Original Article

Dexamethasone and Dexmedetomidine as Adjuvants to Local Anaesthetic Mixture in Supraclavicular Brachial Plexus Block for Upper Limb Orthopaedic Surgeries: A Prospective Randomized Study

Bhavna R Soni[1], Miti H Desai[2], Divyang V Shah[3]

Authors' Affiliation: [1]Associate Professor; [2]Resident Doctor; [3]Professor and Head, Dept. of Anaesthesiology, SMIMER, Surat
Correspondence: Dr. Miti H Desai, Email: miti.1994@gmail.com, Mobile No.: 9099078828

ABSTRACT

Introduction: Supraclavicular brachial plexus block (SCB) is most commonly performed in Upper limb orthopaedic surgeries. A variety of adjuvants have been used to enhance the effect of local anaesthetics in peripheral nerve block. The aim of this study was to compare the onset, duration of sensory and motor block along with duration of analgesia when dexmedetomidine or dexamethasone was added to 0.5% bupivacaine.

Methods: Sixty patients were randomized into 2 different groups to receive SCB using Inj. Bupivacaine Hydrochlorid e(0.5%) 15ml plus Inj. Lignocaine Hydrochloride (2%) 10ml along with either dexmedetomidine (1μg/kg) (Group DM) or dexamethasone 4mg (Group DX)scheduled for upper limb surgeries after taking informed consent.

Results: The time of onset of sensory and motor block was significantly less in group DX as compared to group DM. The duration of sensory and motor block as well as duration of post-operative analgesia was significantly more in group DM as compared to group DX.

Conclusion: On addition of dexmedetomidine to local anesthetic mixture will prolong the time of block and analgesia duration longer than dexamethasone but the onset of block is shorter with dexamethasone.

Keywords: Dexamethasone, Dexmedetomidine, Supraclavicular block, Local anesthetic, Upper limb surgery

INTRODUCTION

Regional Anaesthesia is the safest and valuable approach for upper limb surgeries. In this technique, single injection is given at the site of the brachial plexus (i.e. C5-T1) which leads to adequate pain relief and effective muscle relaxation intra-operatively as well as post-operatively.[1,2]

The efficacy of α-2 adrenoceptor agonists in regional anaesthesia is well proven with clonidine as it prolongs the duration of anaesthesia and analgesia. Dexmedetomidine, a selective α2 adrenoceptor agonist is eight times more potent than clonidine and has been safely utilized in other peripheral nerve blocks and is known to prolong the sensory and motor blockade.[3]

Steriods have this unique anti-inflammatory as well as analgesic property. It suppresses inflammation by inhibiting phospholipase-A2. Local application of steroid can inhibit the transmission of nociceptive C-fibres which suggests the direct membrane action of steroids.[4] Glucocorticoid deposition around nerve fibres along with local anaesthetic influenced the onset and duration of block.[5] Dexamethasone is a highly selective and a potent glucocorticoid which has been used as an adjuvant in brachial plexus block due to its variable effect on the onset but prolonged effect on analgesia and duration of motor block.[6]

The aim of this present study is to compare the onset, duration of sensory and motor block along with analgesia when either dexamethasone or dexmedetomidine is added to local anaesthetic in supraclavicular block during upper extremity surgery.

MATERIALS AND METHODS

This prospective double-blinded, randomized controlled trial included a total of 60 patients posted for upper limb surgeries in Orthopaedic department at Surat Municipal Institute of Medical Education and Research (SMIMER), Surat. This study was conducted between January 2020-March 2020. This study was performed after clearance from Institutional ethical committee and a written informed consent from all the subjects was also obtained after informing them the nature of the study and complications.

Patients were divided into two groups, each group contained 30 patients:

Group DM (Dexmedetomidine group) had received Inj. Dexmedetomidine (1μg/kg) + Inj. Bupivacaine Hydrochloride (0.5%) 15ml (2mg/kg) + Inj. Lignocaine plain (2%) 10ml (4mg/kg), diluted with normal saline, total 30ml in supraclavicular block.

