, we require multicentric study with larger sample size, using different dosages of dexmedetomidine, different volumes with different types and concentrations of local anesthetic agents. Also, studies on patients with ASA III and above physical status need to be done.

CONCLUSION

Dexmedetomidine as an adjuvant, hastens the onset and prolongs the duration of both sensory and motor block and has better duration of analgesia with lower pain score post-operatively, with no significant change in sedation scores and without any adverse effects.

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