Research Article

Dexmedetomidine improves the block characteristics when as an adjuvant to local anesthetic in ultrasound-guided Supraclavicular Brachial Plexus Block

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Abstract
Background and aims: Many studies have been conducted using dexmedetomidine as adjuvant to local anesthetics in peripheral nerve blocks, but few studies compare the effect of different doses of dexmedetomidine. We aimed at comparing the clinical profile of different doses of dexmedetomidine as adjuvant to bupivacaine in ultrasound guided supraclavicular brachial plexus block and finding out the dose which provides maximum improvement in block parameters with minimum undesirable effects. **Patients and Methods:** This double blinded comparative study was conducted in 60 patients belonging to American Society of Anesthesiologist Physical Status (ASA) I or II, undergoing elective and emergency forearm and hand surgeries. The patients were randomly allocated into three groups of 20 each. Ultrasound guided supraclavicular brachial plexus blocks were performed in each group. While group (A) received plain bupivacaine, group (B), (C) received 0.5 microgram (mcg)/ kilogram (Kg) and 1 microgram (mcg)/ kilogram (Kg), dexmedetomidine along with bupivacaine. **Statistical analysis:** was done using ANOVA test, chi-square test and Mann Whitney test comparison tests. **Results:** The demographic profile and hemodynamic variables were comparable in all three groups. Increasing doses of dexmedetomidine showed statistically significant improvement in block parameters **Conclusions:** A dose of 1 mcg / kg of dexmedetomidine showed clinically significant improvement in block characteristics with minimum undesirable effects like bradycardia and prolonged motor blockade.
Keywords: Dexmedetomidine, Bupivacaine, Ultrasound guided supraclavicular brachial plexus block.

Introduction
Upper limb surgeries are mostly performed under peripheral blocks such as the brachial plexus block. Peripheral nerve blocks not only provide intraoperative anesthesia but also extend analgesia in the post-operative period without any systemic side-effects.

These techniques involve the injection of local anesthetic agents in close proximity to the brachial plexus, temporarily blocking the sensation and ability to move the upper extremity. The subject can remain awake during the ensuing surgical procedure, or s/he can be sedated or even fully anesthetized if necessary**.**

The supraclavicular block is ideal for operations involving the arm and forearm, from the lower humerus down to the hand.

The brachial plexus is most compact at the level of the trunks formed by the C5–T1 nerve roots, so nerve block at this level has the greatest likelihood of blocking all of the branches of the brachial plexus. This results in rapid onset times and, ultimately, high success rates for surgery and analgesia of the upper extremity, excluding the shoulder.

Dexmedetomidine , an alpha-2 adrenergic receptor agonists have been the focus of interest for their sedative, analgesic, peri-operative sympatholytic and cardio-vascular stabilizing effects with reduced anesthetic requirements.In humans, dexmedetomidine has also shown to prolong the duration of block and post-operative analgesia when added to local anesthetic in various regional blocks **.**

Patients and Methods

After obtaining institutional ethics committee approval, 60 patients of ASA I/II belonging to either sex, aged 18-75 years scheduled for elective and emergency forearm and hand surgeries were enrolled in this prospective, randomized, double blind, controlled study with written informed consent. Patients with cardiac disease, hepatic or renal impairment, neuromuscular disorders, uncontrolled hypertension or diabetes mellitus, pregnancy, coagulopathy, known hyper-sensitivity to local anesthetics and on adrenergic agonist/antagonist medications were excluded from the study. Patients were allocated into three groups of 20 each (A), (B) and (C) using computer generated table numbers.

The patients and the anesthesiologists performing blocks and assessing patients were blinded to the study groups. The drug solutions were prepared by an anesthe-siologist blinded to the study groups and not involved in the study. On patient's arrival to the operating room, a 20G intravenous cannula was inserted in a peripheral vein of unaffected limb and standard monitoring commenced as Noninvasive blood pressure (NIBP), Electrocardiography (ECG), and Oxygen saturation (Spo_2) (Ultraview SL2700, Spacelaps, USA) .Preparation as for general anesthesia and resuscitation drugs were prepared.

Under sterile condition, the identified area was prepared with anti-septic (Povidone-Iodine 10%) solution and infiltrated with 1-2ml of lidocaine 2% solution subcutaneously

Patient lie down supine with head turned to the contralateral side and ipsilateral arm adducted gently by the assistant and the shoulder kept down with flexed elbow. After sterile preparation of the skin and the ultrasound probe, the brachial plexus was visualized by placing the transducer in the sagittal plane in the supraclavicular fossa behind the middle-third of the clavicle. Two distinct appearances of the brachial plexus was seen at the supraclavicular region, it either appeared as 3 hypoechoic circles with hyperechoic outer rings or as a grape like cluster of 5 to 6 hypoechoic circles, located lateral and superior to the subclavian artery between the anterior and middle scalene muscles at the lower cervical region

The block was performed using local anesthetic mixture according to with a 21-gauge, 50 mm length, short bevel, insulated stimulating needle. The predetermined volume of 40 mL of study drug solution was administered around the brachial plexus after negative aspiration to avoid accidental intravascular needle puncture and spread of local anesthetic drug was observed in tissue planes. Initially, the needle was placed deep to the more caudal elements of the plexus so that the brachial plexus rises closer to the skin surface with the injection of the local anesthetic. Distension of the brachial plexus sheath was regarded as an indication of correct needle placement. The multiple injection technique was used to deposit the total amount of drug. A 3-min massage was performed to facilitate an even drug distribution.

