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Comparative Study of two doses of Magnesium Sulfate as an Adjuvant in Supraclavicular Brachial Plexus block for Post Operative Analgesia

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Abstract

Aims and Objectives: To compare the duration of post operative analgesia with different doses of magnesium sulphate as an adjuvant in USG guided supraclavicular brachial plexus block and its side effects. *Material & methods:* Ninety patients aged 18-50 yr ASA Gr 1-2 divided into 3 groups of 30 each undergoing upper limb surgery under USG guided supraclavicular brachial plexus block. Group C (control group)- (n=30) received 20 ml of 0.5% Bupivacaine + 5 ml of normal saline (NS). Study group 1 (S1) - (n=30) received 20 ml of 0.5% Bupivacaine + 4 ml of NS + 100 mg (1ml) of magnesium sulfate. Study group 2 (S2) - (n=30) received 20 ml of 0.5% + Bupivacaine + 3 ml of NS & 2 ml (200 mg) of magnesium sulphate. *Results:* Onset of sensory block in Group S2 (6.5±1 min), in S1 (10±2.8 min) and in C (15±3 min). Onset of motor block in S2 (9±2 min), in S1 (13±2.2 min) and in C (19±2 min). Duration of post-operative analgesia in S2 (540±25 min), in S1 group, (440±20 min) and in control group C (200±15 min). Addition of $MgSO_4$ as adjuvant hastened the onset of sensory and motor block in study group as compared to control. Duration of sensory and motor block were more in group S2 as compared to S1 and C. Duration of postoperative analgesia was significantly prolonged in group S2 as compared to S1 and C ($p<0.001$) without increased incidence of side effects. *Conclusions:* Addition of magnesium sulphate to local anesthetics in brachial plexus block prolongs the duration of postoperative analgesia. It is dose related, 200mg has greater efficacy than 100mg without increased side effects.

Keywords: Magnesium Sulphate; Postoperative Analgesia; Brachial Plexus Block; Visual Analogue Scale.

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Introduction

Supraclavicular brachial plexus block is widely used for upper limb surgeries (forearm and hand). It is easy, safe with rapid onset and high success rate [1,2]. This block is performed at the level of brachial plexus trunk which blocks the majority of sensory, motor and sympathetic innervations.

USG guided technique allows to see subclavian artery as a prominent marker and neural structures around it above first rib [3] thus increasing success rate and reducing the complications of landmark technique.

Local anesthetics have shorter duration of action and needs additives to increase the duration of postoperative analgesia. Clonidine,

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[4] buprinorphine, [5] tramadol, [6] were used in various studies for early onset and prolonged duration of analgesia providing excellent conditions for surgery. $MgSO_4$ also is an excellent additive to local anesthetics in regional and peripheral nerve blocks [7].

Mechanism of analgesic property of Magnesium on peripheral nerve is explained by surface charge theory [8], high concentration of divalent ions (Mg^{2+}) attracted by negative charges on the outer surface of nerve membrane causes effect on sodium channel gate which results in persistent hyperpolarisation and no conduction of impulse. Another mechanism is voltage dependant. Antagonism of NMDA receptor which prevents central sensitisation from peripheral stimulation and decreases the pain.

Different studies are conducted for $MgSO_4$ as additive to brachial plexus block with fair outcomes. This study was conducted to compare the efficacy of low dose and high dose of $MgSO_4$ for duration of postoperative analgesia and incidence of side effects.

Materials and Methods

Ethical committee approval was obtained and male and female patients of 18 to 50 years age, ASA Grade I or II, undergoing upper limb surgery under USG guided brachial plexus block, were divided into 3 groups of 30 each.

Group C: received 20 ml 0.5% bupivacaine+5 ml of NS

Group S_1: received 20 ml of 0.5% bupivacaine+ 4 ml of NS + 1 ml (100mg) magnesium sulphate.

Group S_2: received 20 ml of 0.5% bupivacaine + 3 ml of NS + 2 ml (200 mg) magnesium sulphate to total volume of 25ml and final concentration of bupivacaine 0.4% in each group.

For calculation of sample size, pilot study was done in 15 patients and randomized in 3 groups of 5 each. The standardized effective size 'cohen's 'd' was calculated, 23 patients per group were required to get stastically significant difference at p=0.05 and 80% power. By taking into consideration, block failure, exclusion, sample size was taken 30 in each group.