Group DX (Dexamethasone group) had Inj. Dexamethasone 4mg (1ml) + Inj. Bupivacaine Hydrochloride (0.5%) 15ml(2mg/kg) + Inj. Lignocaine plain (2%) 10ml (4mg/kg), diluted with normal saline, total 30ml in supraclavicular block.

The treatment group was selected by blinded manner. The local anaesthetic solution used in this study was prepared by the anaesthesiologist. Patients were examined a day before surgery and a detailed history was obtained. Patients were assessed for any evidence of pallor, icterus, cyanosis, clubbing, blood pressure, heart rate, respiratory rate and temperature. Airway was assessed.

Upper Limb surgeries of patients of either sex between 18-65 years of ASA grade I/II were included for the study. Patients below 18 years of age, who refused to take part in study and with other contradictions like infection at the site of block, spine deformity, coagulopathy and history of allergy to local anaesthetic drugs were excluded from the study. Also patients with Advanced Cardiovascular, Respiratory, Hepatic and Renal Insufficiency as well as Psychiatric diseases were excluded from the study.

Sensory and Motor Block parameters were studied

Sensory modalities like touch and temperature were assessed by a wet alcohol sponge. Pain was assessed by loss of pinprick sensation along the distribution of the major peripheral nerves by a blunt 27 G needle at an interval of 5 minutes for the first 30 minutes.

Thenar eminence was used for checking Median Nerve block, Radial Nerve block was cheked over Lateral side of dorsum of Hand, Little Finger was used to check sensation for Ulnar Nerve while Lateral Border of Forearm over the site of radial artery was used to check sensation for Musculocutaneous Nerve.

Sensory block was graded according to Hollmen Scale:

Gr 1 - Normal sensation to pin-prick
Gr 2 - Weaker sensation to pin-prick as compared to other limb.
Gr 3 - Pin-prick recognized as touch with blunt object.
Gr 4 - No perception of Pin-prick

Onset time is defined as the time interval between the end of total local anesthetic administration and complete sensory block (score >2).

Duration of sensory block is defined as the time interval between the end of local anesthetic administration and the complete resolution of anaesthesia (score 1).

Motor function of the limb was measured at every 10 minutes till first 30 minutes and it was assessed by Thumb opposition to check Median Nerve, Thumb abduction for Radial Nerve, Thumb adduction for Ulnar Nerve while Elbow flexion was used to assess Musculocuatneous nerve.

Evaluation of motor block was done using this scale.

Modified Bromage Scale (MBS): 0- Normal motor function, 1- Ability to move only fingers, 2- Complete motor block with inability to move elbow, wrist and finger

Motor block onset time was defined as the time interval between the end of total local anaesthetic administration and complete motor block (MBS score 2).

Duration of motor block was defined as the time interval from the onset to the recovery of complete motor function (MBS score 0).

In operation theatre, the vital signs including Mean arterial pressure, Heartrate, Respiratory Rate and SpO_2 was recorded at baseline, 15, 30, 45, 60, 120 minutes.

At the end of the surgery, patient was kept under observation in the recovery room for vital signs and then shifted to ward for further follow up.

The patients were observed for any adverse event related to the procedure (e.g. pneumothorax, hematoma) or to the study drugs (e.g. hypotension/hypertension, bradycardia, tachycardia, nausea, vomiting, hypoxemia).

Pain will be assessed using a standard Numeric Rating Scale (1-10) post-operatively for every two hours in the recovery room and then in the surgical ward. At a NRS of 4, rescue analgesia will be given. (Inj. Diclofenac Sodium (1.5mg/kg) intramuscularly). Time for first request of post-operative analgesia (duration of analgesia) will be noted.

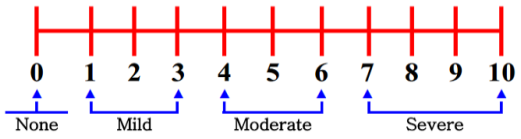

Figure 1: Numerical Rating Scale

Statistical Analysis:

Data were collected, revised, coded and entered to IBM SPSS version 23. The quantitative data were presented as mean, standard deviation and ranges and two quantitative data groups were compared using Independent t test. All qualitative data were presented as number and percentages and their two groups were compared using Chi-square test.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the P- value >0.05: Non-significant (NS). P-value <0.05: Significant(S). P-value <0.01: Highly significant (HS).

