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Original article

Study On Effect of Dexmedetomidine When Added To Bupivacaine On The Onset Time And Duration Of Block In Supraclavicular Brachial Plexus Block

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ABSTRACT:

Background: Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. It is always a subjective experience. Pain has been a major concern of human kind and it has been the object of ubiquitous efforts to understand and to control it. Regional anaesthesia of the extremities and of the trunk is a useful alternative to general anaesthesia in many demanding situations. The main drawback of long acting local anaesthetic drugs such as Bupivacaine was delayed onset of action.

Methods: This is a prospective, randomized, double-blind, placebo-controlled study of 100 orthopaedic cases of upper limb surgery to study the effect of adding dexmedetomidine to bupivacaine for supraclavicular brachial plexus blocks on the onset time and duration of motor and sensory blocks

Results and conclusion: From our study, we conclude that, the addition of Dexmedetomidine (1µg/kg) as an adjuvant to bupivacaine (0.5%) has following effects: Faster onset of sensory block, Faster onset of motor block, Longer duration of sensory block, Longer duration of motor block, Less number of rescue analgesics in post-op 24 hours and no significant difference in haemodynamic variables i.e., pulse rate, systolic BP, diastolic BP and O_2 saturation.

KEYWORDS: Dexmedetomidine; Bupivacaine; Supraclavicular Brachial Plexus Block.

Statement of Originality of work: The manuscript has been read and approved by all the authors, the requirements for authorship have been met, and that each author believes that the manuscript represents honest and original work.

INTRODUCTION

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage[1]. It is always a subjective experience. Pain has been a major concern of human kind and it has been the object of ubiquitous efforts to understand and to control it. Peripheral nerve blocks provide longer and more localized pain relief than neuraxial techniques while also avoiding the side effects of neuraxial blocks. When used with General anaesthesia they can provide excellent pain relief thus obtunding the sympathetic response to pain and thereby more stable perioperative hemodynamics and excellent post-operative analgesia while avoiding the side effects of systemic medication. Regional

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anaesthesia of the extremities and of the trunk is a useful alternative to general anaesthesia in many demanding situations[2].
Regional anaesthesia denotes interruption of pain impulse by physiological blockade at a certain point along their pathway of transmission in peripheral nerves. Brachial plexus block has evolved into a valuable and easy procedure for upper limb surgeries.
The main drawback of long acting local anaesthetic drugs such as Bupivacaine was delayed onset of action. To overcome this drawback following were tried like, addition of enzymes buffered and carbonated solutions, opioids, vasoconstricting agents, alkalinization and warming up of local anaesthetic solutions and potentiation of blockade by pain and muscular exercise.
The use of clonidine, a partial α 2 adrenoreceptor agonist, in peripheral nerve blocks, has been reported to be safe and beneficial (prolongs the duration of anesthesia and analgesia)[3,4]. Dexmedetomidine is also a α 2 receptor agonist, and its 2/ 1 selectivity is 8 times more than clonidine. It has been reported to improve the quality of intrathecal and epidural anesthesia[5,6].

In this study, the effect of adding dexmedetomidine to bupivacaine for supraclavicular brachial plexus blocks on the onset time and duration of motor and sensory blocks was assessed.

AIMS AND OBJECTIVES:

In the present study 100 cases of elective orthopedic operations in the upper limb, under supraclavicular brachial plexus block have been studied in the Department of Anaesthesiology at a teaching hospital in Bhubaneswar from December 2012.
The present study is aimed to compare the addition of Dexmedetomidine to bupivacaine in supraclavicular brachial plexus block. The following are assessed.

- The onset time of sensory and motor blockade.
- The duration of blockades.
- To compare the onset and duration of blockade with that of bupivacaine alone of same concentration.

MATERIALS AND METHODS

After Ethical Committee approval and obtaining written informed consent from patients, the study was undertaken.

INCLUSION CRITERIA

•100 patients aged 18 to 55 years, scheduled for elective orthopedic operations in the upper limb, under supraclavicular brachial plexus block, were included in this study.
•American Society of Anesthesiologists (ASA) Grade I or II physical status.
The procedures were of moderate duration and included implant removal, both bone plating, fixation of lower third of humerus and olecranon fixation.

EXCLUSION CRITERIA

Patients receiving chronic analgesic therapy or adrenoceptor agonist or antagonist therapy, those with severe cardiopulmonary disease, thyroid disorders, diabetes mellitus, central or peripheral neuropathies, history of allergy to local anesthetics, morbid obesity, peripheral vascular diseases or other contraindications to regional anesthesia were excluded from the study.

