

ORIGINAL RESEARCH

Effect of Dexmedetomidine as an Adjuvant in Supraclavicular Brachial Plexus Block with Ropivacaine: A Prospective, Double blinded and Randomized Controlled Study

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ABSTRACT

Introduction: Different types of additives are commonly used to prolong the duration of brachial plexus block. The present study was aimed to test the hypothesis that dexmedetomidine produces a superior analgesia, motor block and post operative analgesia when added as an adjuvant to ropivacaine 0.5% in supraclavicular brachial plexus block.

Materials and Methods: A total of 100 patients (20-50 years) posted for elective forearm and hand surgery under supraclavicular brachial plexus block were divided into two equal groups (Group R and RD) in a randomized, double-blind fashion. In group RD ($n = 50$) 30 ml 0.5% ropivacaine plus 1 ml (100 micrograms) of dexmedetomidine and group R ($n = 50$) 30 ml 0.5% ropivacaine plus 1 ml normal saline were administered in supraclavicular block. Sensory and motor block onset times and block durations, time to first analgesic use, total analgesic need, postoperative visual analog scale (VAS), hemodynamics and side effects were recorded for each patient.

Results: Though with similar demographic profile in both groups, sensory and motor block in group RD ($P < 0.05$) was earlier than group R. Sensory and motor block duration and time to first analgesic use were significantly longer and the total need for rescue analgesics were lower in group RD ($P < 0.05$) than group R. Post-operative VAS value at 12 h was significantly lower in group RD ($P < 0.05$). Intra-operative hemodynamics were significantly lower in group RD ($P < 0.05$) without any adverse side-effects.

Conclusion: It was concluded that addition of dexmedetomidine to supraclavicular brachial plexus block increases the sensory and motor block duration and time to first analgesic use, and decreases total analgesic use with no side-effects

Key words: dexmedetomidine, post operative analgesia, ropivacaine, supraclavicular brachial plexus block.

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INTRODUCTION

In upper limb surgeries regional anaesthesia is a better option. Brachial plexus block provides both intraoperative anaesthesia and better postoperative analgesia without any systemic side-effects.¹ Many local anaesthetics have been used to provide brachial plexus block. One of the commonly used local anaesthetic drug for brachial plexus block is bupivacaine, because of its higher potency and prolonged duration of action. Cardinal disadvantage of bupivacaine is its cardiotoxicity, especially with inadvertent injection into subclavian artery, particularly in supraclavicular approach. So ropivacaine was developed with properties similar to bupivacaine, having lower lipid solubility and less cardiotoxicity.² The chemical structure of ropivacaine is piperocoloxyliidides. It has a propyl group on the piperidine nitrogen molecule. Ropivacaine acts by reversible inhibition of sodium ion influx and thereby blocks impulse conduction in nerve fibres. The concentration of ropivacaine in plasma depends on the total dose of the drug and the route of administration, as well as the haemodynamic and circulatory condition of patient and vascularity of the administration area. Most common adverse effects associated with ropivacaine include hypotension, nausea, vomiting, bradycardia and headache, which can be seen after various routes of administration.³ Ropivacaine has less cardiovascular and central nervous system toxicity as compare to other local anaesthetic drugs, particularly bupivacaine. Less systemic toxicity is due to its stereo selective properties and less lipophilicity. Local anesthetics alone for supraclavicular brachial plexus block provide good intra-operative conditions, but produces a shorter duration of postoperative analgesia. Various adjuvants to local anesthetics were used to prolong analgesia with variable results and advantages.⁴ Recently, α_2 agonists have been studied as adjuvants to local anesthetics in regional anaesthetic techniques for their efficacy to enhance

the quality and duration of analgesia with relatively lesser side effects, when compared to opioids. Dexmedetomidine is a selective α_2 agonist, with affinity eight times that of clonidine. Various studies have shown that dexmedetomidine prolongs the duration of sensory and motor block and provides very good analgesia when used as an adjuvant to local anaesthetics for nerve blocks.^{5,6}

The present study was aimed to test the hypothesis that dexmedetomidine produces a better analgesia, motor block and post operative analgesia when added as an adjuvant to ropivacaine 0.5% in supraclavicular brachial plexus block.

