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Randomised Control Trial of Dexmedetomidine and Magnesium Sulfate as an Adjuvant to Ropivacaine in Supraclavicular Brachial Plexus Block

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Abstract

Background: Several adjuvants potentiate peripheral nerve block. We studied effects of adding magnesium sulfate or dexmedetomidine to 20 ml 0.75% ropivacaine for supraclavicular brachial plexus block.

Materials and Method: 80 patients were divided in four groups, which, in addition to ropivacaine, received: Group A- 1 ml normal saline, Group B- 125 mg magnesium sulfate, Group C- 250 mg magnesium sulfate, Group D- 1 µg/kg dexmedetomidine.

Results: Duration of analgesia was significantly prolonged, onset of sensory and motor blockade was hastened and analgesic requirement was reduced in a dose responsive manner (for magnesium group), without causing clinically significant and unmanageable side effects. Intensity of potentiation was higher with dexmedetomidine than magnesium sulfate.

Conclusion: Magnesium sulfate potentiates supraclavicular block in a dose dependent manner. Potentiation by dexmedetomidine is greater than that by magnesium sulfate.

***Keywords**: Dexmedetomidine, Magnesium sulfate, Supraclavicular block, Ropivacaine*

Introduction

Brachial plexus block is a regional anaesthesia technique that provides important advantages including excellent pain control, reduced side-effects, and shortened stay in the post-anaesthesia care unit.[1] To enhance the sensory and motor effects of this block, several adjuvants like opioids, clonidine, neostigmine, dexamethasone, midazolam have been studied.[2-5] Magnesium sulfate, as an adjuvant to local anaesthetics, has potentiated the effects of local anaesthetics in peripheral nerve blocks.[6-8] Similarly, dexmedetomidine, an adrenergic α_2 agonist, has enhanced the sensory, motor and analgesic effects of peripheral nerve blocks, including brachial plexus blocks.[9-12] However, there are very few studies comparing the effects of these two adjuvants for peripheral nerve block.

We devised this trial to compare the analgesic, motor and sensory effects of magnesium sulfate and dexmedetomidine when used as an adjuvant to local anaesthetics.

Materials & Method

After ethical approval from institutional ethics committee, this prospective study was carried out at King George's Medical University, Lucknow. Total 80 adult patients were randomly allocated to four equal groups using computer-generated random number list. Patients with the American Society of Anaesthesiologists (ASA) physical status I or II, aged between 18 to 60 years of either sex, planned to receive supraclavicular brachial plexus block for surgery were enrolled in the study.

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Written informed consent was taken from all patients.

Group A: Patient received ropivacaine 0.75% (20 ml) plus NS 1 ml in supraclavicular brachial plexus block.

Group B: Patient received ropivacaine 0.75% (20 ml) plus magnesium sulfate 125 mg in supraclavicular brachial plexus block.

Group C: Patient received ropivacaine 0.75% (20 ml) plus magnesium sulfate 250 mg in supraclavicular brachial plexus block.

Group D: Patient received ropivacaine 0.75% (20 ml) plus dexmedetomidine 1 μg/kg in supraclavicular brachial plexus block.

After arrival to operation theatre, patient's baseline blood pressure, pulse rate, and electrocardiogram were recorded. Intravenous access was secured and infusion was started with Ringer's lactate solution. One of the investigators prepared 20 ml of ropivacaine with either 1 ml NS, or 125 mg magnesium sulfate or 250 mg magnesium sulfate or 1 mg/kg dexmedetomidine (to make total study drug volume 21 ml) according to computer generated randomization tables; and data packed in sealed envelopes. The patient received brachial plexus block through supraclavicular approach (ultrasound guided). Patients, and the anaesthesiologist administering block were unaware about drug given.

Hemodynamic variables [Heart Rate (HR), Mean Blood Pressure (MBP), Oxygen saturation (SpO_2), Electrocardiogram (ECG)] were noted at baseline, every 5 minutes till 15 minute, every 15 minutes till 1 hour, then hourly for remaining duration of surgery, every 15 minutes for first postoperative hour, every 30 minutes till 6 hours and hourly till the effect of block was over.

Assessment of the block was carried out every 2 minutes till complete sensory and motor block appeared and then hourly after surgery was over till the effect of the block was completely worn off, with time 0 being the time of completion of injection. Surgery was allowed to start after complete blockade.

Sensory block was assessed by pinprick test with a blunt needle in the distribution of all four nerves (ulnar, median, radial and musculocutaneous nerves) using a three point scale as: 0=no sensory loss, 1=loss of sensation to needle prick, 2=loss of sensation of touch (anaesthesia).

Motor block of the four nerves was evaluated on a three point scale as: 0=normal muscle function, 1=reduced muscle strength, 2=no muscle movement. Onset time for sensory or motor block was defined as the time interval between the local anaesthetic administration and complete sensory or motor block.

