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Comparative Study between Dexamethasone and Dexmedetomidine Added To Bupivacaine in Supraclavicular Approach in Brachial Plexus Block

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Abstract:
Background*: Several researches are going on to find out a suitable method to increase the duration of anaesthesia time during upper limb surgery by supraclavicular approach in brachial plexus block. Thus, the aim of the present study is to compare the onset and duration of sensory and motor block and analgesia in case of dexamethasone, dexmedetomidine and normal saline (control) added to local anaesthesia in supraclavicular brachial plexus block.*
Materials and Methods*: Here three groups were taken each with 30 patients (i) Control: bupivacaine (0.25%) 38ml with 2ml of normal saline. (ii) Group DM: bupivacaine (same dose) with dexmedetomidine 100µg (2ml); and (iii) Group DS: bupivacaine (same dose) dexamethasone 8mg (2ml). The onset and duration of sensory and motor block and analgesia were recorded. The heart rate and blood pressure of all the patients were also checked at different time points. Patients were also checked for other side effects.*
Results*: The DS study group (i.e dexamethasone added to bupivacaine) was found to be most effective. The onset times of the blocks are lowest here with highest block and analgesia duration ($p < 0.001$). However, the heart rate and blood pressure remain comparatively higher during and after surgery than other two groups.*
Conclusion: *It can be concluded that both the drugs are safe and could prolong the block duration. Dexamethasone is effective over dexmedetomidine but the heart rate and blood pressure could slightly increase. However, that does not require any extra oxygen supply or emergency support. So the drug should be selected according to the medical demand of the patient.*
Key Word*: Bupivacaine; Dexamethasone; Dexmedetomidine; Supraclavicular; Brachial plexus block.*

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I. Introduction

Brachial plexus block is a regional anaesthesia technique employed sometimes as a safe and valuable alternative to general anaesthesia for upper limb surgery. In this technique injection of local anaesthetic agents near brachial plexus, temporarily blocks sensation and movement of the upper limbs. It is a great tool in the anaesthetic armamentarium for relief of pain intra-operatively and post operatively. In this procedure post anaesthetic nausea, vomiting and other side effects of general anaesthesia such as atelectasis, hypotension, ileus, dehydration and deep vein thrombosis are reduced. In recent practices of day care surgeries, brachial plexus block seems to be a better alternative to general anesthesia with minimal hospital stay resulting in less financial burden on the patients[1].

Among several techniques of brachial plexus block, supraclavicular approach is considered as easiest, effective and can be performed much more quickly than other approaches. Here a single injection can lead to rapid onset of anaesthesia of the arm and forearm from the lower humerus down to the hand.It is performed at the trunk level (C5–T1 nerve roots), where brachial plexus is presented compactly. This anatomic compactness is responsible for complete and reliable anaesthesia by supraclavicular block. It provides excellent anaesthesia for elbow and forearm surgery. The first supraclavicular brachial plexus block was performed by Kulenkampff in 1912[2]. It was evident by several reports that the method of nerve localization is not very clear in the case of brachial plexus blocks which have been performed over many years. Many reports suggested the methods of nerve stimulation, ultrasound-guided block or combination of both techniques are performed to locate the nerves for effective supraclavicular block [3]. Stimulation of peripheral nerves not only provides intra-operative anaesthesia but also extends analgesia in the post-operative period. However, this nerve block should be combined with anaesthetic drug to prolong the effect of anaesthesia. It has long been a clinical query to search for a proper drug that will prolong the duration of analgesia without any adverse effects.

Several drugs are used routinely for local anaesthetics in brachial plexus block to achieve quick, dense and prolonged block. However, different research is ongoing regarding lowering the dose of the drug and