MATERIALS AND METHODS

One hundred patients undergoing elective orthopedic surgeries of elbow, forearm and hand under supraclavicular brachial plexus block in Rajiv Gandhi Institute of Medical Sciences College and Hospital, Kadapa, Andhra Pradesh, were randomized into two groups based on block randomization. Patients belonging to ASA physical status 3, 4 and 5, patients with history of left ventricular failure, Atrioventricular Conduction Block, with uncontrolled diabetes and hypertension, and taking Beta blocking drugs were excluded from the study.

The study protocol was approved by the Institutional Ethical Committee. Written Informed Consent was taken from each subject willing to enter the study. Pre anaesthetic checkup and routine investigations like complete blood count, serum creatinine and ECG were done. Patients were kept nil by mouth for 6 hours. All patients were clinically examined in the pre-operative period, when whole procedure was explained. 10 cm visual analog scale (VAS) (0, no pain and 10, worst pain imaginable) was also explained during the pre-operative visit. All patients received tab clonazepam 0.5mg orally on the night before surgery. One hundred ASA grade I and II patients undergoing elective orthopedic surgeries of elbow, forearm and hand were randomly assigned to one of the two groups: Group R received 30 ml of 0.5% ropivacaine + 1 ml normal saline for supraclavicular block. Group RD received 30 ml 0.5% ropivacaine + 1 ml (100 μ g) of dexmedetomidine for the same block.

After shifting the patient into operation theater IV line is secured with a large bore cannula. All non-invasive monitors like non-invasive blood pressure (NIBP), pulse rate, oxygen saturation, and electrocardiogram (ECG) were applied to all patients and their baseline vital signs were measured. All patients were provided with supplemental oxygen using nasal cannula at 2 L/min. Patients were sedated with IV administration of midazolam 1 mg and fentanyl 50 μ g before the block. A nerve stimulation technique with a Stimplex[©] needle and a stimulator were used for all patients. After the proper location of the nerve, the local anaesthetic solution was injected in increments of 5 ml boluses with intermittent aspiration. The Anesthesiologist performing supraclavicular block was unaware of the constituent of the drug and

allotment of the group and similarly resident doctors keeping records of different parameters were also unaware of group allotment. Thus, double blinding was properly achieved.

Sensory and motor blockade were assessed every 3 mins after the completion of drug injection until 30 min and then every 30 min after the end of surgery until first 12 hrs, thereafter hourly until the block had completely worn off. Sensory blockade was assessed by pinprick.

The duration of sensory block was defined as the time interval between the onset of sensory block and the first post-operative pain. The duration of motor block was defined as the time interval between the onset of motor block and complete recovery of motor functions. After 30 min, if the block was considered to be adequate, surgery commenced. Injection diclofenac sodium (rescue analgesic) 75 mg was given intramuscularly when VAS ≥ 3 . Number of injection diclofenac given to each patient during first 24 h of the post-operative period was recorded.

STATISTICAL ANALYSIS

Data were expressed as mean \pm standard deviation for quantitative variables, number, and percentage for categorical variables. Chi-square (χ^2) test was used to compare in between groups. $P < 0.05$ was considered statistically significant.

RESULTS

One hundred patients were studied. Of these two patients were excluded, one from each group due to incomplete / failed block to whom general anesthesia was administered. There was no significant difference with respect to age, height, weight, sex, ASA physical status, and duration of surgery. ($P > 0.05$). [Table 1].

Table 2 shows the type of fractures in the patients studied. Fracture lower end humerus was the most common fracture with total of 40 cases (21 in group R and 19 in group RD), followed by fracture olecranon with 31 cases (15 in group R and 16 in group RD) and fracture radius and ulna with 27 cases (13 in group R and 14 in group RD) each.

