Original Article

Clonidine as an adjuvant for ultrasound guided supraclavicular brachial plexus block for upper extremity surgeries under tourniquet: A clinical study

Kumkum Gupta, Vaibhav Tiwari, Prashant K Gupta[1], Mahesh Narayan Pandey, Apoorva B Singhal, Garg Shubham

Departments of Anaesthesiology & Critical Care, [1]Radio-diagnosis, Imaging & Interventional Radiology, and Netaji Subhash Chandra Bose Subharti Medical College, Swami Vivekananda Subharti University, Subhartipuram, Meerut, Uttar Pradesh, India

Abstract

Background and Aims: Clonidine has been used as an adjuvant to local anesthetic to extend the duration of block. The present study was aimed to compare the onset and duration of sensory and motor blockade of 0.75% ropivacaine alone or in combination with clonidine during ultrasound guided supraclavicular brachial plexus block for upper extremity surgeries under tourniquet.
Materials and Methods: Sixty four adult American Society of Anesthesiologist grade 1 and 2 patients, scheduled for upper extremity surgeries were randomized to receive either 19.8 mL of 0.75% ropivacaine with 0.2 mL of normal saline (Group R) or 0.2 mL (30 μg) of clonidine (Group RC) in supraclavicular block. Onset and duration of sensory and motor blockade was compared. The hemodynamic variability, sedation, respiratory adequacy and any other adverse effects were also recorded.
Result: Ultrasound helped to visualize the nerves, needle and spread of local anesthetic at the brachial plexus block site. There was no statistically significant difference in the onset of sensory and motor blockade between the groups. Surgical anesthesia was achieved at the mean time of 20 min in all patients. Prolonged post-operative analgesia (mean duration 956 min) was observed in RC group as compared with R group (736 min). No complication of technique or adverse effect of ropivacaine and clonidine was reported.
Conclusion: Clonidine as an adjuvant to ropivacaine for ultrasound guided supraclavicular brachial plexus enhanced duration of post-operative analgesia. There was no incidence of vessel puncture or pneumothorax.

Key words: Clonidine, ropivacaine, supraclavicular block, ultrasound

Introduction

Supraclavicular brachial plexus block provides effective anesthesia to the upper extremity surgery. Its success relies on proper nerve localization, needle placement and local anesthetic injection. The traditional blind nerve localization techniques rely on surface landmarks before needle insertion and elicitation of paresthesia or nerve stimulated muscle contraction after needle insertion. A single injection is adequate as the brachial plexus is enclosed in a fascial sheath that extends from the neck to the axilla, but often multiple attempts are necessary, resulting in procedure related pain and complications of vessel puncture and pneumothorax.[1]

Ultrasound guidance for regional anesthesia became popular owing to detection of anatomical variants, painless performance and more accurate needle placement. The needle tip can be guided toward the neurovascular bundle to avoid injury to arteries, veins and other adjacent structures. It also helps to monitor the spread of local anesthetic solution in the appropriate tissue planes and thereby reduce the incidence of pneumothorax, arterial puncture and direct nerve damage.[2-4]

Various adjuvants to local anesthetics were used to prolong analgesia with variable results and advantage.[5] Recently, α2

Address for correspondence: Prof. Kumkum Gupta, 108, Chanakyapuri, Shastri Nagar, Meerut - 250 004, Uttar Pradesh, India.
E-mail: kumkumprashant75@gmail.com

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agonist have been studied as adjuvants to local anesthetic in regional anesthetic techniques for their efficacy to enhance the quality and duration of analgesia with fewer adverse effects. Clonidine, an α2 adrenergic agonist has sedative, analgesic, perioperative sympatholytic with cardiovascular stabilizing effects and has been tried in combination with local anesthetic drugs to enhance regional anesthesia.[6,7]

The present study was aimed to evaluate the clinical efficacy of clonidine as an adjuvant to 0.75% ropivacaine for enhancing the quality and duration of sensory and motor block alongwith duration of postoperative analgesia of ultrasound guided supraclavicular brachial plexus block in upper extremity surgery.

