Original Research Article

Indian Journal of Anesthesia and Analgesia
2019; 6(2) (Part - I): 443-448
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.6219.12

Effect of Dexamethasone as Adjuvant to Ropivacaine in Ultrasound Guided Supraclavicular Brachial Plexus Block

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Abstract

Background and Aims: Different additives have been used to prolong Brachial plexus block. We evaluated the effect of adding Dexamethasone to Ropivacaine for Ultrasound guided Supraclavicular Brachial plexus blockade. The primary endpoints were the onset and duration of sensory and motor block and duration of analgesia. *Materials and Methods:* A total of 60 patients (18-60 years) satisfying inclusion and exclusion criteria posted for elective upper limb surgeries 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= 30) 30 ml 0.5% Ropivacaine plus 8 mg (2 ml) of Dexamethasone and group R (n = 30) 30 ml 0.5% Ropivacaine plus 2 ml normal saline were administered in Ultrasound guided supraclavicular block. Sensory and motor block onset times and block durations, duration of analgesia, and side effects if any were recorded for each patient. *Results:* Demographic parameters were comparable in both groups. Onset time of sensory and motor block were shorter in Group RD (10.15 + 1.14 min and 14.95 ± 0.83 min respectively) than in Group R (12.45 + 2.76 min and 16.05 ± 1.96 min respectively) (p = 0.001). Duration of sensory and motor blockade were longer in Group RD (909 ± 22.10 min and 878 ± 19.47 min respectively) than in Group R (450 ± 27.74 min and 420 ± 23.17 min) (p = 0.001). Duration of analgesia was longer in Group RD (1004 ± 25.49 min) than in Group R (498 ± 35.43 min) (p = 0.001). Intra-operative hemodynamic parameters were comparable in both the groups without any adverse effects. *Conclusions:* Dexamethasone when added to Ropivacaine for Brachial plexus block shortens the onset time and prolongs the duration of the block and the duration of post-operative analgesia.

Keywords: Dexamethasone; Ropivacaine; Brachial plexus block; Ultrasound.

How to cite this article:

Kakhandki Srinivas, Kethidi Karthika, Kaja Srirama Murthy. Effect of Dexamethasone as Adjuvant to Ropivacaine in Ultrasound Guided Supraclavicular Brachial Plexus Block. Indian J Anesth Analg. 2019;6(2):443-448.

Introduction

Peripheral nerve block as an anesthetic technique plays an important role in modern regional anesthesia compared with general and systemic analgesia which includes excellent pain control, and shortened stay in post anesthetic care unit and reduced side effects [1,2]. Upper limb surgeries below the shoulder joint are mostly performed under peripheral blocks such as the brachial plexus block. Its increased popularity is because of advancements in regional anaesthesia techniques in terms of local anaesthetic drugs, newer adjuvant drugs and use of Ultrasound for safe and successful conduct of block. It helps in reduced hospital stay, less financial burden and also leads to avoidance of undesirable side-effects of general anaesthesia.

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Received on 20.12.2018, **Accepted on** 03.01.2019

Ropivacaine is structurally closely related to Bupivacaine. Compared to racemic bupivacaine, ropivacaine has lower central nervous system toxicity and Cardiotoxicity [3], and it is better tolerated than bupivacaine [4]. Based on its profile, Ropivacaine may be preferable to bupivacaine. However Ropivacaine alone provide analgesia for not more than 4-6 hours in peripheral nerve blocks. Increasing the duration of local anaesthetic action is often desirable because it prolongs surgical anaesthesia and analgesia. Different additives have been used to prolong regional blockade. Additives like opioids, Clonidine, Tramadol, Butorphanol [5] Verapamil, [6] were added to local anaesthetics, but the results are either inconclusive or associated with side effects.