Group (A) (control group) which receive 20 ml bupivacaine (0.5%) +20ml saline (0.9%). Group (B) which receives 20 ml bupivacaine (0.5%) +20 ml saline (0.9%) +0.5µg ⁄ Kg dexmeditomidine. Group (C)) which receive 20 ml bupivacaine (0.5%) + 20ml saline (0.9%) +1µg ⁄ Kg dexmeditomidine

Onset time for sensory block was defined as the time interval between the end of local anesthetic administration and complete sensory block by min. Duration of sensory block was defined as the time interval between the complete sensory block and complete resolution of anesthesia on all the nerves (score 0).

Onset time for motor block was defined as the time interval between total local anesthetic administration and complete motor block (grade 2) by min. Duration of motor block was defined as the time interval from complete motor block to complete recovery of motor function of hand and forearm (grade 0) by hours.

Adverse effects: any adverse effects such as hypotension (i.e. 20% decrease relative to baseline), bradycardia (HR <60 beats/min), nausea, vomiting, hypoxemia (SpO_2 <90%), local hematoma, hemothorax, pneumo-thorax ,recurrent laryngeal nerve block, intravascular injection ,Horner's syndrome and signs of local anesthetic toxicity were recorded during the operation and for 12 hours postoperative.

Before the study, the number of patients required in each group was determined after a power calculation according to data obtained from pilot study. Pilot study reported a mean sensory duration of 9.3 in group A(control), and reported mean sensory duration of 10.6 in group B(0.5µg \kg), and reported mean sensory duration of 12.3 in group C(1µg \kg). A sample size of 20 patients in each group was determined to provide 99% power for onw way ANOVA test at the level of 5% significance using G Power 3.1 9.2 software

Results

The study included 60 patients, aged from (18-75) years, ASA I, II scheduled to undergo elective and emergency forearm and hand surgeries under ultrasound guided supraclavicular brachial plexus block..

Failure of block occurred in **3 of the studied patients** and they received general anesthesia and we were replaced by other patients.

The studied groups were found to be comparable with respect to **Patient characteristics** such as age, sex, weight, ASA classification and operative time

Characteristics of sensory and motor block are presented in figures (1, 2): showing that the onset of sensory and motor block was faster in patients who received dexmedetomidine in dose of (1µg/kg) than patients in (0.5µg/kg) and control groups**.** No statistically significant differences was found between (0.5µg / kg) and control groups regarding onset of sensory block, but motor onset was faster in group (B) than group (A).

The duration of sensory and motor block was found to be longer in group (c) than in (A) and (B), and group (B) showed longer duration than (A).

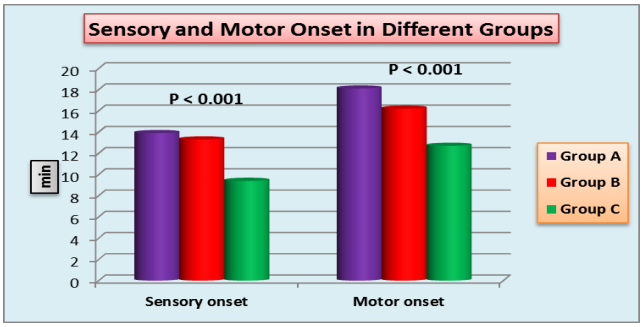

Fig. (1): sensory and motor onset in. different groups

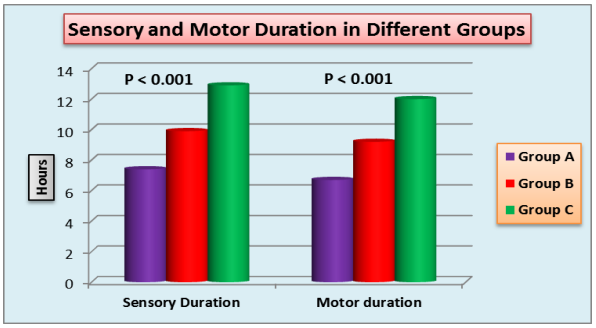

Fig. (2): Sensory and motor duration in different groups.