Materials and Methods

This prospective double-blind randomized clinical study was conducted on 64 adult patients of physical status American Society of Anesthesiologist (ASA) grade 1 and 2, aged 18 to 58 years of both genders, scheduled for upper extremity surgery from July 2011 to June 2012. After approval of Institutional Ethical Committee and written informed consent, all patients were subjected to pre-anesthetic assessment. Patients with a history of pre-existing cardiac or pulmonary diseases, peripheral neuromuscular disease, bleeding or coagulation disorder, allergy to local anesthetic amides, inability to localize the brachial plexus accurately on ultrasound or refusal to technique were excluded from the study. Any patients taking medications with psychotropic or adrenergic activities and patients receiving chronic analgesic therapy other than simple analgesics were also excluded from the study. Patients were randomized according to computer generated number into two equal groups of 32 patients each to receive either 19.8 mL of 0.75% ropivacaine with 0.2 mL of normal saline (Group R) or 19.8 mL of ropivacaine with 0.2 mL (30 μg) of clonidine (Group RC) for ultrasound guided supraclavicular block. The local anesthetic solution was prepared according to a random number table by an anesthetist not involved in the study.

After establishing intravenous access on arrival in the operation theater, the lactate ringer intravenous fluid was started at the rate of 4 mL/kg/h in all patients and continuous monitoring of pulse rate, non-invasive systemic blood pressure and electrocardiography was ensured. Oxygen was connected by Hudson mask at the rate of 4 L/min to all patients after establishing the brachial plexus block. The anesthetist performing the block was blinded to the treatment group. All observations were carried out by a single investigator who was also blinded to the treatment group.The supraclavicular brachial plexus block was performed using a transportable ultrasound system (Sonosite micromax; Sonosite Inc., Bothell, WA, USA) with a 38 mm 8 -13 MHz linear high frequency ultrasound transducer (HFL-38) to obtain the images of brachial plexus in the transverse and longitudinal planes.[8]

Patient lie down supine with head turned to the contralateral side and ipsilateral arm adducted gently by the assistant and the shoulder kept down with flexed elbow. After sterile preparation of the skin and the ultrasound probe, the brachial plexus was visualized by placing the transducer in the sagittal plane in the supraclavicular fossa behind the middle-third of the clavicle. Two distinct appearances of the brachial plexus was seen at the supraclavicular region, it either appeared as 3 hypoechoic circles with hyperechoic outer rings or as a grape like cluster of 5 to 6 hypoechoic circles, located lateral and superior to the subclavian artery between the anterior and middle scalene muscles at the lower cervical region [Figure 1].

The block was performed using local anesthetic mixture according to Group R or Group RC with a 23-gauze 40 mm short beveled echogenic needle for optimal control and visibility. The predetermined volume of 20 mL of study drug solution was administered around the brachial plexus after negative aspiration to avoid accidental intravascular needle puncture and spread of local anesthetic drug was observed in tissue planes. Initially, the needle was placed deep to the more caudal elements of the plexus so that the brachial plexus rises closer to the skin surface with the injection of the local anesthetic. Distension of the brachial plexus sheath was regarded as an indication of correct needle placement [Figure 2]. The multiple injection technique was used to deposit the total amount of drug. A 3-min massage was performed to facilitate an even drug distribution.[4] The sensory dermatome level of analgesia of the upper extremity was assessed by pinprick test along the distribution of each nerve with 25 G hypodermic needle using a 3-point scale for pain (2-sharp pain, 1-blunt pain, 0-no pain)[6] and compared to same stimulation on contralateral arm. Motor weakness was assessed by hand grip and movement at the elbow, wrist and fingers, using a modified Bromage scale[6] (grade 0-normal motor function with full flexion and extension of elbow, wrist and fingers, grade 1-decreased motor power with the ability to move the fingers only, grade 2-complete motor block with inability to move the fingers). Motor block was assessed by thumb abduction (radial nerve), thumb adduction (ulnar nerve) and thumb opposition (median nerve).[4]

Sensory block onset was defined as a reduction in sensibility to 30% or less. Motor block onset was defined as a reduction of muscle force to grade 2 and was considered as the end point. Patients were assessed for onset of sensory and motor

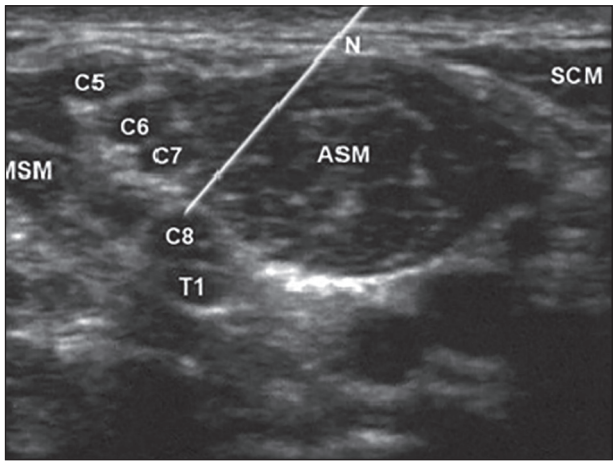

Figure 1: Showing ultrasonographic imaging of brachial plexus (ASM: Anterior scalene muscle, MSM: Medial scalene muscle, SCM: Sterno-clediomastoid muscle)

