Effect of Dexmedetomidine with Ropivacaine in Supraclavicular Brachial Plexus Block

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Citation

Sharma S, Shrestha A, Koirala M. Effect of Dexmedetomidine with Ropivacaine in Supraclavicular Brachial Plexus Block. *Kathmandu Univ Med J.* 2019;67(3):178-83.

ABSTRACT

Background

Brachial plexus block is popular choice for upper limb surgeries and offers good and relatively safe anesthesia. Among various approaches supraclavicular approach is the most consistent method for anaesthesia and postoperative pain management in surgery below the elbow joint. Many drugs are used as adjuvants in brachial plexus block for faster onset, denser block and for prolongation of postoperative analgesia. Dexmedetomidine also has been shown to prolong the sensory and motor duration when added as an adjuvant to local anaesthetic in nerve blocks.

Objective

To assess the effect of adding dexmedetomidine to ropivacaine in brachial block.

Method

Sixty patients, planned for upper limb surgeries under ultrasound guided brachial block were randomly allocated into two groups. Group RS (n=30) received 30 ml of 0.5% Ropivacaine + 1 ml Normal Saline and Group RD (n=30) received 30 ml of 0.5% Ropivacaine + 0.75 mcg/kg Dexmedetomidine diluted to 1 ml solution. The onset time to sensory and motor blockade were recorded. The duration of sensory and motor block and duration of analgesia were recorded.

Result

The mean time to onset of sensory block (12.60±2.67 min Vs 22.17±2.81 min) and motor block (14.20±3.22 min Vs 22.53±3.97) in Group RD was significantly faster in Group RD than Group RS. The mean duration of sensory block (838.70±164.11 min Vs 670.20±145.16 min), motor block (804.16±148.71 min Vs 594.93±53.89 min) and duration of analgesia (1193.80±223.11 min Vs 828.23±136.30 min) were significantly longer in Group RD compared to Group RS. The incidence of side effects in both groups were comparable.

Conclusion

From this study, it can be concluded that addition of Dexmedetomidine 0.75 mcg/kg to 0.5% Ropivacaine results in early onset of sensory and motor blockade, prolongation of duration of sensory and motor blockade and duration of analgesia postoperatively without any significant side effects.

KEY WORDS

Analgesia, Brachial plexus block, Dexmedetomidine, Motor block, Ropivacaine, Sensory block

INTRODUCTION

Brachial plexus block is popular anesthetic technique for upper limb surgeries. Various approaches to the brachial plexus block have been described but the supraclavicular approach is the easiest and the most consistent method for anaesthesia and postoperative pain management in surgery below the elbow joint.[1]

Many local anaesthetics have been used to produce brachial plexus block. Because of its higher potency and prolonged duration of action bupivacaine is most commonly used.[2] One of the disadvantages is that it is cardiotoxic, especially with inadvertent injection into subclavian artery. Ropivacaine was developed with properties similar to bupivacaine, having lower lipid solubility and less cardiotoxicity.[3]

Many drugs are used as adjuvants in brachial plexus block for faster onset, denser block and for prolongation of postoperative analgesia.[4] Tramadol and clonidine have been successfully used as adjuvants to local anesthetic in brachial plexus block.[5,6] Other adjuvants like morphine, buprenorphine, sufentanyl, fentanyl, midazolam, dexamethasone, magnesium and clonidine have also been used in nerve blocks to prolong the effect.[7-12]

Dexmedetomidine, a selective alpha-2 agonist, with affinity eight times that of clonidine, has also been shown to prolong the sensory and motor duration when added as an adjuvant to local anaesthetic in nerve blocks.[13-16] In this study we tried to evaluate the effect of dexmedetomidine with ropivacaine in brachial plexus block with regard to onset time of sensory and motor blockade, duration of sensory and motor blockade, duration of analgesia and side effect profile.

METHODS

This randomized double blinded prospective study was done at Tribhuvan University Teaching Hospital after approval from Institutional Review Board (IRB). American Society of Anesthesiologists (ASA) physical grade I and II patients aged 18-65 years of either gender scheduled to undergo surgery for upper limb were enrolled during the period of 4 months from April to July 2017. Patients receiving adrenoceptor agonist or antagonist therapy or chronic analgesic therapy, patients with suspected coagulopathy, or known allergies and pregnant and lactating patients were excluded from the study. Patients were familiarized and educated about the visual analogue scale (VAS; consisting 100 mm long straight line with no pain at one end and worst imaginable pain at the other end) one day before the surgery and were instructed to point at the line corresponding to their pain when asked.