The results regarding the characteristics of sensory block and motor block are summarized in table 3. The onset of both motor and sensory block in study group (group RD) is faster than in control group (group R). The duration of sensory and motor block was longer in dexmedetomidine group RD compared to ropivacaine group (p < 0.05). The duration of analgesia in group R is 310.67 \pm 64.29 minute and group RD is 480.25 \pm 78.38 minute, which is statistically significant (p < 0.05). Vital parameters like mean pulse rate, systolic blood pressure, mean respiratory rate and mean arterial saturation values were similar in both the groups.

Table 4 shows that group RD required less number of diclofenac sodium injection as rescue analgesics than patients in group R (control group) in first 24 h of post-operative period, and the difference is statistically significant ($P < 0.05$).

Parameter	Group R (n=49)	Group RD (n=49)
Age (yr)	35.68±7.39	36.24±6.8
Weight(kg)	68.42 ± 8.56	67.56 ± 6.02
Height(cm)	154.42±6.29	155.68±6.33
ASA PS (I/II)	43/6	42/7
Sex (male/female)	33/16	31/18
Duration of surgery(min)	92.25±13.72	94.24±14.25

Table-1: Demographic data

Type of Fracture	Group R (n=49)	Group RD (n=49)
Fracture Lower end humerus	21	19
Fracture Olecranon	15	16
Fracture Radius and Ulna	13	14

Table-2: Type of Fracture in the study subjects

Parameter	Group R (n=49)	Group RD (n=49)
Onset of sensory block (min)	12.12 + 2.65	8.14 + 1.12
Onset of motor block (min)	18.93 + 1.44	14.26 + 2.42
Duration of sensory block (min)	263.22±40.42	422.18±62.10
Duration of motor block (min)	290.76±46.43	468.23±84.20
Duration of analgesia (min)	310.67±64.29	480.24±78.38

Table-3: Characteristics of sensory and motor block

No. of diclofenac required in first 24 hrs of post-operative period	Group R (n=49)	Group RD (n=49)
1 (onceinjection)	5	9
2 (twice injection)	16	4
3 (thrice injection)	8	0

Table-4: Rescue analgesic requirement in post-operative period

The side effects were found to be insignificant and incidental. Only two cases of bradycardia and two cases of hypotension were noticed in group RD.

DISCUSSION

Supraclavicular brachial plexus blocks are performed at the level of the brachial plexus trunks. At the level of trunks, almost the entire sensory, motor and sympathetic innervations of the upper extremity are carried in just three nerve structures (trunks), confined to a very small surface area. The typical features of this block include rapid onset, predictable and dense anesthesia along with its high success rate.⁷ Local anesthetics alone for supraclavicular brachial plexus block provide good intra operative conditions but provides a shorter duration of postoperative analgesia. Hence various drugs such as opioids,⁸ clonidine,⁹ neostigmine, dexamethasone,¹⁰ midazolam,¹¹ magnesium etc., were used as adjuvants with local anesthetics in brachial plexus block to achieve rapid, dense and prolonged block, but the results are either inconclusive or associated with side-effects. Dexmedetomidine is a highly selective, α_2 -adrenergic ag-

onist. Dexmedetomidine has sedative, analgesic, anesthetic sparing effects when used in systemic route.¹² Use of dexmedetomidine as an adjuvant mixed with local anesthetics has been performed with neuraxial anesthesia in both adult and pediatric patients.¹³ Addition of dexmedetomidine as adjuvant to local anesthetics during peripheral nerve and nerve plexus blockade has recently been practiced widely by anesthesiologists.¹⁴ Brummett CM *et al.* found that dexmedetomidine when added to ropivacaine in peripheral nerve block caused approximately a 75% increase in the duration of analgesia.¹⁵ Kaslo *et al.* concluded that dexmedetomidine affinity to alpha 2 adrenoceptor agonists is eight times more as compared to clonidine, when dexmedetomidine is added to lidocaine for intravenous regional anaesthesia.¹⁶ Dexmedetomidine improves quality of anaesthesia and postoperative analgesia without causing any side effects.¹⁷

