Section: Anaesthesiology

Original Research Article

COMPARATIVE STUDY OF BUPIVACAINE WITH MAGNESIUM SULFATE AND BUPIVACAINE IN PATIENTS UNDERGOING UPPER LIMB SURGERIES UNDER ULTRASOUND-GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS NERVE BLOCK

M. Selvam[1], A. Revathy[2], D. Sasikumar[3], H. M. Hajashareef[4], S. Saravanakumar[5]

[1]Assistant Professor Department of Anaesthesiology, Government Medical College & Hospital-Tiruvallur, Tamil Nadu, India
[2]Senior Resident, Annapoorna Medical College-Salem, Tamil Nadu, India.
[3]Assistant Professor Department of Anaesthesiology, Government Kilpauk Medical College & Hospital-Chennai, Tamil Nadu, India
[4]Associate Professor Department of Anaesthesiology, Government Medical College & Hospital-Kallakurichi, Tamil Nadu, India
[5]Associate Professor Department of Anaesthesiology, Government Medical College & Hospital-Tiruvallur, Tamil Nadu, India.

Received : 15/12/2023
Received in revised form : 20/01/2024
Accepted : 10/02/2024

Keywords:
Magnesium sulphate, bupivacaine, motor blockade, sensory blockade, postoperative pain.

Corresponding Author:
Dr. M. Selvam,
Email: selvam0803@gmail.com

DOI: 10.47009/jamp.2025.7.1.149

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (1); 760-764

Abstract

Background: Peripheral nerve blockade offers effective analgesia with fewer side effects than opioids, reducing postoperative complications and improving recovery. Bupivacaine, though effective, has a delayed onset; adding $MgSO_4$ enhances onset and prolongs blockade duration. This study aimed to evaluate $MgSO_4$'s efficacy in supraclavicular brachial plexus block. **Materials and Methods:** This prospective, randomised, comparative study was conducted on 52 over six months. Patients were randomly assigned to Group I (0.5% Bupivacaine + 20% $MgSO_4$) or Group II (0.5% Bupivacaine + saline). The supraclavicular block was performed under ultrasound guidance. Sensory and motor blockade onset and duration were assessed at regular intervals. Haemodynamic parameters were monitored, and postoperative pain was evaluated using the Visual Analog Scale (VAS). Rescue analgesia (Inj. Diclofenac I.M.) was administered when VAS exceeded 3 cm. **Result:** Among 52 patients, 11 (21%) were female, and 41 (79%) were male, with no significant differences between groups (P>0.05). The onset of sensory (14.1±1.0 vs. 18.0±1.8 min) and motor blockade (21.0±0.8 vs. 26.7±1.7 min) was significantly faster in Group I (P<0.001). Sensory (585.4±26.4 vs. 370.4±0.1 min) and motor blockade duration (461.5±31.3 vs. 288.8±16.3 min) were significantly longer in Group I (P<0.001). Rescue analgesia and VAS scores were lower in Group I (P<0.001). Hemodynamic parameters showed no significant differences (P>0.05). **Conclusion:** The study concludes magnesium sulphate as an adjuvant to bupivacaine in supraclavicular block significantly accelerates onset, prolongs sensory and motor blockade, enhances postoperative analgesia, and ensures hemodynamic stability without complications, making it highly effective for single-shot blocks.

INTRODUCTION

Peripheral nerve blockade is one of the components of comprehensive anaesthesia care because of its distinct advantages over central neuraxial blockade and general anaesthesia. Peripheral Nerve Blockade provides more effective analgesia with fewer side effects than opioids and other oral analgesics. Its role has expanded from operating room to postoperative and chronic pain management.[1] With careful selection and sedation, these techniques can be employed in all age groups. Skilled application of peripheral neuraxial blockade develops anaesthesiologists' variety of options in giving optimal anaesthetic care. In emergency surgeries for full stomach patients, there is less risk of aspiration even if they vomit because they can be awake. Complications and side effects of general anaesthesia such as post-operative nausea vomiting, atelectasis,

ileus, delirium, and deep vein thrombosis is reduced.[2]

In peripheral nerve blockade, the sympathetic nerves of the anaesthetized limb are blocked, leading to vasodilation, and this improves blood flow to the limb and makes. microvascular surgeries are easy. The anaesthetized hand or foot remains numb for many hours after surgery, thus providing excellent post-operative pain relief.[3] Brachial plexus blockade provides superior pain control with excellent intraoperative anaesthesia as well as post-operative analgesia, eliminating the need for intra-operative opioids and minimizing the need for post-operative opioids.[1,4] This results in quicker recovery, shortened hospital stay, increased patient satisfaction as well as surgeon satisfaction and ultimately a decrease in the financial burden to the patient when compared to general anaesthesia thus permitting its use in day-care surgeries.

