Original Research Article

Indian Journal of Anesthesia and Analgesia
January – February 2020; 7(1) (Part - I): 87-92
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.7120.13

Addition of Dexamethasone to Bupivacaine for Brachial Plexus Block in Patients Undergoing Upper Limb Surgeries

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Abstract

Introduction: Prolongation of analgesia after single shot Brachial Plexus Block (BPB) with local anesthetic remains a challenge. Dexamethasone prolongs duration of action of local anesthetic when used as an adjuvant. We aimed to determine the efficacy of dexamethasone after addition to bupivacaine for prolongation of analgesia & motor block in BPB. *Methods:* A prospective, randomized, double blind study was carried out in a tertiary care hospital during the period of May 2016 to January 2019. Patients (n = 50) between 18 and 70 years of age of either sex undergoing upper limb surgery were enrolled. Patients in Group I (n = 25) received 0.5% bupivacaine plus dexamethasone 8 mg and Patients in Group II (n = 25) received 0.5% bupivacaine plus 0.9% normal saline. Mean duration of analgesia, mean duration of motor block, onset of sensory block & onset of motor block were recorded. 'p' value less than 0.05 was taken as significant. *Results:* Demographic characteristics were comparable in both the study groups. The mean duration of analgesia was significantly longer in Group I as compared to Group II (748.5 ± 65.57 mins *vs* 555.4 ± 35.20 mins: $p < 0.05$). Group I showed significantly longer mean duration of motor block compared to Group II (814.3 ± 100.81 mins *vs* 690.3 ± 81.36 mins: $p < 0.05$). Similarly, the onset of motor block was significantly rapid in Group I as compared to Group II (13.04 ± 2.09 mins *vs* 14.52 ± 2.29 mins: $p < 0.05$). *Conclusion:* Dexamethasone as an adjuvant to bupivacaine in brachial plexus block significantly prolongs the duration of analgesia and motor block in patients undergoing upper limb surgery.

Keywords: Brachial Plexus Block; Bupivacaine; Dexamethasone; Local anesthetic.

How to cite this article:
Raj Kumar Pradhan, Janmejaya Sahoo, Ashwini Patil, et al. Addition of Dexamethasone to Bupivacaine for Brachial Plexus Block in Patients Undergoing Upper Limb Surgeries. Indian J Anesth Analg. 2020;7(1 Part -I):87–92.

Introduction

The Joint Commission on Accreditation of Healthcare Organizations has coined the phrase "Pain: The 5th Vital Sign" to elevate awareness of pain management among healthcare professionals.[1] From time immemorial, attempts were made to relieve the pain of surgical intervention by various means. But it is only during the last few decades that great advances have been made in the management of surgical anesthesia and analgesia using different modalities like systemic opioids,

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Received on 13.10.2019, **Accepted on** 02.11.2019

cyclooxygenase inhibitors, patient controlled analgesia, Transcutaneous Electrical Nerve Stimulation and continuous central and Peripheral Nerve Block (PNB) etc. Despite these technical advances, many patients continue to suffer due to inadequate control of pain, major causes of which include inadequate knowledge regarding effective dosing and also under treatment with opioids due to fear of respiratory depression and addiction.[2] The role of PNB has expanded from the operating suite into the arena of postoperative and chronic pain management. Typical features of PNB include rapid onset, predictable, dense anesthesia and postoperative analgesia. Among the various PNB, Brachial Plexus Block (BPB) is one of the most commonly practiced blocks, as it offers an excellent operative field for surgeries of the upper extremities. One of the common approaches to blockade of brachial plexus is the supraclavicular approach as it has a favorable safety profile, ease of performance, high patient acceptability and broad applicability for hand, wrist and forearm procedures.[3,4]

Single shot BPB can provide analgesia only for the period of action of the local anesthetic used, which is very short and unlikely to provide postoperative pain relief for a long-time. Keeping this in mind, various opioids as well as other drugs have been used as adjuvants with local anesthetics with a view to increase the analgesic efficacy and concept of extending the duration of analgesia.[5–7] But there has been a concern regarding safety profile and adverse effects of these additives. Corticosteroids such as dexamethasone added to bupivacaine microspheres have been proven to prolong peripheral nerve block in animals. Undesirable side effects with single dose of dexamethasone seem to be minor and previous studies have demonstrated safe short-term (< 24 hour) use of dexamethasone.[8]

A review conducted on adjuvants in peripheral nerve blockade and effect of additives on duration of analgesia, neurotoxicity and safety concerns concluded that more data is required prior to undertaking the widespread use of dexamethasone as an additive for peripheral nerve blocks.[9] Hence, the current clinical study was planned with the objective to assess efficacy of dexamethasone after addition to local anesthetic agent for prolongation of analgesia & motor block for BPB in patients undergoing upper limb surgeries.

