Original Research Article

Comparative study of 0.5% bupivacaine with 150mg MgSO4 versus 0.5% plain bupivacaine in interscalene brachial plexus block for shoulder

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Abstract

Objectives: Interscalene brachial plexus block for the shoulder is commonly used for forelimb and hand surgeries. A lot of research is going on to increase the duration of sensory and motor blockade by the addition of adjuvants with the local anesthetics. We evaluated the effect of adding $MgSO_4$ to bupivacaine for Interscalene brachial plexus blockade. Our primary parameters were the onset and duration of sensory and motor block and duration of analgesia. **Methods:** 60 patients posted for elective forearm and hand surgeries under Interscalene brachial plexus block were divided into two equal groups (Group B and B+M) in a double-blind fashion. **Results**: The onset of a blockade in Group B was found to be 15.49 ± 2.38 minutes when compared to the onset time of 18.00 ± 2.80 minutes in Group B+M and this difference was found to be statistically significant ($p<0.001$). The onset of motor blockade found in Group B was 17.75 ± 2.70minutes and Group B+M was19.84 ± 2.50 and it is found to be statistically significant with a p-value of 0.002 The duration of sensory blockade was longer in Group B+M with a duration of 621.60 ± 25.25 minutes compared to Group B having the duration of 503.36 ± 24.51minutes and this difference was found to be statistically significant ($p<0.001$). **Conclusion**: We conclude that the addition of 150 mg $MgSO_4$ to ropivacaine 0.5% bupivacaine interscalene brachial plexus block for shoulder prolongs the duration of sensory, motor blockade, and duration of analgesia but results in a slight delay in the onset time of sensory and motor blockade.

Keywords: Bupivacaine, interscalene brachial plexus block, shoulder, Magnesium sulfate.

Introduction

For shoulder surgery, a brachial plexus block is a good alternative to general anesthesia. It produces full muscle relaxation and steady intraoperative hemodynamics, resulting in optimal operating circumstances. Because of the greater preservation of pharyngeal and laryngeal reflexes, regional anesthesia is more important in orthopedic surgery than general anesthesia. This reduces the danger of aspiration [1], reduces stress response in impaired patients, and avoids problematic intubation [2]. Regional Anaesthesia also results in better postoperative analgesia without undue sedation and facilitating early mobilization and discharge from the hospital. The supraclavicular approach is commonly used for brachial plexus block because of its ease, reliability, and high success rate. Moreover, this approach doesn't result in the sparing of musculocutaneous or axillary nerves [3]. Bupivacaine is one of the most often utilized local anesthetics because of its extended duration of action, which ranges from 3 to 8 hours [4]. It does, however, have drawbacks, such as delayed onset, uneven or partial analgesia. Local anesthetics alone for supraclavicular brachial plexus block give excellent operating circumstances, but postoperative analgesia lasts less time. To extend the duration and severity of brachial plexus block, different adjuvants such as opioids [5], clonidine [6,] and dexamethasone [7] were given to local anesthetics, although the results were mixed.

Magnesium sulfate ($MgSO_4$) has been proved to have antinociceptive effects in animal and human models by blocking the *N*-methyl-D-aspartate receptor [8] and associated calcium channels, thus preventing the central sensitization that is caused by peripheral nociceptive stimulation [9]. The addition of magnesium sulfate to local anesthetics for neuraxial anesthesia prolongs the duration of anesthesia and improves the quality of the block [10, 11].

We conducted a clinical study to compare the study of 0.5% bupivacaine with 150mg $MgSO_4$ versus 0.5% plain bupivacaine in interscalene brachial plexus block for the shoulder.

Material and methods

Study site and location

Department of Anesthesiology, Government Medical College, Nizamabad.

Study Design

Prospective randomized double-blind study

Study Period

December 2019 to November 2020

Study Population

Patients between 18 to 60 years, ASA Grade I and II, undergoing elective shoulder orthopedic surgeries.

