

Anaesthetic and Analgesic Effects of Adding Dexamethasone to Bupivacaine in Supraclavicular Brachial Plexus Block – A Comparative Study

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Summary:

The present study was designed to observe the analgesic and anaesthetic effects of adding dexamethasone to bupivacaine in supraclavicular brachial plexus block for upper limb surgery.

Sixty patients of ASA grade I and II were randomly enrolled in this study, thirty in each group after taking informed consent and particulars of patients. Group A received only bupivacaine and Group B received dexamethasone in bupivacaine. Group A was considered as control group. Patients demographic variables and perioperative haemodynamics characteristics (pulse, BP, respiratory rate, PaO₂ saturation) change were not statistically significant between two groups. This study showed that earlier onset of sensory and motor blockade were seen in group B and also showed that duration of sensory and motor blockade were quite prolonged in Group B.

Introduction:

Brachial plexus regional anaesthesia has been a mainstay of the anaesthesiologist armamentarium since Hall et al first reported the use of cocaine to block upper extremity nerves in 1884.¹ Regional nerve block avoids the unwanted effects of anaesthetic drugs used during general anaesthesia and the stress of laryngoscopy and tracheal intubation.

Various approaches (Interscalene, supraclavicular, infraclavicular, axillary) can be used to block brachial plexus providing anaesthesia and analgesia for upper extremity surgery.² Interscalene approach is most optimal

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Prevalence of sedation in Group B slightly higher but not statistically significant. The incidence of other side effects was not statistically significant. Comparison between groups regarding onset and duration of both sensory and motor block were highly significant differences. There were no significant difference of inter group haemodynamic variables which was observed up to 8 hrs of postoperative period.

But intensity of pain measured on VAS, Group A experienced highest VAS (worse pain) at 8 hrs of postoperative period and Group B shows highest VAS at 12 hrs thereafter.

Result of duration of effective analgesia (time from supraclavicular block to first analgesic demand) study Group B had significantly longer mean duration of analgesia in comparison to control Group.

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for procedures on the shoulder, arm and forearm. In contrast, the axillary to the brachial plexus is most optimal for procedure from elbow to hand. The supraclavicular and infraclavicular approach to brachial plexus result in a more even distribution of local anaesthesia and can be used for procedures on the arm, forearm and hand.² In supraclavicular approach the plexus is blocked where it is most compactly arranged at the level of nerve trunks with rapid onset can be achieved, with high success rate for elbow, forearm, hand surgery because all the branches of the brachial plexus can be reliably blocked³. It avoids the sparing of the ulner nerve that frequently occur with an intersclene block and produces good musculo-cutaneous anaesthesia which is often missed with an axillary block⁴.

Now-a -days different drugs have been used as an adjuvant with local anaesthetic in brachial plexus block to achieve quick, dense and prolonged blocked⁵. Drugs like Morphine, Pethedine, Clonidine, Fentanyl, Dexamethasone, Midazolam are commonly used along with anaesthetic for this purpose. However their use is limited because of side effects like heavy sedation, respiratory depression and psychomimetic effects.

Steroids relieve pain by reducing inflammation and by blocking transmission in nociceptive c fibres as well as suppressing ectopic neuronal discharge.^{6,7} They decrease inflammation by inhibiting the action of phospholipase A₂. The block prolonging effect may be due to its local action on nerve fibers and not a systemic one.⁸ Dexamethasone with local anaesthetics cause faster onset of action and prolong duration of analgesia.

Most of the orthopedic surgeries are of uncertain duration. Local anaesthetic produces 3-4 hours of block, which is sufficient for most upper limb surgeries but not enough duration for elective postoperative analgesia. Addition of dexamethasone with local anaesthetics prolongs analgesic period. This study was carried out to compare the analgesic and anaesthetic effects of local anaesthetic with or without dexamethasone in supraclavicular brachial plexus block in respect of duration of analgesia & onset time of anaesthesia as well as the quality of block by adding dexamethasone.

Materials and methods:

This clinical study on comparison of supraclavicular brachial plexus block with or without dexamethasone in upper limb surgery was carried out at the Department of Anaesthesia, pain management and ICU, Dhaka Medical College Hospital, Dhaka, Bangladesh.

