Original Article

Comparison of effects of ropivacaine with and without dexmedetomidine in axillary brachial plexus block: A prospective randomized double-blinded clinical trial

ABSTRACT

Background: Addition of dexmedetomidine to ropivacaine for peripheral nerve blocks has shown to improve the efficacy of ropivacaine by prolonging the duration of analgesia. This study was undertaken to evaluate the effects of ropivacaine alone and in combination with dexmedetomidine in the axillary block.

Materials and Methods: A total of 80 patients belonging to American Society of Anesthesiologists physical status I, II, and III, scheduled for elective forearm and/or hand surgeries were randomly allocated into one of the two groups to receive either 39 ml of 0.375% ropivacaine and 1 ml normal saline (Group R) or 39 ml of 0.375% ropivacaine and 1 μg/kg dexmedetomidine diluted to 1 ml with normal saline (Group RD).

Results: There was a significant early the onset of sensory and the motor block in Group RD. Duration of sensory block in Group RD was 677.25 ± 99.64 min and in Group R was 494.38 ± 70.64 min and the difference was clinically significant ($P < 0.001$). Duration of motor block in Group RD was 712.88 ± 89.32 min and in Group R was 526.25 ± 70.229 min and was clinically significant. Duration of analgesia in Group RD was 764.38 ± 110.275 min and that in Group R was 576.88 ± 76.306 min and was clinically significant. There was a significant alteration in hemodynamics in Group RD when compared to Group R without any side effects.

Conclusion: Dexmedetomidine as an adjuvant to ropivacaine provides quicker onset of anesthesia, longer duration of analgesia. It offers convenient, simple, effective mode of anesthesia, and postoperative analgesia for forearm and/or hand surgeries.

Key words: Axillary block; dexmedetomidine; peripheral nerve block; ropivacaine

Introduction

Regional anesthesia provides site specific, effective, long-lasting anesthesia. Plexus block is being used as primary and sole anesthesia technique to facilitate painless surgery. It is used in postoperative pain relief and chronic pain management.

Brachial plexus block is used in upper limb surgeries to provide regional anesthesia. Various approaches are interscalene, supraclavicular, infraclavicular, and axillary. Axillary approach to the brachial plexus block is popular because of its ease of accessibility, safety, and reliability. It is indicated in surgeries involving forearm and hand.

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Ropivacaine is a new long-acting amide local anesthetic (LA) with safer cardiac profile than bupivacaine used for peripheral nerve blocks. It provides sensory as well as a motor blockade.

Addition of adjuvant improves the efficacy of LA by hastening the onset of action, prolonging the duration of action, and postoperative analgesia.

Dexmedetomidine is a selective alpha 2 adrenoreceptor agonist, which is used as an adjuvant to LAs. It is assumed to hasten the onset of action, prolong the duration of action, and postoperative analgesia.[1]

The aim of the study was to compare the effects of ropivacaine with and without dexmedetomidine in axillary brachial plexus block in terms of the onset of sensory and motor block, duration of sensory and motor block, and duration of analgesia.

Materials and Methods

After obtaining Institutional Ethics Committee clearance, 80 patients undergoing elective forearm and/or hand surgeries in our institute from November 2012 to August 2014 were randomized by computer generated table using Random Allocation Software, version 1.0, May 2004, developed by M. Saghaei, MD., Department of Anaesthesia, Isfahan University of Medical Sciences, Isfahan, Iran. Adults aged between 18 and 80 years belonging to American Society of Anesthesiologists (ASA) physical status I, II, III were included. Patients are weighing <50 kg, known the history of allergy to study drugs, pregnant patients and with significant blood coagulation disorders, and infection at the site of the block were excluded.