The study was designed as a prospective, randomized, double-blind, placebo-controlled trial. Participants were allocated to two equal groups of 50 each using a computer generated random number list.
On arrival into the Operating room standard monitoring was set up which included Heart rate, Systolic blood pressure, Diastolic blood pressure, oxygen saturation by pulse oximetry and ECG. An Intravenous line was established with an 18-gauge IV cannula. The surgical procedure was performed by using a standard arm tourniquet inflated to 70 mmHg higher than systolic blood pressure. Hemodynamic variables were measured 10 min before block placement and every 3 min thereafter till the end of surgery.

Nerve blocks were performed, with the aid of a nerve stimulator, by using a 22G short-beveled, insulated (Teflon;-coated) 25 mm long stimulating needle. Stimulation frequency was set at 2 Hz, while the intensity of stimulating current was initially set to deliver 1 mA and gradually decreased to < 0.5 mA. Intermittent negative aspiration was performed while injecting the drug solution to avoid any intravascular placement.

- **Group BD:** Received 25 ml of 0.5% Bupivacaine and Dexmedetomidine (1 mcg/kg).
- **Group B:** Received 25 ml of 0.5% bupivacaine.

Sensory and motor blocks on the operated limb were evaluated at 2, 5, 10, 20, 30 and 60 min after the completion of anaesthetic injection by an uninvolved anaesthesiologist. Sensory block was

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assessed by comparison of pinprick discrimination (with 22G hypodermic needle) in the primary innervation areas of the respective nerves in the anesthetized arm with the other arm as reference (score 100) and motor block was evaluated by asking the patient to move the forearm against resistance and to flex the forearm. Brachial plexus block was considered successful by Vester-Andersen's criteria when at least two out of four nerve territories (radial, ulnar, median, and musculocutaneous) were effectively blocked. Onset of sensory block was defined as a reduction of sensibility to 30% or less while onset of motor block was defined as reduction of muscle power to grade 3 or less.

Following operation, all patients were observed in postanesthesia care unit and received rescue analgesic (Tramadol 100mg i.v infusion) on demand and repeated if necessary and the time was noted.

RESULTS

AGE DISTRIBUTION

The minimum age of the patient was 15 years and the maximum age was 55years. The mean age of the patients in group BD was 32.9 ± 12.3 and in group B was 33.4 ± 10.81 years which is comparable

SEX DISTRIBUTION

Time of onset of Sensory block:

The mean time for onset of sensory block in group BD was 11.26 ± 1.53 min and in group B was 19.08 ± 1.7 min. The statistical analysis by student's unpaired 't' test showed that, the time for onset of sensory block in group BD was significantly faster when compared to group B ($p < 0.001$).

Time of onset of Motor block:

The mean time for onset of motor block in group BD was 9.56 ± 1.32 min and in group B was 15.3 ± 2.09 min. The statistical analysis by unpaired student's 't' test showed that, the time for onset of motor block was significantly faster when compared to group B ($p<0.001$).

Duration of Sensory Block (Analgesia time)

The mean duration of sensory block in group BD was 13.81 ± 1.23 hours and in group B was 5.84 ± 0.49 hours. The statistical analysis by students unpaired 't' test showed that the duration of sensory block in group BD was significantly longer when compared to group B ($p < 0.001$).

Duration of Motor Block:

The mean duration of motor block in group BD was 8.13 ± 0.58 hours and the group B was 5.13 ± 0.45 hours. The statistical analysis by students unpaired 't' test showed that the difference between duration of motor block in group BD was significantly longer when compared to group B ($p < 0.001$).

Number of rescue analgesic doses in post-op 24 hrs:

In group BD, 74% patients required only 1 rescue analgesic dosage and 26% of patients required 2 rescue analgesic doses in post-op 24 hours. In group B 76% of patients required 2 and 24% of patients required 3 rescue analgesic doses in post-op 24 hours. This difference in number of rescue analgesic doses required by patient of both groups is statistically significant by chi-square test ($\chi 2 = 61.25, p < 0.05$).

Hemodynamic variables:

In group B, the mean pulse rate ranged from 76 ± 6.0 to 77 ± 7.0 beats / min. In group BD, the mean pulse rate ranged from 78 ± 7.0 to 79 ± 7.0 beats / min. The statistical analysis by student's unpaired 't' test showed that there was no significant difference in pulse rate between the two groups ($p > 0.05$).