Subjects were recruited and grouped randomly after clear explanation and written consent. After approval of the Ethical Review Committee of DMCH patients belonging to ASA grade I and II, aged between 18 to 60 years undergoing elective operation for upper limb (elbow, forearm and hand) were included and patients with coagulopathy receiving anticoagulant, H/O allergy to local anaesthetics, H/O hypertension, peripheral neuropathy, COPD, inadequate block those were not interested to be included in the study were excluded.

A total 60 patients of upper limb surgery were divided into two groups by card sampling containing 30 patients in each group. Group A: Received bupivacaine (0.25%) 38ml + Normal saline 2ml (total 40 ml). Group B: Received bupivacaine (0.25%) 38 ml + Dexamethasone 2ml (8mg) (total 40ml).

In the operation room patients Pulse, BP, Respiratory rate, Heart, Lungs, Base line pain score were recorded. Patients were hydrated with IV fluid infusion at a rate of 30 drops per minute with 18G canula. With all aseptic precaution supraclavicular brachial plexus block were done using paresthesia technique. Patient should be supine position, head turned to the opposite side and arm placed medially

towards the body, using 22G IV cannula stylet. After getting paresthesia drugs were deposited with repeated aspiration. The time of block was noted, patients were monitored with pulse oxymeter. The onset of sensory block was assessed every 5mins with application of cold spirit swab and by response to a traumatic prick with blunt needle in different areas innervated by radial, ulnar, median, musculocutaneous nerve. The time of complete sensory block was noted. The motor block was assessed every 5 mins by asking the patients to raise their hands or move their fingers. When the patient could not move the finger or raise the hand, this was considered as complete motor block (modified Bromage scale) and the time was noted. The duration of analgesia was noted according to 0- 10 cm visual analog scale (VAS) for pain at every .5 hr, 1 hr, then 2hrs interval up to 24 hrs. Sedation, nausea, vomiting, hypotension, arrhythmia, shivering were recorded.

The data were compiled and analyzed statistically using mean standard deviation independent student t-test, ANOVA, chi-square test, Fisher's Exact test as appropriate. A p-value <0.05 were regarded as significant. The statistical calculations were done by using Statistical Package for Social Science (SPSS) version -12.

Results:

This study was intended to observe the outcome of dexamethasone as adjuvant therapy to bupivacaine for Supraclavicular brachial plexus block in upper limb surgery. 30 were assigned to Group A (received 38 ml of 0.25% bupivacaine along with 2ml normal saline) and 30 to Group B (received 38 ml of 0.25% bupivacaine along with dexamethasone (8mg) 2ml). Changes in pulse, systolic and diastolic blood pressures, respiratory rate, Spo₂ and pain measured on VAS scale were compared at different time interval perioperatively. Demographic variables demonstrate that mean age of Group B and Group A were 29.5±11.2 and 33.1±13.2 years respectively with no significant differences between the groups in terms of sex and weight (P=0.559 and p=0.160 respectively).

The mean duration of surgery was although slightly higher in Group B than that in Group A, the difference was not statistically significant (p=0.413). Onset of sensory block was significantly early in Group B than those in Group A (p < 0.001). Duration of sensory block was significantly higher in Group B than in Group A (P=<0.001). The onset and persistence of motor block were significantly higher in Group B than those in Group A (p=0.026) and p<0.001 respectively).

Table-I

Anaesthesia record	Group		P value
	GroupA(n=30)	GroupB(n=30)	
Duration of surgery(mins) *	89.5±23.7	94.7±24.7	0.413
Onset of sensory block (mins)*	11.9±2.7	8.9±2.9	<0.001 ^s
Duration of sensory block(mins)*	364.5±31.3	558.0±66.4	<0.001 ^s
Onset of motor block(mins)*	9.8±2.1	8.3±2.7	0.026 ^s
Duration of motor block(mins)*	388.2±34.8	574±40.9	<0.001 ^s

Student's t Test was done to analysis the data ; s= significant.

The mean pulse rate of Group B was 80/min at baseline which gradually decreased to 68/min at 90 minutes interval and did not vary much throughout the whole period of observation in Group A. There was no significant difference in respect to changes in pulse rate (p=0.068).