Preanesthetic evaluation was done; informed consent was obtained. All patients were kept nil per oral as per standard guidelines, premedicated with tablet diazepam 10 mg, and tablet ranitidine 150 mg 2 h before surgery. Preoperative baseline values of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO$_2$) were noted. Limb to be operated was positioned, under all aseptic precautions, axillary brachial plexus block was performed by the anesthesiologist using 24 G 50 mm length, short beveled, insulated stimulating needle according to multiple injection techniques using nerve locator. After positioning the limb, the axillary artery was palpated in the upper one-third of the arm. Just above and below the pulsation, skin wheal was raised by injecting 2% lignocaine plain solution of 1 ml each. Electro location of each nerve

was done by starting the stimulation with current intensity at 2 mA. The current intensity was decreased slowly to a minimum of 0.5 mA by redirecting the needle to obtain the best desired appropriate response. Continuous negative aspiration was done to check for inadvertent intravascular needle placement during electrolocation. A volume of 8 ml of the drug solution per nerve (radial nerve, ulnar nerve, median nerve, and musculocutaneous nerve) was injected after checking for the absence of blood by negative aspiration.

Intercostobrachial nerve was blocked by injecting 8 ml of the drug solution subcutaneously superiorly and inferiorly along the axillary crease using 1.5 inch 25 G needle.

Group R received 39 ml of 0.375% ropivacaine and 1 ml of normal saline, Group RD received 39 ml of 0.375% ropivacaine and 1 µg/kg dexmedetomidine diluted to 1 ml with normal saline, according to the group allocated by computer generated random table. Drug combinations were prepared by an anesthesiologist who is independent of the study. 1 µg/kg of dexmedetomidine was taken in insulin syringe and diluted accordingly to 1 ml with normal saline.

To maintain uniformity, we have used ropivacaine 0.75% of 10 ml ampoule (Ropin®, Neon Laboratories, Mumbai, India). A volume of 20 ml of 0.75% ropivacaine was diluted with 20 ml of normal saline, to make 40 ml of 0.375% ropivacaine. Dexmedetomidine (Dextomid®, Neon Laboratories, Mumbai, India) of 100 µg/ml strength of 1 ml ampoule was used to maintain uniformity.

The time of administration of the drug was noted. HR, SBP, DBP, MAP, SpO$_2$ were noted every 5 min (min) for the first 30 min and every 15 min for next 1½ h and every hour later on till regression of sensory block. Sensory block was assessed by pinprick (20 G hypodermic needle) test in respective dermatomal distribution of nerves using a 3-point scale: 0 = Normal sensation, 1 = Loss of sensation to pinprick (analgesia), 2 = Loss of sensation to touch (anesthesia).[1]

Motor block was evaluated by thumb abduction for radial nerve, thumb adduction for ulnar nerve, thumb opposition for median nerve, and flexion of elbow for musculocutaneous nerve on a 3-point scale: 0 = Normal motor function, 1 = Reduced motor strength but able to move fingers, 2 = Complete motor block.[1]

The time of the onset of complete sensory blockade and motor blockade were noted individually. Sensory and motor

blocks were evaluated for every 5 min for the first 30 min and then every 30 min postoperatively till the regression of sensory block and return of motor function, respectively. The time to the first analgesic administered postoperatively was noted.

Surgery started 30 min after administration of block to facilitate the sensory and the motor block evaluation.

Successful nerve block is defined as complete loss of pinprick sensation in the radial, ulnar, median, and musculocutaneous nerve distribution with the concomitant inability to abduct, adduct and oppose thumb, and inability to flex elbow within 30 min after the LA injection. In patients showing incomplete nerve block within 30 min after injection, intravenous (IV) midazolam 2 mg, and IV fentanyl 2 µg/kg were administered. If patient complained of pain despite supplemented fentanyl analgesia, general anesthesia was induced, and these patients were considered, nerve block failures were excluded from the study.

Onset of sensory block was defined as the time interval between the end of total local anesthesia drug administration and complete sensory block. Complete sensory block was defined by anesthetic block (score 2) on all nerve territories. Duration of sensory block was defined as the time interval between the start of a complete sensory block and the complete resolution of the sensory block in all nerve territories. Onset of motor block was defined as the time interval between the end of total local anesthesia drug administration and complete motor block. Complete motor block was defined as the absence of voluntary movement on hand and forearm (score 2). Duration of motor block was defined as the time interval between the start of a complete motor block and the recovery of complete motor function of the hand and forearm. The time between the start of a complete sensory block and the first analgesic given was recorded as the duration of the analgesia.