increasing the duration of anaesthesia. Some of the commonly used local anaesthetics for this block are morphine, pethidine, clonidine, dexmedetomidine, butorphanol, buprenorphine etc. However, most of them are associated with side effects like heavy sedation, respiratory depression and psychomimetic effects[3]. Several studies reported combination of either 0.5% bupivacaine or 0.5% ropivacaine with different drugs like buprenorphine hydrochloride, morphine, pethidine, clonidine, dexmedetomidine etc to prolong the analgesia duration and lowering the anaesthesia onset time [4-8]. Among these drugs α2 adrenergic receptor agonists received attention due to their sedative, analgesic, perioperative sympatholytic and cardiovascular stabilizing effects with reduced anaesthetic requirements. Moreover, different mode of drug administration eg. epidural, intrathecal and peripheral injections tried to prolong and intensify the anaesthesia[9-10]. Dexmedetomidine, a potent α2 adrenoceptor agonist, is approximately eight-times more selective towards the α2 adrenoceptor than clonidine[11]. It was evident from different animal experiments as well as human studies that dexmedetomidine enhanced sensory and motor blockade and increased duration of analgesia[12-14]. Another drug Dexamethasone is a very potent and highly selective glucocorticoid which can prolong the analgesic duration of supraclavicular block. Different combinations of dexamethasone and bupivacaine have also been studied to prolong the duration of anaesthesia[15-16]. However, there are very limited reports available to study the comparison between dexamethasone and dexmedetomidine as an adjuvant to bupivacaine. Thus, the aim of the present study is to compare the onset and duration of sensory and motor block and analgesia in case of dexamethasone, dexmedetomidine and normal saline (control) added to bupivacaine in supraclavicular brachial plexus block during upper extremity surgery. The incidence of cardiac complications like bradycardia, tachycardia, dysrhythmia, hypertension and other complications were also addressed.

II. Material And Methods

Study population: patients (age range 18 to 60 years) who underwent forearm surgery in the Department of Orthopaedics, Medical College and Hospital, Kolkata during January 2015 to December 2015. Study was performed with prior permission from the Institutional Ethics Committee. 30 patients were recruited in each of the three study groups so total 90 patients were recruited considering the following criteria.

Inclusion criteria

- Patient scheduled for elective forearm surgery
- Patient with ASA physical status I and II
- Age between 18 to 60years

Exclusion criteria

- Patient refusal
- Patients undergoing emergency surgery
- Allergic to any of study drugs
- Inadequate block
- Previous neurovascular deficit
- Patients with bleeding disorder or local infection
- Body mass index >30kg/m2
- Patients with severe systemic disease like diabetes, stage 2 hypertension, musculoskeletal disorder, patients on anticoagulants.

Parameters studied:

Sensory block: Sensory modalities like feelings of touch, pain and temperature were assessed by application of cotton-soaked spirit. Analgesia was assessed by loss of pinprick sensation in each of the major peripheral nerve distributions(ulnar, radial, median and musculocutaneous) by using the blunt end of a 27-gauge needle at 0, 2, 5, 10, 15, 20, and 30 min. Sensory block was graded according to Hollmen scale (HS) score:

HS Score 1=Normal sensation to pinprick.

HS Score2=Weaker sensation to pinprick as compared to other limb.

HS Score3=Pinprick recognized as touch with blunt object.

HS Score4=No perception of pinprick.

The onset time of the sensory block was recorded as the time interval in minutes from time-0 (just after delivery of drug) till the sensory block started appearing i.e. HS score > 1.The total duration of the Sensory Block was recorded as the duration of the time in minutes between onset of block till the time when the HS Score reached <4 in the postoperative period.

Motor block: Motor block 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 and small finger (ulnar nerve).
The motor block was evaluated by using the Modified Bromage Scale (MBS) for the upper extremity.
Modified Bromage Scale
Grade 2- complete motor block with inability to move fingers
Grade 1- decreased motor strength with ability to move fingers only
Grade 0- normal motor function with flexion and extension of elbow, wrist and fingers
The onset of motor block was recorded from time0 (just after delivery of drug) till the complete loss of the motor power was achieved i.e MBS Score=2.The total duration of the Motor Block was taken as the duration of the time in minutes between onset of block till the time when the MBS Score reached <2 in the postoperative period.The duration of motor block postoperatively was assessed two hourly by asking the patients to move their fingers and to see whether they are able raise the hand.

Duration of analgesia: Postoperative follow up was carried out and duration was recorded according to 0-10 visual analogue score (VAS) for pain at every half an hour during the operation and postoperatively from time-0 (just after delivery of drug) till to the time when VAS Score <4.

Cardiorespiratory variables: Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Heart Rate (HR), Respiratory Rate] were assessed by Pulse oximeter, NIBP etc.

Incidence of side effects of brachial plexus block: Incidence of drowsiness, pruritus, nausea/vomiting, Horner's syndrome, phrenic nerve palsy, pneumothorax, hoarseness of voice and signs and symptoms for local anaesthetic toxicity were looked for and noted, if any. (Management of unsuccessful block: In the circumstance of inadequate or patchy action of the local anaesthetic drugs, the block was supplemented with general anaesthesia. These cases were excluded from the study).