The changes of systolic blood pressure at different time interval showed that the mean systolic blood pressure of Group B at baseline was 118.8mmHg and 114.7 mmHg in Group A which experienced a gradual fall up to 90 minutes interval. The changes of systolic blood pressure were similar in both groups throughout the observation (p=0.129). And the mean diastolic blood pressure in Group B and Group A decreased insidiously from 76.1 and 74.2 mmHg respectively at baseline to 68.3 and 71.9 mmHg respectively at 90 minutes interval. The overall changes in diastolic blood were not statistically different (p=0.500).

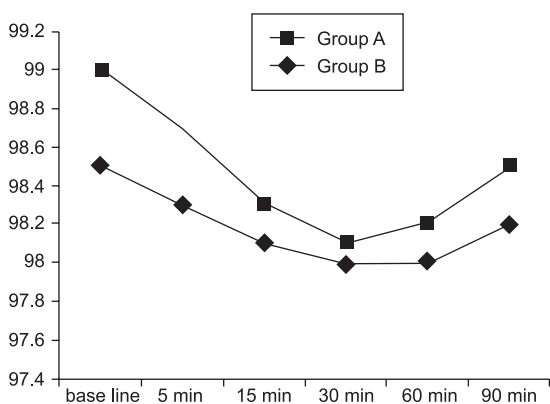


Fig-1: Monitoring of SpO₂ at different time intervals.

The mean SpO₂ in Group B and in Group A were 99.1% and 98.5% respectively at baseline which gradually declined 98.5% and 98.2% in Group B and Group A respectively at the end of 90 minutes. No significant difference between the groups was noted in terms of

changes in SpO₂ (p=0.245) (Fig. 1). Repeated measure ANOVA statistics was employed to analyze the data and P refers to overall differences between groups.

The changes in postoperative systolic and diastolic blood pressure at different time interval observed, with no significant difference (p=0.128). The mean diastolic blood pressure of Group B at 30 minutes was 74.3 mmHg without any demonstrable change over time and in Group A was 70.6 mmHg which experienced a gradual rise up to 8 hrs.

The intensity of postoperative pain measured on visual analog scale (VAS) showed that in Group B had no pain from 0.5 hour to 6 hours period. Then worst pain (VAS=8-10) after 12 hours, considered that the analgesic action of the drug was terminated and an analgesic dose was needed. No pain was observed in Group A at 0.5 hour. It increases insidiously to 2.9 cm at 4 hours interval, 7.7 cm at 6 hours interval, 8.3 cm at 8 hours interval which decreased sharply to 2.5 cm and 1.2 at 10 and 12 hours interval respectively following an analgesic dose.

Table-II

Pain VAS (cm)	Group		P value
	GroupA (n=30)	GroupB (n=30)	
Pain VAS at 0.5 hr	00	00	
Pain VAS at 1 hr	0.3±0.2	00	
Pain VAS at 2 hr	0.8±0.4	00	
Pain VAS at 4 hr	2.9±2.7	00	
Pain VAS at 6 hr	7.7±2.2	1.3±1.1	<0.001 ^s
Pain VAS at 8 hr	8.3±1.4	2.6±1.8	
Pain VAS at 10 hr	2.5±1.9	3.9±1.9	
Pain VAS at 12 hr	1.2±1.1	7.5±2.3	
Pain VAS at 14 hr	1.1±0.9	2.4±1.7	
Pain VAS at 16 hr	0.9±0.7	0.9±0.8	

Repeated measure ANOVA statistics was employed to analyse the data and p refers to overall differences between groups. S = significant.

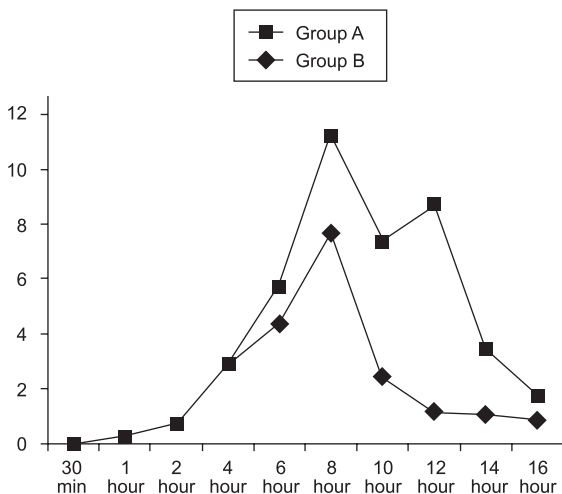


Fig.-2: Monitoring of post operative pain VAS at different time intervals

The mean post operative SpO_2 from 0.5 hour to 8 hours of observations were almost identical between Group B and Group A ($p=0.104$).