Study Sample size

Minimum total sample size is 66. Group-A (33); Group-B (33);

Study inclusion criteria

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1. Patients undergoing elective shoulder surgeries.
2. ASA Grade I and II patients
3. Age group between 18 to 60 yrs
4. Patients of either sex male or female

Study exclusion criteria

1. Patients own refusal for participation
2. Age < 18 yrs or >60 yrs
3. Co-existing cardiovascular diseases (ischemic heart disease, uncontrolled hypertension, valvular heart disease), neuromuscular diseases, uncontrolled diabetes mellitus, hepatic or renal failure, Pregnant or Lactating woman
4. History of allergy to Bupivacaine.
5. Contraindication to individual drug
6. Surgeries lasting less than 30 minutes
7. Contraindication to Interscalene nerve block (contralateral Phrenic nerve dysfunction, severe chronic obstructive pulmonary disease)

Preoperative preparation

After obtaining approval from the ethics committee of the hospital this prospective randomized double-blind study was carried out, the patients posted for elective shoulder surgeries were visited and evaluated thoroughly on the day before surgery. Patients were screened and those who fulfilled the inclusion criteria (and none of the exclusion criteria were present), were explained the study. After they accepted to be a part of this study, then written informed consent was taken.

During the pre-anesthetic evaluation, a thorough evaluation of all the systems was undertaken. The anesthetic procedure to be undertaken including the development of paraesthesia were explained to the patients and an attempt was made to alleviate the anxiety of the patient. Pre-anesthetic preparation of the patient included a period of overnight fasting. All patients received oral alprazolam 0.25mg the night before surgery. A meticulous airway assessment was also carried out. Routine laboratory examinations were conducted including complete haemogram, urine analysis, and blood sugar, ECG and chest X-ray was also done in patients above 40 years. The relevant details of the patients who have given consent were filled in the study performed attached at the end of this document.

The study was designed as a prospective randomized, double-blind study. Patients were allocated to two equal groups of 33 each using a computer-generated random number list as group B+M: Bupivacaine+Magnesium Sulphate group (n=33) and group B: Bupivacaine group(n=33). Patients in group B+M (Bupivacaine + Magnesium Sulphate group) (n=33) received 20 ml of 0.5% Bupivacaine + 150mg Magnesium Sulfate (total 23ml) and patients in GROUP B (Bupivacaine group) (n=33) receive 20 ml of 0.5 % of Bupivacaine .To avoid bias, Group B patients will receive an additional 3ml of 0.9% sodium chloride. The allocation sequence was generated by another anesthesiologist. To avoid bias, the drugs were prepared by the same anesthesiologist who is not involved in administering the injections and in further evaluation of the patients. The block was given by me who is unaware of the contents of the drugs and was blinded to the treatment group. All observations were carried out by a single investigator who was also blinded to the treatment group.

Intravenous access was obtained in the limb opposite to that undergoing surgery with 18 G cannula. ECG monitoring, Pulse oximeter, Noninvasive blood pressure was connected and monitored in all the patients. Interscaene brachial plexus block was performed after eliciting paraesthesia. All the patients were premedicated with Intravenous Injection Midazolam 2 mg, 15 minutes before block. All necessary types of equipment and drugs needed for the administration of general anesthesia and emergency resuscitation were kept ready to manage the failure of block or complications occurring during the procedure. The brachial plexus shares a close physical relationship with several structures that serve as important landmarks for the performance of the interscalene block. In its course between the anterior and middle scalene muscles, the plexus is superior and posterior to the second and third parts of the subclavian artery. The dome of the pleura lies anteromedial to the inferior trunk. This technique can be performed with the patient's arm in any position and is technically simple because of the easy identification of necessary landmarks. The patient should be in the supine position, with the head turned away from the side to be blocked. The posterior border of the sternocleidomastoid muscle is readily palpated by having the patient briefly lift the head. The interscalene groove can be palpated by rolling the fingers posterolaterally from this border over the belly of the anterior scalene muscle into the groove. A line is extended laterally from the cricoid cartilage to intersect the interscalene groove, indicating the level of the transverse process of C6. Although the external jugular vein often overlies this point of intersection, it is not a constant or reliable landmark. After injection of a skin wheal, a 22- to 25-gauge, a 4-cm needle is inserted medially perpendicular to the skin in interscalene groove, at the level of the cricoid cartilage.