Pain in the postoperative period was assessed using a visual analog scale (VAS). When VAS score >4 cm, first analgesia was given as IV tramadol 50 mg, and duration of analgesia was noted.

Any side effects of hypoxia (defined as SpO_2 <93%) was treated with supplemental oxygen. Hypotension (defined as SBP <90 mm of mercury) was treated by the fluid administration and if necessary, IV vasopressors. Bradycardia (defined as HR <40 beats/min) was treated with IV atropine 0.6 mg. Any other untoward effects were recorded.

Statistical analysis

Statistical analysis was done using IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. Age and weight have been compared between two groups using independent Student *t*-tests. Chi-square test was used to compare the gender distribution. $P < 0.05$ was considered statistically significant. Proportions were represented in percentages. Independent Student *t*-tests were used to measure the difference of outcome, which were continuous.

Results

The patients in Group RD were compared with patients in Group R.

As shown in Table 1, a comparison was done using independent Student's *t*-test (two-tailed) for age, weight, duration of surgery. The difference between the two groups was not significant ($P = 0.652, 0.696, 0.32$, respectively).

Chi-square test was used for gender distribution, American Society for Aesthetic Plastic Surgery distribution. The difference between the two groups was not significant ($P = 0.639, 0.577$, respectively).

As shown in Table 2, a comparison was done using independent Student's *t*-test. The difference in onset of

Table 1: Results of study

Variable	Mean±SD		P
	Group R	Group RD	
Age (years)	41.15±15.772	39.5±16.834	0.652
Weight (kg)	60.9±5.943	60.33±7.112	0.696
Gender			
Males	25	27	0.639
Females	15	13	
ASAPS			
I	18	18	0.557
II	21	19	
III	1	3	
Duration of surgery (min)	81.38±17.831	85.98±22.185	0.32

SD: Standard deviation; ASAPS: American Society for Aesthetic Plastic Surgery

Table 2: Results of the study

Variables	Mean ± SD (in min)		P
	Group R	Group RD	
Onset of sensory block	20.5±3.889	16.13±4.001	<0.001
Onset of motor block	23.13±3.337	18±3.889	<0.001
Duration of sensory block	494.38±70.64	677.25±99.664	<0.001
Duration of motor block	526.25±70.229	712.88±89.32	<0.001
Duration of analgesia	576.88±76.306	764.38±110.275	<0.001

SD: Standard deviation

sensory block, the onset of motor block, duration of sensory block, duration of the motor block, and duration of analgesia between two groups was significant ($P \leq 0.001$).

Hemodynamics

The HR, SBP, DBP, mean blood pressure, and SpO_2 were compared using independent Student's *t*–test [Figure 1].

The decrease in HR from baseline after block administration was seen in both the groups. There was statistically significant ($P < 0.05$) decrease in the HR between 10 min and 480 min in Group RD compared to Group R. There was no clinically significant bradycardia (HR <40/min) requiring treatment [Figure 2].

There was a decrease in the SBP from baseline after block administration in both the groups. There was statistically significant ($P < 0.05$) decrease in the SBP between 15 min and 540 min in Group RD compared to Group R. There was no clinically significant hypotension (SBP <90 mm of Hg) requiring intervention [Figure 3].

There was a decrease in the DBP from baseline after block administration in both the groups. There was statistically significant ($P < 0.05$) decrease in the DBP between 15 min and 480 min in Group RD compared to Group R [Figure 4].

There was a decrease in the mean blood pressure from baseline after block administration in both the groups. There was statistically significant ($P < 0.05$) decrease in the mean blood pressure between 15 min and 540 min in Group RD compared to Group R [Figure 5].

