Original Article

A comparative study of clonidine and dexmedetomidine as an adjunct to bupivacaine in supraclavicular brachial plexus block

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Abstract

Background and Aims: Various additives are mixed with local anesthetic agents to increase the quality of block in regional anesthesia. We compared clonidine and dexmedetomidine as an adjunct to bupivacaine in supraclavicular brachial plexus block with respect to the onset and duration of sensory and motor block and duration of analgesia.

Material and Methods: Sixty American Society of Anesthesiologists Grades I and II patients scheduled for various orthopedic surgeries of the upper limb under supraclavicular brachial plexus block were divided into two equal groups in a randomized, double-blind manner. Patients were assigned randomly to one of the two groups. In Group C (n = 30), 39 ml of 0.25% bupivacaine plus 1 ml (1 μg/kg) clonidine and in Group D (n = 30), 39 ml of 0.25% bupivacaine plus 1 ml (1 μg/kg) dexmedetomidine were given. The onset and duration of sensory and motor block, duration of analgesia, and quality of anesthesia were studied in both the groups.

Results: There was no statistically significant difference in the onset of sensory and motor block in both the groups. The durations of sensory and motor block were 316.67 ± 45.21 and 372.67 ± 44.48 min, respectively, in Group C, whereas they were 502.67 ± 43.78 and 557.67 ± 38.83 min, respectively, in Group D. The duration of analgesia was 349.33 ± 42.91 min, significantly less in Group C compared to 525.33 ± 42.89 min in Group D ($P < 0.001$). The quality of anesthesia was significantly better in dexmedetomidine group compared to clonidine group ($P < 0.001$).

Conclusion: The addition of dexmedetomidine prolongs the durations of sensory and motor block and duration of analgesia and improves the quality of anesthesia as compared with clonidine when injected with bupivacaine in supraclavicular brachial plexus block.

Key words: Clonidine, dexmedetomidine, supraclavicular brachial plexus block

Introduction

Supraclavicular brachial plexus block is a common regional anesthetic technique used to provide anesthesia and analgesia for upper extremity surgery at our institution. α-2 adrenoreceptor agonists have been the focus of interest for their sedative, analgesic, and perioperative sympatholytic and cardiovascular stabilizing effects with reduced anesthetic requirements.

Clonidine, an imidazoline, α-2 adrenoreceptor agonist, has been extensively studied as an adjuvant to local anesthetic in peripheral nerve blocks.[1-9] Dexmedetomidine is also α-2 adrenoreceptor agonist and its selectivity to α-2 adrenoreceptor is 8 times greater than clonidine.[10] The anesthetic and analgesic requirements get reduced to a huge extent by the use of these two adjuvants because of their analgesic properties and augmentation of local anesthetic effects.

The present study was undertaken to compare the efficacy of clonidine and dexmedetomidine as an adjunct to bupivacaine in supraclavicular brachial plexus block in upper extremity surgery for the onset and duration of sensory and motor block and duration of analgesia.

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Material and Methods

After the Institutional Ethics Committee's approval and written informed consent, this prospective randomized, double-blind study was conducted on sixty patients of American Society of Anesthesiologists Grade I and II of either sex, aged 21–60 years who were scheduled for moderate orthopedic surgeries on the upper limb under supraclavicular brachial plexus block. Patients with history of cardiac, respiratory, hepatic and/or renal disorders, and pregnant women were excluded from the study. Patients known to be sensitive or allergic to study medications were also excluded from the study. Patients not included in the study were those with usual contraindication to brachial plexus block such as clotting disorders, local infections, and patient refusal. Details of anesthetic procedure and study protocols were fully explained to patient during preoperative visit.