The needle is then advanced until paresthesia is elicited. This usually occurs at a superficial level. Paresthesia or motor response of the arm or shoulder is equally efficacious as a distal response. If a blunt needle is used, a click may be detected as the needle passes through the prevertebral fascia. If the bone is encountered within 2 cm of the skin, it is likely to be a transverse process, and the needle can be walked into this structure to locate the nerve. Contraction of the diaphragm indicates phrenic nerve stimulation and anterior needle placement; the needle should be redirected posteriorly to locate the brachial plexus. After the appropriate paresthesia is obtained, and after negative aspiration, 23mL of the solution is injected. All the parameters like heart rate, blood pressure, motor block, sensory blocks, and side effects were assessed at 5mins, 15mins, and 30mins after giving the block and every half and hourly thereafter.

Statistical Analysis

After data collection, data entry was done in Origin Pro 8.5. Descriptive statistical analysis was carried out in the present study. Results on continuous measurements were presented on Mean ± SD and results on categorical measurements were presented in Number (%). Significance was assessed at a 5 % level of significance. Student t-test (two-tailed, independent) was used to find the significance of study parameters on a continuous scale between two groups (Intergroup analysis) on metric parameters. Chi-square/ Fisher Exact test was used to find the significance of study parameters on a categorical scale between two or more groups. In the present study, we analyzed the statistical significance of the difference between the Bupivacaine Group and the Bupivacaine and Magnesium Sulphate group. A value of $p > 0.05$ meant that the difference between the groups was insignificant. A value of $p < 0.05$ was taken to be statistically significant and a value $p < 0.01$ was highly significant.

Results

The chart compares the age of patients in both groups. The mean age in group B was 42.39 ± 8.03 years and in the group, B+M was 39.87 ± 9.07 years with the P-value of 0.238. The P-value was found to be statistically insignificant. The variables in the demographic data did not show a statistically significant difference between the three groups concerning age, sex, weight, height, ASA physical status, and duration of surgery (Table 1).

Table 1 Demographic data of the two studied groups

Variables	Group-B (N=33)	Group- B+M (N=33)	*P*-value
Age (years)	42.39 ± 8.03	39.87 ± 9.07	0.238
Weight (kg)	76.65± 2.56	75.14 ± 4.42	0.176

Sex (M/F)	22/11	20/13	0.38
Height (cm)	156.45 ± 2.6	156.14 ± 3.2	0.62
ASA (I/II)	25/8	23/10	0.58

Values are mean ± SD for the age, the weight, and the duration of anesthesia, and the number of patients for sex and ASA; P > 0.05 was considered statistically nonsignificant.

The onset of sensory blockade (loss of sensation to pinprick) in the two groups. The onset of a blockade in Group B was found to be 15.49 ± 2.38 minutes when compared to the onset time of 18.00 ± 2.80 minutes in Group B+M and this difference was found to be statistically y significant (p<0.001). The onset of motor blockade found in Group B was 17.75 ± 2.70minutes and Group B+M was19.84 ± 2.50 and it is found to be statistically significant with a p-value of 0.002 (Table-2; figure-1)