There was no decrease in the SpO_2 from the baseline after block administration in either group. There was no statistically significant difference in the SpO_2 in between two groups.

Discussion

Axillary brachial plexus block is one of the most widely used regional anesthesia technique for upper limb surgeries. It offers many advantages over general anesthesia. Many
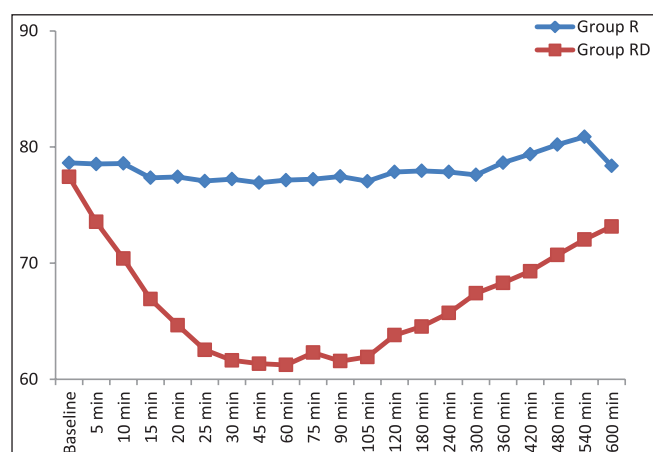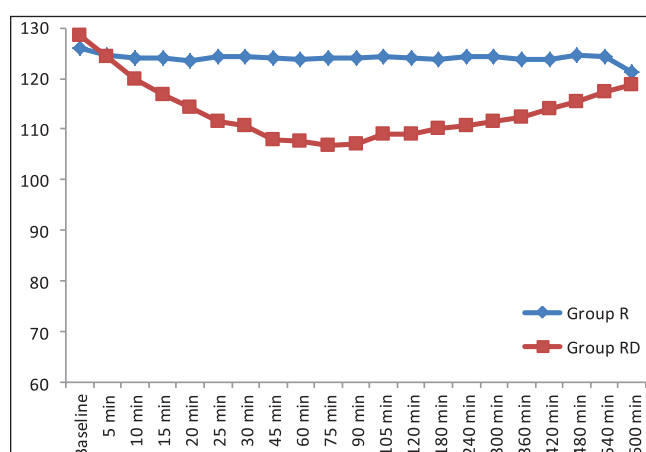

Figure 1: Changes in the heart rate

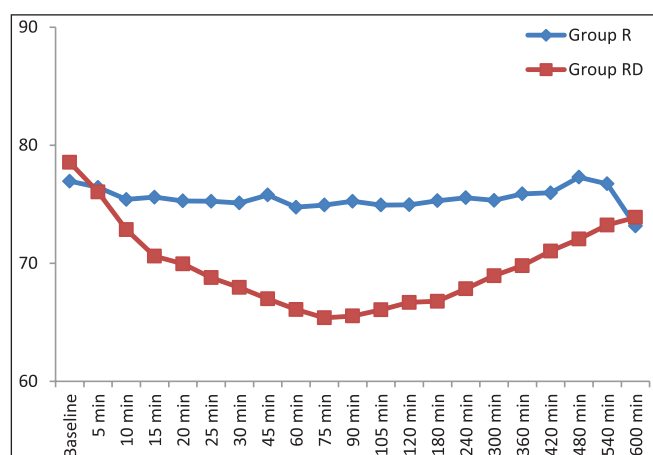**Figure 2: Changes in the systolic blood pressure**

