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Original Research Article

A Comparative Study to Assess the Advantages of Dexmedetomidine as an Additive To 0.75% Ropivacaine in Ultrasound Guided Axillary Brachial Plexus Block

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Conflict of interest: Nil

Abstract:

Aim of The Study: This study is aimed to assess the advantages of addition of Dexmedetomidine, an alpha-2 agonist to Ropivacaine 0.75%, by observing the block characteristics of ultrasound-guided axillary brachial plexus blocks.

Methods: For this study a total of sixty patients belonging to Anaesthesiologists physical status I and II, posted for forearm and hand surgeries were selected and randomly allocated into two study groups, with 30 individuals allotted to each group. Patients in Group A were administered ultrasound guided axillary brachial plexus block with 20 ml of Ropivacaine 0.75% along with 1 ml of normal saline and those in Group B: received ultrasound guided axillary brachial plexus block with 20 ml of Ropivacaine 0.75% combined with 1 mL of Dexmedetomidine (50 µg). The onset and duration of motor and sensory block, total duration of analgesia, hemodynamic parameters and any side effects were all monitored in the patients.

Results: There was no statistically significant difference in demographic data, intraoperative hemodynamics and surgical characteristics of patients in both groups. Onset of sensory and motor block was faster in group B ($P < 0.05$). Sensory block's duration and time to first analgesic use was significantly prolonged in group B ($P < 0.05$). Adverse effects related to regional anaesthesia procedure or drugs were not observed in patients of either group.

Conclusion: In this study, adding dexmedetomidine to ropivacaine for axillary brachial plexus block shortens sensory block onset time. It also prolongs sensory block duration and time to first analgesic use, and with less total analgesic use with no side effects.

Keywords: Ropivacaine, Dexmedetomidine, Axillary Brachial Plexus Block, Brachial Plexus Block.

Introduction

Regional anaesthesia technique of choice for Upper limb surgeries is brachial plexus block. Axillary approach to brachial plexus block is a preferred regional anesthesia technique for forearm and hand surgeries, the use of which as the primary anesthetic technique avoids the complication associated with general anesthesia and provides prolonged post-operative analgesia. Use of adjuvant drugs to local anaesthetic mixture has numerous advantages based on the drug used, viz. faster onset of motor and sensory blockade, prolonged duration of analgesia, reduction in local anaesthetic dose requirement and many others. One such group of drugs which has many desirable effects when used as an adjuvant to local anaesthetic agents is alpha agonists. Two of the widely used alpha agonists are Clonidine and Dexmedetomidine. Dexmedetomidine is an active D-isomer of medetomidine and is similarly related to clonidine. It is a specific α2 receptor agonist with an α2: α1 ratio of 1620:1 indicating greater affinity to α2 receptors. It mainly inhibits nucleus pontine locus ceruleus which mediates sympathetic nervous system functions of vigilance, memory, analgesia, and arousal. Initially it received its approval from FDA in 1999 to be used in patients on mechanical ventilation for short term sedation, and was further approved for sedation and analgesia by European Medicines Agency in 2017. However, the

mechanism by which it enhances the effects of local anaesthetic agent when used as an adjuvant in peripheral nerve block procedures is being debated and mechanism at different level of nerve conduction hypothesised. In this study, dexmedetomidine was used as an adjuvant with ropivacaine to determine the change in onset and duration of sensory and motor block, safety and effectiveness as a postoperative analgesic.

Methodology

A total of Sixty patients of ASA 1 and ASA 2 physical status aged between 18 to 60 years scheduled to undergo elective upper limb orthopedic surgeries, will be randomly allocated to two groups with Group A patients receiving 25 ml Ropivacaine 0.75% 0.5 ml of Normal Saline and Group B patients receiving 25 ml Ropivacaine 0.75% and 0.5ml Dexmedetomidine (50 μg)

After obtaining clearance of the ethical committee in Adichunchanagiri Institute of Medical Sciences, those patients who fulfill the inclusion criteria were enrolled for the proposed study and informed written consent was obtained for the ultrasound guided axillary brachial plexus block.

Double blinding was done by excluding the anesthesiologist who prepared the drug combination, in the process of monitoring and assessment of the patient.

