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Original Research Article

Dexamethasone as an adjuvant to bupivacaine in brachial plexus block in upper limb surgery

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ABSTRACT

Background: Supraclavicular brachial plexus block is widely used for surgery below shoulder joint. Adding adjuvant to local anesthetic drugs enhance the duration of block as well as postoperative analgesia. Dexamethasone very potent glucocorticoid when added to local significantly prolongs the duration of analgesia.
Methods: This randomized, single blind, controlled study include 100 patients of either sex, aged 18–60 years, ASA status I–III, undergoing upper limb surgery were randomly allocated to receive either 0.375% 30 cc bupivacaine with 2 ml normal saline (group C, n=50) or 0.375% bupivacaine with 2 ml (8 mg) dexamethasone (group D, n=50). The observed parameters include onset and duration of motor and sensory block, duration of effective analgesia any side effects and hemodynamic (pulse rate, NIBP, SpO2).
Results: Mean onset time of sensory and motor block in group C was significantly longer as compared to group D. ($p<0.0001$) The duration of sensory and motor blockade was significantly prolonged in group D compared to group C. ($p<0.0001$) The duration of effective analgesia was also significantly prolonged in group D (931.2±69.88 mins) compared to group C (454.8±34.47 mins) ($p<0.0001$).
Conclusions: Addition of dexamethasone to 0.375% bupivacaine in brachial plexus block speeds the onset and prolongs the duration of sensory and motor blockade. It also prolongs the duration of effective analgesia.

Keywords: Dexamethasone, Bupivacaine, Brachial plexus block, Supraclavicular, Analgesia

INTRODUCTION

The peripheral nerve blocks may be used for surgical anaesthesia alone or in conjunction with general anaesthesia.[1] In outpatient surgery peripheral nerve blocks facilitates early mobilization due to better analgesia.[2] Brachial plexus block is a versatile and reliable regional anaesthetic technique first performed by Halsted in 1884.[3] Lignocaine and Bupivacaine are two most commonly used local anaesthetic agents in brachial plexus block.[4] The effect of local anaesthetic will last for 3 to 4 hours. Different adjuvants like epinephrine, bicarbonate, opioids, ketamine, midazolam, clonidine, neostigmine and dexmeditomidine have been tried in combination with bupivacaine in an attempt to achieve quick, dense and prolonged block. However, they can cause unwanted side effects.[5] In recent years dexamethasone has been studied as an adjuvant to local anaesthetic in peripheral nerve blocks.

Dexamethasone is a very potent and highly selective glucocorticoid with analgesic property. It relieves pain by reducing inflammation and blocking transmission of nociceptive C fibers and by suppressing ectopic neural discharge. Steroids induce vasoconstriction decreases the systemic absorption of local anaesthetic.[2]

This study was carried out to compare analgesic and anesthetic effect of local anesthetic with or without dexamethasone in supraclavicular brachial plexus block in respect of onset and duration of sensory and motor block and duration of postoperative analgesia.

METHODS

This randomized, single blind, controlled study was carried out after obtaining institutional ethical committee approval and written and informed consent. Study was duration was from April 2015 to December 2016. One hundred patients, aged 18–60 years, either sex, ASA class I–III, undergoing elective or emergency unilateral upper limb surgery were included in the study. Patients with polytrauma, acid peptic disease, peripheral neuropathy, coagulopathy and known hypersensitivity to local anesthetic drugs were excluded from the study. Patients were divided into two groups of 50 each. Patients in group C received bupivacaine 0.375% 30 cc and normal saline 2 cc and in group D bupivacaine 0.375% 30 cc and dexamethasone 2 cc (8 mg), total 32 ml volume.

Pre anesthetic checkup was done before surgery. Procedure was explained to the patient. Intravenous line was secured and crystalloid started. Pulse, NIBP, SpO_2 were recorded base line, just before block and at regular intervals thereafter. Patients were premedicated with I.V midazolam 0.02 mg/kg and fentanyl 1 µg/kg.

Supraclavicular brachial plexus block was given in supine position with head turned away to opposite side. Under full aseptic and antiseptic precautions 22 gauge, 1.5 inch hypodermic needle was introduced at 1.5-2 cm above the mid clavicular point just lateral to subclavian pulsation. Needle was directed caudal and medially until paresthesia and/or pulsation and/or rib was encountered. Drug was injected after negative aspiration for blood, under ECG monitoring. In this single blind study person who observed all data was not aware of the drug injected.