Bradycardia was observed in 4 patients in group C and 1 patient in group (B) treated by atropine, nausea was detected in 4 patients in group(C) and 3 in group (B) but no interference was needed and local hematoma needed only compression watched in 3 patients in group (A)

As regard inadvertent intravascular injection, neurological manifestations of toxicity, hemothorax, pneumothorax, vomiting, dysesthesia and neuropraxia we didn't record any case.

Discussion

Dexmedetomidine is an α2-adrenoreceptor agonist with excellent analgesic properties and wide margin of safety. It has α2/α1 binding selectivity ratio of 1620:1 as compared to 220:1 for clonidine. This high

selectivity for α2 receptors makes it more effective as a sedative and analgesic agent while minimising the unwanted effect of α1 receptor stimulation[1]. Agarwal et al., compared equal doses (1mcg/kg) of clonidine and dexmedetomidine in peripheral nerve block and concluded that that dexmedetomidine is more efficient than clonidine in improving block characteristics[2]. The mechanism by which dexmedetomidine affects the nerve block is multi-factorial. Peripherally, it acts by inhibiting the release of nor-epinephrine and also by direct effect on nerve action potential. Centrally, it acts by activation of α2-adrenoreceptors of locus coeruleus and by inhibiting the release of substance P.[3] Brummet et al., demonstrated a dose dependent increase in sensory and motor blockade duration in rat sciatic nerve with dexmedetomidine as adjuvant to bupivacaine and found that even a very high dose of 40mcg/kg did not cause any neurotoxicity.[4] In a study by Gandhi et al., a dose of 30mcg dexmedetomidine added to bupivacaine in supraclavicular block was found to delay the onset of sensory and motor blockade. The duration of sensory and motor blockade and duration of analgesia was found to be prolonged without any significant change in vital parameters.[5]

Marhofer et al., used a smaller dose of 20mcg along with ropivacaine for ulnar nerve block in healthy volunteers and observed a faster onset of sensory block and prolonged duration of both sensory and motor block. No significant change in onset of motor block or vital parameters was noted.[3] In our study, with a dose of 0.5mcg /kg, only the duration of sensory block was significantly prolonged without any effect on onset and duration of block, hemodynamic profile or sedation score. We are not able to explain the inconsistencies in block characteristics observed with lower doses of dexmedetomidine.Almarakbi et al., studied the effects of 0.5mcg/kg of dexmedetomidine along with bupivacaine in transversus abdominis plane block and concluded that perineural dexmedetomidine, in this dose, provided better pain control without any side-effects. There was change in sedation score as compared to control group [6] Rancourt et al., studied the effects of 1mcg/kg dexmedetomidine along with ropivacaine on posterior tibial nerve of healthy volunteers and found a prolonged duration of sensory block with a significant fall in systolic and diastolic BP. No significant change in onset time was noted.[7]

In our study, with a similar dose of 1mcg/kg, we got significant decrease in onset time of both sensory and motor blockade. Lin et al., studied the effects of 1mcg/kg of dexmedetomidine in cervical plexus block along with ropivacaine and found this dose significantly decreased the onset time of block, prolonged the duration of analgesia and increased the sedation score. Our results with a dose of 1mcg/kg were consistent with that of the above study and the studies conducted by Kaygusuz et al., and Obayah et al., in which 1mcg/kg dexmedetomidine was used as adjuvant in axillary brachial plexus and greater palatine nerve blocks respectively.[9,10]

Esmaglou et al., evaluated the effect of 100 mcg dexmedetomidine added to levobupivacaine for axillary block and found that even though the block characteristics were improved, dexmedetomidine caused significant fall in HR and BP with bradycardia that needed intervention.[11]

Agarwal et al., used 100 mcg dexmedetomidine along with bupivacaine for supraclavicular block and found a significant improvement in block characteristics including onset time and duration.[2] A significant fall in heart rate was found, of which three patient required intervention for bradycardia. Similar results were obtained by Bisaws et al., when 100mcg dexmedetomidine was used as adjuvant to levobupivacaine in supraclavicular block.[12] The results we got with the same dose were consistent with that of above studies. On the contrary, Das et al., reported that 100mcg dexmedetomidine used as adjuvant to ropivacaine in supraclavicular brachial plexus block prolonged the duration of block with significant decrease in heart rate without any clinically significant change in onset time [13] From our study and from previous

studies with perineural dexmedetomidine, we found that higher the dose of dexmedetomidine, more improved was the block characteristics with more sedation and hemodynamic changes.

Conclusion

In this double blinded comparative study, we compared the clinical profile of varying doses of dexmedetomidine as adjuvant to bupivacaine in ultrasound guided supraclavicular brachial plexus block.

We conclude that dexmedetomodine when used as an adjuvant to bupivacaine in ultrasound guided supraclavicular brachial plexus block has advantage over bupivacaine alone especially in the quality of sensory block and provide safe and effective post-operative analgesia in patients undergoing forearm and hand surgeries these findings were obvious in dose of (1μg/kg).

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