Materials and Methods

The present study was carried out in a tertiary care hospital during the period of May 2016 to January 2019. It was a prospective, randomized, double blind study of 50 patients undergoing upper extremity surgeries below shoulder joint. The study was approved by institutional ethical committee and patients were enrolled in the study after taking written informed consent.

Patients were randomly allocated using a standard randomization code into one of the following Two Groups depending upon the drugs, they received for brachial plexus block. Anesthesiologist prepared study drugs, who was involved in randomization process not involved further in the study. Thus, the patient and the observer were blinded to the study drug.

Group I (n = 25): Patients in this group received 1.5% adrenalized xylocaine (20 ml) and 0.5% bupivacaine (16 ml) plus dexamethasone 8 mg (2 ml) making a total volume of 38 ml.

Group II (n = 25): Patients in this group received 1.5% adrenalized xylocaine (20 ml) and 0.5% bupivacaine (16 ml) plus 0.9% normal saline (2 ml) making a total volume of 38 ml.

Patients between 18 and 70 years of age of either sex and of physical status, American Society of Anesthesiologists (ASA) Class I and II posted for upper limb surgery and with normal sensory and motor function in affected limb were selected. Patients with ASA Grade 3 and 4, any bleeding disorder and patient on anticoagulants, severe respiratory disease, neuro deficit involving brachial plexus, local infection at the injection site, history of allergy to local anesthetic, patients with a history of peptic ulcer disease, diabetes mellitus, hepatic or renal failure (contraindication to steroids), pregnant women, failed block, patchy block were excluded from the study.

Drug solution and dosages used were:

a. Xylocaine 5% ampoule. 6 ml of it was diluted to 20 ml with 0.9% normal saline to make it 1.5%. Xylocaine was used in a dose not exceeding 7 mg/kg.
b. Adrenaline 100 μg i.e. 0.1 ml of 1:1000 Adrenaline to make a dilution of 1:200000 or 5 µg/ml was taken with tuberculin syringe and added to xylocaine solution.
c. Bupivacaine 0.5% ampoule was used. 16 ml of it was taken in 20 ml syringe. It was used in the dose not exceeding 2 mg/kg.
d. Dexamethasone ampoule (4 mg/ml; 2 ml). 2 ml was added to xylocaine in Group I patients.

An intravenous drip started before undertaking the procedure which continued throughout the surgery. Vital parameters were recorded throughout the procedure and oxygen at the rate of 2l/min administered through oxygen mask.

The brachial plexus block was carried out after thorough explanation of the procedure and emphasising the need for patient cooperation. The classical approach to supraclavicular block using a single-injection, nerve-stimulator technique was used. The patient was asked to be in the dorsal recumbent position without a pillow, arms at his/her sides and head turned to side opposite to the one being blocked. This manoeuvre allowed for detection of any subtle finger movement produced by nerve stimulation. Part of neck was aseptically cleaned and draped. The operator stood on the same side to be blocked. With the patient in the above described position and the shoulder down, the lateral (posterior) border of the Sternocleidomastoid (SCM) muscle was identified and followed distally to the point where it met the clavicle. The point of needle entrance was about 1 in (2.5 cm) lateral to the insertion of the SCM in the clavicle or one "thumb breadth" lateral to the SCM. Palpation of the subclavian artery at the site confirms the landmark. The palpating index finger was placed at this site. Local infiltration of 1 ml of 2% lignocaine was given at the proposed puncture site. The needle was connected to nerve locator by the electrodes and was properly grounded with the help of ECG lead. The stimulation was started with an intensity of 2.0 mA and a pulse width of 100 μs. Once the desired response was obtained (muscle twitch of the fingers) current was decreased gradually upto 0.6 mA. After getting desired response the drug solution was injected. It was aimed to elicit an isolated muscle twitch in all fingers either in flexion or extension. Injection area was massaged, to help the solution to track along the plexus. The site of injection was sealed with tincture benzoin seal. During the conduct of block and thereafter, the patient was observed vigilantly for any complications of the block and for the toxicity of the drugs injected.

