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Research Article

Comparing the Effects of Perineural Magnesium Sulphate with Intravenous Magnesium Sulphate as an Adjuvant to Bupivacaine in USG Guided Supraclavicular Block

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ABSTRACT

Background: In present anaesthesia practice to prolong postoperative analgesia use of various adjuvants is routinely done. Magnesium sulphate is one of the widely used adjuvant used in different routes along with regional anaesthesia to prolong postoperative analgesia. We compared perineural magnesium sulphate and intravenous magnesium sulphate when used as an adjuvant with bupivacaine in supraclavicular block under USG guidance for upper limb surgeries.

Methods: We enrolled ninety patients with physical status I or II, age ranging from 20-60 years, scheduled for upper limb surgeries under USG guided brachial plexus block were categorised into 3 groups (n-30). In study all patients were received 28 ml 0.5% injection Bupivacaine in addition patients in Group 1 and 2 were received 2 ml of Normal Saline (NS) and in Group 3 were received 1.5 ml of NS with 250 mg of Magnesium sulphate. Along with this intravenously 30 minutes prior to block patients in Group 1 and 3 were received 100 ml of 0.9% of NS and patients in Group 2 were received 100 ml of 0.9% normal saline with injection Magnesium Sulphate 50 mg/kg. They were evaluated for block characteristics and total dose of rescue analgesic required in post-operative period for 24 hours were noted.

Results: We found that sensory, motor block and postoperative analgesia duration was significantly longer in both study groups (2 and 3) compared to group 1 (control) but significantly prolonged in perineural group compared to intravenous group. Postoperative analgesic consumption was less in both study group with insignificant difference between them.

Conclusion: We concluded that in supraclavicular block magnesium sulphate was more effective when used perineurally as compared to intravenous route as an adjuvant to Bupivacain 0.5% regarding to provide prolong duration of postoperative analgesia with insignificant side effects.

Unrelieved pain in postoperative period leads discomfort to patients and also predisposes to the development of chronic pain syndromes especially in orthopaedic surgeries [1]. Regional anaesthesia techniques are preferred over general anaesthesia (GA) as they owe an advantage of not only best pain control but also has less adverse effects and shortened stay in the post anaesthesia care [2]. Brachial plexus block (BPB) under USG guidance has been the cornerstone for surgeries of upper limb since the last few decades. Various adjuvants like fentanyl, butorphenol, buprenorphine, clonidine, and dexamethasone have been used to enhance the duration of analgesia of peripheral nerve blocks with different degrees of success. [2-5].

For enhanced post-operative analgesia Magnesium sulphate (MgSO4) has been evaluated by using as an adjuvant to local anaesthetic (LA) in regional anaesthesia. By virtue of its NMDA receptors antagonist

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property, it enhances the analgesic actions of LA when used perinuerally or intravenously along with blocks [6-10].

In patients undergoing GA intravenous administration of injection MgSO4 causes attenuation of cardiovascular response associated with tracheal intubation and reduces the requirement for anaesthetic agents [10]. It effectively also attenuates perioperative pain by reducing somatic stimuli and autonomic reflexes due to painful stimulations [11-13].

We conducted this study with the primary objective to compare postoperative analgesia by intravenous versus perineural MgSO4 and secondary objective to study analgesic consumption in 24 hours and any side effects. We hypothesize that MgSO4 when administered perineurally is more effective in enhancing postoperative analgesia.

Methods

This double blind randomized study was carried in May 2020 to January 2021 after the institutional ethics committee approval. We took written informed consent from all participants in the study. Ninety patients with physical status I and II, of either sex, between 20 to 60 years, posted for upper limb orthopedic surgeries in supraclavicular brachial plexus block (BPB) under USG guidance were enrolled for the study. The patients who refused to give consent, those with moderate to severe co-morbid illness, deranged coagulopathy, block site infection, allergic to study drugs in study, peripheral neuropathy, motor neuron disorders and pregnant women were excluded from the study. According to inclusion criterias patients who are eligible were included in the study and were categorized randomly into three groups by computer generated number list as follows:

Group 1 (Control) (n=30): Patients received 28 ml injection Bupivacaine 0.5% + 2 ml of normal saline in block and 100 ml 0.9% normal saline intravenously 30 minutes before giving supraclavicular BPB.

Group 2 (IV) (n=30): Patients received 28 ml injection Bupivacaine 0.5% + 2 ml of normal saline in block and injection Magnesium sulphate 50 mg/kg in 100 ml of 0.9% normal saline intravenously 30 minutes before giving supraclavicular BPB.

Group 3 (PN) (n=30) Patients received 28 ml injection Bupivacaine 0.5% + 250 mg (1/2cc) of 50% magnesium sulphate diluted with 1.5 ml of normal saline in block and 100 ml of 0.9% normal saline intravenously 30 minutes before giving supraclavicular BPB.