OBSERVATION & RESULTS

Comparison of Age, Sex, ASA grading and Weight of the patients which is comparable in both the groups. Comparison of Duration of Surgery between Group DM and Group DX which is not significant in both groups (P>0.05). Comparison of Onset of Sensory Block between Group DM and Group DX, which is highly significant between both groups (P <0.001)

Table 1: Comparison of Age, Sex, ASA grading and Weight of the patients

Variables	Dexmedetomidine Group Mean ± SD	Dexamethasone Group Mean ± SD	P-Value
Age (Mean ± SD)	32.5 ± 7.2	33.7 ± 5.4	0.2
Sex			
Male	19	20	
Female	11	10	
ASA			
1	21	19	
2	9	11	
Weight (Mean ± SD)	61 ± 10.1	60.5 ± 9.3	0.13

Table 2: Comparison of intraoperative variables between Group DM and Group DX

Variables	Dexmedetomidine Group Mean ± SD	Dexamethasone Group Mean ± SD	P-Value
Duration of Surgery (min)	78.8 ± 25.7	75.7 ± 26.7	0.12
Onset of Sensory Block (min)	9.36 ± 0.6	7.95 ± 0.79	<0.001
Duration of Sensory Block (min)	958.1 ± 6.6	838.7 ± 6.5	<0.001
Onset of Motor Block (min)	12.3 ± 0.6	14.3 ± 2.5	0.0002
Duration of Motor Block (min)	900.6 ± 6.2	780.4 ± 0.5	<0.001
Duration of Analgesia (min)	969 ± 4.1	840 ± 1.99	<0.001

Table 3: Preoperative and Intraoperative vitals of Group DM and Group DX

	Dexmedetomidine group Mean±SD		Dexamethasone group Mean±SD		P value	
Time (min)	Heart Rate	Mean Arterial Pressure	Heart Rate	Mean Arterial Pressure	Heart Rate	Mean Arterial Pressure
Pre Op Vitals	71.8 ± 4.5	95.2 ± 3	72.1 ± 5.2	96 ± 4.1	0.27	0.21
0 min	73.3 ± 6.96	96.5 ± 3.5	76 ± 7.1	95.8 ± 2.7	0.06	0.1
5 min	75 ± 7.8	96 ± 4.1	73 ± 4.9	96 ± 4	0.23	0.2
10 min	74 ± 6.6	96 ± 4	73 ± 4.9	96 ± 4.1	0.21	0.23
15 min	75.8 ± 7.76	96 ± 4.1	75 ± 5.4	96 ± 3.6	0.26	0.4
20 min	75.7 ± 7.1	95.7 ± 3.9	75 ± 6.8	96 ± 3.8	0.34	0.17
25 min	75.5 ± 7	96.5 ± 3.6	74.7 ± 7	95.7 ± 2.8	0.31	0.12
30 min	76.7 ± 7.2	95.8 ± 2.9	75.2 ± 5	96 ± 3.8	0.43	0.4
60 min	75 ± 6.9	96 ± 2.7	75 ± 7.2	96 ± 3.8	0.3	0.4
90 min	77.9 ± 7.8	96 ± 4	76 ± 7.2	96.2 ± 3.6	0.19	0.35
120 min	77 ± 8.8	96 ± 3	75 ± 6.2	96.1 ± 3.6	0.18	0.26

Table 4: Preoperative and Intraoperative SpO_2 and Respiratory Rate monitoring of Group DM and Group DX

