

Comparison of motor blockade, sensory blockade and duration of analgesia between dexmedetomidine and dexamethasone as an adjuvant to bupivacaine in axillary block

Gunaseelan S¹, Arun Kumar. J^{2*}

¹Associate Professor, ²Senior Resident, Dept. of Anaesthesia, Sri Venkateshwarra Medical College, Hospital and Research Centre, Puducherry, India

***Corresponding Author:**

Email: arunpouls89@gmail.com

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Abstract

Introduction: Axillary block with Bupivacaine mixed with adjuvants like dexmedetomidine, a more selective α_2 adrenoreceptor agonist, induces faster onset of blockade, delays the absorption of local anaesthetic and prolongs its action. Steroid adjuvants like dexamethasone can decrease inflammation at the same time demonstrated prolonged analgesic effect. The study aimed at comparing the efficacy of these adjuvants in affecting regional block onset and duration.

Materials and Methods: This Randomized, uncontrolled, single blinded, two-arm, concurrent parallel trial was conducted during January to March 2017 among 60 participants posted for forearm and hand surgeries randomly allocated into two groups viz: Group A: 30 subjects given a mixture (30ml) of Bupivacaine (0.25%) and Dexamethasone (8mg) and Group B: 30 subjects given 30ml a mixture (30ml) of Bupivacaine (0.25%) and 1 ml of dexmedetomidine (100 μ g). The intra and post-operative outcomes of the two groups were compared statistically.

Results: The onset of motor and sensory blockade was significantly ($p < 0.001$) earlier in the dexmedetomidine group (B) compared to the dexamethasone group (A). Similarly the duration of the sensory/motor blocks and duration of analgesia were significantly more ($p < 0.001$) in group B compared to group A.

Conclusion: Dexmedetomidine when compared with Dexamethasone used as an adjuvant to Bupivacaine in axillary block for forearm and hand surgeries showed marked efficacy in terms of earlier onset of action, prolonged blockade and longer duration of post-operative analgesia.

Keywords: Bupivacaine, Axillary block, Dexmedetomidine, Dexamethasone.

Introduction

Regional blocks can be claimed as successful as other anaesthetic techniques like spinal anaesthesia for limb surgeries when the start and extent of analgesia, degree of muscular relaxation, maintenance of stable intra-operative hemodynamics and provision of optimal pain relief post-operatively are in par with Sub-arachnoid and epidural blocks. Axillary block is a popular technique widely employed for forearm and hand surgeries due its technical ease, reliability, and a lower rate of complication.¹ Bupivacaine is a widely used local anesthetic with an unpredictable latency of nerve block.^{2,3} Various classes of adjuvants to local anesthetics have been used to improve duration and patient comfort intra-operatively and post-operatively. Among them the steroid adjuvants like dexamethasone can decrease inflammation and increase the analgesic effect due to blockade of nociceptive C fibers and phospholipids A2.⁴ Dexmedetomidine, a more selective α_2 adrenoreceptor agonist, by acting through the α_2 adrenoreceptor can induce vasoconstriction along the site of injection, prevents fast dissemination of the local anaesthetic and hence prolong its action in the forearm.⁵ Both the adjuvants when used with Bupivacaine have their own advantages which are compared in the present study.

Materials and Methods

This Randomized, uncontrolled, single blinded, two-arm, concurrent parallel trial was conducted during January to March 2017 in a tertiary care hospital in Ariyur, Puducherry. Initially an approval from the Institutional Ethics Committee was sought prior to the study. Based on the response rate of 50% in each parallel arm, an effect size of 20% (anticipated difference in effect between the two drugs) and standard error of 5%, a sample size of 30 per each group was calculated. 60 patients were enrolled for the study as per the inclusion criteria viz: aged 18-65 years, either sex, categorized as ASA I or II, normotensives without established end organ damage and other concurrent morbidities and posted for below elbow surgeries. Individuals with known incidences of allergic reactions to local anaesthetics, bleeding disorders, pregnancy, breast feeding women and local site infection on axillary block were excluded from the study. An informed written consent was taken from all the study participants after explaining the nature and risks involved in the anaesthetic technique. The patients posted for below elbow and hand surgeries were then randomly allocated into two experimental groups viz: Group A: 30 subjects given a mixture (30ml) of Bupivacaine (0.25%) and Dexamethasone (8mg) and Group B: 30 subjects given

30ml a mixture (30ml) of Bupivacaine (0.25%) and 1 ml of dexmedetomidine (100µg). Randomization of study subjects into the two study arms was done using sequential alternate random allocation technique viz: the patients as they come were allocated to undergo either of the anaesthetic method alternatively by the investigator. Detailed history taking regarding morbidities and treatment as well as clinical examination was done pre-operatively followed by necessary pre-medications as per protocol.

Procedure: Nerve Stimulator technique was employed to localize the nerves as an initial step in the Axillary brachial plexus block. The axillary artery was used as a guide tracing its pulsations along the intramuscular groove between the triceps and coraco-brachialis. With guarding fingers a wheal was raised using a 22 gauge, 38 mm shorter bevelled needle, pierced in a cephalic direction, beside the proximal half of the artery. A stimulating current delivering 1.5 mA with a frequency of 1Hz was employed and its intensity tapered gradually. The 22G insulated, stimuplex-A needle was positioned as the indicator pointed an output current < 0.5 mA and till a motor response was elicited below elbow. The local anesthetic mixture was injected after negative aspiration of blood to rule out the intravascular injection. The onset of anaesthesia was evaluated by the pin prick with a 23 gauge needle. The spirit soaked cotton touched on the skin was used to test temperature sense and loss of that sense was taken as the end point to define the time of onset of sensory blockade. Inability to move elbow, wrist and fingers is taken as time of onset of motor blockade. Duration of sensory block was defined as the time interval between the end of drug administration and complete resolution of anaesthesia on all nerves. The duration of motor block was defined as the time interval between the end of drug administration and the recovery of complete motor function of elbow, forearm and fingers.