Onset of sensory block i.e. the time from injection to onset of analgesia in each of the major peripheral nerve distributions was assessed by pinprick. Sensory block was graded as per the following scale: 0 = no block (normal sensation), 1 = partial block (decreased sensation), and 2 = complete block (no sensation). Onset of motor block i.e. the time from injection to the inability of the patient to move his/her fingers or raise their hand was measured at 0, 10, 20, and 30 min by assessing the following motor functions: flexion at the elbow (musculocutaneous nerve), extension of the elbow and the wrist (radial nerve), opposition of the thumb and index finger (median nerve), and opposition of the thumb & small finger (ulnar nerve). Motor block was graded according to the following scale: 0 = no block (full muscle activity), 1 = partial block (decreased muscle activity), and 2 = complete block (no muscle activity). Duration of analgesia was considered satisfactory if the patient did not complain of any pain or discomfort and if no sedation was necessary. Postoperative follow-up was carried out in the recovery and postoperative ward. The duration of analgesia was noted according to 0–10 Visual Analog Score (VAS) for pain at every half an hour for first 10 hours and then hourly till 24 hours. When the patients began to experience the worst pain (VAS = 8–10), it was considered that analgesic action of the drugs was terminated and rescue analgesic (IM Diclofenac 1–1.5 mg/kg or tab Tramadol) was given. Duration of motor block was assessed hourly.

Possible side effects of brachial plexus block like incidence of drowsiness, pruritus, nausea/vomiting, Horner's syndrome, phrenic nerve palsy, pneumothorax, respiratory depression and sign and symptoms for local anesthetic toxicity were noted. In the circumstance of inadequate or patchy action of the block, the block was supplemented with general anesthesia and excluded from the study. If in case surgery was unduly prolonged and the effect of the block wore off, rescue analgesia with IV propofol or IV ketamine was given. For statistical analysis, association among the study groups were assessed with the help of Fisher test, student '*t*' test and Chi-square test. '*p*' value less than 0.05 was taken as significant.

Results

Demographic characteristics were comparable in both the study groups (Table 1). The mean duration of analgesia was significantly longer in Group I as compared to Group II (748.5 ± 65.57 mins *vs* 555.4 ± 35.20 mins). This difference was statistically significant ($p < 0.05$). The mean duration of motor block was significantly longer in Group I as compared to Group II (814.3 ± 100.81 mins *vs* 690.3 ± 81.36 mins: $p < 0.05$). The onset of sensory block in Group I was earlier as compared to Group II (8.48 + 1.58 mins *vs* 9.60 + 1.73 mins: $p < 0.05$) and was statistically significant. Similarly, the onset of motor block was rapid in Group I as compared to Group II

(13.04 ± 2.09 mins *vs* 14.52 ± 2.29 mins: $p < 0.05$) as mentioned in (Table 2). 7 (28%) patients in Group I required 50 mg of Tramadol while 1 (4%) patient required 100 mg of Tramadol. 17 (68%) patients in Group I did not require rescue analgesic. 10 (40%) patients in Group II required 50 mg of Tramadol while 11 (44%) and 1 (4%) patients required 100 mg and 200 mg of Tramadol respectively. 6 (12%) patients in Group II did not require rescue analgesic. It was observed that significantly higher number of patients in Group II required rescue analgesic and at higher dosages ($p < 0.05$) (Fig. 1). Postoperative complications between groups were comparable and most common complications were nausea & vomiting.

Table 1: Demographic data

Parameters	Group I (n = 25)	Group II (n = 25)	p - value
Age (in years, Mean ± SD)	38.9 ± 12.59	39.6 ± 12.28	> 0.05
Sex (Male: Female)	15:10	14:11	> 0.05
Weight (in kg, Mean ± SD)	64.1 ± 10.57	64.8 ± 10.07	> 0.05

(n = Number of Patients, SD = Standard Deviation)

Table 2: Efficacy Parameters

Parameters	Group I	Group II	p - value
Mean duration of analgesia (min)	748.5 ± 65.57	555.4 ± 35.20	< 0.05
Mean duration of motor block (min)	814.3 ± 100.81	690.3 ± 81.36	< 0.05
The onset of sensory block (min)	8.48 + 1.58	9.60 +1.73	< 0.05
The onset of motor block (min)	13.04 ± 2.09	14.52 ± 2.29	< 0.05