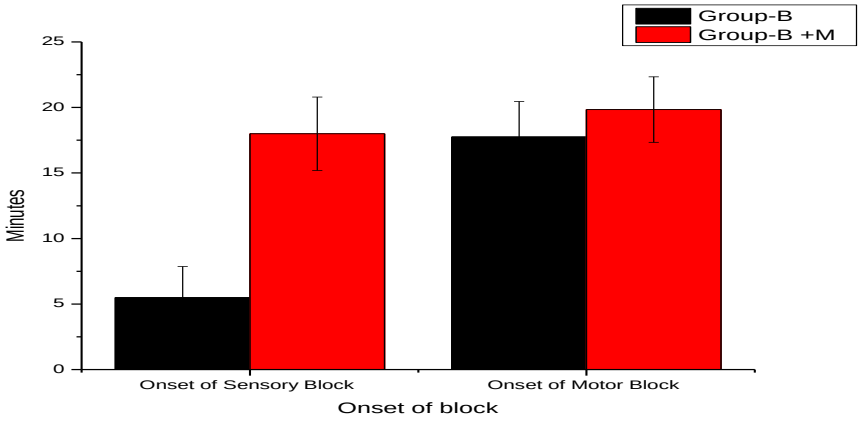

Fig 1: onset of sensory and motor block of group B and group B+M

The duration of sensory blockade was longer in Group B+M with a duration of 621.60 ± 25.25 minutes compared to Group B having the duration of 503.36 ± 24.51minutes and this difference was found to be statistically significant (p<0.001). Duration of motor blockade was found to be longer with a duration of 316.51 ± 21.50 minutes in Group B+M when compared to Group B with the duration of 292.75 ± 20.52 minutes. The p-value was found to be statistically significant (p<0.001). Duration of analgesia was found to be longer in Group B+M (632.36 ± 22.50minutes) when compared to Group B (517.00 ± 21.51minutes) and the p-value calculated was <0.001, which is statistically significant (Table-2 and Figure-2).

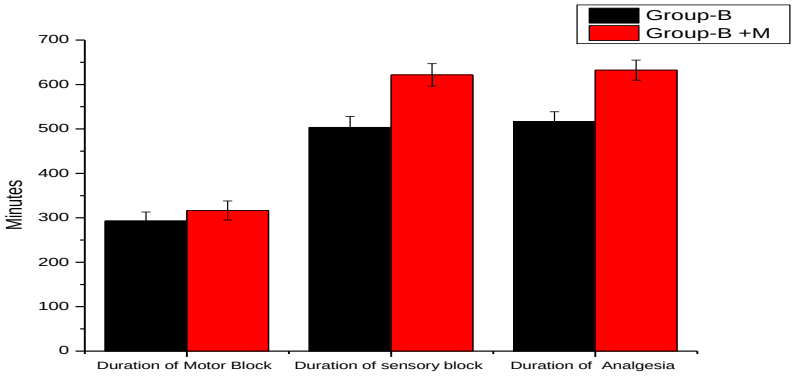

Fig 2: Duration of motor block, duration of sensory block, and duration of analgesia of group B and group B+M

Table 2: Demographic data of the two studied groups

Variables	Group-B (N=33)	Group- B+M (N=33)	*P*-value
The onset of Sensory Block (min)	5.49 ± 2.38	18.00 ± 2.80	0.001
The onset of Motor Block (min)	17.75 ± 2.70	19.84 ± 2.50	0.002
Duration of Motor Block (min)	292.75 ± 20.52	316.51 ± 21.50	<0.001
Duration of sensory block (min)	503.36 ± 24.51	621.60 ± 25.25	0.001
Duration of Analgesia (min)	517.00 ±21.51	632.36 ± 22.50	<0.001

We observed that there were no significant clinical or statistical alterations in heart rate in both groups. We found that there were no significant changes in the Mean Arterial Pressures in both the groups throughout the study. In the present study, no side effects were observed in both groups.

Discussion

The addition of MgSO4 in two doses to bupivacaine in interscalene brachial plexus block considerably prolongs the duration of analgesia, hastens the onset of sensory and motor blockade, and reduces the number of analgesics required in a dose-responsive way without producing adverse effects [12].

Since the introduction of $MgSO_4$ as an NMDA receptors antagonist, its role has been evaluated for the analgesic properties in anesthesia practice. The NMDA receptors play an important role in central nociceptive transmission, modulation, and sensitization of acute pain states. In addition to a central location, NMDA receptors are found in the muscle and skin [13], knee joint [14], and play a role in the sensory transmission of the noxious signal [15].