On the day of surgery patient was shifted inside the operation theatre after confirming the patient's identity and NPO status. Non-invasive monitors were connected for recording heart rate, NIBP, ECG, SpO2 and baseline vital parameters recorded. An intravenous (IV) line with 18G cannula was secured. Patients were placed in supine position for the procedure and the upper limb to be blocked was positioned for the axillary brachial plexus block with the arm abducted to 90º and the elbow flexed. Under the supervision of an experienced anesthesiologist, ultrasound (LOGIQ E, GE health care system) was used to locate the brachial plexus, and the needle was inserted. Using negative aspiration, 0.5ml of saline was injected to confirm needle's location. After the confirmation 25ml of the drug was delivered. After the injection, the arm was kept adducted and the hand resting on the chest. The onset and duration of motor and sensory block, the complete duration of analgesia, and any adverse effects were recorded. The treatment groups were concealed from both anesthesiologists. Pulse rate, blood pressure, Spo2 at 5 min intervals until 30 min & with 30 min intervals thereafter, until the end of the operation, at 1 hour interval were noted. Onset of Sensory block was assessed every 3 minutes following a drug injection, using the pin prick method and a three-point rating system Grade-0 for no block, Grade-1 for sensory blockade with persistence of touch, and Grade-2 for total sensory blockage. Time from injecting of drug to Grade-2 sensory block was known as the "onset of sensory block." Time from the moment study drug was injected to until the sensory block was fully resolved (Grade-0) was the duration of the sensory block. For the assessment of motor blockade, modified Bromage scale [2] was used. On this scale,

Grade 0 denoted the capacity to move the elbow, wrist, and fingers freely.

Grade 1 denoted the inability to extend the arm for two seconds.

Grade 2 denoted the inability to extend the arm or flex the forearm.

Grade 3 denoted the inability to do any of these three actions.

The period of time between a drug injection and a grade 3 motor block was noted as onset of motor block. And the period of time between the injection of study drug and the full restoration of hand and forearm motor function (Grade-0) was taken as the total motor block duration.

Block was considered incomplete when, even after 30 minutes of drug injection, any of the segments supplied by the median, radial, ulnar, and musculocutaneous nerve lacked complete sensory or motor block. Following their exclusion from the research, these individuals would've been given general anesthesia.

Using the Numeric Rating Scale (1–10), postoperative pain was evaluated hourly in the post-operative ward. The following pain score was used:

Table 1:

0	No pain
1- 3	mild pain
4 – 6	moderate pain
7 -10	severe pain

Rescue analgesic drug selected was intramuscular Inj. Diclofenac Sodium (1.5 mg/kg), which was administered for a pain score of 4 and above. The interval between the drug injection and the initial request for analgesia was considered as the duration of analgesia. Every 8th hour after that, Inj. Diclofenac Sodium 1.5 mg/kg was repeated if required. During the intraoperative and postoperative phases, all patients were monitored for

any adverse reactions, including nausea, vomiting, dry mouth, hematoma, and post-block neuropathy.

The sample size was determined using the timing of the initial analgesic request as the main variable. Pilot research was carried out, with five patients in each group. Assuming validity of the difference between the time of initial analgesic request and effect size achieved, we computed the number of patients needed in each group to achieve power 0.8 and significance level of 0.05 for the study. SPSS (standard statistical software SPSS) software Inc., version 16.0 for Windows, was used to code, enter, and analyze the data. For quantitative variables, the mean, standard deviation, minimum, and maximum were used to summarize the data; for categorical variables, the relative frequencies (percentages) were used. T-tests were used to analyze normally distributed variables between the two groups. The Mann Whitney test was used to evaluate variables that were not regularly distributed. To evaluate categorical variables, Pearson's Chi-square ($\chi 2$) test was employed. When the anticipated frequency is less than 5, the Fisher exact test was utilized instead. A statistically significant result was defined as $P < 0.05$, and a very significant result as $P < 0.001$.

Results

In terms of demographic characteristics, the patients in the two groups were similar. In both groups, the baseline hemodynamic values were similar. Group B's HR significantly dropped from the baseline at 30, 60, 90, and 120 minutes when compared to group A ($P < 0.001$).