In group B, the mean systolic blood pressure ranged from 117±9.85 to 118±10.38 mm of Hg. In group BD, the mean systolic blood pressure ranged from 117±10.53 to 118±11.19 mm of Hg. The statistical analysis by unpaired student's "t" test showed that there was no significant difference in systolic blood pressure between the two group ($p>0.05$).

In group B, the mean diastolic blood pressure ranged from 76±6.9 to 77±7.1 mm of Hg. In group BD, the mean diagnostic blood prssure ranged from 77±6.6 to 77±6.9 mm of Hg. The statistical analysis by student's unpaired "t" test showed that there was no significant difference in diastolic blood pressure between the two groups ($p>0.05$).

DISCUSSION

Dexmedetomidine produces this effect by its action on alpha 2 adrenergic receptors which are also found in peripheral nerves. Hence an attempt has been made to assess the efficacy of Dexmedetomidine as an adjuvant to Bupivacaine (0.5%) in brachial plexus block (supraclavicular approach) in terms onset time, duration of analgesia and sedation. Haemodynamic variables and rescue analgesic requirements in first 24 hours was also studied.

In our study we found that the onset of sensory and motor blocks was significantly faster in patients who received a combination of Dexmedetomidine and Bupivacaine. Onset of

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sensory block (group BC, 11.26 ± 1.5 min; group B, 19.08 ± 1.7 min). Onset of motor block (group BC, 9.56 ± 1.32 min; group B, 15.30 ± 2.09 min).This could be due to a local direct action of Dexmedetomidine and its synergistic action with that of local anaesthetics. The onset of motor block was found to be faster than the onset of sensory block in both groups. Winnie et al.[4], also observed this and attributed this to the somatotrophic arrangement of fibres in a nerve bundle at the level of the trunks in which motor fibres are located more peripherally than sensory fibres. Hence, a local anaesthetic injected perineurally will begin to block motor fibres before it arrives at the centrally located sensory fibres.

Our results showed that sensory block tended to last longer as compared to motor block which agrees with the observation by de Jong et al.[12,13] These authors explained that large fibres require a higher concentration of local anaesthetic than small fibres. The minimal effective concentration of local anaesthetic for large (motor) fibres is greater than for small (sensory) fibres. Thus, motor function return before pain perception and duration of motor block is shorter than the sensory block.

In our study duration of motor block was prolonged when dexmedetomidine was added to bupivacaine. (Group BD, 8.13 ± 0.58 hrs; group B, 5.13 ± 0.45 hrs).

In our study, the mean duration of sensory block (i.e. time elapsed from time of injection to appearance of pain requiring analgesia) was significantly higher ($p < 0.05$) in group BD than in group B. (group BD, 13.81 ± 1.23 hrs; group B, 5.84 ± 0.49 hrs).

A prospective, randomized, double blind, placebo-controlled study was conducted by Rachana Gandhi et al.[10] to compare the postoperative analgesic efficacy and safety of dexmedetomidine for brachial plexus blockade along with bupivacaine.

This prospective double blind study was conducted on 70 patients of age 18 to 60 years posted for various upper limb surgeries and randomly allocated into two equal groups of 35 each. Control group-C received injection bupivacaine (0.25%) 38 milliliter plus 2 milliliter normal saline, dexmedetomidine group-D received injection bupivacaine (0.25%) 38 milliliter plus dexmedetomidine 30 microgram (2 milliliter). Assessment of motor and sensory blockade, pulse, systolic blood pressure, respiration and side effects were noted every 5 minutes for first 30 minute and every 10 minute till end of surgery. Duration of analgesia and incidence of various complications following the procedure were observed.

The mean onset of sensory block (group B, 21.4 ± 2.5 min, group BD, 18.4 ± 2.5 min) and motor block (group B, 11.2 ± 2.1 min; group BD, 8.5 ± 1.4 min) was significantly faster in group B than in group BD ($p < 0.001$). The duration of analgesia (group B146.5 ± 34 min; group BD, 732.4 ± 48.9min) was also longer in group BD than in group B. the duration of motor block (group B, 100.7 ± 48.3min, group BD, 660.2 ± 60.4 min) was also longer in group BD than in group B. These results are comparable with our study.