Patients were randomized using computer generated randomization technique into two groups. Group RS received 30 ml of 0.5% Ropivacaine and 1 ml of Normal Saline (NS) and Group RD received 30 ml of 0.5% Ropivacaine and 0.75 mcg/kg of Dexmedetomidine diluted to 1 ml solution and blinding was done using a sealed envelope technique.

Ultrasound (USG) guided Brachial plexus block was performed by supraclavicular route via the subclavian perivascular approach using 22 gauge spinal needle. Sonosite Edge II ultrasound machine with linear probe (13-6 MHz) was used for the block. Drug was administered according to the allocated group with repeated aspiration and incremental dosing.

Sensory block was assessed by pin prick test in the six nerve territories (Musculocutaneous nerve = Lateral side of forearm, radial nerve = Dorsum of the hand over the second metacarpophalangeal joint, median nerve = Thenar eminence, ulnar nerve = Hypothenar eminence, medial cutaneous nerve of arm = Medial side of the arm and medial cutaneous nerve of forearm = Medial side of the forearm) using a 3-point scale.[17]

Grade 0 = normal sensation,

Grade 1 = loss of sensation of pin prick (analgesia)

Grade 2 = loss of sensation of touch (anaesthesia)

Motor block was evaluated by thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb opposition (median nerve) and flexion at the elbow (musculocutaneous nerve) using Bromage scale for upper extremity.[18]

Grade 0 = Able to raise the extended arm to 90° for full 2 seconds.

Grade 1 = Able to flex the elbow and move the fingers but unable to raise the extended arm.

Grade 2 = Unable to flex the elbow but able to move the fingers.

Grade 3 = Unable to move the arm, elbow and fingers

Both sensory and motor blocks were assessed every 3 min till their onset and the time between administration of drug and onset of complete sensory and motor blockade was recorded.

Sensory and motor blockade was then assessed every hour after the end of surgery until first 12 hours and thereafter every two hourly until the block completely wore off. Onset time of sensory blockade was defined as the time interval between the end of local anesthetic injection and loss of sensation to pin prick. Onset time of motor blockade was defined as the time interval between the end of local anesthetic injection and loss of movement in all the nerve distributions. Orthopaedic upper limb surgeries were commenced after the onset of sensory and motor blocks. In any event of inadequate sensory or motor block after 30 min of injection of drug, the case was converted to general anaesthesia and was excluded from the study.

After completion of the surgery, the patients pain was assessed with VAS score every hourly till 12 hours post operatively. The time between drug administration and

request for first analgesic medication (VAS score ≥3) was recorded as duration of analgesia. Duration of sensory block was defined as the time interval between the end of study drug administration and complete resolution of sensation on all nerves. Duration of motor block was defined as the time interval between the end of study drug administration and the recovery of complete motor power of the hand and forearm to pre-injection level.

Patients were questioned for side effects such as nausea, vomiting, skin rash and observed for tachycardia (HR >20% of baseline value), bradycardia (HR < 50 bpm), hypotension (SBP > 20% below baseline value) hypoxemia (SpO_2 < 90%), or any other side effects such as pneumothorax, horners syndrome, phrenic nerve palsy or respiratory depression intraoperatively and postoperatively. The data hence obtained was then recorded.

Hypotension was managed with intravenous mephentermine 6 mg bolus used in incremental doses. Bradycardia was managed by awakening the patient if the patient was asleep and if HR was still below 50 bpm then intravenous atropine 0.6 mg was administered.

Data collection was done in a preformed sheet and entered in Microsoft Excel. Statistical analysis was done by using statistical package for the social sciences (SPSS) software version 20.0 (SPSS Ltd, Chicago, IL, USA). Values are presented as mean ± standard deviation (SD) or frequency. Hemodynamic data were analyzed using t-test and Mann-Whitney U-test for group comparison. Nominal categorical data such as gender was also analyzed with Chi-square test. For all determination p-value < 0.05 (2-tailed) was considered as statistically significant.

RESULTS

The demographic profile of the study population is shown in Table 1. There was no significant difference in mean age, sex, weight, ASA physical status and duration of surgery between the two groups.

Table 1. Demographic Profile

	RD (n=30)	RS (n=30)	P-Value
Age (years)	38.17±14.86	42.13±16.23	0.32
Gender (M/F)	15/15	20/10	0.19
Weight (kg)	64.30±5.90	61.37±10.52	0.19
ASA-PS (I/II)	19/11	20/10	0.42
Duration of surgery (mins)	120.83±65.70	120.73±50.85	0.99

Data described as (mean±SD); n=number, p-value<0.05 is significant

The details of comparison of baseline characteristics are shown in the Table 2. There were no significant differences in baseline values between the two groups.