The observations in the recovery room were made by anaesthesiologist who was unaware of patient group. On arrival in recovery room patients were asked to rate their pain on a 10 centimetre visual analogue scale (VAS) and thereafter pain was assessed regularly every 30 min for first 2 hours and then hourly till 24 hours.

Duration of sensory block was defined as the time interval between block administration and complete resolution of sensation on all nerves. Duration of motor block was defined as the time interval between block administration and the complete recovery muscle power. Intravenous paracetamol 1 gram was administered when VAS score was ≥4 centimetre. The time interval between block administration and first rescue analgesic administration was taken as the duration of analgesia. Total amount of paracetamol used in first 24 hours period postoperatively was noted. Patients were questioned for nausea, vomiting, skin rash and were observed for tachycardia (>20% above baseline value), bradycardia (<50 beats per minute), hypotension (>20% below baseline value), hypertension (>20% above baseline value), hypoxemia (SpO_2<90%), sedation or any other side effect if any, during 24 hours postoperative period. Sedation was assessed using Ramsay sedation score.

Sample size was calculated with 80% power and 95% confidence limit. Minimum 17 patients in each group were needed to detect a difference of 30 minutes in duration of analgesia. We recruited 20 patients in each group to account for patient/data loss. The results were analysed using SPSS 22.0 for windows. A two-sided (α=2) $p<0.05$ was considered statistically significant.

Results

Baseline and demographic characteristics were statistically similar (Table 1). Block characteristics (analgesia, onset and duration of sensory and motor block) are compared in Table 2. All the comparisons were statistically significant. Post hoc comparison yielded, significant difference ($p<0.001$) in all the

values. Similarly, amount of paracetamol consumed was significantly different between all the groups. Significant differences in VAS score (Figure 1) was found in between groups at 6 hours and onwards ($p<0.05$). Sedation was higher in group D as compared to other groups (Table 3). Blood pressure and heart rate was statistically similar.

Table 1: Demographic Characteristics of the patients

	Group A (n=20)	**Group B (n=20)**	**Group C (n=20)**	**Group D (n=20)**	**p-value**
Age (yrs)	33.40±8.65	31.10±8.37	34.00±10.75	33.10±9.46	0.781
Gender					
Female	7 (35.0%)	7 (35.0%)	6 (30.0%)	7 (35.0%)	
Male	13 (65.0%)	13 (65.0%)	14 (70.0%)	13 (65.0%)	0.983
Weight (kg)	63.55±8.51	64.75±9.27	62.75±9.68	62.25±10.58	0.853
ASA Grade					
I	11 (55.0%)	11 (55.0%)	12 (60.0%)	12 (60.0%)	0.977
II	9 (45.0%)	9 (45.0%)	8 (40.0%)	8 (40.0%)	

ASA= American Society of Anaesthesiologists.

Table 2: Comparison of duration of analgesia and block characteristics

	Group A Mean±SD	**Group B Mean±SD**	**Group C Mean±SD**	**Group D Mean±SD**	**p-value**
Onset of Sensory Block (min)	16.65±2.25	14.20±2.14	12.75±2.31	8.80±2.61	<0.001*
Onset of Motor Block (min)	22.50±2.84	19.55±1.96	17.25±2.22	12.75±2.67	<0.001*
Duration of Analgesia (min)	401.5±31.7	473.5±26.8	605.0±44.5	981.5±107.8	<0.001*
Duration of Sensory Block (min)	323.8±26.9	438.3±26.6	569.8±45.1	920.3±103.2	<0.001*
Duration of Motor Block (min)	286.8±24.5	404.8±24.4	534.3±46.0	805.5±94.5	<0.001*
Amount of PCM used (mg)	3100.0±718.2	2400.0±502.6	1750.0±444.3	1250.0±444.3	<0.001*