Time (min)	Dexmedetomidine group Mean±SD		Dexamethasone group Mean±SD		P value	
	SpO2	Respiratory Rate	SpO2	Respiratory Rate	SpO2	Respiratory Rate
Pre Op Vitals	98 ± 1.2	15.6 ± 2.2	98 ± 1.2	15.8 ± 2.9	0.4	0.33
0 min	98.3 ± 1.03	16 ± 2	98 ± 1	16 ± 2.3	0.38	0.4
5 min	98 ± 1	15 ± 2.3	98 ± 1	16 ± 2.2	0.16	0.1
10 min	98.2 ± 1.1	16 ± 2.1	98.4 ± 1.13	16 ± 2.4	0.15	0.5
15 min	98 ± 1.19	16 ± 2	98.4 ± 1.17	16 ± 2.2	0.37	0.3
20 min	98 ± 1.19	16 ± 1.7	98 ± 1.17	16 ± 2.1	0.3	0.15
25 min	98 ± 1.2	16 ± 2.1	99 ± 1.2	16 ± 2.2	0.13	0.25
30 min	98.5 ± 1.2	16 ± 2.2	98 ± 1.2	16 ± 2.4	0.1	0.4
60 min	98 ± 1.2	16 ± 1.9	98.4 ± 1.17	16 ± 2.3	0.16	0.37
90 min	98.4 ± 1.04	16 ± 1.9	98 ± 1.2	16 ± 2.2	0.19	0.35
120 min	98.3 ± 1.09	16.5 ± 2	98.4 ± 1.17	16 ± 2	0.12	0.1

Table 5: Post Operative Heart Rate and Mean Arterial Blood Pressure Monitoring between Group DM and Group DX

Time (hr)	Dexmedetomidine group Mean±SD		Dexamethasone group Mean±SD		P value	
	Heart Rate	Mean Arterial Pressure	Heart Rate	Mean Arterial Pressure	Heart Rate	Mean Arterial Pressure
1st Hour	74.8 ± 7.7	95.3 ± 3.3	73 ± 5.2	96 ± 3.8	0.09	0.24
2nd Hour	72.2 ± 13.5	96 ± 3.8	74.2 ± 5	96 ± 3.9	0.23	0.43
3rd Hour	76 ± 8.1	96 ± 4	73 ± 5.3	95.9 ± 3.87	0.1	0.4
4th hours	75 ± 8	96 ± 3.8	74 ± 4.8	96 ± 4	0.19	0.2
5th hours	76 ± 8.2	95 ± 2.9	74 ± 5,7	96 ± 3.8	0.11	0.2
6th hours	75.6 ± 8	96 ± 3.9	73 ± 4.7	96 ± 3.8	0.07	0.4

Table 6: Post Operative Respiratory Rate and SpO2 monitoring between group DM and Group DX

Time (hr)	Dexmedetomidine group (Mean±SD)		Dexamethasone group (Mean±SD)		P value	
	SpO2	Respiratory Rate	SpO2	Respiratory Rate	SpO2	Respiratory Rate
1st Hour	98 ± 1.2	16 ± 2.1	98 ± 1.2	16 ± 2.2	0.4	0.4
2nd Hour	98.4 ± 1.19	16 ± 2.3	98.4 ± 1.17	16 ± 2.3	0.37	0.43
3rd Hour	98.4 ± 1.19	16 ± 2.3	98.4 ± 1.17	16 ± 2.4	0,37	0.4
4th hours	98.4 ± 1.19	16 ± 2.3	98 ± 1.17	16 ± 2.3	0.2	0.2
5th Hour	98.4 ± 1.19	16 ± 2.3	98.4 ± 1.17	16 ± 2.3	0.3	0.4
6th hour	98.3 ± 1.18	16 ± 1.8	98 ± 1.2	16 ± 2.2	0.37	0.3

Table 2 shows Comparison of Duration of Sensory Block (min) between Group DM and Group DX, which is highly significant between both groups ($P < 0.001$). Table 5 shows Comparison of Onset of Motor Block (min) between Group DM and Group DX, which is Highly Significant between both groups ($P < 0.001$). Table 6 shows comparison of Duration of Motor Block (min) between Group DM and Group DX, which is Highly Significant between both groups ($P < 0.001$). Table 7 shows Comparison of Duration of Analgesia (min) between Group DM and Group DX, which is Highly Significant between both groups ($P < 0.001$).

Table 3 shows Preoperative and Intraoperative vitals of Group DM and Group DX which is statistically not significant ($P>0.05$).

Table 4 shows Preoperative and Intraoperative SpO_2 and Respiratory Rate monitoring of Group DM and Group DX which is statistically not significant ($P> 0.05$).

Table 5 shows Post Operative Heart Rate and Mean Arterial Blood Pressure Monitoring between Group DM and Group DX which is statistically not significant ($P>0.05$).