There are several hypothesis to explain the mechanism of action of the analgesic effect of dexmedetomidine. The most common possible explanations include vasoconstriction around the injection site.¹⁸ Dexmedetomidine also provides analgesia by direct suppression of impulse propagation through neurons as a result of a complex interaction with axonal ion channels or receptors,¹⁹ local release of enkephalin like substances,²⁰ a decrease in localized pro inflammatory mediators²¹ and an increase in anti-inflammatory cytokines through an α_2 -adrenoceptor mediated mechanism.²²

The onset time of sensory block (8.14 ± 1.12 min in RD group vs. 12.12 ± 2.65 min in R group) was faster in group RD compared to group R ($P < 0.05$). [Table 3]. These findings are correlated with the studies of Rancourt *et al.*²³ Also Ammar and Mahmoud²⁴, Kaygusuz *et al.*²⁵, found significantly earlier onset of sensory block in the RD group than in the group R. The onset time of motor block (14.26 ± 2.41 min in RD group vs. 18.93 ± 1.44 min in group R) was also faster in group RD than in group R ($P < 0.05$). Also Ammar and Mahmoud²⁴, Gandhi *et al.*²⁶ in their study found that motor block onset was hastened with the addition of Dexmedetomidine adjuvant in brachial plexus block with bupivacaine. Again in a study conducted by Marhofer *et al.*²⁷ in 36 volunteers it has been found that dexmedetomidine as adjuvant though produced early onset of motor block, sensory block was not different from the control group.

In our study, the duration of sensory block (422.18 ± 62.10 min in group RD vs. 263.22 ± 40.42 min in group R) was significantly longer in the dexmedetomidine group than in the control group ($P < 0.05$). The duration of motor block (468.23 ± 84.20 min in RD group vs. 290.76 ± 46.43 min in R group) was also significantly longer in the dexmedetomidine group than in the control group ($P < 0.05$). These findings are similar to the observations of various previous studies by Ammar and Mahmoud, Esmaoglu *et al.*⁶

In our study, mean duration of analgesia and motor block in the dexmedetomidine plus ropivacaine group were 422.18 min (7.03 hrs) and 263.22 min (4.24 hrs) respectively. While the mean duration of analgesia and motor block in the dex-

medetomidine plus bupivacaine group were 2.99 hrs and 2.59 hrs respectively, in the study conducted by Ammar and Mahmoud.²⁴ Again the median duration of sensory and motor block in the dexmedetomidine plus levobupivacaine group in infraclavicular brachial plexus block were 14.78 h and 12.88 h respectively, in the study by Esmoglu *et al.*⁶

In our study, patients of RD group required significantly less number of diclofenac sodium injection in first 24 h of post-operative period than the patients R group ($P < 0.05$). This finding is correlating with the studies of Kaygusuz *et al.*²⁵ Kaygusuz *et al.* found that 11 patients of levobupivacaine group required 75 mg intramuscular injection of diclofenac sodium as rescue analgesic, whereas dexmedetomidine plus levobupivacaine group required nodi clofenac sodium injections and the result was also statistically significant.²⁵ Reduced requirement of rescue analgesic in the dexmedetomidine group during first 24 h of post-operative period is due to prolonged duration of sensory block. Again Ammar and Mahmoud²⁴ also experienced statistically much less amount (4.9 mg vs. 13.6 mg) of i.v morphine administration as rescue analgesic in bupivacaine with dexmedetomidine group while comparing with plain bupivacaine group in infraclavicular brachial plexus block.

In group RD, bradycardia was observed in four patients and all of these patients were managed with atropine. There was no such episode of bradycardia in group R. Sideeffects including pneumothorax, Horner syndrome were not observed in both groups, and the difference was statistically insignificant ($P > 0.05$). Esmoglu *et al.*⁶ also found significant bradycardia in Dexmedetomidine plus levobupivacaine group than levobupivacaine alone. Also, they found significant hypotension with dexmedetomidine group, which was absent in our study.

CONCLUSION

Addition of Dexmedetomidine to local anesthetic agents in supraclavicular brachial plexus block significantly prolongs the duration of analgesia and duration of motor block in patients undergoing upper limb surgeries.

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