* =statistically significant, min=minutes

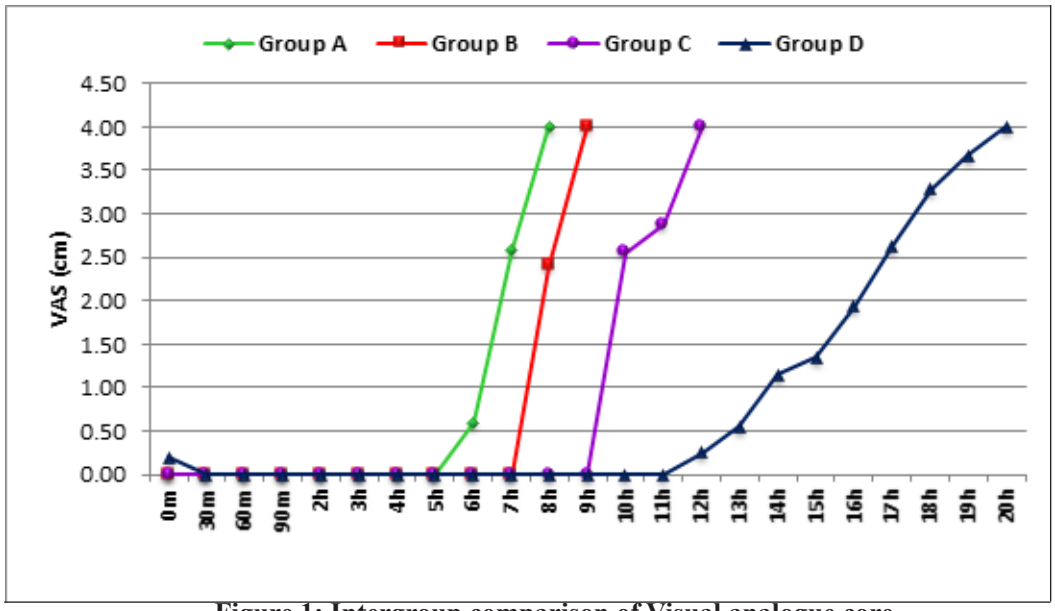

Figure 1: Intergroup comparison of Visual analogue core

VAS in Group D, Group C, Group B and Group A were significantly less than other groups from 11 hours, 9 hours, 7 hours and 5 hours respectively.

Table 3: Intergroup Comparison of Side effects

	Group A n=20	Group B n=20	Group C n=20	Group D n=20	p-value
Nausea	1 (5.0%)	1 (5.0%)	1 (5.0%)	2 (10.0%)	0.887
Bradycardia	1 (5.0%)	0 (0.0%)	2 (10.0%)	2 (10.0%)	0.504
Hypotension	1 (5.0%)	1 (5.0%)	1 (5.0%)	3 (15.0%)	0.539
Sedation	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (30.0%)	<0.001*
Respiratory depression	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (10.0%)	0.104
Hypoxemia	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (5.0%)	0.386

* =statistically significant

Discussion

Our study demonstrated that the addition of dexmedetomidine or magnesium sulfate (in a dose dependent manner) to ropivacaine resulted in early onset of sensory and motor block. The onset of sensory block and motor block were fastest for dexmedetomidine group than for magnesium sulfate group (250 mg) followed by magnesium sulfate group (125 mg) and was slowest in normal saline group. The difference in onset time among the four groups was significant.

Dexmedetomidine has been reported to improve the quality of intrathecal and epidural anaesthesia.[13-15] Dexmedetomidine in a dose of 1 µg/kg, when added to lignocaine for intravenous regional anaesthesia, improves quality of anaesthesia and analgesia without causing any side effects.[11] Dexmedetomidine potentiates peripheral nerve block by acting on central nervous system (adrenergic receptors on locus coeruleus), on peripheral nerves (on unmyelinated C-fibres). It also may have local action by producing local vasoconstriction, causing prolonging of the duration of action of local anaesthetics.[14-16] Dexmedetomidine has not been

associated with respiratory depression, despite frequent side effect of sedation.

Magnesium has long been used for its anaesthetic sparing effects and its property to enhance the effects of analgesics. It is necessary for the presynaptic release of acetylcholine from nerve endings.[17,18] It exerts anti-nociceptive effects by inhibition of calcium influx into the cell and antagonism of the N-methyl-D-aspartate receptors.[6-8,17,18]

Findings of our study are well supported by several studies which have observed potentiation of local anaesthetic action by both dexmedetomidine and magnesium sulfate.[7-9,14,15,19,20] Our study adds that the effects of magnesium sulfate are dose dependent without any side effects. The intensity of potentiation was greater with dexmedetomidine as compared to magnesium sulfate, but was accompanied with sedation as side effect.

One limitation of our study was that we did not use some of the study medications (ropivacaine, magnesium sulfate) according to weight of the patient. Other limitation was that the sample size was too small to detect differences in side effects.

Conclusion

We concluded that adding dexmedetomidine 1 µg/kg or magnesium sulfate in two doses (125 mg and 250 mg) to ropivacaine 0.75% in ultrasound guided supraclavicular brachial plexus block, significantly prolongs the duration of analgesia, hastens the onset of sensory and motor blockade, and decreases the number of analgesic requirement in a dose responsive manner (for magnesium group), without causing clinically significant and unmanageable side effects. Dexmedetomidine is a better adjuvant as compared to magnesium sulfate (125 mg or 250 mg) to ropivacaine in supraclavicular brachial plexus block.