Peripheral nerve blockade of the upper limb includes various methods of brachial plexus block where the brachial plexus is blocked at different levels. Due to the long duration of action of Bupivacaine and high-quality sensory blockade and motor blockade, it has been the most used local anaesthetic for peripheral nerve blocks.[5] Bupivacaine yields good anaesthesia in the regional block but delayed onset thereby adding adjuvant MgSO4 to increase the onset and duration of sensory and motor blockade. MgSO4 is an NMDA receptor antagonist in CNS and peripheral nervous system.[6] Anti-nociceptive effects of magnesium are due to the regulation of calcium influx into the cell and antagonism of NMDA receptors.

Local anaesthetics alone for supraclavicular brachial plexus block provide good operative conditions but have a shorter duration of postoperative analgesia. Local anaesthetic adjuvants have been studied previously to prolong the duration of analgesia after peripheral nerve blockade.[7,8] Hence, various adjuvants like opioids, clonidine, neostigmine, dexamethasone, midazolam, etc., were added to local anaesthetics in brachial plexus block to achieve quick, dense, and prolonged block, but the results are either inconclusive or associated with side effects. Magnesium has been used in intravenous, intrathecal, and epidural/caudal routes to improve analgesia.[2,3,9]

Aim

The study aimed to determine the efficacy of Mgso4 in fastening the onset and increasing the duration of sensory and motor blockade when added to Bupivacaine in supraclavicular brachial plexus block under USG guidance in upper limb surgeries.

MATERIALS AND METHODS

This prospective, randomised, comparative study was conducted on 52 patients at Government Kilpauk Medical College Hospital and Government Royapettah Hospital for a period of 6 months from November 2019 to June 2020. The Institutional Ethics Committee approved (Protocol ID. No. 266/2019) the study before initiation, and informed consent was obtained from all patients.

Inclusion criteria

Patients undergoing elective upper limb surgeries under supraclavicular brachial plexus nerve block, aged between 20 to 60 years, including both males and females, only patients classified as ASA class 1 and 2 and those who provided valid informed consent were included.

Exclusion criteria

Patients with an allergy or sensitivity to local anaesthetics, pre-existing peripheral neuropathy of the upper limb, bleeding disorders, or an infection at the injection site. Patients with untreated pneumothorax, those who were unconscious or severely ill, and pregnant patients were excluded.

Methods

All the patients had undergone pre-anaesthetic evaluation before surgery. All systems were examined including the airway. The procedure to be carried out was explained and consent was obtained. All patients were kept nil per oral as per ASA guidelines. A total of 52 patients were randomly divided into two equal groups. Group I (n=26) received 20 ml of 0.5% Bupivacaine with 1 gm of 20% magnesium sulphate (5 ml), while Group II (n=26) received 20 ml of 0.5% Bupivacaine with 5 ml of normal saline.

For the procedure, a portable tray covered with towels was prepared with the required equipment, including syringes (5 ml, 10 ml), a bowl containing iodine, sponge holding forceps, towels, towel clips, and drugs such as 0.5% Bupivacaine, 1 gram of 20% magnesium sulphate, and normal saline. An ultrasound machine with a linear probe (10-15 MHz), a sterile probe cover, and a 10 cm insulated needle were used for guidance. Emergency resuscitation equipment, including an anaesthesia machine, oxygen source (central and cylinder), laryngoscope, suction apparatus, oral and nasal airways, emergency intubation tray, and drugs such as atropine, adrenaline, ephedrine, thiopentone, and intra lipid emulsion, were kept ready.

For the supraclavicular block, patients were positioned lying flat with their heads turned to the opposite side and the arm to be blocked positioned by their side. After skin preparation and draping, the ultrasound probe was placed in the supraclavicular fossa and moved laterally to locate the subclavian artery. Once the artery was visualized, the area lateral and superficial to it was explored to identify the brachial plexus, appearing as a honeycomb structure. The first rib and pleura were visualized before proceeding. Using an in-plane technique, the needle was inserted, and an assistant aspirated and injected the local anaesthetic, with its spread visualized in real-time.

The sensory block was evaluated using pinprick stimulation at areas supplied by the radial, median, ulnar, and musculocutaneous nerves. The sensory assessment was documented as anaesthesia (score 2: no pain, no touch sensation), analgesia (score 1: no

ISSN (O): 2687-5365; ISSN (P): 2753-6556

pain), or pain (score 0: feels pain). Motor block was assessed using a three-point scale: normal movement (score 2), paresis with some movement possible (score 1), or total paralysis (score 0). The onset of sensory and motor blockade was assessed every 5 minutes for the first 30 minutes, while the duration of blockade was monitored hourly until recovery. The end of the motor block was marked by the return of complete movement, and the end of the sensory block was defined as the return of pain sensation on pinprick testing.

Pulse rate and blood pressure were recorded every 5 minutes for the first 30 minutes and then hourly until the end of surgery. Postoperative pain relief was assessed using the Visual Analog Scale (VAS) at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 hours postoperatively. A rescue analgesic (Inj. Diclofenac I.M.) was administered when the VAS score exceeded 3 cm. Pain scores were recorded on a scale of 0 (no pain) to 10 (unbearable pain).

