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Comparative analysis of fentanyl and dexmedetomidine as an adjuvant to ropivacaine in supraclavicular nerve block procedures involving upper limbs

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Abstract
Background and Aim: Supraclavicular brachial plexus block is preferable to general anaesthesia in upper limb surgeries. Various adjuvants have been added to improve the quality of the block and prolong postoperative analgesia. Present study was performed to compare the effect of dexmedetomidine and fentanyl as adjuvant to Ropivacaine on onset and duration of block and postoperative analgesia during ultrasonic guided supraclavicular nerve block for upper limb surgeries.
Material and Methods: Present prospective study performed on 240 patients scheduled for upper limb surgeries at Department of Anesthesia, Tertiary Care Teaching Institute of India for the duration of 1 year. 240 patients were randomly allocated to either receive 30 ml ropivacaine 0.5% (Group R), 30 ml ropivacaine 0.5% with fentanyl 50 mcg (Group RF) or 30 ml ropivacaine 0.5% with dexmedetomidine 50 mcg (Group RD) in Supraclavicular brachial plexus. Patients were observed for onset and duration of sensory and motor blockade, duration of analgesia, postoperative pain, and adverse effects.
Results: The onset time of sensory and motor blockade was shortened and the duration of the block was significantly prolonged in the B Group ($p<0.05$) and C Group ($p<0.05$). The duration of postoperative analgesia was also longer in the B Group compared with the Group C and Group A.
Conclusion: In ultrasound guided supraclavicular block for elbow, forearm and hand surgeries, when compared to group A, the mixture of Bupivacaine, Lignocaine with Dexmedetomidine effectively reduced the onset time of sensory and motor blocks. It increased sensory and motor blocks' duration time without considerable side effects such as hypotension and bradycardia.

Keywords: Dexmedetomidine, upper limb surgeries, supraclavicular block

Introduction
In general, regional nerve blockade avoids the unwanted effects of anesthetic drugs used during general anesthesia and beneficial for the patients with various cardiorespiratory comorbidities. In the upper limb, surface ultrasound can clearly identify neural elements of the brachial plexus as well as surrounding structures [1]. Ultrasound guided brachial plexus block gains the advantage of accurate nerve localization, real time visualization of brachial plexus, blood vessels, needle placement, local anaesthetic spread. It minimizes the number of needle attempts. To increase the duration of local anesthetic effect in the supraclavicular block, epinephrine, $\alpha 2$ agonist, corticosteroids, bicarbonate, and opioids have been used [2-3]. The rare complications of supraclavicular nerve block are pneumothorax, phrenic nerve block, Horner syndrome, neuropathy, and nerve damage [4].
Various adjuvants, including opioids, midazolam, magnesium sulfate, dexamethasone, and neostigmine, have been added to local anesthetics in an attempt to increase the duration of block and postoperative analgesia [5]. The use of these drugs to reduce onset block time, increasing the duration time of analgesia without incidence of unwanted systemic complications, motor block prolongation, and finally reducing the total dose of local anesthetics drugs, has been proposed and studied.
Dexmedetomidine (α2 adrenoceptor agonist) is being used for intravenous (IV) sedation and analgesia for intubated and mechanically ventilated patients in Intensive Care Units [6]. Its use in peripheral nerve blocks has recently been described.

It has been reported to have a rapid onset time, to prolong the duration of local anesthetics, and it is approximately 8 times more potent than clonidine and is also reportedly safe and effective in peripheral nerve blocks [7]. Dexmedetomidine prolongs the block duration and duration of post- operative analgesia when added to local anaesthetic in various regional blocks. It has been reported to improve the efficacy of intrathecal, caudal and epidural anaesthesia. Its use in peripheral nerve blocks has recently been described [8].

Opioids such as fentanyl have been used for regional nerve plexus blocks to improve the block duration and quality. The peripheral administration of opioids provides stronger and longer lasting analgesia without central side effect. Studies have shown better block duration and success rate of brachial plexus block on addition of fentanyl [9].

Present study was performed to compare the effect of dexmedetomidine and fentanyl as adjuvant to ropivacaine on onset and duration of block and postoperative analgesia during ultrasonic guided supraclavicular nerve block for upper limb surgeries.

Materials and Methods

This randomized, double-blind prospective clinical trial 240 patients scheduled for upper limb surgeries at Department of Anesthesia, Tertiary Care Teaching Institute of India for the duration of 1 year. After obtaining a written informed consent for anesthesia from each patient after explaining to them the nature of study and complications. 240 patients were randomly allotted into 3 groups. All the patients received injection Midazolam 0.05mg/kg intravenously 15 minutes before the procedure. The basal HR, SBP and DBP and SpO2 were recorded. An IV cannula of size 18 gauge (G) was inserted in non-operated arm and lactated Ringer's solution was started.