Conflict of Interest – Nil

Source of Funding- Self

Ethical Clearance –Taken from ethical committee

References

1. Bruce BG, Green A, Blaine TA, Wesner LV. Brachial plexus blocks for upper extremity orthopaedic surgery. J Am Acad Orthop Surg. 2012;20:38-47.
2. Kohli S, Kaur M, Sahoo S, Vajifdar H, Kohli P. Brachial plexus block: Comparison of two different doses of clonidine added to bupivacaine. J Anaesthesiol Clin Pharmacol. 2013;29:491-5.
3. Bazin JE, Massoni C, Groslier D, Fenies V, Bittar M, Schoeffler P. Brachial plexus block: effect of the addition of sufentanil to local anesthetic mixture on postoperative analgesia duration. Ann Fr Anesth Reanim. 1997;16:9-13.
4. Jarbo K, Batra YK, Panda NB. Brachial plexus block with midazolam and bupivacaine improves analgesia. Can J Anaesth. 2005;52:822-6.
5. Yadav RK, Sah BP, Kumar P, Singh SN. Effectiveness of addition of neostigmine or dexamethasone to local anaesthetic in providing perioperative analgesia for brachial plexus block: A prospective, randomized, double blinded, controlled study. Kathmandu Univ Med J. 2008;6:302-9.
6. Gunduz A, Bilir A, Gulec S. Magnesium added to prilocaine prolongs the duration of axillary plexus block. Reg Anesth.2006;31:233-6.
7. Lee AR, Yi HW, Chung IS, Ko JS, Ahn HJ, Gwak MS, Choi DH, Choi SJ. Magnesium added to bupivacaine prolongs the duration of analgesia after interscalene nerveblock. Can J Anaesth. 2012;59:21-7.
8. Dogru K, Yildirim D, Ulgey A, Aksu R, Bicer C, Boyaci A. Adding magnesium to levobupivacaine for axillary brachial plexus block in arteriovenous fistule surgery. Bratisl Lek Listy. 2012;113:607-9.
9. Prabha R, Raman R, Kumar M, Singh D. Effect of Adding Dexmedetomidine to Ropivacaine for Transversus Abdominis Plane Block: A Prospective Randomised Controlled Trial. Journal of medical science and clinical research 2015;03:4550-7
10. Raman R, Prabha R, Kumar M. Comparison of three doses of intrathecal dexmedetomidine as an adjuvant to ropivacaine. International Journal of Contemporary Medicine 2015;03:36-40
11. Abosedira MA. Adding clonidine or dexmedetomidine to lidocaine during Bier's block: A comparative study. J Med Sci. 2008;8:660-4.
12. Marhofer D, Kettner SC, Marhofer P, Pils S, Weber M, Zeitlinger M. Dexmedetomidine as an adjuvant to ropivacaine prolongs peripheral nerve block: a volunteer study. Br J Anaesth. 2013;110:438-42.

13. Swami SS, Keniya VM, Ladi SD, Rao R. Comparison of dexmedetomidine and clonidine (α2 agonist drugs) as an adjuvant to local anaesthesia in supraclavicular brachial plexus block: A randomised double-blind prospective study. Indian J Anaesth. 2012;56:243-9
14. Dhasmana S, Singh V, Raman R, Pal M. Dexmedetomidine versus clonidine as an adjunct to intrathecal small dose ropivacaine in patients undergoing transurethral resection of prostate. Ain-Shams J Anaesthesiol 2014;7:534-8
15. Raman R, Prabha R, Singh GP, Kaushal D, Gautam G, Khan MP. Determination of Optimal Dose of Intrathecal Dexmedetomidine. Journal of medical science and clinical research. 2018;06:1144-50
16. Prabha R, Raman R, Khan MP, Abbas H, Sinha N. Comparison of 0.25% Bupivacaine and Dexmedetomidine with 0.5% Bupivacaine for Ultrasound Guided Supraclavicular Brachial plexus Block. International Journal of Contemporary Medicine 2018;6:28-33.
17. Irvinskas E, Laurinaitis R. Use of magnesium sulfate in anesthesiology. Medicina (Kaunas). 2002;38:695-8.
18. Begon S, Pickering G, Eschalier A, Dubray C. Magnesium increases morphine analgesic effect in different experimental models of pain. Anesthesiology. 2002;96:627-32.
19. Mukherjee K, Das A, Basunia SR, Dutta S, Mandal P, Mukherjee A. Evaluation of Magnesium as an adjuvant in ropivacaine-induced supraclavicular brachial plexus block: A prospective, double-blinded randomized controlled study. J Res Pharm Pract. 2014;3:123-9.
20. Haghighi M, Soleymanha M, Sedighinejad A, Mirbolook A, Naderi Nabi B, Rahmati M, Ashoori Saheli N. The effect of magnesium sulfate on motor and sensory axillary plexus blockade. Anesth Pain Med. 2015;5:e21943.