Steroids have powerful anti-inflammatory as well as analgesic property. Perineural injection of steroids is reported to influence postoperative analgesia. Dexamethasone microspheres have been found to prolong the block duration in animal and human studies [7]. Steroids produce analgesia by blocking transmission in nociceptive myelinated c-fibers and suppressing ectopic neuronal discharge. They might bring about this effect by altering the function of potassium channels in the excitable cells. Thus, Dexamethasone was selected as an adjuvant to Ropivacaine in supraclavicular brachial block. In this study, we investigated the effect of adding Dexamethasone to Ropivacaine for supraclavicular brachial plexus blocks. Our primary endpoints were the onset time, duration of motor and sensory blocks, and duration of analgesia.

Materials and Methods

After ethical committee approval and written informed consent, 60 American Society of Anaesthesiologist (ASA) grade I or II patients, scheduled for elective upper limb surgery below mid-humerus level under supraclavicular Brachial plexus block were enrolled in this prospective, randomized, double-blind controlled trial.

The patients were randomized into two groups based on block randomization.

Group R: 30 patients received 30 ml of 0.5% Ropivacaine + 2 ml saline.

Group RD: 30 patients received 30 ml of 0.5% Ropivacaine + 8 mg (2 ml) Dexamethasone

Inclusion Criteria

ASA I and II, 18-60 years, both sexes, mid humerus, elbow, forearm and hand surgeries were included.

Exclusion Criteria

Patient refusal, coagulopathy, ASA III and above, H/O severe cardiovascular, pulmonary, kidney, liver disease, neurological, psychiatric, neuromuscular disorder, infection at the site of injection/sepsis/allergy to the study drugs, pneumothorax, and peripheral neuropathy were excluded.

Pre-anesthetic assessment of all the patients was done the day before scheduled surgery. Patients were premedicated with tablet Alprazolam 0.25 mg and tablet Ranitidine 150 mg on night before surgery.

Coded study drug solutions were prepared by an Anaesthesiologist not involved in further study and handed over to concerned Anaesthesiologist for administration. After shifting the patient to operating table, standard anaesthesia monitoring in the form of the baseline measurement of heart rate, non-invasive arterial blood pressure, and peripheral oxygen saturation (SpO_2) was started. Intravenous access was achieved using 20G cannula in the non operative arm and ringers lactate was started. With all aseptic precautions, Supraclavicular brachial plexus block was given with the patient lying supine with the head turned to opposite side. The high frequency linear probe of Ultrasound machine (sonosite micromax machine) was placed over the supraclavicular region and Brachial plexus was identified and is approached in plane using a 23G, 55 mm needle. The local anaesthetic solution was injected after careful aspiration, and spread was seen encircling the trunks.

Assessment of sensory blockade was done in the dermatomal areas corresponding to median nerve, radial nerve, ulnar nerve and musculocutaneous nerve. Sensory blockade was tested using pin prick method along the distribution of the four nerves. Sensory block is graded as-Grade 0=sharp pin felt, Grade 1= analgesia, dull sensation felt, Grade 2= anaesthesia, no sensation felt. Sensory onset is considered when there is no sensation to pin prick (Grade 2) along the distribution of any of the above –mentioned nerves. The duration of sensory blockade is defined as time interval between onset of sensory blockade and complete resolution of anesthesia of all the nerves.

Motor blockade assessment was done using the modified Bromage scale for upper extremities on a three point scale. Grade 0 = normal motor function with full extension of elbow, wrist and fingers. Grade 1=decrease motor strength with ability to move fingers and/or wrist only, Grade 2= complete

motor blockade with inability to move fingers. Onset of motor blockade is considered when there is Grade 2 motor blockade. The duration of motor block is defined as the time interval between the onset of motor block and recovery of complete motor function of the hand and forearm.

Sensory and motor blockade and vital parameters were assessed every minute after the completion of drug injection until the onset of block and then every 10 min intraopertively and half hourly after the end of surgery until first 12 hrs, thereafter hourly until the block had completely worn off.

Injection Diclofenac sodium 75 mg intramuscular was administered when VAS [8] score was ≥4. The time between the end of local anaesthetic administration and first rescue analgesic administration was recorded as the duration of analgesia.