The details of onset of sensory and motor block are shown in Table 3. The onset of both sensory and motor block were significantly faster in dexmedetomidine group.

Table 2. Comparison of baseline characteristics

	RD (n=30)	RS (n=30)	P value
Heart rate	76.07±6.97	76.93±7.51	0.64
SBP (mmHg)	123.57±7.90	127.13±10.93	0.64
DBP (mmHg)	77.40±6.08	78.20±6.95	0.63
Respiratory Rate	14.30±1.14	13.80±1.34	0.12
Oxygen Saturation (%)	95.80±1.12	95.17±1.31	0.64

Data described as (mean±SD); n=number, p-value<0.05 is significant

Table 3. Comparison of Onset of sensory block and motor block

	Group RD (n=30)	Group RS (n=30)	P value
Onset of Sensory block(min)	12.60±2.67	22.17±2.81	0.01
Onset of Motor block (min)	14.20±3.22	22.53±3.97	0.01

Data described as [mean ± SD]; n=number, p-value < 0.05 is significant

The details of duration of sensory block and motor block are shown in Table 4. The duration of both sensory and motor block were significantly prolonged in dexmedetominine group.

Table 4. Comparison of duration of sensory and motor block

Duration of	Group RD (n=30)	Group RS (n=30)	P value
Sensory block (min)	838.70±164.11	670.20±145.16	0.01
Motor block (min)	804.16±148.71	594.93±53.89	0.01

Data described as (mean±SD); n=number, p-value <0.05 is significant

The median duration of analgesia in Group RD was 1266 min compared to 803 min in Group RS. The mean duration of analgesia (1st request for rescue analgesia or VAS more than or equal to three) in Group RD was also significantly prolonged (1193.80±223.11 min vs 828.23±136.30 min, p = 0.01, fig. 1).

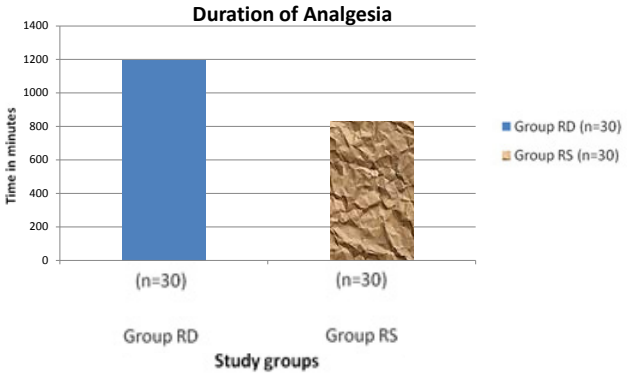

Figure 1. Comparison of duration of analgesia

There were episodes of hypotension during the surgery in two patients (6.66%) belonging to the RD group which was managed with incremental doses of intravenous Mephentermine 6 mg. No episode of hypotension was recorded in any patient belonging to the RS group. Similarly, there was episode of bradycardia in one patient (3.33%) belonging to the RD group which was managed by awakening the patient. The incidence of hypotension and bradycardia were not statistically significant. No other side effects such as nausea, vomiting, skin rash, horners syndrome, pneumothorax, phrenic nerve palsy or respiratory depression were observed in any group. In all of the cases except 8 (4 in each group) tourniquet was used however no patient in any group complained of tourniquet pain during the procedure.

DISCUSSION

Our study demonstrated that addition of dexmedetomidine to ropivacaine resulted in prolongation of duration of analgesia postoperatively. It also showed that there was early onset and prolonged duration of sensory and motor blockade. Thus, with a single block, we could achieve a longer duration of postoperative analgesia without significant clinical side-effects.

We used 0.5% ropivacaine for supraclavicular block. The rationale for choosing this concentration is based on the study done by Klein et al. who found that increasing the concentration of ropivacaine from 0.5% to 0.75% failed to improve the onset or duration of block, suggesting that the risk of increased total dose of local anesthetic may be avoided.[19] Hickey and coworkers have shown that 0.25% ropivacaine when used for subclavian perivascular brachial plexus block for upper limb surgery required frequent analgesia supplementation due to the low concentration of local anesthetic used.[20]

In our study, the mean time to onset of sensory block and motor block in dexmedetomidine group was faster. These findings were quite similar to those of Chinappa et al. who performed a similar study by adding 1 mcg/kg dexmedetomidine to 0.5% ropivacaine.[21] Similar study performed by Kathuria et al. also demonstrated quicker time to onset of sensory and motor blockade in the group receiving dexmedetomidine as compared ropivacaine.[17] They compared the effects of adding 50 mcg dexmedetomidine to 0.5% ropivacaine in supraclavicular brachial plexus block. Ammar et al. and Kaygusuz et al. in their studies also found significantly earlier onset of sensory block in the dexmedetomidine group than in the Ropivacaine alone group.[22,23] Gandhi et al. in their study also found that motor block and sensory block onset was hastened by the use of dexmedetomidine adjuvant in brachial plexus block with bupivacaine.[24]