As study was a double-blinded; both patient and observer who analyzed postoperative data were blinded to the drug administered. The blinding was done using sealed opaque envelopes in which perineural and intravenous study drug were enclosed. The anesthetist performing the block was blinded to drugs administered in block and in normal saline.

After taking patient inside the operation theater standard monitors including ECG, NIBP and pulse oximeter was attached. Baseline vitals such as heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and oxygen saturation (SpO2) were recorded. 20G intracath was secured and Ringer Lactate was started on the non-operating hand. The intravenous study drug, provided in the sealed envelope, was started via a separate 22G intravenous cannula 30 minutes before BPB. After antiseptic skin preparation and sterile draping USG guided supraclavicular BPB was given on operating side using perineural drug from the sealed envelope.

Assesment of sensory block was done by using pinprick method. Three point scoring of sensory block was graded as: 0- normal sensation, 1- loss of sensation to pinprick, and 2- loss of sensation to touch [8]. Onset of sensory block is the time interval between the completion of LA injection in block and loss of touch sensation (Grade 2), duration of sensory block was defined as the time interval from the completion of LA injection to complete resolution of sensation (Grade 0). Motor block was assessed using 3 point modified Bromage scale: grade 0-normal motor function with full extension and flexion of elbow, wrist, and fingers, Grade 1- decreased motor strength, with ability to move only fingers, and Grade 2-complete motor block with inability to move elbow, wrist, and fingers [8]. Onset of motor block was defined as the time interval between completion of LA injection in block and loss of complete motor power (Grade 2); duration of motor block was defined as the interval between completion of LA injection and complete resolution of motor power (Grade 0).

The sensory and motor blocks were assessed every 2 minutes till end of first 10 minutes and then every 5 min for next 30 min after block. Failure of the block was considered when patients experienced pain or had partial loss of sensation and motor power even after 30 min of LA injection. Such patients were given GA or supplementation of opioids and were excluded from further the study.

Pain was assessed every 60 minutes till end of 24 hours after block by using Visual analog scale (VAS) which is 0–10 cm horizontal scale [14]. Patients were asked to mark on a 10cm horizontal scale according to their pain intensity: no pain corresponding to zero and the worst unbearable, excruciating pain corresponding to 10. The scale was explained to patients in his or her language. Patients whoes VAS score ≥ 4 were recieved injection diclofenac sodium 1.5 mg/kg intravenously as rescue analgesic. Duration of postoperative analgesia was defined as interval from time of completion of LA injection in block to the time of first rescue analgesic required. Patients were also assessed for total dose of rescue analgesia required in 24 hours after block.

During surgery and postoperatively patients were assessed for sedation by using Ramsay sedation score (RSS) [15].

1- Patients is anxious and agitated or restless or both.
2- Patient is co-operative, oriented and tranquil.

3- Patients responds to commands only.
4- Patients exhibits brisk response to light glabellar tap.
5- Patients exhibits a sluggish response to light glabellar tap.
6- Patients exhibits no response.

In postoperative period vitals were assessed every hour till resolution of block.

The patients were monitored for adverse effects such as hypotension (20% decrease from baseline), bradycardia (<50 bpm), hypoxia (SpO2< 90%), and nausea and vomiting throughout perioperative period.

Statistical Analysis

From previous related studies the onset of sensory block was taken as one of the variables and sample size was calculated [16]. To detect a statistically significant difference at 80% power 25 patients in each group were needed. As there was chances of drop out of patients during study or chances of failure of block 30 patients were chosen for each group. The data was analyzed using Statistical Package for the Social Sciences (SPSS) Version 20.0 software (SPSS Inc., Chicago, IL, USA). Data were represented as mean ± standard deviation, numbers, and percentages. Age, onset and duration of sensory and motor blocks, hemodynamic parameters, and duration of surgery were analyzed using independent Student's t-test. Sex ratio and ASA classes were compared using the Chi-square test. P< 0.05 was considered statistically significant, and P< 0.01 was considered highly significant.

Results

Demographic profile was comparable in all three groups including types of surgeries and their duration (Table 1). Baseline vital parameters were comparable in both the groups.

The mean duration of onset of sensory block in control group was 4.10 ± 2.3 min, in intravenous (IV) group was 4.50 ± 2.15 min and in perineural (PN) group was 5.00 ± 2.08 min. whereas mean duration of onset of motor block in control, IV and PN group was 4.12 ± 3.2 min, 4.15 ± 3.2 min and 5.15 ± 3.2 min respectively. The mean duration of sensory block was 270 ± 100 min in control group, was 410 ± 70 min in IV group and 550 ± 126 min in PN group (p value between both study groups when compared with control group 0.0001 and p value on comparison between study groups 0.0004). The mean duration of motor block in control, IV and PN group was 230 ± 195 min, 365±75 min and in 450 ± 112 min respectively. (p value on comparison between study and control group 0.0001, and between IV and PN group was 0.0004). Thus, sensory and motor duration was significantly prolonged in intravenous as well as perineural groups as compared to control group. Within groups, PN group had significantly prolonged sensory and motor action compared to IV group (Figure 1).