Statistical Analysis

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

Results

There was no statistically significant difference among the patients in the three groups with respect to age, height, sex ratio, duration of surgery, type of surgery and the ASA physical status (Table 1).

The sensory and motor block onset was significantly early and duration of sensory and motor blockade was prolonged in group RD than in group R (Table 2).

The mean sensory block onset time was 10.15 ± 1.14 min in group RD as compared to12.45 ± 2.76 in group R ($p<0.001$). (Fig. 1).

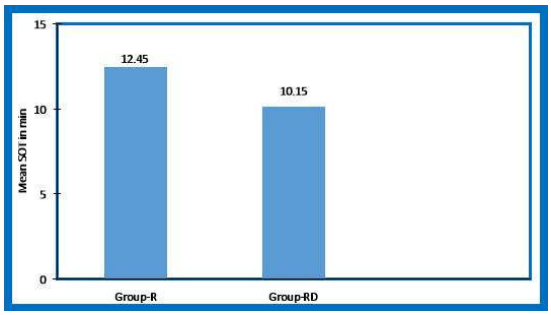

Fig 1: Onset of sensory block of the study groups

The mean motor block onset time was 16.05 ± 1.96 min in group R when compared to 14.95 ± 0.83 min in group RD. ($p <0.001$)(Fig. 2).

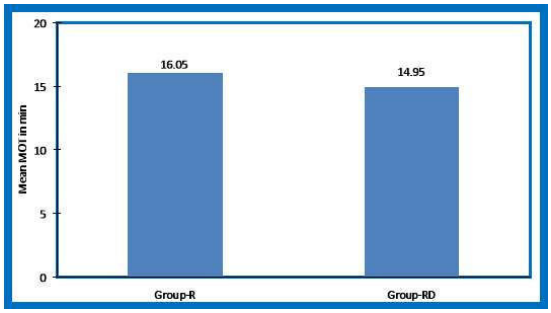

Fig 2: Onset of motor block of the study groups

The duration of sensory as well as motor block was significantly prolonged in group RD as compared to group R. The duration of sensory block was more in group RD 909 ± 22.10 min as compared to group R 450 ± 27.74 min ($p<0.001$)(Fig.

Table 1: Comparsion of demographic parameters

Demographic data	Group-R (n=30) (M ± SD)	Group-RD (n=30) (M ± SD)	p value
Age (years)	36.86 ± 9.23	35.43 ± 8.84	>0.05
Weight (Kg)	59.33 ± 7.86	57.96 ± 8.81	>0.05
Sex ratio (male: Female)	21/9	25/5	>0.05
Duration of surgery(min)	115.33 ± 16.76	114.66 ± 16.33	0.87

Table 2: Comparsion of block characteristics

Block Characteristics	Group-R (n=30) (M ± SD)	Group-RD (n=30) (M ± SD)	p value
Onset of sensory blockade (min)	12.45 ± 2.76 min	10.15 + 1.14 min	<0.001
Onset of motor blockade (min)	16.05 ± 1.96 min	14.95 ± 0.83 min	<0.001
Duration of sensory blockade (min)	450 ± 27.74 min	909 ± 22.10 min	<0.001
Duration of motor Blockade (min)	420 ± 23.17 min	878 ± 19.47 min	<0.001
Duration of analgesia (min)	498 ± 35.43min	1004 ± 25.49 min	<0.001

3). The duration of motor block was also more in group RD 878 ± 19.47 min where as in group R it is 420 ± 23.17 min ($p<0.001$). (Fig. 4).