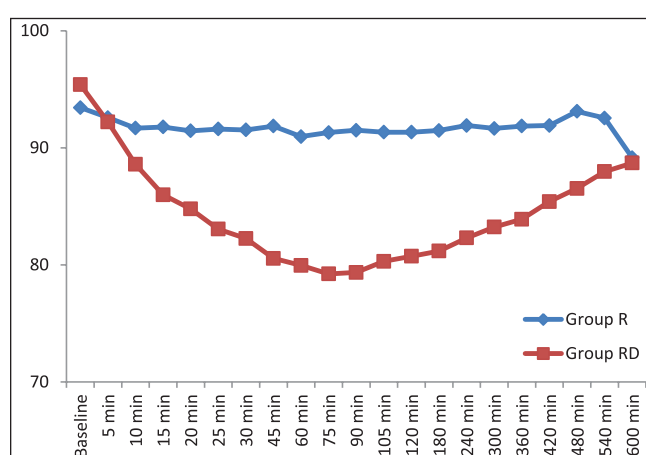**Figure 3: Changes in the diastolic blood pressure**

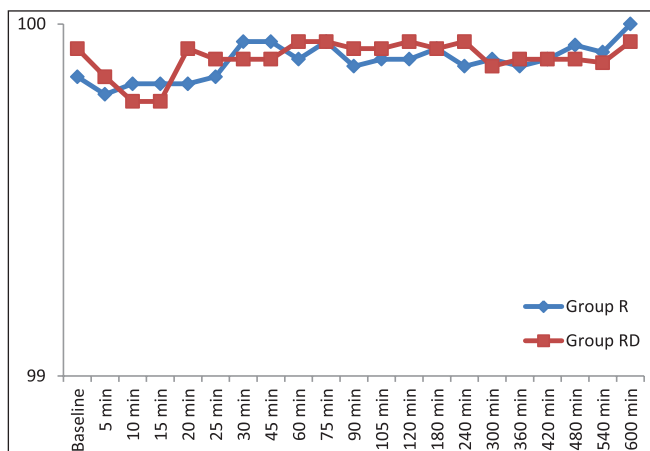**Figure 4: Changes in the mean blood pressure**

Figure 5: Changes in the oxygen saturation

problems like pneumothorax, vascular injuries, which are common in interscalene, supraclavicular, and infraclavicular brachial plexus block are avoided in axillary brachial plexus block. Numerous drugs have been used for axillary brachial plexus block. Bupivacaine was the most common drug used. Recently, ropivacaine is gaining popularity in its use for regional anesthesia because it is less cardiotoxic and neurotoxic than bupivacaine.

Adjuvants have been added to the LAs for axillary brachial plexus block to intensify, prolong the duration of block and analgesia.

Both the groups were comparable with respect to age, gender, weight, ASA physical status, and duration of surgery. No patients were excluded from the study.

In our study, we found that the onset of sensory block was 16.13 ± 4.0001 min in Group RD which was earlier and statistically significant ($P < 0.001$) than that in Group R which was 20.5 ± 3.889 min.

Similar results were found in the study done by Lin *et al*. in 40 ASA Class I or II adult patients undergoing thyroid surgery.[2] Group D with 20 patients received cervical plexus block with 30 ml of 0.375% ropivacaine combined with 1 μg/kg dexmedetomidine whereas Group C with 20 patients received 30 ml of 0.375% ropivacaine combined with saline (control) for cervical plexus block. In this study, the onset of sensory block in Group D was 4.72 ± 1.15 min, which was earlier than that in Group C, which was 6.64 ± 1.27 min. This difference was statistically significant ($P < 0.05$).

In our study, we found that the onset of motor block in Group RD was 18 ± 3.889 min, Group R was 23.13 ± 3.337

min. The early onset of motor block in Group RD compared to Group R was statistically significant ($P < 0.001$). In our study, the duration of sensory block in Group RD was 677.25 ± 99.64 min, Group R was 494.38 ± 70.64 min. The longer duration of sensory block in Group RD was statistically significant in comparison to Group R ($P < 0.001$). Similarly, we found in our study that the duration of motor block in Group RD was 712.88 ± 89.32 min and in Group R was 526.25 ± 70.229 min. This longer duration of motor block in Group RD than in Group R was statistically significant ($P < 0.001$).