The patients were randomly divided into two groups of thirty patients each. Patients in Group C (n = 30) received 39 ml of bupivacaine 0.25% with 1 ml (1 μg/kg) clonidine and those in Group D (n = 30) received 39 ml of bupivacaine 0.25% with 1 ml (1 μg/kg) dexmedetomidine in a double-blinded manner. Identical syringes containing 1 ml of either clonidine or dexmedetomidine and labeled only with study number were prepared by an investigator neither involved in the administration of block nor following up of patients. All patients fasted for 6–8 h before surgery. On arrival in the anesthetic room, intravenous access secured with 18G cannula in the nonoperated arm and infusion of lactated ringer started. The patients were premedicated with injection midazolam 2 mg intravenously. Baseline measurement of heart rate (HR), noninvasive blood pressure, and SpO_2 were recorded before the block was performed. Under all aseptic precautions, the supraclavicular brachial plexus block was performed in the supine position. Neural localization was achieved using a nerve stimulator (Stimuplex; B. Braun Melsungen, Melsungen, Germany) connected to 22G, 55 mm long stimulating needle (Stimuplex D; B. Braun Melsungen, Melsungen, Germany). The position of the needle was judged adequate when an output current 0.5 mA elicited a slight distal motor response. Sensory and motor blocks were evaluated every 3 min within first 30 min following completion of drug administration. Vital parameters (pulse, arterial pressures, and SpO_2) were recorded every 5 min for first 30 min and thereafter every 10 min till the end of surgery. Postoperatively, sensory and motor blockade and vitals parameters were noted at 10 min, 30 min and 1, 2, 4, 6, and 12 h after the end of surgery. Sensory block was assessed by pinprick test and graded as Grade 0 = no sensation felt, Grade 1 = dull sensation felt, Grade 2 = sharp pain felt. Motor block was assessed using a modified Bromage scale[4] (3 = extension of elbow against gravity, 2 = flexion of wrist against gravity, 1 = finger movement, and 0 = no movement).

The onset of sensory block was defined as the time from injection of local anesthetic till no response to pinprick test whereas onset time of motor block was defined as the time between injection and motor paralysis. The duration of sensory block was considered as the time interval from complete sensory block till first postoperative pain, and the duration motor block was defined as the time interval between the complete paralysis and complete recovery of motor function. Postoperative pain levels were assessed by 10 cm visual analog scale (VAS) from 0 (no pain) to 10 (severe pain). Injection diclofenac 75 mg administered intramuscularly, as rescue analgesic, when VAS reached >4. The time to first analgesic was noted. The time between the end of local anesthetic administered and the first analgesic request was recorded as the duration of analgesia. Adverse events comprised hypotension (a 20% decrease from baseline value), bradycardia (HR <50 beats/min), hypoxemia (SpO_2 <90%), or nausea and vomiting. At the end of surgery, the quality of anesthesia was assessed according to a numeric scale;[11] 4 = excellent: no complaint from patient, 3 = good: Minor complaint with no need for supplemental analgesia, 2 = moderate: Complaint which required supplemental analgesics, and 1 = unsuccessful: Patient was given general anesthesia. The data were analyzed by Student's t-test and Chi-square test. A $P < 0.05$ was considered statistically significant.

Results

The demographic data were similar in each group [Table 1]. Although sensory and motor block onset times were shorter in Group D than in Group C, the difference was statistically insignificant [Table 2].

Sensory and motor block durations were significantly prolonged in Group D compared to Group C ($P < 0.001$). The duration of analgesia was significantly longer in dexmedetomidine group than in clonidine group ($P < 0.001$) [Table 2]. Block was successful in all patients.

Table 1: Demographic data

Characteristics	Group C	Group D
Age (years)	37.83±11.28	38.03±11.25
Weight (kg)	57.93±7.36	56.47±7.80
Sex ratio (male:female)	22:8	20:10
Type of surgery		
Lower end of humerus	6	9
Radius and/or ulna	20	18
Hand	4	3

Values are expressed as mean±SD or n. SD=Standard deviation

The baseline hemodynamic parameters were comparable in both groups [Figures 1 and 2]. Although there was significant fall in mean pulse rate and blood pressure in dexmedetomidine group as compared to clonidine group up to 90 min, no treatment was required. Thereafter, pulse rate and arterial pressure were comparable during the study period in both groups. The quality of anesthesia was found significantly better in patients who received dexmedetomidine compared to those who received clonidine ($P < 0.05$) [Table 3].