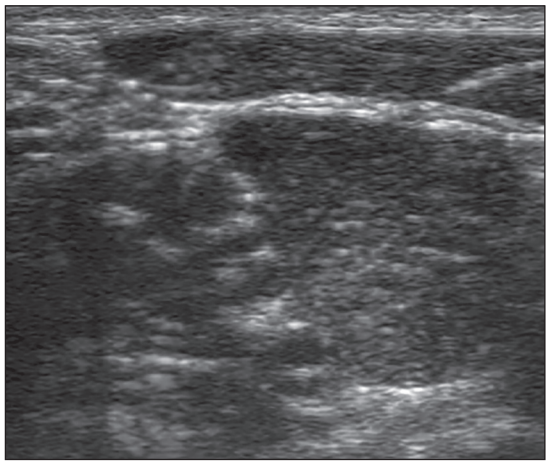

Figure 2: Distribution of local anesthetic

blockade at every 5 min until desired surgical anesthesia has occurred. If, 30 min after study dose injection, any of the major nerves involved in the planned surgical intervention had a sensibility of more than 30%, they were separately blocked and patient was excluded from the study. Duration of sensory blockade was defined as the time interval between injection and complete recovery of sensation. Duration of motor blockade was determined until recovery of full muscle power.

The hemodynamic variables of heart rate and non-invasive blood pressure, ventilation rate and oxygen saturation were monitored initially at 5 min interval until 1 h then at 10 min interval until completion of surgery. Patients were observed for any discomfort, nausea, vomiting, shivering, bradycardia, pain and any other side-effects. Any need for additional medication was noted.

Post-operative pain was assessed by using 10 point visual analogue scale, 0-no pain to 10-excruciating pain, at 2, 4, 6, 8, 12 and 16 h. Injection tramadol (100 mg) was used as rescue analgesic on patient's demand.

Statistical analysis

The sample size was based on initial pilot study, which indicated that approximately 27 patients should be included in each group in order to detect clinically significant difference (>20%) of duration of blockade and post-operative analgesia between the groups for type 1 error of 0.01 and power of 90%. Assuming a 5% dropout rate, the final sample size was determined to comprise of 64 patients. Results are expressed as Mean ± SD. Statistical analysis was performed for comparing observed data by using student *t*-test, Chi-square test and Mann-Whitney U test. *P* value of <0.05 was considered statistically significant.

Results

A total of 64 adult consented patients scheduled for elective upper extremity surgery were randomized to two equal groups of 32 patients. Both groups were comparable for their demographic data of age, weight, ASA classification, type and duration of upper extremity surgeries. The ultrasound has aided to visualize the nerves, needle and spread of local anesthetic at the brachial plexus block site. The brachial plexus imaging in the supraclavicular region was consistent in all patients and they all were successfully operated upon and were cooperative with subsequent assessment [Table 1].

The baseline hemodynamic parameters were comparable in both groups. Significantly, lower pulse rate was observed after 30 min and throughout the perioperative period in Group RC, but pulse rate was never lesser than 60 beats/min. The systolic and diastolic blood pressures were comparable between both groups. No medication was needed.

Onset of sensory block was faster in Group RC (2.36 ± 1.7 min) than Group R (2.57 ± 1.5 min) while the onset of motor block was faster in ropivacaine group (3.10 min vs. 3.87 min), but the difference was not statistically significant [Table 2].

The duration of sensory blockade was 535.39 ± 25 min in Group R as compared with 673.9 ± 35 min in Group RC. Statistically significant longer duration of sensory blockade was observed in Group RC. The duration of motor blockade was 485.12 ± 30 min in Group R as compared with 614.58 ± 29 min in Group RC. The duration of motor blockade was statistically significantly longer in Group RC. There was a statistically significant increase in duration of post-operative analgesia in Group RC (956.47 ± 38 min) as compared with Group R (736.53 ± 47 min) [Table 2].