Study groups: Total 90 patients were recruited and distributed into three equal study groups (n=30). (i) Group C (n=30) received bupivacaine (0.25%) 38ml with 2ml of normal saline. (ii) Group DM (n=30) received bupivacaine (0.25%) 38ml with dexmedetomidine 100µg (2ml); and (iii) Group DS (n=30) received bupivacaine (0.25%) 38 ml with dexamethasone 8mg (2ml). The anaesthetic solution accepted for the study was only prepared by an anaesthesiologist. The treatment group was also selected by blinded manner. On the day before surgery, patients were attended and examined properly. A detailed history was obtained from every patient regarding any symptoms of breathlessness, asthmatic attack, bleeding disorder, drug allergy, previous history of surgery and anaesthesia, unconsciousness, seizures, hereditary or pre-existing any neurological disorder, addiction, prolonged drug treatment and hospitalization. Patients were assessed for any evidence of pallor, icterus, cyanosis, clubbing. Blood pressure, pulse rate, respiratory rate and temperature were also noted. Airway was assessed. The body weight and height of each patient were also recorded.

Statistical analysis: Results are expressed as mean ± standard deviation. Differences between groups were determined by Chi square trends and ANOVA (oneway analysis of variance). P value <0.05 and < 0.001 were considered as statistically significant. Treated groups were compared with control group.

III. Results

Effect of drugs on patient demography:
There are no significant differences in age group, sex and body mass index among patients of different study groups which were selected in a blinded manner (Table 1). Almost 61% (55/90) of the patients of selected patients were male (Table 1). Most of the patients (67%) were from ASA I physical status (61/90) (Table 1). There is no significant difference among the duration of surgery among different study groups (Table 1).

Table 1

Parameters		**Control**	**DM**	**DS**	**F-value**	**p-value**
Age (in years)(Mean ± SD)		43.30±9.12	41.33±11.84	43.40±9.67	$F_{2,87} = 0.38$	0.68
Sex	Male	18	19	18	-	p=0.93
	Female	12	11	12		
Body mass index (in kg/m2)(Mean ± SD)		21.49±1.34	20.98±1.45	21.19±1.29	$F_{2,87} = 1.07$	0.34
Physical Status	ASA I	19	21	21	-	0.81
	ASAII	11	9	9		
Duration of		2.58±0.71	2.42±0.77	2.46±0.51	$F_{2,87} = 0.49$	0.61

Surgery(hours)(Mean ± SD)						

Table 1: Control- bupivacaine + normal saline;DM- bupivacaine + dexmedetomidine; DS- bupivacaine + dexamethasone,p-value significant if <0.5.

Effect of drugs on onset and duration of Sensory and motor block:

It was found that the time required for the onset of sensory block in the case of DS and DM group were significantly lower than that of the control group. It was lowest in the case of DS group ($p< 0.0001$). Similar result were observed in case of onset of motor block. Here also the DS group showed the lowest time ($p < 0.0001$)(Table 2, Fig 1). Likewise, duration of sensory as well as motor block was found to be highest in case of DS group (Table 2, Fig 1). There was a significant difference between the control and treated groups but in between treatment groups there was no such significant difference (Table 2, Fig 1).

Effect of drugs on duration of analgesia:

It was found that the duration of analgesia was higher in the DS group than the other two (Table 2).

Table 2

	Control	DM	DS	F-value
Onset time of the block (in minutes) (Mean ± SD)				
Sensory block	13.13±2.18	9.37±2.17	7.43±1.33	$F_{2,87} = 67.$
Motor block	14.90±2.44	9.43±1.57	8.20±1.37	$F_{2,87}$=111.04
Duration of the block (in hours) (Mean ± SD)				
Sensory block	7.70±0.54	10.91±1.19	10.95±1.18	$F_{2,87} = 101.45$
Motor block	6.38±0.90	7.59±0.51	10.90±1.22	$F_{2,87}$= 192.07
Duration of analgesia (in hours) (Mean ± SD)				
	6.27±0.97	7.65±0.51	10.99±1.13	$F_{2,87} = 215.03$