This duration of post op-operative analgesia was 250 ± 120 min, 450.105 ± 105 min and 580 ± 115 min in control, IV and PN group respectively. Regarding this 'p' values were significant on comparing each study group with control (0.0001), as well as within the two study groups (0.041) (Figure 1).

Total postoperative analgesic requirement in control, IV and PN group was 130, 105 and 95 mg respectively, which was significantly less in both study groups compared to control group (p value between control and IV group 0.0023, between control and PN group was 0.0053). There was no significant difference within the study groups (IV versus PN group p value was 0.1869) (Figure 2).

Intraoperative hemodynamics including HR, SBP, DBP and SPO2 were comparable in all three groups monitored at interval time periods and none of the patients required any intervention. Only 3 patients in IV group had RSS> 3 whereas one patients from PN group had RSS> 3. RSS was comparable in all three groups. None of the patients had side effects like nausea, vomiting, hypotension, bradycardia during intraoperative and postoperative periods.

Table 1- Demographic data

Demographic parameters	**Group 1 control group (n = 29) Mean ± SD**	**Group 2 IV group (n = 30) Mean ± SD**	**Group 3 PN group (n = 30) Mean ± SD**
Age (Years)	52.66±8.776	51.13±9.413	49.57±11.057
Weight (kg)	61.93±6.491	58.23±6.663	57.10±7.810
Height (cm)	156.21±6.383	154.20±7.989	156.90±6.294
BMI (Kg/m2)	25.157±2.445	24.390±2.983	23.530±3.185
ASA Status (I/ II)	29/ 0	28/2	28/2
Duration of surgery (min.)	105.17±32.26	94.72±19.94	103.31±31.43

Value expressed as mean ± SD

Figure 1- Comparison of block characteristics

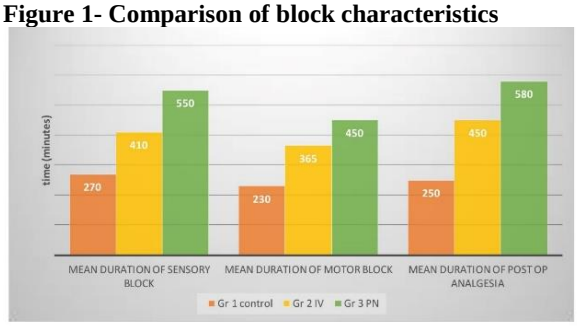
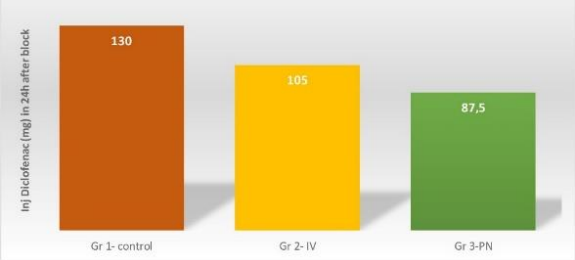


Figure 2- Requirement of total dose of post-operative analgesia



Discussion

Magnesium Sulphate has property to potentiate analgesic effect of local anaesthetic drugs so widely used with regional anaesthesia [10]. In lot of studies magnesium sulphate has been used perineurally as adjuvant to LA but there are very few study to see the effects on peripheral nerve block when used intravenously. So we did this study to compare the effects of intravenous and perineural magnesium sulphate in upper limb surgeries under USG guided BPB. We hypothesized that MgSO4 prolongs the duration of motor and sensory action plus duration of post-operative analgesia when given via perineural route.

The dose of perineural MgSO4 which we used was based on study of Versha V. et al. where they compared two doses of magnesium (125 mg and 250 mg) given along with Bupivacaine in supraclavicular block (perineurally). They found prolonged postoperative analgesia with both doses but more with 250 mg (10 to 11 hours) [7]. Arvind K. et al. and Samir et al. compared intravenous versus intrathecal MgSO4. They used intravenous MgSO4 50 mg/kg prior to spinal anaesthesia which was proved to be safe and effective. Hence we selected intravenous magnesium sulphate in dose of 50 mg/kg for the IV group. [16-17]

Versha V. et al were used MgSO4 perineurally in two doses (125 mg and 250 mg) along with Injection Bupivacaine 0.5% in BPB and they found that onset of sensory and motor block was faster with 250 mg as compared to 125 mg dose [7]. One more study done by Samir et al. used MgSO4 intravenously and intrathecally and observed that sensory block onset was delayed in intrathecal group compared to intravenous group [17]. This result was similar to our study where time of onset of sensory block as well as motor block was comparable in IV group (4.50 ± 2.15 min, 4.15 ± 3.2 min) and control group (4.10 ± 2.3 min, 4.12 ± 3.2 min) but delayed in PN group (5.00 ± 2.08 min, 5.15 ± 3.2 min).