Similar results were found in a study done by Marhofer *et al*. in 36 volunteers for ultrasound guided ulnar nerve block.[3] Volunteers were randomly allocated to one of the three groups. Group (R) received 3 ml of ropivacaine for 0.75% and 0.2 ml of saline for the block and 5 ml of saline intravenously. Group (RpD) received 3 ml of ropivacaine for 0.75% and 20 mg of dexmedetomidine for the block and 5 ml of saline intravenously. Group (RsD) received 3 ml of ropivacaine for 0.75% and 0.2 ml of saline for the block and 20 μg of dexmedetomidine diluted in 4.8 ml saline intravenously. In this study, the onset of motor block was 47 min, 21 min, 43 min, respectively in Group (R), Group (RpD), and Group (RsD). The faster onset of motor block in Group (RpD) was statistically significant compared to other groups ($P < 0.05$). The duration of sensory block in Group (R), Group (RpD), and Group (RsD) were 350, 555, 395 min, respectively. In this study, there was statistically significant ($P < 0.01$) longer duration of sensory block in Group (RpD) in comparison to both the other groups. The duration of motor block was 348, 590, 438 min, respectively in Group (R), Group (RpD), and Group (RsD); and statistically significant ($P < 0.05$) longer duration of motor block in Group (RpD) when compared to Group (R) and Group (RsD).

Zhang *et al*. found similar results in their study of axillary brachial plexus block in 45 ASA I or II patients, aged 25-60 years who were scheduled for elective forearm and hand surgery.[4] They randomly divided patients into three equal groups of Group DR1: 40 ml of 0.33% ropivacaine + 1 ml dexmedetomidine (50 μg) (1), Group DR2: 40 ml of 0.33% ropivacaine + 1 ml dexmedetomidine (100 μg), and Group R 40 ml of 0.33% ropivacaine + 1 ml saline. The duration of sensory block was 689 ± 269 min, 804 ± 340 min, 1190 ± 456 min, respectively in Group R, DR1, and DR2. In this study, the duration of sensory block was longer and statistically significant ($P < 0.05$) in Group DR2 when compared to Group R and DR1. The duration of motor block in Group R, DR1 and DR2 were 511.86 ± 135.51, 737.73 ± 135.99, 1033.8 ± 273.76, respectively and the

longer duration of motor block in Group DR2 was statistically significant ($P < 0.01$).

In our study, we found that the duration of analgesia in Group RD was 764.38 ± 110.275 min and that in Group R was 576.88 ± 76.306 min. The duration of analgesia was longer and statistically significant ($P < 0.001$) in Group RD.

Paul *et al*. found similar results in their study of the efficacy of intra-articular dexmedetomidine for postoperative analgesia in arthroscopic knee surgery in 60 patients, who were randomly assigned to two groups of 30 each.[5] Group R received 19 ml of 0.25% ropivacaine and 1 ml of isotonic saline (total volume 20 ml) intra-articularly. Group RD received 100 µg (1 ml) of dexmedetomidine added to 19 ml of 0.25% ropivacaine intra-articularly (total volume 20 ml). Analgesic effect was evaluated by measuring pain intensity (VAS score) and duration of analgesia was obtained. They found that the duration of analgesia was 5.38 ± 1.4 h and 10.84 ± 2.6 h in Group R and Group RD, respectively. They found that this difference of the longer duration of analgesia in Group RD was statistically significant ($P < 0.001$). They also found that in Group RD the consumption of fentanyl in the postoperative period was low and statistically significant ($P < 0.01$).

Sinha *et al*. found similar results in their comparative study of the analgesic efficacy of ropivacaine with ropivacaine plus dexmedetomidine for a paravertebral block in unilateral renal surgery in 60 adult patients belonging to either ASA Group I or II.[6] Group I received 18 ml of ropivacaine for 0.25% and Group II received 18 ml of ropivacaine for 0.25% plus 1 µg/kg dexmedetomidine. They found that the mean duration of analgesia was longer in Group II (324.4 ± 56.35 min) as compared to Group I (149.2 ± 30.64 min) and statistically significant ($P < 0.05$).