Table 6 shows Post Operative Respiratory Rate and SpO2 monitoring between group DM and Group DX which was statistically not significant($P>0.05$).

DISCUSSION

We observed in our study that patients who underwent supraclavicular brachialplexus block in upper limb surgeries, addition of dexmedetomidine or dexamethasone to LA solution resulted in shorter onset of block along with prolongation of analgesia duration. Brachial plexus blocks are reliable, effective and easy to perform in day to day anesthesia practice and addition of adjuvants will affect the onset, quality as well as duration of analgesia.[7]

Dexmedetomidine is pharmacologically active, highly selective α-2 adrenoceptor agonist which has both sedative and analgesic effects due to its action on locus cerelus in central nervous system. The propagation of pain signal is terminated by inhibition of norepinephrine release due to presynaptic activation of α-2 adrenoceptors in CNS whereas the post-synaptic activation inhibits sympathetic activity leading to decrease in heart rate and blood pressure. [1]

Dexamethasone effect to prolong the duration of analgesia when added to bupivacaine is mediated via glucocorticoid receptors. It suppresses the ectopic neuronal discharge and alters the function of potassium channels in the excitable cells by reducing the transmission in unmyelinated C-fibers.[8-9]

The current study showed that the addition of dexmedetomidine to bupivacaine in supraclavicular block leads to prolongation of sensory and motor block along with prolongation in duration of analgesia. On the other hand,dexamethasone leads to shorter onset of sensory and motor block.

Dexmedetomidine as an adjuvant to LA in different regional and peripheral nerve blocks have been used in a lot of studies and they have found it to be an excellent choice in potentiating local anesthetic effect.[3]

Brummet et al. reported in his study the mechanism of analgesic effect of dexmedetomidine to be multifactorial and not very clear.**10** Possible mechanisms explained by **Kaur M et al. , Biswas D et al** were that dexmedetomidine acts through α-2 adrenoceptors or it provides analgesic effect through inhibition of norepinephrine release and increasing potassium conduction along the unmyelinated C-fibres responsible for conduction of pain stimulus. Its analgesic and sedative action is also centrally mediated through its action on locus cerelus. [1,7]

In our study, we found the addition of dexmedetomidine (1μg/kg) to 15 ml bupivacaine plain (0.5%) and 10ml lignocaine plain (2%) significantly prolonged the block duration as well as analgesia duration. These results is met with **Hamada *et.al*, Marhofer*et.al***, they found in their studies that the dexmedetomidine as an adjuvant significantly prolonged block duration as well as analgesia.[3,11]

Zhang P *et.al*, has studied the addition of dexmedetomidine in interscalene nerve block along with ropivacaine and has shown to improve the quality as well as analgesia with no adverse effects.[12]

On the other side, there are studies that have used dexamethasone as an adjuvant to local anesthetic and resulted in longer sensory and motor blockade duration.This results are met with **Tandoc MN *et.al.***

Tandoc MN *et. al*, Demonstrated that perineural dexamethasone (4mg and 8mg) significantly prolongs the duration of motor block and improved quality of analgesia with 0.5% bupivacaine in inter-scalene nerve block. In addition, this study did not show statistically significant difference between low-dose and high-dose of dexamethasone on analgesia duration and motor block prolongation.[13]

Cummings III K *et.al*, studied the addition of dexamethasone as an adjuvant to ropivacaine (30 ml) or bupivacaine (30 ml) in interscalene nerve block and found to have produced nearly the same 22 hours of analgesia with both the local anesthetic but block duration was found longer with bupivacaine.[14]

Biradar et al, demonstrated a relatively rapid onset of motor and sensory block when dexamethasone was used as an adjuvant to bupivacaine in ultrasound guided supraclavicular plexus block.[15]

Regarding demographic data, operative characteristics and hemodynamic parameters (HR,MAP,RR,SPO_2) there was no significant statistical difference between the two groups which is met with the results of **Hamada et al** and **Kaur M et.al.** [3,7]

There were no complications recorded in relation to the block technique or to the drugs in the form of hemodynamic instability, nausea, vomiting, hematoma formation, infection or local anesthetic toxicity.