There are 3 different studies by Kumar M et al., Kiran S et al and Agarwal A et al. who observed that duration of sensory and motor blockade was prolonged after using MgSO4 as a bolus infusion before subarachnoid block followed by continuous infusion [15-17]. Arvind K et al. and Samir E et al. used single intravenous bolus infusion of 50 mg/kg of MgSO4 before subarachnoid block and found significant prolongation in sensory as well as motor blockade compared to control group but insignificant difference between study groups [16-17]. Similarly in our study the motor and sensory duration was prolonged in both study groups compared to control group. However, in our study the duration between two study group was also significantly different (p value on comparison between IV and PN group for sensory duration 0.0001, for motor duration 0.0004).

Agarwal A et al studied and compared effect of IV Magnesium sulphate on subarchnoid block and they found significantly prolonged analgesic duration [18]. Arvind K et al. and Samir E compared intravenous and intrathecal MgSO4 for postoperative analgesia and observed that duration of analgesia was significantly prolonged in intravenous group compared to control and intrathecal group [16-17]. However in our study we observed that duration of post-operative analgesia was significantly increased in both study groups compared to control group. Within the study groups, it was prolonged significantly in perineural group compared to intravenous group (duration of analgesia in control, IV and PN group- 250 ± 120 min, 450.105 ± 105 min and 580 ± 115 min respectively, p value IV versus PN :0.04). In one case, Hossam A et al. observed effects of injection Magnesium sulphate 500 mg in femoral nerve block as an adjuvant to 20 ml 0.25% Bupivacaine, where the postoperative analgesia lasted for 10 to 11 hours [19]. Al Rafaey K et al. used 150 mg Magnesium Sulphate as an adjuvant in TAP block postoperatively for laparoscopic cholecystectomy and found significantly prolonged analgesia (19 -20 hours) [20]. Reza A. et al. compared Magnesium sulphate and fentanyl as adjuvants to Lignocaine in supraclavicular block and they found significantly prolonged pain free period with magnesium sulphate [21]. Similar to these studies we also found prolonged duration of analgesia in perineural group patients.

Meta-analysis done by Albrecht and colleagues administered 40 to 50 mg/kg magnesium sulphate intravenously and they found reduction in dose of morphine postoperatively [22]. Kumar M et al. found that postoperatively in 24 hours the total requirement of

rescue analgesic injection diclofenac was maximum in the control group as compared to the IV group and intrathecal group but no significant difference was observed between study groups [23]. Similarly, in study by Samir E et al. difference of total postoperative analgesia required in 24 hours was insignificant between study groups though it was significant when compared to control group [17]. This result was similar to our study.

Hari K et al. concluded in their study that only 2 patients from IV group were sedated but easily arousable [14]. Concomitantly our study also had similar results of RSS> 3 in IV group (n=3) and PN group (n=1). All patients in our study were arousable and comfortable.

Study by Samir E et al. and Arvind K et al. found that intraoperative hemodynamic as systolic, diastolic and mean arterial blood pressure, heart rate, peripheral oxygen saturation was comparable in three groups similar to our study [16-17].

Our results showed that the patients who received magnesium sulphate perineurally not only had prolonged sensory, motor action but also had enhanced duration of postoperative analgesia with less requirement of doses rescue analgesic in first 24 hrs of postoperative period as compared to the patients in intravenous group or control group. All the patients were comfortable in the postoperative period.

This study has few limitations. We did not measure the serum Mg++ levels preoperatively, which could have helped us in better correlation of serum magnesium concentration with the pain free period in intravenous group. Another limitation was, as upper limb surgeries in our study were under tourniquet so we were unable to compare the surgical field in all three groups. Therefore further studies are required in this regard.

Conclusion

From our study we conclude that magnesium sulphate can be used as an adjuvant, both intravenously as well as perineuraly, in supraclavicular brachial plexus block to improve the efficacy as well as prolong the duration of sensorimotor block. Perineural magnesium sulphate is more effective in prolonging the duration of block as compared to intravenous route.

List of Abbreviations

GA – General Anaesthesia.
LA- Local anaesthesia.
BPB- Brachial plexues block.
MgSO4- Magnesium Sulphate.
IV- intravenous
PN- perineural.
RSS- Ramsay Sedation Score.
ASA- American Society of Anaesthesiology.
ECG- Electrocardiograph
NIBP- Non- invasive blood pressure

Acknowledgment:

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