Inclusion criteria: patients aged 18–60 years, weighted 55–85 kg, and with American Society of Anesthesiologists physical status Classes I and II scheduled for upper limb surgeries not exceeding 2 h as fractures and plastic surgeries.

Exclusion criteria were: Patients having any neurologic deficit in the upper limb, patients having history of hematological disorders, patients with severe hepatic impairment, and patient had a known allergy to study drug or additions.

The patients were randomly divided into three study groups as simple randomization by computer generated random numbers. Each group contains 80 patients.

The patient lied supine with 45° head elevation with a bellow below shoulder and with the head turned 45° to the contralateral side. After skin sterilization, an ultrasound with (Linear) probe placed in the coronal plane in the supraclavicular fossa to visualize the brachial plexus. After anesthetizing the skin and the subcutaneous tissue with 2–4 ml 2% lidocaine, a 22-gauge Short bevel needle was placed at the outer end of the probe and advanced along the long axis of the probe until the tip of the needle was located lateral to round pulsating hypoechoic subclavian artery on the top of hyperechoic first rib. The drug solution was prepared and administered as a single injection of 0.5 mL/kg up to a maximum of 40 mL. Group A was to receive 0.5% ropivacaine 30 ml, Group B, 0.5% ropivacaine 30 ml with 50 mcg Fentanyl and Group C, 0.5% ropivacaine 30 ml with 50 mcg Dexmedetomidine.

The sensory and motor blockade onset and duration were studied.

Motor block was determined according to the modified Bromage scale scale.

Duration of analgesia was recorded with the help of Visual Analog Scale (VAS) which ranges from 0 - 10. This scale was noted per every 60 minutes post-operatively till it comes to 5. Then the rescue analgesia was provided. The drug used was Inj. Diclofenac sodium (1.5 mg/kg) intramuscularly. The time of administration was recorded. All patients were monitored for complications (if any) during the intra- operative period and up to 48 hours post-operatively.

The primary outcome of this study was to compare duration of sensory block between groups. The secondary outcomes of this study were to compare the onset of sensory block, the onset of motor block, and the duration of motor block between groups.

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program and then exported to data editor page of SPSS version 15. Quantitative variables were described as means and standard deviations or median and interquartile range based on their distribution. Qualitative variables were presented as count and percentages. For all tests, confidence level and level of significance were set at 95% and 5% respectively.

Results

According to Table 1, no statistically significant difference between the three groups characterizes data including gender, weight, and age. ($p > 0.05$).

There was a statistically significance difference between study groups as regards total sensory and motor duration, with high mean among Group B sensory 821.48±76.24 and motor 776.10±71.54, low mean among Group A sensory 520.10±39.48 and motor 460.58±46.2, and Group C between the two groups with sensory 472.45±48.3 and motor 430.24±48.2.

There was statistically significance difference between study groups as regards onset of sensory and motor duration, with low mean among Group B sensory 04.9 ± 7.10 and motor 06.12±2.54, high mean among Group C sensory 11.24±02.50 and motor 10.90±09.22, and Group A between the two groups with sensory 13.9±4.1 and motor 15.2±2.5. (Table 2).

There was statistically significance difference between Group C and each of A and B groups as regards to postoperative HR after 3 h; also between Group F and C as regards postoperative HR after 5, and 6 h with decrease HR among Group C. ($p \leq 0.05$) There was statistically significance difference between Group C and Group A with high MBP among Group C, also between Group C and B, as regards to MBP after 10, 20, and 30 min with low MBP among Group B.

Mean pain score based on VAS after surgery in the Group B, was significantly lesser than the Group C and Group A. ($p \leq 0.05$) No complications or significant adverse effects were observed in both the study groups.

Table 1: Studied patients' demographic data and surgical characteristics

Variables	Group A	Group B	Group C	P value
Age (Years)	28.9±6.4	31.10±9.2	30.50±8.1	0.1
Weight (kg)	71.6±6.107	70.48±7.2	73.54±6.6	0.09
Gender (%)				
Male	50 (83.3)	42 (70)	44 (73.3)	0.65
female	10 (16.6)	18 (30)	16 (26.6)	
ASA physical status (%)				
I	52 (86.6)	51 (85)	50 (83.3)	0.1
II	8 (13.3)	9 (15)	10 (16.6)	