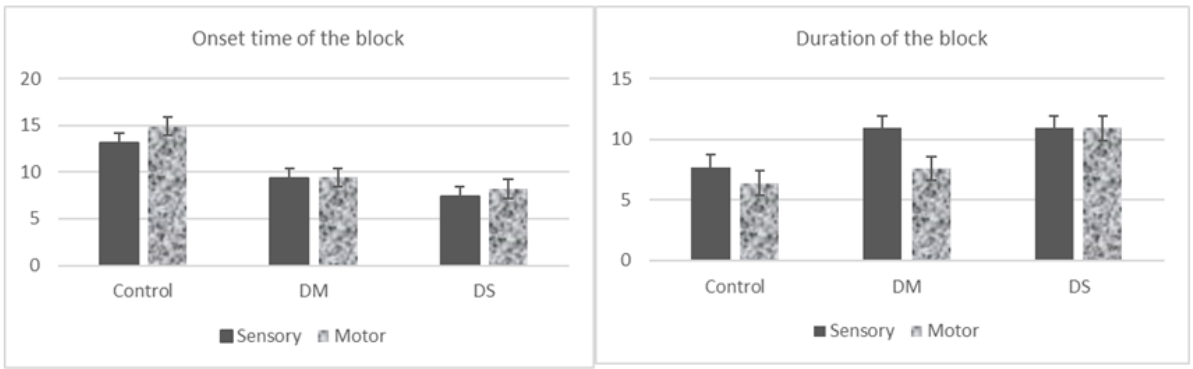

Fig 1: Graphs showing onset time and duration of the sensory and motor block. Y axis shows the time in minutes.

Distribution of heart rate and mean arterial pressure before and after anesthesia:

It was observed from Table 3 that before and during applying anaesthesia there were no significant differences in heart rate and blood pressure among the study groups (Table 3, fig 2). However, there were significant differences in both the parameters among the study groups during operation at different time points (15 and 30 minutes) and post operatively at different time points (10, 20 and 30 minutes) (Table 3, fig 2). The heart rate was maximum in case of the DS group followed by control and DM group. Thus, heart rates of DM

group were minimum among all the groups (Table 3; fig 2). Similar phenomenon was observed in case of blood pressure also (Table 3; fig 2).

Table-3

	Distribution of heart rate at different time				Distribution of Mean arterial pressure (MAP) mmHg at different time			
Time	**Control**	**DM**	**DS**	**F-value($F_{2,87}$) and p-value**	**Control**	**DM**	**DS**	**F-value($F_{2,87}$) and p-value**
Before giving drug	73.03±8.08	77.57±9.53	77.30±8.66	2.51p=0.08	89.43±6.56	94.83±6.05	92.17±6.43	2.42 p=0.09
During giving drug	73.57±7.71	76.70±9.76	78.13±8.50	2.16p=0.12	89.66±5.58	95.33±5.16	93.41±6.35	7.64 p<0.0001*
Immediate after giving drug	73.40±7.26	77.07±9.68	78.53±8.44	2.89p=0.06	89.97±5.77	95.68±5.42	94.13±6.01	7.95 p<0.0001*
Intra-OP 15 Minutes	73.47±7.95	59.20±8.93	78.97±8.20	44.56p<0.0001*	90.62±5.56	84.73±4.39	100.59±6.53	62.29 p<0.0001*
Intra-OP 30 Minutes	73.57±7.95	61.20±8.75	79.83±7.92	39.97p<0.0001*	91.32±5.52	84.60±4.51	103.02±5.71	93.84 p<0.0001*
PACU 10 Minutes	73.33±8.28	66.30±8.25	79.53±8.17	19.39p<0.0001*	90.58±4.53	86.50±3.04	101.31±4.75	100.73 p<0.0001*
PACU 20 Minutes	73.80±7.58	67.47±8.00	79.53±7.45	18.53p<0.0001*	89.92±4.63	88.01±3.26	100.27±4.94	69.31 p<0.0001*
PACU 30 Minutes	74.37±7.70	68.77±8.84	79.17±7.14	12.93p<0.0001*	89.31±4.40	89.09±3.11	98.68±5.14	48.62 p<0.0001*