A study conducted by Marhofer et al. in 36 volunteers found that dexmedetomidine as adjuvant produced early onset of motor block, however sensory block was not different from the control group.[25] Das et al. however, found no difference in the onset of either sensory block or motor block in ropivacaine group and dexmedetomidine group.[26]

In our study, the mean duration of sensory block as well as motor block in dexmedetomidine group was significantly longer. The findings of our study are quite similar to those demonstrated by Kathuria et al. and Chinappa et al. who studied the effect of adding 1 mcg/kg and 50 mcg dexmedetomidine to 0.5% ropivacaine respectively.[17,21] The duration of sensory and motor block was significantly prolonged in the dexmedetomidine group. One study by Das et al. demonstrated prolongation of sensory and motor block in Dexmedetomidine group compared to Ropivacaine only group.[26] Similar studies performed by Marhofer et al., Das et al., Ozaki et al., and Zhang et al. also demonstrated significantly prolonged duration of sensory and motor blockade in Dexmedetomidine group.[25,27,28,29] Masuki et al. suggested that Dexmedetomidine induces vasoconstriction via α2 adrenoceptors in the human forearm possibly also causing vasoconstriction around the site of injection, delaying the absorption of local anesthetic and hence prolonging its effect.[30]

In our study, the mean duration of analgesia in Group RD was 1193.80±223.11 min and in Group RS was 828.23±136.30 min which was statistically significant. The study done by Chinappa et al. and Bansal et al. also demonstrated a significantly prolonged duration of analgesia in the group receiving Dexmedetomidine.[21,31] The findings of our study also lend support to the observations of various early studies by Esmaoglu et al., Swamy et al., Ammar et al., Marhofer et al., Das et al., Rancourt et al. where the duration of analgesia was significantly prolonged in the group receiving Dexmedetomidine.[13,15,22,25,26,32]

In our study, there were episodes of hypotension in two patients (6.66%) belonging to the RD group which was managed with incremental doses of intravenous Mephentermine 6 mg. Similarly, there was episode of bradycardia (3.33%) in one patient belonging to the RD group which was managed by awakening the patient. Other side effects such as nausea, vomiting, skin rash, horners syndrome, pneumothorax, phrenic nerve palsy or respiratory depression were not observed in any patients of either group. Study performed by Bansal et al. showed significantly increased number of bradycardia and more episodes of hypotension in the Dexmedetomidine group in comparison to Ropivacaine alone group.[31] Higher incidence of side effects in that study was most likely associated with the use of higher dose of Dexmedetomidine (100 mcg).

In this study, a large volume (30 ml) of Ropivacaine was deposited in the vicinity of nerve plexus under ultrasound guidance. We used relatively large volume of local anesthetic even during ultrasound guided block because of our recently started practice of performing ultrasound guided brachial plexus block. Another technique for

administration of local anesthetic in close proximity of nerve plexus is use of a nerve stimualtor, which is quite often used in combination with ultrasound guidance for brachial plexus block nowadays for better results. We didn't use nerve stimulator however taking into consideration the cost factor. The use of ultrasound guidance will be helpful for us to use a lower volume of local anesthetic during supraclavicular brachial plexus block in our future studies.

In this study we took only ASA grade I and II patients only, hence the result may not be applied to more sicker patients. The volume of local anaesthetic used in our study was quite high though there were no side effects of such doses noted. The block could have been done with low volume. The use of a nerve stimulator could have been helpful in identifying the plexus with higher degree of accuracy and could have resulted in the use of lower volume of drug which was unlike what happened in our study.

CONCLUSION

Thus, from this study, it can be concluded that addition of an alpha agonist Dexmedetomidine 0.75 mcg/kg to local anesthetic 0.5% Ropivacaine results in early onset of sensory and motor blockade, prolongation of duration of sensory and motor blockade and prolongation of duration of analgesia postoperatively without any significant side effects in ultrasound guided brachial plexus block.

ACKNOWLEDGEMENTS

Hence, from this study we can recommend the use of 0.75 mcg/kg Dexmedetomidine as an adjuvant to 0.5% Ropivacaine for supraclavicular brachial plexus block in upper limb surgeries to quicken the onset of sensory and motor blockade, to prolong the duration of sensory blockade and duration of analgesia without increasing the incidence of side effects associated with the use Dexmedetomidine.

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