Bradycardia was not observed (heart rate <60bpm). When mean arterial pressures (MAP) were compared between the two groups, there was no statistically significant difference ($P > 0.05$). Group B experienced a faster onset of sensory and motor block than group A ($P < 0.001$). Group B's sensory blockade length was noticeably longer ($P < 0.0001$). Also, group B's analgesic duration was considerably longer than group A's ($P < 0.0001$). No group experienced any medication side effects or procedure-related issues.

Block Characteristics

a. Onset of sensory block

Onset of sensory block in group A was 12.5 ± 1.343 minutes, and in group B the onset of sensory block was in 9.5 ± 0.928 minutes. The difference between the two groups in terms of sensory block onset was statistically significant. p value <0.05.

Table 2:

Parameter	Group A (n=30) Mean± S.D	Group B (n=30) Mean± S.D	P -value
Onset of sensory block (min)	12.5 ± 1.343	9.5 ± 0.928	0.01

b. Onset of motor block: Onset of motor block in group A was 15.1 ± 1.589 minutes, and in group B the onset of motor block was in 13.1 ± 0.925 minutes. The difference between the two groups in terms of motor block onset was statistically significant. p value <0.05.

Table 3:

Parameter	Group A (n= 30) Mean± S.D	Group B (n=30) Mean± S.D	P –value
Onset of motor block (min)	15.1 ± 1.589	13.1± 0.925	0.034

c. Total Duration of Sensory block: Duration of sensory block in group A was 422.6 ± 9.665 minutes, and in group B the duration of sensory block was in 599.33 ± 10.807 minutes. The difference between the two groups in terms of sensory block duration was statistically significant. p value <0.05.

Table 4:

Parameter	Group A (n= 30) Mean± S.D	Group B (n=30) Mean± S.D	P –value
Duration of sensory block (min)	422.6 ± 9.665	599.33 10.807	0.028

d. Duration of Motor Block: Motor block lasted for 350.67 ± 9.71 minutes in group A and 353± 8.3 minutes in group B, with the difference between the two groups being statistically significant. P value was < 0.05.

Table 5:

Parameter	Group A (n= 30) Mean± S.D	Group B (n=30) Mean± S.D	P –value
Duration of motor block (min)	350.67 ± 9.71	353± 8.3	0.032

e. Duration of Analgesia: Duration of analgesia lasted for 603.33 ± 13.629 minutes in Group A and 770.67 ± 10.743 minutes in Group B, with the difference between the two groups statistically significant P value < 0.05.

Table 6:

Parameter	Group A (n= 30) Mean± S.D	Group B (n=30) Mean± S.D	P –value
Duration of analgesia (min)	603.33 ± 13.629	770.67 ± 10.743	0.01