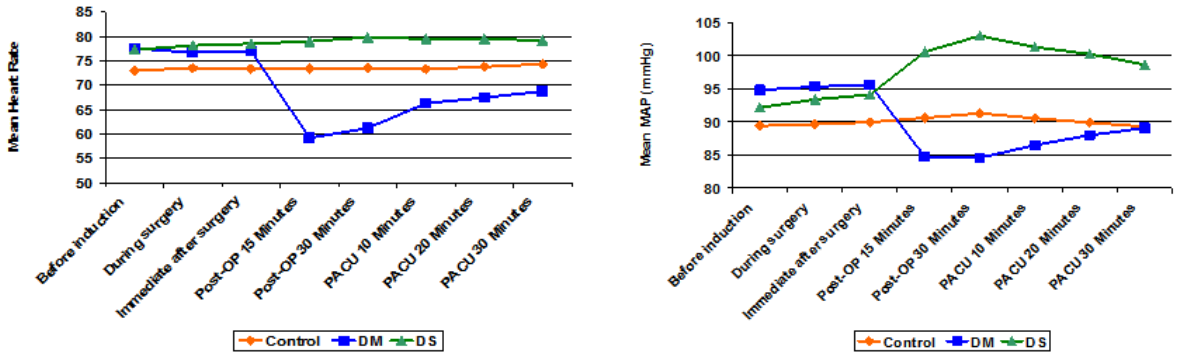

Fig 2: Graph showing heart rate and mean arterial pressure at different times point among different study groups.

IV. Discussion

Considerable advances have been made in the management of perioperative pain in recent years. Still a significant proportion of patients still suffer from inadequate pain control causing several deleterious effects on the patient's body and mind. Brachial plexus block is a well-established, easy and relatively safe procedure for upper limb surgery. Bupivacaine produces 3-4 hours of block, which is sufficient for most upper limb surgeries but it is not sufficient enough for elective post-operative analgesia. Therefore, addition of dexamethasone with bupivacaine effectively and significantlyprolongs the duration of analgesia. The effect of dexamethasone is mediated via glucocorticoid receptors by altering the function of potassium channels in the excitable cells by reduction of the transmission in unmyelinated C-fibers and suppressing ectopic neuronal discharge[17-18].

Dexmedetomidine is well known as a highly selective α2 adrenoreceptor agonist shown to have both sedative and analgesic effects[19]. Presynaptic activation of α2 adrenoceptor in central nervous system (CNS) inhibits the release of norepinephrine, terminating the propagation of pain signals and their post synaptic activation inhibits sympathetic activity, thereby decreasing heart rate and blood pressure[20].

Several similar studies have been performed in recent years to increase the anaesthetic block time with no adverse effect. Zhang P, et al. observed that combination of both drugs with 0.5% ropivacaine effect[21]. Another report showed the equal effectiveness of both drugs using Brachial plexus[22]. However, Hamada et. al. showed dexmedetomidine to bupivacaine prolonged the duration of block and analgesia than dexamethasone, but the onset time of block was shorter when dexamethasone was added to bupivacaine[23]. Thus, researches are

ongoing to evaluate the actual effect of the drugs on the block duration in case of Brachial plexus block. The results also varied depending on the dose of the drugs. Here in this study the onset and duration of sensory and motor block were evaluated among 3 above mentioned (DM, DS and C) study groups with different doses of drugs. The patient population selected in each category in a blinded manner. The onset time of both sensory (7.43±1.33 mins) and motor block (8.20±1.37 mins) was lowest in case of DS than DM group followed by control group. Similar results were observed by other groups[24-25]. In this group the analgesic duration (10.99±1.13 hrs) is also higher than the other two groups.Similar results were observed by other groups[26-27]. The mean duration of sensory (10.95±1.18 hrs) and motor block (10.90±1.22 hrs) is significantly longer in the DS group than the other groups.

There was no statistically significant difference in three groups in respect to postoperative heart rate and blood pressure. None of the patients required additional oxygen at the post anaesthesia care unit. None of the patients developed respiratory depression.

Here in this study ultrasound-guided block was not used due to unavailability of the instrument in our institution during the study period. The impact of perineural dexamethasone on glucose homeostasis and wound healing was also not studied. The drug doses were selected from previous study[28].

V. Conclusion

From this study, it can be concluded that dexamethasone and dexmedetomidine both the drugs can be safely used as an adjuvant with local anaesthetic in peripheral nerve blocks and it is statistically proved that both of these drugs reduce the onset of sensory and motor block and increase the duration of block as well as analgesia; however, further trials needed to determine the exact dose-response and effects on complex nerve structures such as in brachial plexus block.

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