None of the patients experienced an episode of hypotension, bradycardia, or hypoxemia that required treatment during either intraoperative or postoperative period. Side effects such as drowsiness, nausea, and vomiting were not seen in any patient in the two groups.

Discussion

In our study, we compared the addition of clonidine (1 μg/kg) and dexmedetomidine (1 μg/kg) to bupivacaine in supraclavicular brachial plexus block. The results of our study revealed that the onset time for both sensory and motor blocks after the supraclavicular brachial plexus block using either clonidine or dexmedetomidine in bupivacaine were similar. However, dexmedetomidine provided longer duration of both motor and sensory blocks and prolonged duration of analgesia. Moreover, dexmedetomidine group had better quality of anesthesia.

There has been increasing use of some adjuncts, e.g., opioids, epinephrine, α-2 adrenoreceptor agonists to local anesthetic agents to improve the block quality in peripheral nerve blocks. It was reported in various studies that the addition of α-2 adrenoreceptor agonists to local anesthetic agents in peripheral nerve blocks improved the quality the anesthesia and prolonged the duration of analgesia.[12-15]

Several animal studies have investigated the analgesic effects of α-2 adrenoreceptor agonists as an adjuvant to local anesthetic agents. Yoshitomi *et al.*[16] found that addition of clonidine or dexmedetomidine to lignocaine enhances local analgesic effect. They postulated that improved analgesic effect of clonidine and dexmedetomidine was mediated through α-2 adrenoreceptors. In another animal study, dexmedetomidine has been shown to increase the duration of bupivacaine anesthesia and analgesia of sciatic nerve block in rats.[17] In two different sciatic nerve rat models, Brummett *et al.*[18,19] found that dexmedetomidine added to ropivacaine significantly prolonged the duration of analgesia.

Moreover, in humans, various studies have found clonidine and dexmedetomidine to be safe and effective in various neuraxial and regional anesthesia including intrathecal and intravenous regional anesthesia. Abosedira[20] compared the effect of adding either clonidine or dexmedetomidine to lidocaine during Bier's block and reported that adding dexmedetomidine to lignocaine during Bier's block is superior in quality of anesthesia, tourniquet tolerance, and intraoperative and postoperative analgesia than is the

Table 2: Block characteristics

Variables	Group C	Group D
Onset of sensory block	4.53±1.38	3.97±1.27
Onset of motor block	5.97±1.77	6.47±1.43
Duration of sensory block	316.67±45.21	502.66±43.78*
Duration of motor block	372.66±44.48	557.67±38.83*
Duration of analgesia	349.33±42.91	525.33±42.89*

**P<0.001 compared with Group C. Values are expressed as mean±SD.*
SD=Standard deviation

Table 3: Quality of anesthesia

Grades	Group C, *n* (%)	Group D, *n* (%)
4	12 (40)	24 (80)*
3	18 (60)	6 (20)
2	0 (0)	0 (0)
1	0 (0)	0 (0)