Comparison of duration of effective analgesia (time from Supraclavicular block to first demand of analgesic) demonstrates that mean duration of analgesia was significantly longer in Group B (12.75 ± 5.33 hours) than that produced by Group A (3.16 ± 0.48 hours). Statistical analysis revealed a significant difference ($p=0.000$).

Table-III

Comparison of effective analgesia between groups

Group	Duration of effective analgesia (hours)	P value
	Mean \pm SD	
Group A	3.16 \pm 0.48	0.000 ^s
Group B	12.75 \pm 5.33	

Student's t Test Was done to analysis the data and presented as mean \pm SD; s = significant.

Four(13.3%) in Group A required 1st analgesic dose within 6 hours after operation , while none in Group B required analgesics within the same period.

Table-IV

Comparison of analgesic demand between groups

Analgesic required 1 hr after 1 st analgesic dose	Group		P value
	Group A (n=30)	Group B (n=30)	
Yes	4(13.3%)	0 (0.0%)	0.056 ^{ns}
No	26(86.7%)	30(100%)	

Fisher's Exact Test was done to analyse the data; NS= not significant.

Table-V

Comparison of side effects between groups

Side effects	Group		P value
	Group A (n=30)	Group B (n=30)	
Deep sedation*	0(0.0)	3 (10.0)	0.834
Bradycardia*	3(10)	2(6.7)	0.217
Nausea*	2(6.7)	4(13.3)	0.341
Hypotension*	6(20.0)	4(13.3)	0.135
Shivering [#]	4 (13.3)	2(6.7)	0.335

Chi Square (χ^2) test was employed to analyze the data, *Student's t test was done to analyze the data.

Table V demonstrates 3 (10%) subjects in Group B had deep sedation but not in Group A at all ($P=0.834$). Other side effects like bradycardia, nausea, hypotension were not significant. Shivering was higher in Group A than in group B, without statistically significant.

Discussion:

Supraclavicular brachial plexus block is widely employed regional nerve block to provide anaesthesia and analgesia for the upper extremity surgery. Supraclavicular block provide anaesthesia of the entire upper extremity in the most consistent manner of any brachial plexus techniques. Local anaesthetics are used for this purpose. Currently available local anaesthetics can provide analgesia for limited period of time when used as single injection. Plain Bupivacaine when used alone in brachial plexus block , has been claimed to produce block as long as 3 – 8 hrs⁹. Practically the result could not be produced in series of study with sole bupivacaine. It is cardiotoxic and slower onset of action but has got long duration of action of certain duration. Relative duration of action with bupivacaine is 2 – 4 hrs.¹⁰

Now a days different drugs have been used as adjuvant to achieve quick, dense and prolong block.⁵ Adjuvant improves analgesia, reduces systemic side effects and reduce total dose of local anaesthetic required.¹¹ Drugs like Morphine, Pethidine, Clonidine, Butorphanol, Midazolam are commonly used along with local anaesthetics for this purpose. Since Morphine, Pethidine, Butorphanol are associated with side effects like heavy sedation, respiratory depression and psychomimetic effects¹².

Dexamethasone is selected as adjuvant to local anaesthetics in brachial plexus block in this study because respiratory depression is not a major problem with its use. Steroids have nerve block prolonging effects. They block the nociceptive impulse transmission along the myelinated C fibres.^{6,7} Steroids are very potent anti-inflammatory and immunosuppressive agents. Perineural injection of steroids is reported to influence post operative analgesia. A study in axillary plexus block suggest that dexamethasone when added to lignocaine significantly prolonged duration of analgesia.¹³ In 1998 Drager Christiane, reported prolonged intercostals nerve block by using bupivacaine and dexamethasone.¹⁴ Perineural injection of steroid is reported to influence postoperative analgesia in a study on intercostal nerve blockade.⁸ The early onset of action in steroids group is due to the synergistic action with local anaesthetic on blockage of nerve fibres.^{15,16} Addition of dexamethasone as an adjuvant to local anaesthetics in brachial plexus block results in significantly early onset and markedly prolonged duration of analgesia without any unwanted effects.^{12,17} In 2003 Shrestha BR et al have been found addition of 4-6mg of dexamethasone effectively and significantly prolongs the duration of the analgesic as well as producing earlier onset of action.¹⁸ When steroid alone is used in regional blocks, the blockade is not produced. Steroids might bring about this effect by altering the function of potassium channels in the excitable cells.^{19,20,21}