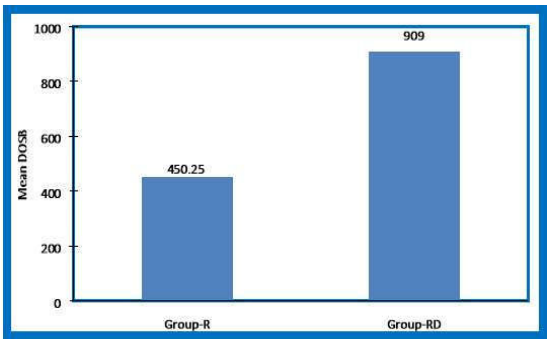

Fig 3: Duration of sensory block

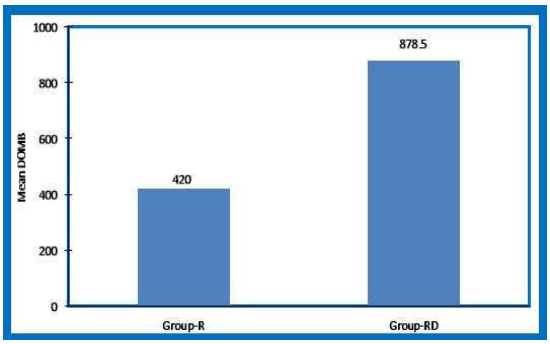

Fig 4: Duration of motor block

The duration of analgesia was significantly prolonged in group RD (1004 ± 25.49 min) when compared with group R (498 ± 35.43 min) (Fig. 5).

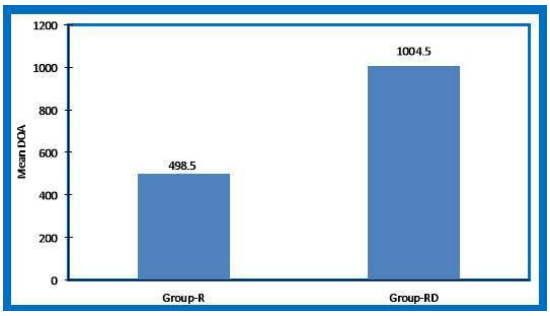

Fig 5: Total Duration of Analgesia

The total analgesic consumption in 24 h postoperatively was significantly higher in group R than group RD.

No episode of hypoxemia or respiratory depression during 24 h period postoperatively was seen in any patient. No episode of nausea, vomiting, or any other side-effect was observed.

Discussion

Although general anesthesia continues to be used for most of the surgical procedures, regional anesthesia has been increasing in popularity in recent years. This is mainly because of the fact that the regional anesthesia techniques can be utilized for analgesia not only during the operative period, but during the postoperative period as well and avoids complications of general anaesthesia. The brachial plexus block consists of injecting local analgesic drugs in the fascial spaces surrounding the nerve plexus, thereby blocking the autonomic, sensory and motor fibres supplying the upper extremity. It is a simple, safe and effective technique of anesthesia having distinct advantages over general and intravenous regional anesthesia.

Supraclavicular brachial plexus block is widely employed regional nerve block to provide anaesthesia and analgesia for the upper extremity surgery. Supraclavicular block provides a rapid, dense and predictable anesthesia of the entire upper extremity in the most consistent manner of any brachial plexus technique [9]. Here, the brachial plexus is approached at the level of trunks and the compact arrangement of trunks at supraclavicular level gives a high success rate with minimum local anaesthetic drug volume with fast onset and a dense block.

In our study we used Ultrasound guided supraclavicular block the advantage being, avoidance of intraneuronal /intravascular injection, visualization of spread of local anaesthetic, low volume of drug, faster onset of action, and decreased need for rescue analgesia. Abrahams et al. [10] concluded that Ultrasound method improves the quality of blockade when compared to peripheral nerve stimulator for nerve identification.

We used 0.5% Ropivacaine for supraclavicular block. Ropivacaine is a long-acting regional anaesthetic that is structurally related to bupivacaine. It is a pure S (-) enantiomer, unlike bupivacaine. It developed for the purpose of reducing potential toxicity and improving relative sensory and motor block profiles. Ropivacaine has lower lipid solubility and has produced less central nervous system and cardiac toxicity than bupivacaine for which it is gaining popularity over bupivacaine for peripheral neural blockade when large volumes of local anaesthetic are required. Ropivacaine is as effective as bupivacaine and levobupivacaine when used in peripheral nerve blocks. Clinically adequate doses of Ropivacaine appear to be associated with a lower grade of motor

block than bupivacaine [11]. However the brief duration of action of Ropivacaine may result in block resolution before the period of worst postoperative pain. Continuous catheter based nerve blocks can extend post operative analgesia but their placement require additional time, cost and skill. To overcome this various perineural adjuvants such as Opioids, Clonidine, Dexmedetomidine [12], Neostigmine, Midazolam, Dexamethasone, etc., were added to local anaesthetics in Brachial plexus block to achieve quick, dense and prolonged block.