The primary hypothesis of our study, regarding the dose-dependent effect of $MgSO_4$ as an adjuvant, on peripheral nerves, is based on the surface charge theory as explained by Akutagawa *et al*.[16] The authors suggested that modulation of the external magnesium concentration resulted in the synergistic effect on nerve blockade due to local anesthetics. Mert *et al*.[17] also observed that a high concentration of divalent ions (Mg^{2+} and Ca^{2+}) attracted by the negative charge of the outer membrane surface affected Na^+ channel gating and could cause hyperpolarization resulting in nerve conduction block. The above-mentioned studies support our hypothesis that the higher concentration of magnesium (250 mg) provided a more pronounced prolongation of a block.

The $MgSO_4$ dosages utilized in our study (150mg) were similar to those employed by Goyal et al. [18] In Groups $BM_{0.5}$ and BM_1, $MgSO_4$ dosages of 150 mg were utilized to establish efficacious $MgSO_4$ concentrations (0.5 percent and 1 percent, respectively) in 25 ml of medication solution. Mukherjee et al [19] used 150 mg of $MgSO_4$ in supraclavicular brachial plexus block, while Bansal et al [20] used 1.5 g of $MgSO_4$ in IVRA, with no documented adverse effects or neurotoxicity.

The onset of sensory and motor block was faster in the magnesium groups in a dose-dependent manner than in the bupivacaine group. The findings of our study were following a study by Bansal *et al*.[20] In another study,[19] no statistical significance was observed in the onset time of sensory and motor block with magnesium (150 mg) used as an adjuvant to bupivacaine. This could be because the larger volume of local anesthetic (30 ml) used in the study lead to a reduced effective concentration of $MgSO_4$. In the study by Lee *et al*.,[21] the authors used 0.5% bupivacaine 20 ml with epinephrine (1:200,000) plus 10% $MgSO_4$ 2 ml or NS 2 ml in patients, who received an interscalene brachial plexus block for arthroscopic shoulder cuff repair. The onset times and durations of sensory and motor blocks were comparable between the two groups. The addition of epinephrine might be the contributing factor as compared to the present study. However, the mean duration of analgesia was increased in the magnesium group and is consistent with the present study. Regarding total doses of rescue analgesia, Group B received maximum doses of rescue analgesics followed by Groups BM0.5 and BM1 and is by to study [19]. However, these findings were not consistent with the findings in the study by Choi *et al*.,[22] and various factors might have contributed to this discrepancy in the results, such as lesser concentration of ropivacaine (0.2%), lesser volume of the drug (20 ml) used in axillary block and blind technique of block administration. In our study the onset of sensory block find that the P-value was not significant, it is was found that there was some delay in onset of the sensory block when $MgSO_4$ was added. The onset of motor block was found that statistically significant ($p < 0.002$).

Choi et al [22] also found similar complications (nausea, hypotension) in their study and the difference between the magnesium group and normal saline group was statistically insignificant ($p>0.05$). We observed that there were no significant clinical or statistical alterations in heart rate in both groups. We found that there were no significant changes in the Mean Arterial Pressures in both the groups throughout the study. In the present study, no side effects were observed in both groups.

Conclusion

Our data support the hypothesis that the action of $MgSO_4$ to Bupivacaine solution for brachial plexus block can modify the action of the local anesthetic solution by its local action. $MgSO_4$ when added to Bupivacaine appears to be with a prolonged duration of the sensory and motor blockade. In addition, $MgSO_4$ has a greater analgesic potential when used as an adjuvant to Bupivacaine in the Interscalene Brachial plexus block. We conclude that the addition of 150 mg $MgSO_4$ to ropivacaine 0.5% bupivacaine interscalene brachial plexus block for shoulder prolongs the duration of sensory, motor blockade, and duration of analgesia but results in a slight delay in the onset time of sensory and motor blockade.

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