Epidural steroids were used for treatment of back pain and sciatica²². Various steroid has been used for this purpose. But dexamethasone, a 9 α derivative synthetic glucocorticoid is preferred because of its highly potent anti-inflammatory property, about 25 – 30 times as potent as hydrocortisone and without any mineralocorticoid activity thus was found to be safer and devoid of potential side effects.²³ The onset of motor

block was faster than the sensory block in either of the group in this study. As described by Winnie in 1977 the outer motor fibers are blocked earlier than the sensory fibers which are situated deeper in the brachial plexus at the level of trunk and division.²⁴ Our study showed the same result that the motor block was quicker than the sensory block. The duration of analgesia with dexamethasone in brachial block in the study by Shrestha BR et al was 12 hrs but only 4 hrs with local anaesthetics. Duration of analgesia in terms of hours, it was nearly matched with this present study. Many previous workers have included dexamethasone in Bupivacaine micro-spheres to see the block effect in animal models and found prolonged duration of block (7-11 days) when steroid was used together.⁷ Additional of small amount of dexamethasone to bupivacaine micro-capsules prolongs the local analgesia when compared to micro-capsules with plain bupivacaine after subcutaneous placement in humans.^{8,15} Kopacz DJ, Lacouture PG et al explored the effect of dexamethasone in bupivacaine micro capsules for intercostal blockade in healthy human volunteers and concluded that dexamethasone increased the duration of intercostal block to at least 96 hours.⁸ Methylprednisolone added to local anaesthetic in axillary block produced the prolong nerve block in the study conducted by Stan, Goodman et al. Onset of anaesthesia with dexamethasone in brachial plexus block in the study by Yadav RK et al was 16.3 \pm 4.3 mins and only with local anaesthetics was 9.5 \pm 3.6 mins which was statistically significant. In another study by Shrestha BR et al also showed that onset of action was 10-30 mins in local anaesthetic group (mean 18.15 \pm 4.25) and 10- 20 mins (mean 14.5 \pm 2.10) in local anaesthetic plus steroid group. Statistical analysis revealed a significant difference between the two groups ($P < 0.005$). Onset of anaesthesia in terms of minutes, it was nearly matched with this present study. Regarding analgesic demand between two groups, four (13.3%) of 30 patients in Group A required 1st analgesic dose within 6 hours period after operation while none of the patient in Group B required analgesic within same period ($P = 0.056$) that was not significant. In this study 3(10%) subjects in Group B had deep sedation which was not observed in Group A at all ($P = 0.834$). Other side effects like bradycardia, nausea, hypotension were observed in Group B ($P = 0.217$, $P = 0.341$, $P = 0.136$),

shivering was higher in Group A than that in Group B although the difference was not statistically significant ($P= 0.335$). None of the patients had respiratory complication in perioperative period.

Steroids have block prolonging effect according to their anti inflammatory potency. Dexamethasone prolongs the action of local anaesthetics when used together.²⁵ The pharmacodynamics and pharmacokinetics of the drugs when administered in regional nerve block is difficult to explain. There are some proposed mechanisms of action of glucocorticoids when used with bupivacaine micro- spares to extend the block effect.²⁶ The dense and earlier motor block in the steroid group is due to the synergistic action with local anaesthetic on blockade of nerve fibers.²⁵The block prolonging effect of dexamethasone is due to its local action and not a systemic one.^{26,27} It has been found that this effect of steroid is mediated via steroid receptors.²⁸When steroid alone was used to block the nerves the effect was not prolonged.^{25,15} The action of steroid has been related with the alteration of function of potassium channels on the excitable tissues^{25,26}

Conclusion:

The randomized comparative study of brachial plexus block with local anaesthetics, with or without dexamethasone has revealed that there was significant faster onset of action and prolonged duration of analgesia in the dexamethasone group than in the other group without any unwanted effects. This helps to minimize the cost and provides patient comfort.

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