In our study, the mean baseline HR, systolic, diastolic, and mean blood pressures were 77.43/min, 128.4, 78.55, 95.4 mm of Hg, respectively. We found that the HR, SBP, DBP, and mean blood pressure in Group RD were lower than the baseline between 15 min and 480 min after block administration, but we did not come across any bradycardia (defined as HR <40 beats/min) or hypotension (defined as SBP <90 mm of mercury) which required treatment. These hemodynamic changes were statistically significant ($P < 0.001$).

Similar results were found by Rancourt *et al*. in their prospective, randomized, controlled, double-blind, crossover trial in 14 healthy volunteers.[7] Volunteers were allocated to two groups who received an ultrasound-guided tibial nerve block. Group R received 10 ml of 0.5% ropivacaine,

Group RD received 10 ml of a solution containing 0.5% ropivacaine with 1 µg/kg of dexmedetomidine hypotension, bradycardia, hypoxia, and sedation. They found that the duration of sensory block lasted longer in Group RD than in Group R and was statistically significant ($P < 0.0001$). The duration of sensory block was 21.5 h and 16.2 h in Group RD and Group R, respectively. They also found that the mean systolic and DBP levels were stable throughout the study period in Group R but in Group RD, they noticed decrease in SBP and DBP between 60 and 480 min ($P < 0.05$).

Similar results were found in the study done by Swami *et al*. in 60 ASA Grade I and II patients, aged 18–60 years, of either sex, undergoing upper limb orthopedic bony surgeries under supraclavicular brachial plexus block.[8] Group C of 30 patients received bupivacaine 0.25% (35 cc) and clonidine 1 µg/kg. Group D of 30 patients received bupivacaine 0.25% (35 cc) and dexmedetomidine 1 µg/kg. In this study the duration of sensory block was 227.00 ± 48.36 min in Group C as compared with 413.97 ± 87.31 min in Group D. Statistically significant longer duration of sensory block was observed in Group D ($P = 0.001$). Similarly, the duration of motor block was 292.67 ± 59.13 min in Group C as compared with 472.24 ± 90.06 min in Group D. The duration of motor block was longer and statistically significant in Group D ($P = 0.001$). There was a significant increase in duration of analgesia in Group D (456.12 ± 97.99 min) as compared with Group C (289.67 ± 62.50 min). This difference was also statistically significant ($P = 0.001$). SBP and DBP were found to be significantly lower than baseline from 30 to 120 min in Group D as compared with Group C and were statistically significant ($P < 0.001$).

Abdallah and Brull did a systemic review and meta-analysis on facilitatory effects of perineural dexmedetomidine on neuraxial and peripheral nerve block.[9] In this study, nine randomized controlled trials and 516 patients were analyzed. Randomized controlled trials comparing the effect of dexmedetomidine as an LA adjuvant to LA alone on neuraxial and peripheral nerve blocks were reviewed. Of nine randomized controlled trials analyzed, five were on spinal anesthesia and four were on the brachial block. They concluded that onset of sensory block, the onset of motor block for the brachial block were early and statistically significant ($P = 0.00001$) by the addition of dexmedetomidine to LA as an adjuvant. It was also found that the duration of the motor block and duration of analgesia were prolonged and statistically significant ($P = 0.00001$) by the addition of dexmedetomidine to LA as an adjuvant to brachial block.

Obayah *et al.* conducted a study on effects of addition of dexmedetomidine to bupivacaine for greater palatine nerve block for postoperative analgesia after cleft palate repair. Totally, 30 children were included in the study.[10] The B Group received bupivacaine 0.25%, whereas the BD Group received bupivacaine 0.25% with 1 μg/kg dexmedetomidine. In this study, the duration of analgesia in the Group BD was longer and statistically significant. This was similar to our findings.

Conclusion

Dexmedetomidine as an adjuvant to ropivacaine provides quicker onset of anesthesia and longer duration of analgesia. It offers convenient, simple, effective mode of anesthesia with favorable hemodynamic stability, and postoperative analgesia for forearm and/or hand surgeries.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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