The onset of sensory block was assessed with pinprick. It was rated on a verbal analogue scale (VAS) from 100 (normal sensation) to 0 (no sensation). Motor block was quantified using a modification of the Lovett rating scale. (0- complete paralysis, 1- almost completes paralysis, 2- pronounced mobility impairment, 3- slightly impaired mobility, 4- pronounced reduction of muscular force, 5- slightly reduced muscular force, 6- normal muscular force)

Patients with unsatisfactory effect of block were supplemented with general anaesthesia using I – gel or classical LMA. The duration of analgesia was noted according to 0-100 verbal analog scale (VAS) for pain at every hour for 10 hours then at 2 hours for 24 hours. Rescue analgesic was given when VAS score was more than 40. Patients were observed for any side effects and complications.

After collecting all the relevant data mean and standard deviation was calculated using MS excel software for age, sex, type and duration of surgery, onset time of sensory and motor block, duration of sensory and motor block, duration of effective analgesia, pulse rate, systolic and diastolic blood pressure. To determine the statistical significance for above mentioned parameters unpaired t-test was applied using Graphpad software and p-value was calculated.

RESULTS

The patients of both groups were comparable to age, sex, ASA grading and duration of surgery (Table 1). There was no statistically significant difference between two groups regarding types of surgery (Table 2). 100% patients of group D had sensory onset time of ≤ 10 min while 96% patients of group C had onset time of ≥ 10 min (Figure 1). 100% patients of group D had motor onset time of ≤15 min while 96% patients of group C had onset time of ≥15 min (Figure 2).

Table 1: Demographic data.

	Group C (N=50)	Group D (N=50)	P value
Age (years) (mean±SD)	32.36±13.93	36.1±12.16	0.1558
Sex (male: female)	35:15	37:13	0.8238
Duration of surgery (mins) (mean±SD)	77.7±26.73	93.8±34.89	0.0111
ASA grading (II/III)	47/3	48/2	0.6464

Table 2: Types of surgery.

Types of surgery	Group C (No=50)	Group D (No=50)	P value
Deformity correction– hand/elbow	14	16	0.8729
Fracture radius/Ulna nailing/K-wire/plating	18	16	
Fracture humerus nailing/K-wire/plating	09	11	
Tendon repair	09	07	

Table 3: Mean onset time and duration of sensory and motor block.

Onset time and duration of block (in min)	Group C	Group D	P-value
Sensory onset time (mean±SD)	14.32 ±1.71	7.12 ±1.73	<0.0001
Motor onset time (mean±SD)	18.64±1.69	11.46±2.39	<0.0001
Duration of sensory block (mean±SD)	504.3±30.43	990±76.66	<0.0001
Duration of motor block (mean±SD)	441.6±35.74	900±71.19	<0.0001

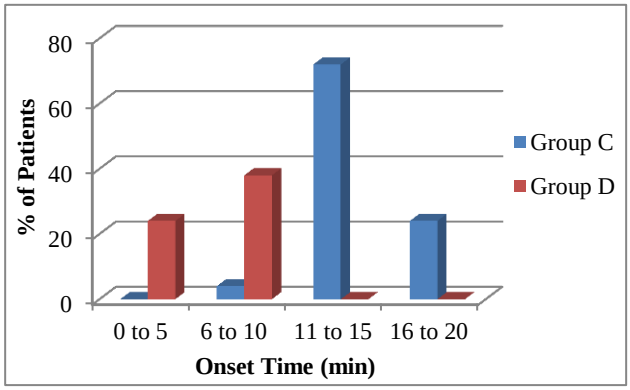

Figure 1: Sensory onset time.

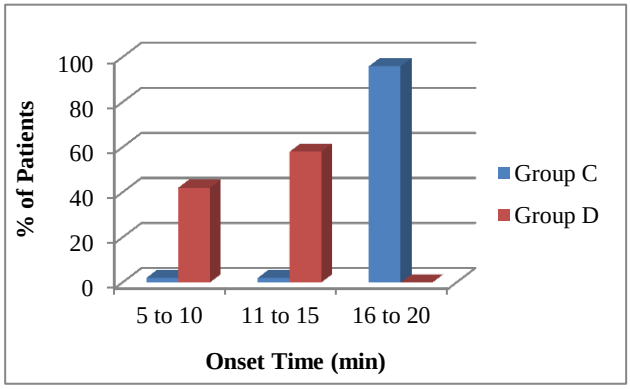

Figure 2: Motor onset time.

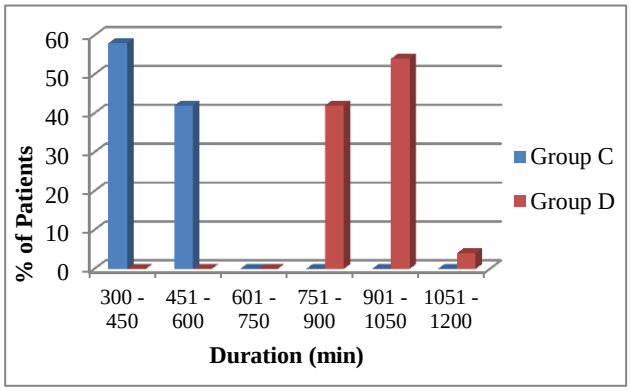

Figure 3: Duration of effective analgesia.