Sensory block was graded as Grade 0, 1 and 2 based on a Sharp, dull and nil sensation respectively on pin prick. Motor block was graded based on the modified Bromage 3-point applied for upper extremities. Accordingly, Grade 0, 1 and 2 were given for Normal muscle power with full flexion/extension of the elbow, wrist and fingers, decreased muscle power with ability to move the fingers only and complete motor block with inability to move the fingers respectively. Postoperatively the subjects were asked to determine their pain sensation on a scale of 0-10 [VAS], in which 0 referred to nil pain, 1-3 scored for mild pain, 4-6 for moderate pain, 7-9 for severe pain and 10 for worst pain. Intra-muscular Diclofenac sodium injection was used as rescue analgesic whenever post-operatively patients suffered intensive pain [VAS score - 7]. Time duration of motor block, sensory block and first demand for analgesic were recorded.

Statistical Analysis

The data entry was done in Microsoft Excel version 2010 and analyzed using Statistical Package for Social services (SPSS version 20). Data is depicted as means, proportions and percentages. Quantitative continuous data was tested using student t- test. Qualitative data was associated using Chi-Square test. A p value of less than 0.05 was considered as statistically significant.

Results

The study included 60 participants undergoing forearm and hand surgeries in the tertiary care centre posted for forearm and hand surgeries. The patients were randomly allocated into the two arms of the trial and were comparable in terms of socio-demographic features and time taken for the surgery. [Table 1]

Table 1: Comparison of demographic characteristics of patients among the two groups

Socio-clinical variables	Group A (n=30)	Group B (n=30)	p value
Age (years)	39.7 ± 5.4	38.1 ± 3.6	0.18
Gender (Male : Female)	19:11	18:12	1.25
Height (Cms)	157 ± 11.4	153 ± 15.2	0.25
Weight (Kg)	65 ± 7.8	63 ± 5.6	0.26
Duration of surgical procedure (min)	128 ± 13.1	130 ± 15.4	0.59

The time of onset of sensory blockade was much significantly ($p < 0.001$) earlier in the dexmedetomidine group (B) compared to the dexamethasone group (A). [Table 2]

Table 2: Time duration of motor, sensory blocks and analgesia among the study groups

Time duration (in minutes)	Group A (n=30)	Group B (n=30)	p value
Onset of sensory block (min)	12.8 ± 5.3	9.9 ± 2.9	<0.001
Onset of motor block (min)	24.1 ± 2.2	19.4 ± 2.4	<0.001
Duration of sensory block (min)	149.5 ± 29.4	489 ± 42.7	<0.001
Duration of motor block (min)	109.8 ± 22.4	460 ± 35.6	<0.001
Duration of analgesia (min)	145.5 ± 26.9	485 ± 42.8	<0.001

Similarly the time of onset of motor blockade, duration of the sensory/motor blocks and duration of analgesia were significantly ($p < 0.001$) better in the dexmedetomidine group (B) compared to the dexamethasone group (A).

Discussion

Dexmedetomidine is a chemically active d-isomer of medetomidine with greater specificity to α_2 receptors and poses an α_2 : α_1 binding selectivity ratio approximately close to 1620:1 as a result of which inadvertent adverse reactions due to α_1 binding could be minimized.⁶ One of the highest densities of α_2 receptors have been located in locus ceruleus. The hypnotic and sedative effects of α_2 adrenoreceptor activation have been attributed to this site in CNS. It is also the site of origin of the descending medullospinal noradrenergic pathway, known to be an important modulator of nociceptive neurotransmission. In the region of the brain, α_2 adrenergic and opiodergic system have common effector mechanisms, indicating that dexmedetomidine has a supraspinal site of action. Presynaptic activation of α_2 adrenoreceptor in CNS inhibits the release of norepinephrine, terminating the propagation of pain signals and their postsynaptic activation inhibits sympathetic activity, thereby decreasing the heart rate and blood pressure in higher doses.⁷ The specificity of this adjuvant is the reason for quick commencement of motor and sensory blockade. In our study, the onset of motor and sensory blockade was significantly [$p < 0.001$] earlier in dexmedetomidine group when compared to the dexamethasone group. [Table 2] This was contrasting to the results documented in the study done by Lee et al.⁸ which showed no significant differences between dexmedetomidine and dexamethasone as adjuvant. Another similar study by Kumari et al.⁹ showed findings in line with our study results documenting a significant difference in quick onset of sensory and motor blockade in the group where dexmedetomidine was used as an adjuvant. Various research works done earlier have documented dexmedetomidine prolonging the time duration of analgesia in the recovery room and maintained the cardiovascular parameters stable.^{9,11} In our study, we documented that duration of analgesia in the dexmedetomidine group was significantly [$p < 0.001$] longer than the dexamethasone group. [Table 2] The duration of sensory and motor blockades were also significantly [$p < 0.001$] longer in the dexmedetomidine group. The previous study by Lee et al.⁸ showed no significant differences whereas other studies^{9,10} showed dexmedetomidine to be more effective in prolonging analgesia and reduced post-operative complications which was not highlighted as part of the present study. The possible mechanism of analgesia is due to the anti-inflammatory property of dexamethasone.¹²

Conclusion

Dexmedetomidine when compared with Dexamethasone used as an adjuvant to Bupivacaine in axillary block for forearm and hand surgeries showed marked efficacy in terms of earlier onset of action, prolonged blockade and longer duration of post-operative analgesia.

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