CONCLUSION

We demonstrated that patients undergoing upper limb orthopedic surgeries under supraclavicular plexus block with the addition of perineuraldexmedetomidine (1μg/kg) to 0.5% bupivacaine had further increase in the duration of analgesia and prolongation in the time of block but the onset of block was shorter when dexamethasone was added to bupivacaine.

REFERENCES

1. Kaur M, Lakhani A, Hashia A. Comparative study between dexamethasone and dexmedetomidine in supraclavicular block. International Journal of Advances in Medicine. 2018;5(1):57.
2. Albrecht E, Vorobeichik L, Jacot-Guillarmod A, Fournier N, Abdallah F. Dexamethasone Is Superior to Dexmedetomidine as a Perineural Adjunct for Supraclavicular Brachial Plexus Block. Anesthesia& Analgesia. 2019;128(3):543-554.
3. Aswin D. A Comparative Study between the Effect of Addition of Dexamethasone to Bupivacaine and Bupivacaine alone in Supraclavicular Brachial Plexus Block for Upper Limb Surgeries. Journal of Medical Science And clinical Research. 2017;5(11).
4. Zhang P, Liu S, Zhu J, Rao Z, Liu C. Dexamethasone and dexmedetomidine as adjuvants to local anesthetic mixture in intercostal nerve block for thoracoscopic pneumonectomy: a prospective randomized study. Regional Anesthesia& Pain Medicine. 2019;44(10):917-922.
5. Kumar D.A Comparative study between supraclavicular brachial plexus block with Bupivacaine plus dexamethasone and supraclavicular brachial plexus block with Bupivacaine alone.Journal of Medical Science And clinical Research. 2020;08(07).
6. Yadav D, Saini D. Comparison of Tramadol and Dexamethasone as an adjuvant to Bupivacaine in Supraclavicular brachial plexus block: A Randomised Comparative Study in Patients undergoing Elective Upper limb surgeries. Scholars Journal of Applied Medical Sciences. 2016;4(6):2153-2158.
7. Kaur M, Lakhani M, Hashia A. Comparative study between dexamethasone and dexmedetomidne in supraclavicular block. International Journal of Advances in Medicine.2018;5(1):1-5.
8. Castillo J, Curley J, al. e. Glucocorticoids prolong rat sciatic nerve blockade in vivo from bupivacaine microspheres. Anaesthesiology. 1996 nov; 85(5): p. 1157-66.
9. Takimoto K, Levitan E. Glucocorticoid induction of Kv1.5 K+ channel gene expression in ventricle of rat heart. Circ Res. 1994 dec; 75(6): p. 1006-13.
10. Brummett CM, Norat MA, Palmisano JM, Lydic R.Perineural administration of dexmedetomidine in combination with bupivacaine enhances sensory and motor blockade in sciatic nerve block without inducing neurotoxicity in rat. Anesthesiology.2008;109:502–511
11. Marhofer D, Kettner SC, Marhofer S *et al.* Dexmedetomidine as an adjuvant to ropivacaine prolongs peripheral nerve block: A volunteer study. Br J Anesth.2012; 15:438-442.
12. Zhang P, Liu S, Zhu J *et al.* Dexamethasone and dexmedetomidine as adjuvants to local anesthetic mixture in intercostal nerve block for thoracoscopic pneumonectomy: a prospective randomized study.RegAnesth Pain Med.2019;0:1-6.
13. Tandoc MN, Fan L,KolesnikovS ,Kruglov A *et al.* Adjuvant dexamethasone with bupivacaine prolongs the duration of interscalene block: a prospective randomized trial. Journal of Anesthesia.2011; 25(5):704–709.
14. Cummings III KC, Napierkowski DE, Parra-Sanchez I et al. Effect of dexamethasone on the duration of interscalene nerve blocks with ropivacaine or bupivacaine.British Journal of Anesthesia.2011;107(3): 446–453.
15. Biradar PA, Kaimar P,Gopalakrishna K.Effect of dexamethasone added to lidocaine in supraclavicular brachial plexus block: a prospective, randomised, double-blind study.Indian Journal of Anesthesia.2013; 57(2):180–184.