**P<0.001 compared with Group C*

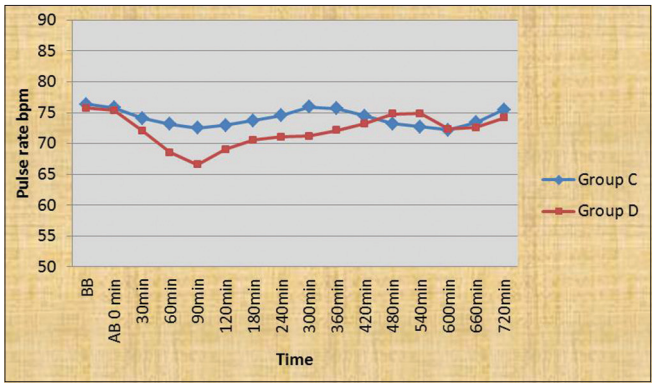

Figure 1: Comparison of pulse rate. BB: Before block; AB: After block

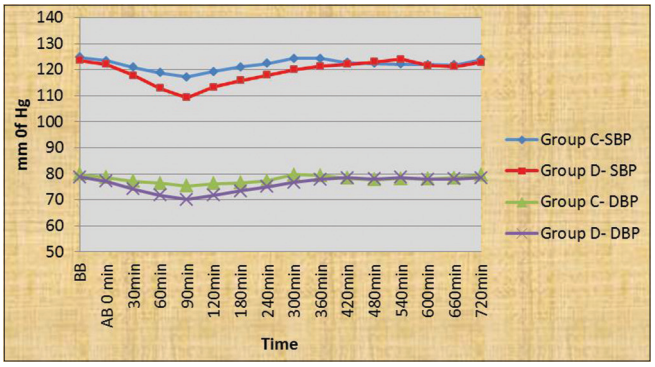

Figure 2: Comparison of blood pressures. BB: Before block; AB: After block; SBP: Systolic blood pressure; DBP: Diastolic blood pressure

addition of clonidine. Memis *et al.*[11] and Esmaoglu *et al.*[21] found the improved quality of anesthesia and tourniquet pain and reduced postoperative analgesic requirement when they used dexmedetomidine lignocaine mixture during Bier's block.

Bajwa *et al.*[22] had compared the dexmedetomidine and clonidine in epidural anesthesia and concluded that dexmedetomidine is a better neuraxial adjuvant compared with clonidine for providing an early onset of sensory analgesia and prolonged postoperative analgesia. However, El-Hennawy *et al.*[13] found no difference in duration of analgesia between either dexmedetomidine or clonidine when added to bupivacaine during pediatric caudal anesthesia.

Till date, several studies investigated that effects of clonidine or dexmedetomidine in axillary brachial plexus block[3,4,7,23-25] and found that these drugs had an improving effect on quality and duration of anesthesia. During our literature search, we did not find any study comparing dexmedetomidine and clonidine as an adjuvant to bupivacaine in supraclavicular brachial plexus block. Dexmedetomidine is approximately 8 times more selective toward the α-2 adrenoreceptors than clonidine.[10] Therefore, we assumed that dexmedetomidine may be more effective in supraclavicular brachial plexus block. There is no study which has compared the dose equivalence of these drugs in peripheral nerve block. The dose of studied drugs was selected on the basis of study by Abosedira,[20] in which he/she used dexmedetomidine 1 μg/kg and clonidine 1 μg/kg in lidocaine during Bier's block.

The mechanism by which α-2 adrenoreceptor agonist produces analgesia and sedation is not fully understood and likely to be multifactorial.[23] Peripherally α-2 adrenoreceptor agonists produce analgesia by reducing release of norepinephrine[26] and causing α-2 receptor-independent inhibitory effect on nerve action potentials.[27] Centrally, α-2 adrenoreceptor agonists produce analgesia and sedation by inhibition of substance *P* release in the nociceptive pathway at the level of the dorsal root neuron and by activation of α-2 adrenoreceptors in locus coeruleus.[28] α-2 adrenoreceptors are coupled via a pertussis toxin-sensitive G protein to potassium ion channel. Stimulation of α-2 adrenoreceptors results in an increase in the potassium ion channel conductance.[10]

Some studies reported the incidence of bradycardia and hypotension with α-2 adrenoreceptor agonists.[23,29,30] The results of our study showed stable perioperative hemodynamics, also drowsiness, which often associated with the use of clonidine,[31] was not noted in our patients. No other side effects were noted in any of the patients in the present study.

We had taken a volume of 40 ml of local anesthetic agent because this volume was associated with a more complete spread for brachial plexus block as found by Winnie *et al.*[32]

Conclusion

Thus, our study demonstrated that addition of dexmedetomidine to bupivacaine in supraclavicular brachial plexus block prolonged the duration of analgesia and improved the quality of anesthesia as compared to clonidine with hemodynamic stability and lack of side effects, thus making dexmedetomidine an attractive choice as an adjuvant to bupivacaine for supraclavicular brachial plexus block.

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Conflicts of interest

There are no conflicts of interest.

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