Mean onset time of sensory and motor block in group C was significantly longer as compared to group D. Mean duration of sensory block in group D was significantly prolonged as compared to group C (Table 3). 58% patients from group C had duration of effective analgesia ≤450 min (7.5 hr) while 54% patients from group D had duration of effective analgesia ≥900 min (15 hr) (Figure 3). There was no statistically significant difference in pulse rate in both groups at any point of time. (Figure 4) There was no statistically significant difference in systolic and diastolic blood pressure in both groups at any point of time (Figure 5). In present study supplementation with general anaesthesia was required in 4 patients from group C and 2 patients from group D.

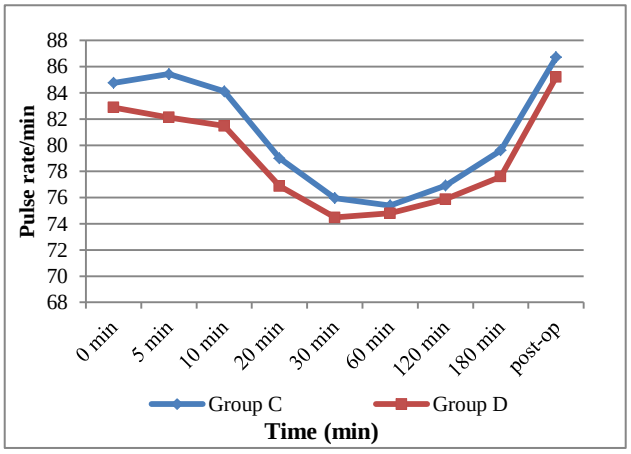

Figure 4: Perioperative pulse rate changes.

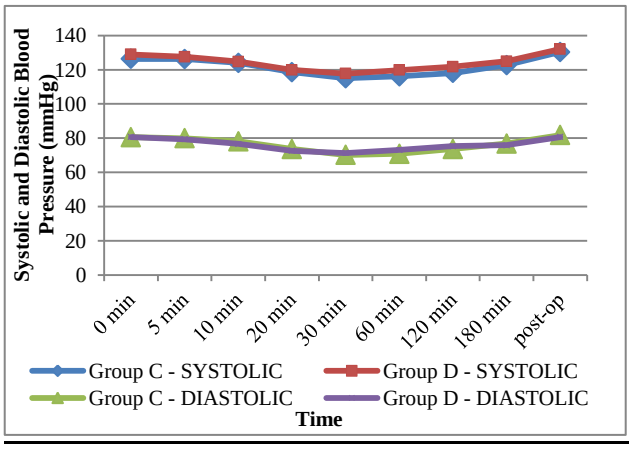

Figure 5: Perioperative systolic and diastolic BP changes.

DISCUSSION

Although general anaesthesia continue to be used for upper limb surgical procedures, peripheral nerve block

has been increasing in popularity in recent years.[6] Brachial plexus blockade for ambulatory upper limb surgeries can significantly reduce pain and allow faster discharge from hospital when compared with general anesthesia.[7] Advantages of brachial plexus block compared with general anaesthesia are early discharge of outpatients, smooth transition to pain control, increased blood flow to extremity, less nausea, vomiting, drowsiness, avoids stress of laryngoscopy and tracheal intubation.[6] It is beneficial for the patient with various cardio-respiratory comorbidities.[8] Use of neostigmine and tramadol as an additives in local anaesthetics were tried to extend the analgesia.[1,8]

In recent years dexamethasone has been studied as an adjuvant to local anaesthetic in peripheral nerve blocks. 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.[9,10] Steroids produce analgesia by blocking transmission in nociceptive c-fibres and suppressing ectopic neuronal discharge. Local application of methylprednisolone has been found to block transmission in c-fibres but not in *a* and *B* fibres.[6] 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.[11] Some authors believe that analgesic properties of corticosteroids are the result of their systemic effect.[12]

In this study dexamethasone was used as an adjuvant to bupivacaine in upper limb surgeries. Group C received 0.375% 30 ml bupivacaine with 2 of normal saline and group D received same volume and concentration of bupivacvaine with 2 ml of dexamethasone to avoid bias and alteration in concentration of local anaesthetic.