One sample Kalmogorov – smirnov test was used to determine differentiation between data sets from normal distribution.

Normally distributed data were analysed using analysis of variance. Catagorical data was analysed by chi square test.

Bonferroni correction was used to correct for multiple testing at different time points.

Study Method

Prospective double blind randomized controlled trial., Randomization done by computer generated random number table.

Exclusion Criteria

Contraindication to block (infection or bleeding disorders), history of cardiac disease, hepatic or renal failure, patients on long term calcium channel blockers, respiratory disorders, neuromuscular disorders, allergy to local anesthetics, mentally retarded patients, pregnant woman, neuropathy, ASA III and IV, failed block.

Thorough pre anesthetic evaluation was done, anesthesia procedure and Visual Analogue Scale (VAS) was explained to patients.

Written and informed consent was obtained. Patients were kept nil orally after 10 pm, oral antacids and anxiolytics were given.

In the operation theatre, monitoring devices were set up, IV line secured, Ringer Lactate infusion was started. Baseline parameters i.e. Heart Rate, Mean arterial pressure, oxygen saturation and respiratory rate were noted.

Procedure explained to patient and placed in supine position with head turned to opposite side. After cleaning and draping, local infiltration was done in supraclavicular area, block was performed by using high frequency linear probe, pulsatile subclavian artery was identified and confirmed with Doppler flow. Plexus located posterolateral to artery with hyper echoic honeycomb appearance. 23 gauge lumbar puncture needle is inserted by using in-plane technique and the drug is injected according to group allocation after negative aspiration for blood. Patient and observer were blind about the study solution. Vital parameters were monitored every 3 min for 30 min, and thereafter every 15 min till the end of surgery.

Sensory block is assessed by three point scale with pin prick method.

Grade 0 = sharp pin prick felt

Grade 1 = loss of pin prick sensation (analgesia) but dull sensation felt.

Grade 2 = loss of sensation (anesthesia)

Motor block is graded as

Grade 0 = normal motor function with full movement of wrist and fingers.

Grade 1 = decreased movements

Grade 2 = complete loss of movements (paralysis)

Assessment of sensory and motor blocks was done every 3 min till 30 min or till complete block is obtained. Assessment was done every hourly in intraoperative period for analgesia and every two hourly in postoperative till the requirement of systemic analgesics.

Onset of sensory block is defined as time interval between administration of drug and complete loss of sensation, and duration is time interval between drug injection and complete recovery of sensation to pin prick. Onset of motor block is defined as time interval between drug injection and complete loss of movement of fingers and duration is time interval between drug injection to complete recovery of finger movements and muscle power. Duration of surgery is time interval between skin incision to skin closure. Duration of analgesia is defined as time interval between drug injection and first injection of systemic analgesics.

Duration of analgesia or duration of sensory block is defined as the time from complete establishment of sensory block to the time of first rescue analgesia.

Analgesia was assessed by using 10 cm Visual Analogue Scale (VAS). Markings of 0 at the extreme left indicates no pain and 10 at the extreme right indicating maximum pain. Patients were asked to mark a point according to intensity of pain. When patient felt pain with VAS > 3, rescue analgesia was provided with either Inj. Diclofenac or Inj. Tramadol.

All patients were monitored in perioperative period for hemodynamic stability, any side effects of the block i.e. arterial puncture, pneumothorax, phrenic nerve palsy, failure of block or inadequate block and the side effects or drugs i.e. nausea, vomiting, respiratory depression, cardiac depression, muscle weakness, neuropathy.

Assessment of sensory, motor blockade and pain score was done at 0 min, 30 min, 1, 2, 3, 4, 6, 9, 12, 15, 18, 21, and 24 (hours).

There was no need of measuring serum Magnesium levels as the dose (100mg and 200mg) used was far less than the therapeutic dose of Magnesium Sulfate which is 300mg to 400mg per day for adults. The study dose will not cause toxic serum levels and clinical parameters were assessed (knee jerk, respiratory rate, muscle power, urine output) for early diagnosis of toxicity.

Statistical analysis was done by using SPSS software. Comparison was done by using Chi Square test. p values considered are $p > 0.05$ (not significant) $p < 0.05$ (significant) and $p < 0.001$ (highly significant)

Observations and Results

All patients completed study successfully. There was no block failure. All patients were comparable in respect to demographic data, duration of surgery, and vital parameters.

Consort Flow Diagram (Fig.1).