Statistically significance at $p \leq 0.05$

Table 2: Patients' Supraclavicular Block Characteristics in Three Groups

Variable	Group A	Group B	Group C	P value
Onset time of motor block	15.2±2.5	06.12 ± 2.54	10.90 ± 09.22	0.002*
Onset time of sensory block	13.9±4.1	04.9 ± 7.10	11.24 ± 02.50	0.002*
Duration time of motor block (Min)	460.58±46.2	776.10±71.54	430.24±48.2	0.004*
Duration time of sensory block (Min)	520.10±39.48	821.48±76.24	472.45±48.3	0.05*
First analgesia request (Min)	380.48±36.25	459.74±122.48	315.65 ± 110. 43	0.006*

* indicate statistically significance at $p \leq 0.05$

Discussion

The current study shows that addition of Dexmedetomidine to Ropivacaine for ultrasound-guided supraclavicular nerve block significantly leads to earlier onset of sensory and motor block as well as increased duration of analgesia than addition of fentanyl or Ropivacaine alone while fentanyl was better than Ropivacaine alone in the same outcomes.

In our study, the duration of sensory blockade and motor blockade and both these findings were statistically significant. Keshav Govind Rao *et al.* (2014) [10] and Rachana Gandhi *et al.* [11] found that there was significant reduction of onset in the duration of motor and sensory blockade.

There was statistically significance difference with $p < 0.05$ between study groups as regards onset of sensory and motor duration, with low mean among Group B sensory 04.50±8.24 and motor 05.97±2.03, high mean among Group A sensory 10.45±01.48 and motor 10.20 ± 08.45, and Group C between the two groups with sensory 14.1±3.2 and motor 15.8±3.9. Murphy *et al*. and Brummett *et al*. in their studies on administration of dexmedetomidine as an adjuvant to local anesthetics reported that the mechanism of the analgesic effect of dexmedetomidine is still not clear and may be multifactorial [12, 13]. Possible mechanisms explained by Lee *et al*., Talke *et al*., and Yoshitomi *et al*. were that dexmedetomidine induces vasoconstriction through an action on α2 adrenoceptors or it produces analgesia peripherally by reducing norepinephrine release and increasing the potassium conduction in C and A-delta neurons responsible for passage of pain stimulus, whereas it produces analgesia and sedation centrally by inhibition of substance P release in the nociceptive pathway at the level of the dorsal root ganglia and locus caeruleus [14-16].

Ropivacaine, an amide-linked local anaesthesia and an S (-) enantiomer, is less lipophilic than bupivacaine and hence a decreased potential for cardiotoxicity and central nervous system (CNS) toxicity. It has less penetration of large myelinated nerve fibres due to less lipophilicity, resulting in greater degree of motor sensory differentiation. In the present study, 30 mL of 0.5% ropivacaine was used. It was observed from previous studies that increasing the concentration of ropivacaine from 0.5% to 0.75% fails to improve the onset or duration of the block, and using 0.25% ropivacaine for subclavian perivascular brachial plexus block requires frequent analgesia and supplementation. Adjuvants to ropivacaine that enhances the motor and sensory blockade, therefore, provide adequate surgical anaesthesia [17, 18].

Our results shows that there was statistically difference between fentanyl group, dexmedetomidine group, and Ropivacaine group as regards to intraoperative HR with low HR among fentanyl group which can be explained by association of fentanyl with a vagus nerve mediated bradycardia. Esmaoglu *et al.* [19] had observed bradycardia in their patient group in which 100 μg of Dexmedetomidine was used with Levobupivacaine. Technical complications of supraclavicular brachial Plexus block such as hematoma and pneumothorax were not observed in our study. No respiratory depression was observed in any patient of the study.

Quality of anesthesia was excellent in three groups of the study with no incidence of block failure necessitating induction of general anesthesia. Achievement of sedation with the lack of the hemodynamic or any other side effect can make dose of 50 mcg Dexmedetomidine an attractive choice as adjuvant for supraclavicular brachial plexus block. All patients were monitored for complications during the intraoperative period and up to 48 hours post-operatively. The observations and particulars of each patient were recorded in the proforma enclosed. No complications or significant adverse effects were observed in both the study groups.

A limitation of our study was small sample size; more studies with larger sample sizes will be needed to confirm our results. We recommend using dexmedetomidine as adjuvant with supraclavicular nerve block to provide earlier onset of the block and longer period of postoperative analgesia.

Conclusion

Dexmedetomidine prolongs the duration of sensory and motor block and postoperative analgesia as compared to fentanyl when used as an adjuvant to ropivacaine in supraclavicular brachial plexus block and is not associated with any major adverse events.

Conflict of interest: No! Conflict of interest is found elsewhere considering this work.

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