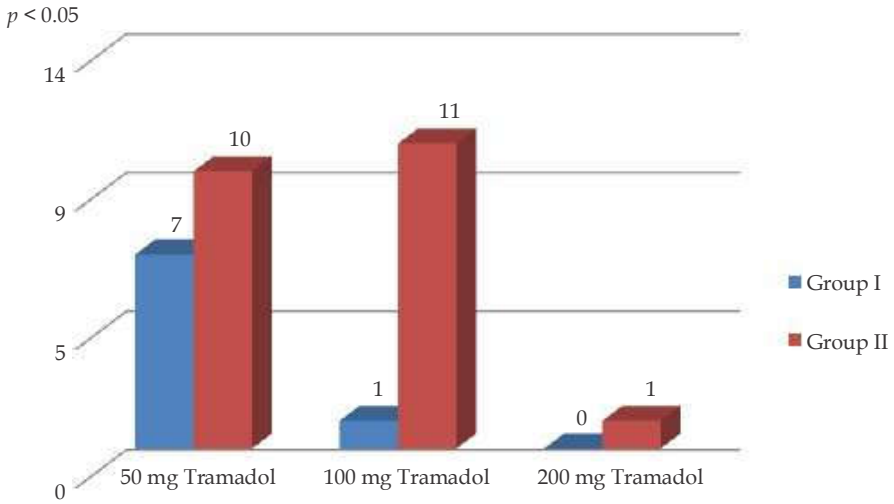

Fig. 1: Number of patients required rescue Analgesia (Tramadol).

Discussion

Pain experienced during and after orthopedic upper limb traumatic surgeries is pivotal to be treated. Regional anesthesia in the form of Brachial plexus nerve block for these surgeries has widespread acceptance due to improved postoperative pain relief, decreased need of postoperative rescue analgesia, less incidence of nausea, reduced recovery time with the benefit of patients resuming ambulation sooner and faster discharge from hospital when compared with General Anesthesia,[10] leading to improved patient satisfaction. Besides, brachial plexus block remains the sole substitute to GA for surgeries of the upper limb and can be used effectively in patients with significant comorbidities. Supraclavicular Brachial plexus block is conducted with anesthetic agents for upper limb surgeries and is not only an anesthetic method that allows easier homeostasis control

during surgery, but also allows easier postoperative pain control.

Dexamethasone is a nonparticulate steroid that has been shown in animal studies to be nonneurotoxic[11,12] and may even be cytoprotective.[13] One exception to these findings is that Williams BA et al.[14] found that bathing isolated rat sensory neurons in a solution of ropivacaine combined with high-dose dexamethasone (133 mcg/ ml), clonidine and buprenorphine exacerbated the neurotoxicity associated with ropivacaine. They reported that dexamethasone alone or in combination with ropivacaine had no influence on cell death after 24 hours of exposure. This study suggested that although individual adjuvants may not be neurotoxic, combinations may be and urges caution. The relevance of this *in vitro* study to clinical practice remains unknown, but certainly warrants further study on the neurotoxicity of combinations of agents.

Persec et al. as well as Kim et al. showed that dexamethasone in addition to local anesthetic significantly prolonged duration of postoperative analgesia and decreased requirement of rescue analgesia in 24 hours.[15–16] The mechanism of corticosteroids related to their analgesic activity is not yet fully understood. It has been reported that corticosteroids induce a degree of vasoconstriction, that results in reducing absorption of local anesthetic, and they modulate nuclear transcription after attachmentto the intracellular receptor. Stan et al. concluded that corticosteroids suppress the synthesis & secretion of various inflammatory mediators, which extends the period of analgesia. Attardi et al. reported that dexamethasone increases the activity of inhibitory potassium channels on nociceptive C-fibers by acting on glucocorticoid receptors, but more research on the action of steroids on peripheral nerve fiber as well as its mechanisms is necessary.[17,18]

Persec et al. conducted randomized controlled study, by assessing 70 patients undergoing upper-limb surgeries using single-shot supra-clavicular blockade. They investigated the analgesic efficacy of low-dose dexamethasone added to levobupivacaine and concluded that single-shot low-dose dexamethasone in addition to levobupivacaine results in prolonged duration of analgesia and less rescue analgesic consumption compared with levobupivacaine alone.[19] In our study, 17 patients from Group I compared to 3 patients from Group II did not require rescue analgesia in 24 hours postoperatively.

Conclusion

Adding dexamethasone to local anesthetic agents in brachial plexus block significantly prolongs the duration of analgesia and motor block and is a remarkably safe and cost effective method of providing postperative analgesia. We conclude that dexamethasone could be a promising adjuvant, which significantly prolongs the duration of analgesia in brachial plexus nerve blockade. As such, large, well-designed, randomized controlled trials would be needed to either support or refute its adoption into mainstream clinical practice with particular attention to comparison with systemic administration.

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