Onset of sensory and motor blockade was faster in group S_2 as compared to s1 and c, which is highly significant.

Duration of sensory and motor block was significantly longer in group S_2 as compared to S_1

Table 1: Demographic data of patients in three groups

Parameters	Groups			
	C	S_1	S_2	p
Age (yrs)	35.5±15.4	40.2±12	36.5±13	>0.05
Weight in Kg	60.5±5.5	58±6.6	57.2±5.5	>0.05
Male	12	15	16	>0.05
Female	18	15	14	>0.05
ASA1	20	25	19	>0.05
ASA2	10	5	11	>0.05

Table 2: Vital Parameters and Duration of Surgery

Parameters	Groups			
	C	S_1	S_2	p
Mean Heart Rate (bpm)	78.5±10	84±20	82±14	>0.05
Mean Blood Pressure(mm Hg)	84±8	90±10	88±10	>0.05
Mean Saturation (Sp02%)	99.7±0.5	99.4±0.6	99.2±0.5	>0.05
Duration of Surgery (min)	75.9±10.5	73.8±20	74.5±19.6	>0.05

Table 3: Onset of Sensory Block and Motor Block

Group	Onset of Sensory block(min)	Onset of Motor Block(min)	p Value
S2	6.5±1	9±2	P<0.001
S1	10±2.8	13±2.2	P<0.001
C	15±3	19±2.1	P<0.001

Table 4: Duration of Sensory and Motor Block

Group	Duration of Sensory Block (Min)	Duration of Motor Block (Min)	p Value
S2	550±15	440±30.2	<0.001
S1	440±10	330±15.5	<0.001
C	240±30	200±33.5	<0.001

Table 5: Duration of Analgesia

Group	Duration of Analgesia (min)
S2	540±25 min
S1	440±20 min
C	200±15 min
	p. Value <0.001