Discussion

Axillary brachial plexus block provides excellent regional anesthesia for forearm and hand surgeries. It also provides good post-operative analgesia. There is no manipulation of airway like in general anesthesia which is one of the main pros of brachial plexus block. Anatomically, axillary brachial plexus block has advantage over other brachial plexus block in terms of complications such as pneumothorax, vascular injuries. Local anesthetics such as bupivacaine, ropivacaine, levobupivacaine are used for these blocks. However, ropivacaine has advantage over bupivacaine because it is less cardiotoxic and neurotoxic. Along with ropivacaine, dexmedetomidine was used as adjuvant in this study to intensify, prolong the duration of block and analgesia. It is a sympatholytic and has cardiovascular stabilizing properties. Atipamezole is an alpha 2 adrenergic receptor antagonist, which reverses the action of dexmedetomidine. In this prospective randomized control study, we evaluated the onset of sensory block and motor block, duration of sensory and motor block, duration of analgesia and time for rescue analgesia were recorded. Ultrasound guided axillary brachial plexus block was used in this study for better visualization of injection of drug. 30 ml of 0.75% Ropivacaine with 1ml of normal saline and 30ml of 0.75% ropivacaine with 1ml dexmedetomidine (50mcg) was used for group A and group B respectively. Previous studies showed that 30ml of local anesthetics is sufficient for an effective brachial plexus block. This study showed that addition of 50 µg of dexmedetomidine to 25 ml of 0.75% ropivacaine in group B reduced the onset time for sensory block when compared to 0.75% ropivacaine with normal saline in group A. In the group A the onset of sensory block was only 12.5±1.343 compared to group B which was 9.5±0.928. This result was concurrent with the Feroz Ahmad Dar et al (2013) where they concluded sensory and motor block onset times were shorter in group RD(11.3± 2.61) minutes than in group R (13.12±2.30) minutes. This also correlated with study of Y.N. Lin et al where they concluded that the addition of dexmedetomidine to ropivacaine (Group D) shortened the sensory block onset time compared with the ropivacaine group (Group C) (95% confidence interval [CI] 4.18±5.26; $p < 0.05$). Onset of motor block was faster in group B than in group A. In group A, the onset of motor block was only 15.1±1.589 compared to group B which was shorter 13.1±0.925. This result was correlated with following studies: 1) Feroz Ahmad Dar et al where they concluded motor block onset time was shorter in group RD (15.61±4.37) minutes than in group R (13.40±3.73) minutes. 2) Marhofer et al observed that motor onset time was significantly faster in Group Rp (dexmedetomidine20 µg+ 0.75% ropivacaine) when compared with the other study groups [mean (SD)] [21 (15) vs 43 (25) min in Group RD and 47 (36) min in Group R, $P<0.05$. Duration of sensory block in group A was shorter, comparing it to group B. In group A the duration of sensory block was 422.6±9.665 minutes compared to group B which was 599.33±10.807 minutes, P (<0.005). This result was concurrent with: 1) Feroz Ahmad Dar et al where they concluded that sensory block duration is significantly greater with dexmedetomidine ropivacaine group (412.61± 73.77 minutes) than the group with only ropivacaine (590.61± 80.30 minutes), $P <0.0001$. 2) Malenfant Rancourt et al, Compared the addition of dexmedetomidine with ropivacaine (RD) and ropivacaine alone (R)for tibial nerve block, they found that sensory block lasted longer in group RD than in group R (21.5 VS 16.2 hours), $p <0.001$. This result was also correlated with the studies conducted by D. Marhofer et al and Yu Zhang et al. This study shows that addition of 50 µg of dexmedetomidine to 25 ml of 0.75% ropivacaine in group B prolongs the duration of motor block when compared to 25 ml of ropivacaine 0.75% with normal saline in group B but not in a significant way. In group A the duration of motor block was 350.67±9.71 minutes compared to group B 353±8.3 minutes even though various studies described significant increase in motor block duration, our study shows an insignificant increase in motor duration in dexmedetomidine group (RD) when compared to ropivacaine alone group(R). Group B has prolonged duration of analgesia. It also prolongs the patients first analgesic request, 770.67 ±10.743 minutes, when compared to 25 ml of ropivacaine 0.75% with normal saline in group A 603.33±13.629. This result was correlated with following studies: 1) Feroz Dar et al observed that duration of analgesia was significantly longer in group RD than in group R ($P< 0.001$). They found that, duration of analgesia was (600.14 ±90.82) minutes in ropivacaine dexmedetomidine group and (760.69±120.12) minutes in ropivacaine alone group, ($P <0.0001$). 2) This result also correlated with the study Kaygusuz et al where they concluded that adding dexmedetomidine to axillary brachial plexus block increases the time to first analgesic use, and decreases total analgesic use with no side effects.

Hemodynamic Stability: The heart rate, mean arterial pressure, remained stable both during intraoperative and postoperative period. The blood pressure never decreased below 20% of baseline values. No significant hypotension and bradycardia were observed and is correlated with the results of

Kaygusuz et al. SIDE-EFFECTS: Bradycardia, hypotension, hypoxemia, nausea, vomiting, and any other side effects were not seen in any patients.

Conclusion

Using 50µg of dexmedetomidine as an adjuvant to 0.75% ropivacaine in axillary brachial plexus block appears to improve outcomes by increasing the duration of analgesia, shortening the onset time of both sensory and motor blockade, and prolonging the duration of sensory blockade, all without notable side effects.

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