The mechanism of the analgesia induced by corticosteroids is not fully understood. This effect is suspected to be mediated by their anti-inflammatory or immune-suppressive effects [13]. The use of corticosteroids as an adjuvant to local anaesthetic for peripheral nerve blocks rarely has been described, and its mechanism of action is not clearly understood. Corticosteroids cause skin vasoconstriction on topical application. The vasoconstriction effects of topical steroids are mediated by occupancy of classical glucocorticoid receptors rather than by nonspecific pharmacological mechanisms [14]. According to the traditional theory of steroid action, steroids bind to intracellular receptors and modulate nuclear transcription. Corticosteroids may have a local effect on the nerve [15]. It was found that steroids produce analgesia by reduction of inflammation by inhibition of Phospholipase A2 by blocking transmission in nociceptive c-fibres and suppressing ectopic neuronal discharge. The effect was reversible, suggesting a direct membrane action of steroids. Steroids might bring about this effect by altering the function of potassium channels in the excitable cells [16].

The dose of dexamethasone as an adjuvant to local anaesthetics for peripheral nerve block has not been described; we used a dose of 8 mg because administration of this dose seems to be safe in adults. Adverse effects with a single dose of dexamethasone are probably extremely rare and minor in nature, and previous studies have demonstrated that short-term (< 24 hours) use of dexamethasone was safe [17].

In the study by Shrestha BR et al. [18] on 60 patients undergoing forearm surgeries to evaluate the effect of Dexamethasone added to ropivacaine on the onset and duration of supraclavicular brachial block, concluded that mean onset time of sensory and motor block in dexamethasone group (9.89 ± 1.97 min and 11.09 ± 1.28 min respectively) was significantly early than plain ropivacaine group (11.64 ± 2.19 min and 13.32 ± 0.98 min). There was markedly prolonged duration of analgesia in dexamethasone group (11.87 ± 0.53 hours) as compared to plain ropivacaine group (3.43 ± 0.49 hours). Santosh Kumar et al. [19] demonstrated that the addition of 8 mg of dexamethasone to 0.5% ropivacaine for supraclavicular brachial plexus prolongs sensory and motor block as compared ropivacaine given alone. The findings in our study are in accordance and comparable to these studies.

In another study, Cummings III and co-workers [20] reported longer analgesia when using ropivacaine or bupivacaine for interscalene blocks, with the effect being more potent with ropivacaine. However, the block duration was more prolonged with bupivacaine than with ropivacaine. Persec et al., [21] concluded that using single-shot low-dose dexamethasone in a mixture with levobupivacaine results in prolonged analgesia duration and less analgesic use compared with levobupivacaine alone. In accordance to these studies no side effects were noticed in any of the study groups in our patients.

Thus, our study has shown that addition of dexamethasone to Ropivacaine in the brachial plexus block, using ultrasound guided supraclavicular approach, produced prolonged sensory and motor blockade and effective postoperative analgesia which lasted longer than that produced by ropivacaine alone without any significant side effects. Also it is a very cost effective way of providing analgesia.

Conclusion

We conclude that addition of Dexamethasone 8mg as adjuvant to Ropivacaine in Ultrasound guided supraclavicular brachial plexus block hastens the onset of sensory and motor blockade and significantly prolongs the duration of sensory and motor blockade and duration of analgesia in patients undergoing upper limb surgeries and is a remarkably safe and cost effective method of providing post operative analgesia.

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