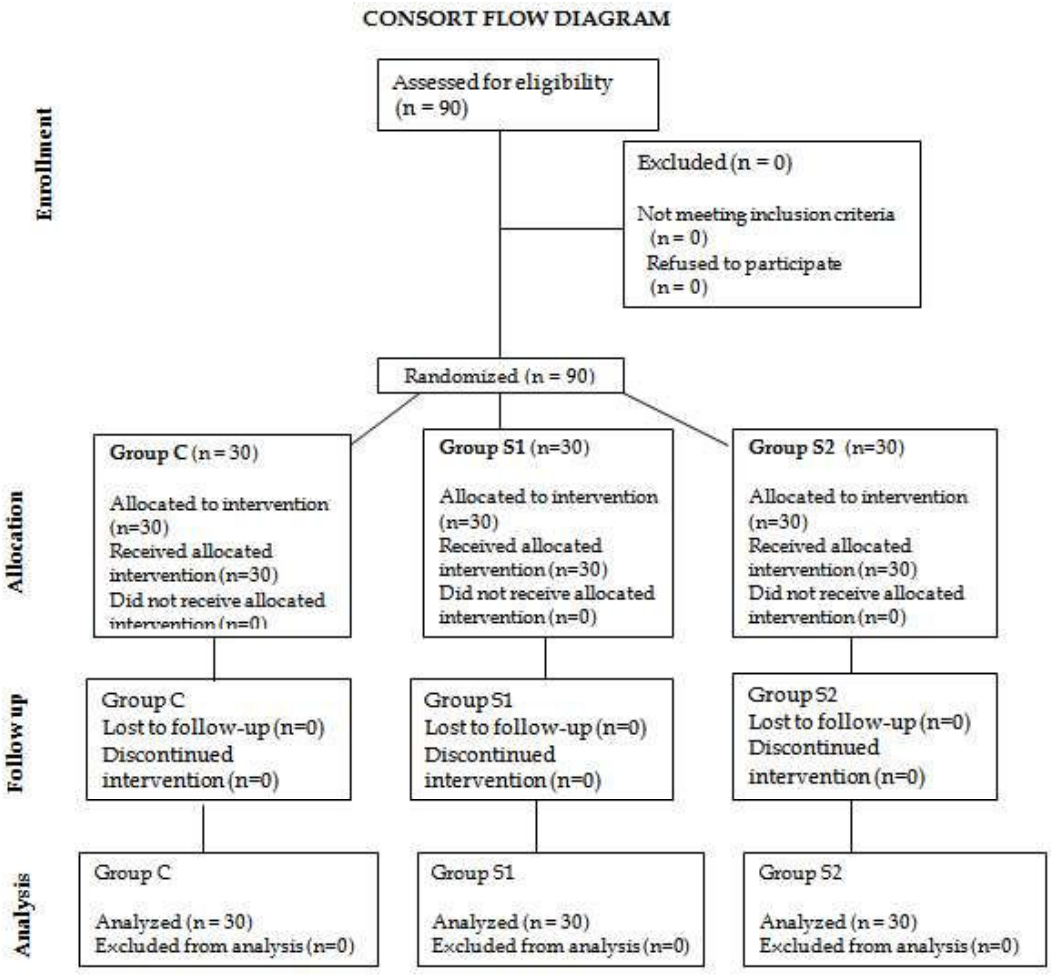

Fig. 1: Consort Flow Diagram

and C ($p<0.001$)

Duration of analgesia was significantly more in S_2 group than S_1 and C groups. Group C received maximum doses of rescue analgesics followed by group S_1 than S_2.

All patients were hemodynamically stable and no obvious side effects in perioperative period. Patients in group S_2 with $MgSO_4$ 200 mg were more comfortable than S_1 group with $MgSO_4$ 100 mg.

None of the patients experienced any symptoms and signs of Magnesium toxicity.

Discussion

The major results of our study are addition of Magnesium sulphate to local anesthetics prolongs the duration of local analgesia, fastens the onset of sensory and motor block in dose dependent manner. Higher doses have prolonged duration of analgesia without increased incidence of side effects.

There are studies on addition of $MgSO_4$ for peripheral nerve blocks. Gundez et al. [9] found that addition of $MgSO_4$ to 2% prilocaine for axillary block prolonged the duration of sensory and motor block significantly. Hypothesis for analgesic properties of Magnesium on peripheral nerves is surface charge theory. Akutagawa et al. [8] showed that modulation of extracellular magnesium concentration near the nerve bundle speeds the onset of action of local anesthetics. Mert et al. [10] reported that high concentration of divalent ions (Mg^{2+}) attracted by negative charges of surface membrane results in hyperpolarisation of nerve bundles and results in condition block. Hence more the concentration of Mg^{2+} ions, prolonged is the duration of analgesia. It supports our results that higher doses (200 mg) had more prolonged analgesia than lower dose (100 mg).

Another mechanism for analgesic property of $MgSO_4$ is NMDA receptor antagonism, which prevents central sensitisation from peripheral nociceptive stimulation. This is the basis of analgesic effect after intravenous administration and neuraxial route [11].

NMDA receptors are also found in muscles, skin [12], joint and play a role in sensory transmission of noxious signals [13]. In the study by Mukherjee et al. [14] used 150 mg of $MgSO_4$ with Ropivacaine in supraclavicular brachilal plexus block with desirable results. Whereas Bansal et al. [15] used 1.5 gm of $MgSO_4$ in intravenous regional anesthesia with excellent results and less side effects.

A R Lee [16] et al. studied 200 mg of $Mgso_4$ as adjuvant to bupivacaine with adrenaline in interscalene brachial plexus block with prolonged mean duration of analgesia which is consistent with our study.

Regarding total dose of rescue analgesics, control group received maximum doses followed by group S_1 and then S_2, which is correlating with the observation by Mukherjee et al. [14].

Prolonged analgesia with higher doses is consistent with studies by Varsha Verma et al. [17] who compared 250 mg and 125 mg $MgSO_4$ and found that 250 mg provides longer duration of analgesia as compared to 125 mg. Thus it is dose dependent.

Santosh Kumar et al. [18] reported use of $MgSO_4$ 150 mg as an adjuvant in USG guided supraclavicular block is better than Potassium Chloride for post operative analgesia.

Conclusion

After seeing the observations and results we come to conclusion that analgesic action of magnesium sulphate added as additive to bupivacaine for supraclavicular brachial plexus block is dose dependent. It also speeds the sensory and motor blockade and prolongs the duration of blockade.

$MgSO_4$ helps in reducing the rescue analgesic requirement in the post operative period making patient more comfortable.

$MgSO_4$ is economical and easily available.

Higher dose i.e. 200 mg is more effective than 100 mg without any side effects.

$MgSO_4$ can be used as an adjuvant to local anesthetics in regional blocks as it potentiates the action of local anesthetics.

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