Various studies in which Dexmedetomidine was used in peripheral nerve block found that Dexmedetomidine with Bupivacaine improves analgesic characteristics compared to Bupivacaine alone.

a. Kenan Kaygusuz, MD et al.[7] found that adding dexmedetomidine to levobupivacaine for an axillary brachial plexus block shortens sensory block onset time, increases the sensory and motor block duration and time to first analgesic use, and decreases total analgesic use with no side effects.
b. Amany S. Ammar et al. in 2012[8] found that adding dexmedetomidine to bupivacaine during the placement of an ICB provides: (1) enhancement of onset of sensory and motor blockade, (2) prolonged duration of analgesia, (3) increases duration of sensory and motor block, (4) yields lower VRS pain scores, and (5) reduces supplemental opioid requirements.

In our study, the number of patients who required rescue analgesia and the mean number of supplemental analgesic boluses required were also significantly lower in patients in Group BD. Similar observation was made in the above mentioned study by Sarita S Swami et al., in 2012[9] The prolonged analgesia in Group BD could be due to the action of Dexmedetomidine by inhibiting action potential of A & C fibers in peripheral nerves as demonstrated by Gaumann et al, 1992[11]

In conclusion, Dexmedetomidine1 µg/kg when added to 25mL of Bupivacaine 0.5% for supraclavicular brachial plexus block speeds the onset of sensory and motor blocks ($p < 0.05$). The combination produces improved analgesia, resulting in a prolonged effect and reduced requirements for rescue analgesics.

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CONCLUSION

From our study, we conclude that, the addition of Dexmedetomidine (1µg/kg) as an adjuvant to bupivacaine (0.5%) has following effects:

i. Faster onset of sensory block.
ii. Faster onset of motor block.
iii. Longer duration of sensory block.
iv. Longer duration of motor block.
v. Less number of rescue analgesics in post-op 24 hours.
vi. Comfortable sedation intraoperatively without any need for airway assistance.
vii. No significant difference in haemodynamic variables i.e., pulse rate, systolic BP, diastolic BP and O_2 saturation.

SUMMARY

This study "A clinical comparison between Bupivacaine-Dexmedetomidine Combination and Bupivacaine (plain) in brachial plexus block by supraclavicular Approach" was conducted in 100 patients of either sex, belonging to 15-55 years of age, ASA grade I and II admitted to SCB Medical College & Hospital, Cuttack for upper limb surgeries from 2010-2012.

They were randomly divided into 2 groups:

• **Group BD:** Received 25 ml of 0.5% Bupivacaine + 1µg / kg of Dexmedetomidine
• **Group B**: Received 25 ml of 0.5% Bupivacaine only.

The following parameters were recorded and compared.

- Onset of sensory and motor block
- Duration of sensory and motor block
- Number of rescue analgesics in post-op 24 hours.
- Sedation score
- Haemodynamic variables like pulse rate, systolic and diastolic blood pressure and O2 saturation.

Onset of sensory and motor block:

The mean time for onset of sensory block in group B was 19.08 ± 1.7 min and in group BD was 11.26 ± 1.53 min.

The mean time for onset of motor block in group B was 15.30 ± 2.09 min and in group BD was 9.56 ± 1.32 min.

Both differences were statistically significant ($p < 0.05$).

Duration of sensory and motor block:

The mean duration of sensory block in group B was 5.84 ± 0.49 hours and in group BD was 13.81 ± 1.23 hours.

This difference was statistically significant ($p < 0.05$).

The mean duration of motor block in group B was 5.13 ± 0.45 hours and in group BD was 8.13 ± 0.58 hours. This difference was statistically significant ($p < 0.05$).

Rescue analgesic requirement:

In Post OP 24 hours

In group BD 74% of patients required only 1 and 26% of patients required 2 rescue analgesic doses in post op 24 hours.

In group B, 76% of patients required 2 and 24% of patients required 3 rescue analgesic doses in post op 24 hours.

Rescue analgesia requirement in group B was significantly higher ($p < 0.05$).

Sedation score:

In group BD, 20% of patients at 15 min, 32% of patients at 30 min and 26% of patients at 60 min has sedation score of 2 is sedated, but responding to verbal stimulus. In group B, all patients had sedation score of 1 i.e. awake and alert. The sedation in group BD patients was mild and desirable, without any need for airway assistance.

This difference was statistically significant (P < 0.05).

Hemodynamic variables:

Both groups were comparable with regard to pulse rate, systolic blood pressure, diastolic blood pressure and O_2 saturation. There was no statistically significant difference ($p > 0.05$).

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