Addition of Dexamethasone with bupivacaine in the brachial plexus block has faster onset of action and prolonged duration of analgesia without unwanted side effects.[5] In our study the mean sensory onset time was significantly high in group C (14.32±1.71 mins) compared to group D (7.12±1.73 mins). Mean motor onset time also was significantly high in group C (18.64±1.69 mins) compared to group D (11.46±2.39 mins). Similar results were observed in study done by Islam et al and Shrestha et al.[3,13] However study by Ali et al using dexamethaosne added to lidocaine found no difference in onset time of sensory and motor blockade.[4]

The early onset of action might be due to synergistic action of dexamethasone with local anaesthetic on blockage of nerve fibers.[11,14] Corticosteroids cause skin vasoconstriction on topical application. It is mediated by occupancy of classical glucocorticoid receptors rather than by nonspecific pharmacological mechanisms.[9]

Addition of 8 mg dexamethasone to bupivacaine 0.25% solution in supraclavicular brachial plexus block prolongs the duration of sensory and motor blockade, reduces the requirement of rescue analgesic in postoperative period.[5,15] In our study mean duration of sensory block (group C- 504.3±30.43 mins, group D- 990±76.66 mins) and motor block (group C- 441.6±35.74 mins, group D - 900±71.19 mins) was significantly high. Addition of dexamethasone to lidocaine 1.5% solution in axillary brachial plexus block prolongs the duration of sensory and motor blockade.[4]

Incorporation of bupivacaine dexamethasone micro-spheres in rat demonstrated prolonged percutaneous block of sciatic nerve.[14] Authors believe that there is a causative relationship between the suppression of inflammation and remarkably longer duration of effect.

Human study using subcutaneous dexamethasone and bupivacaine microcapsules found prolonged local analgesia compared with plain bupivacaine micro-capsules.[16] Intercostal injection of dexamethasone bupivacaine microspheres in healthy volunteers produces a prolonged duration of anaesthesia and analgesia.[17]

In a study by Taludkar et al showed prolonged duration of effective analgesia with 0.25% bupivacaine 38ml and dexamethasone 2ml (12.75±5.33 hrs) compared to control group (3.16±0.48 hrs).[5] Study by Rahaman et al also used 0.25% bupivacaine 38 ml and dexamethasone 2 ml and observed mean duration of effective analgesia in dexamethasone group 1091.11±107.42 mins as compared to control group 605.37±58.60 mins.[15] These studies support our study. In our study duration of effective analgesia in group D (931.2±69.88 mins) was significantly more compared to group C (454.8±34.47 mins).

Islam et al showed that addition of dexamethasone to 30 ml bupivacaine 0.5% and lignocaine 2% resulted in increase duration of analgesia (11.87±0.53 hrs) compared to controlled group (3.43±0.49 hrs).[3]

Effectiveness of dexamethasone 4mg to lignocaine 1.5% with adrenaline (1:200000) had fastened onset, complete blockade of sensory and motor nerves and prolonged duration of analgesia (454.2±110.7 mins) without any side effects as compared to both control (176.5±53.5 mins) as well as neostigmine group (225.7±53.3mins).[1]

Walid et al studied ultrasound guided supraclavicular brachial plexus block. They conclude that dexamethasone 8 mg provides longer analgesia (18.5 hrs) and reduces postoperative pain without excessive associated motor blockade than tramadol 100 mg (4 hrs) and controlled group (3 hrs) when added to 2% lodocaine 15 ml. They observed that time for first analgesia demand was longer in the dexamethasone group than in tramadol group.[18] Similarly prolong duration of analgesia 12.75±5.33 hours in dexamethasone group verses 3.16±0.48 hrs in control group was mentioned by Shreshtha et al.[16]

Cummings et al studied effect of dexamethasone with ropivacaine or bupivacaine. They concluded that dexamethasone prolonged analgesia using ropivacaine or bupivacaine with the effect being stronger with ropivacaine.[2]

No complications were like pneumothorax, intra-arterial or intravascular placement of drug, nausea, vomiting, pruritus, neurotoxicity or cardiotoxicity in intra as well as post-operative period in any of the patients enrolled in the study.

Toxicity of corticosteroid is attributed to the particulate natureor vehicle used in different steroid preparations.[19,20] In animal experiments, repeated intrathecal injections of small-dose betamethasone did not induce spinal neurotoxicity.[21] Nerve injury is a rare complication of dexamethasone injection, and it usually occurs due to direct needle trauma to the nerve.[22]

Systemic toxicity of dexamethasone is unlikely as it is widely administered i.v. by anaesthesiologists for prophylaxis against postoperative nausea and vomiting and to improve postoperative pain.[23]

CONCLUSION

Dexamethasone when added to bupivacaine in supraclavicular brachial plexus block for upper limb surgery produce faster onset of action, increased duration of sensory, motor block and duration of effective analgesia without any side effects. Dexamethasone with bupivacaine is a safe and cost effective option for postoperative analgesia for upper limb surgery under brachial plexus block.

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Ethical approval: The study was approved by the institutional ethics committee

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