Table 1: Demographic profile of patients

Data/groups	Group (R)	Group (RC)
Age (years)	36.4±12.4	37.3±9.3
Sex (male:female)	21:11	23:09
Weight (kg)	58.2±9.7	63.7±7.8
Region of surgery elbow/FA	12/20	13/19
Duration of surgery (min)	162.15±14	156.35±20
ASA grade (I/II)	15/17	18/14

Data are presented as mean ± SD or absolute numbers. FA = Forearm; ASA = American society of anesthesiologist

Table 2: Sensory and motor blockade characteristics

Parameter/groups	Group I (R)	Group (RC)
Onset time of sensory block (min)	2.57±1.5	2.36±1.7
Onset time of motor block (min)	3.10±4.3	3.87±1.6
Duration of sensory block (min)	535.39±25	673.9±35*
Duration of motor block (min)	485.12±30	614.58±29*
Duration of analgesia (min)	736.53±47	956.47±38**

**P value <0.05 is statistically significant. **P value is highly significant*

The breathing frequency and peripheral oxygen saturation were comparable between the groups. None of the patients had complaints of breathing difficulty or had clinical evidence of accessory muscles of respiration being in use or a drop in saturation below 95%, suggestive of no diaphragmatic palsy or pneumothorax. No side-effects of nausea, vomiting, pruritus or dry mouth were reported during the first 24 h in the post-operative period in both groups.

Discussion

We observed that clonidine 30 μg in 19.8 mL of 0.75% ropivacaine significantly enhanced the quality of supraclavicular brachial plexus block for upper extremity surgeries by a faster onset and prolonged duration of sensory and motor blockade with enhanced duration of post-operative analgesia. These benefits were not associated with any hemodynamic changes or any adverse events. Patient satisfaction was achieved by a painless performance and excellent block qualities.

Regional anesthesia makes a simple demand that the right dose of the right drug to be given in the right place. The principal challenge of regional anesthesia is the unreliability of conventional modalities for confirming precise nerve localization due to anatomical variation. The real-time ultrasound guidance has been used to localize the peripheral nerve or plexus, accurate needle placement and verification of local anesthetic spread in the appropriate tissue planes.[4] Most comparative studies have shown faster onset times and longer duration of blocks when real-time ultrasound has aided the technique in comparison with other nerve localisation techniques.[9]

Clonidine and local anesthetic agents have a synergistic action. Systemic review of various adjuvants for brachial plexus block suggests that the clonidine appears to have greater analgesic benefit with minimal adverse effects.[8,10] In the present study, an enhancement of quality and duration of sensory and motor blockade profile of brachial plexus block was observed in the clonidine group.

Clonidine in neuraxial techniques affects mainly synaptic adrenergic receptors. Four mechanisms have been proposed, which are centrally mediated analgesia; α2 adrenoceptor mediated vasoconstrictive effects, attenuation of the response and direct action on the peripheral nerve.[6,11] Dalle *et al.*, have proposed that clonidine enhanced the activity by dependent hyperpolarization, generated by the Na/K pump during repetitive stimulation, increased the threshold for initiating the action potential causing slowing or blockade of conduction.[12] Regardless of mechanism of action, clonidine was found to be a valuable adjuvant for peripheral nerve blocks when added to local anesthetic solution.

In the present study, we did not find a statistically significant difference in the onset of sensory and motor blockade between the two groups. Most authors have also reported no effect on the onset of block.[11,13,14]

The beneficial effect of clonidine on the prolongation of analgesia was observed by Pöpping *et al.*, with all tested local anesthetics.[13]Singelyn *et al.*, reported that a minimum dose of clonidine (0.5 μg/kg) added to mepivacaine prolongs the duration of anesthesia and analgesia after brachial plexus block and found no added advantage by exceeding the dose of clonidine to 1.5 μg/kg.[14] Therefore, we decided to use clonidine in dose of 30 μg with 19.8 mL of 0.75 % ropivacaine for supraclavicular brachial plexus block.

No patient in RC group required sedation as they were comfortable with arousable sedative effect. It may be due to systemic absorption of clonidine as α2 agonists produce sedation by inhibition of substance *P* release in the nociceptive pathway at the level of the dorsal root neuron and by activation of α2 adrenoceptor in locus coeruleus. No patient in any of the groups exhibited significant side effects or hemodynamic variability in both groups during the perioperative period.

Conclusions

Clonidine (30 μg) as an adjuvant to 0.75% ropivacaine for upper extremity surgeries under ultrasound guided supraclavicular brachial plexus block has a definite advantage for enhancement of duration of sensory and motor blockade profile and post-operative analgesia without any hemodynamic variations and adverse events.

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