Statistical analysis: Data are presented as mean, standard deviation, frequency, and percentage. Continuous variables were compared using an independent-sample t-test and repeated measure ANOVA. Categorical variables were compared using Pearson's chi-square test. Significance was defined as P values less than 0.05 using a two-tailed test. Data analysis was performed using IBM-SPSS version 21.0.

RESULTS

The mean age in group I was 31.8 ±11.3 years and among group II was 35.3±2.1 years with no significant differences (p=0.3). In group I, 6 (54.6%) were female patients, 20 (48.9%) were male patients. In group II 5 (45.4%) were female patients and 21 (51.2%) were male patients, showing no significant differences (p=0.7) The mean weight in group I, was 58.5+5.3 kgs and in group II, was 58.4± 4.0 kgs, showing no significant differences (p=0.9) [Table 1].

Table 1: Comparison of demographic details between the groups.

		Group I	Group II	P value
Age (in years)		31.80±11.30	35.30±2.10	0.3
Sex	Male	20(48.9%)	21(51.2%)	0.7
	Female	6(54.6%)	5(45.4%)	
Weight (in kgs)		58.50±5.30	58.40±4.00	0.9

Table 2: Comparison of sensory blockade, motor blockade, rescue analgesia and haemodynamic parameters between groups

		Group I	Group II	P value
Sensory blockade	Onset (mins)	14.10±1.00	18.00±1.80	<0.001
	Duration (mins)	585.40±26.40	370.40±30.10	<0.001
Motor blockade	Onset (mins)	21.00±0.80	26.70±1.70	<0.001
	Duration (mins)	461.50±31.30	288.80±16.30	<0.001
Rescue analgesia (mg)		150.00±0.00	213.50±27.60	<0.001
Systolic Blood Pressure (mmHg)		122.90±5.00	123.40±5.20	0.7
Diastolic Blood Pressure (mmHg)		80.00±6.10	78.70±6.20	0.4
Pulse rate (beats/min)		79.90±8.70	81.90±7.10	0.309

The mean onset time of sensory blockade in Group I was 14.10 ± 1.00 minutes, whereas in Group II, it was 18.00 ± 1.80 minutes, with a significant difference (P<0.001). The duration of sensory blockade was prolonged in Group I (585.40 ± 26.40 minutes) compared to Group II (370.40 ± 30.10 minutes), with a significant difference (P<0.001).

Regarding, the mean onset time of motor blockade in Group I was 21.00 ± 0.80 minutes, which was shorter than in Group II (26.70 ± 1.70 minutes), with a significant difference (P<0.001). The duration of motor blockade was longer in Group I (461.50 ± 31.30 minutes) compared to Group II (288.80 ± 16.30 minutes), with a significant difference (P<0.001)

The mean rescue analgesia in group I was 150±0.0 mg of Inj. Diclofenac sodium for 24 hours and in group II for 24 hours was 213.5±27.6 mg of Inj. Diclofenac sodium, with a significant difference (p<0.001). The mean systolic blood pressure in group I was 122.9±5 mmHg and in group II the mean systolic blood pressure was 123.4±5 mmHg, showing no significant difference (p=0.7). The mean diastolic pressure in group I was 80±6.1 mmHg and in group II the mean diastolic pressure was 78.7±6.2 mmHg, showing no significant difference (p=0.4). Regarding the pulse rate, in group I the mean pulse rate was 79.9±8.7 beats/min and in group II the mean pulse rate was 81.9±7.1 beats/min, showing no significant difference (p=0.309) [Table 2].

Table 3: Comparison of VAS score between groups

		Mean±SD		P value
		Group I	Group II	
VAS score	At 6 h	0.00±0.00	1.20±0.70	<0.001
	At 9 h	1.00±0.20	3.00±0.00	<0.001
	At 12 h	3.00±0.00	3.00±0.00	0.99

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Between subjects (groups)	<0.001
Within subjects (over time)	<0.001

The mean VAS score at 6 hours postoperatively, in Group I was 0.00 ± 0.00, whereas in Group II, it was 1.20 ± 0.70, with a significant difference (p<0.001). At 9 hours, the VAS score increased to 1.00 ± 0.20 in Group I and 3.00 ± 0.00 in Group II, showing a significant difference (P<0.001). By 12 hours, the VAS score was 3.00 ± 0.00 in both groups, with no significant difference (P=0.99).

There was a significant difference between subjects (groups) (P<0.001), indicating that pain perception varied significantly between the two groups over time. Similarly, there was a significant difference within subjects (over time) (P<0.001), showing that pain levels changed significantly throughout the postoperative period [Table 3].

DISCUSSION

In our study, the mean onset time of sensory blockade was 14.1 ± 1.0 minutes in Group I and 18 ± 1.8 minutes in Group II, demonstrating a statistically significant difference. A study conducted by Olapour et al. reported similar findings in a comparative study between lignocaine with magnesium sulfate and plain lignocaine in supraclavicular brachial plexus nerve block.[10] Similarly, the mean onset time of motor blockade in Group I was 21 ± 0.8 minutes, whereas in Group II, it was 26.7 ± 1.7 minutes, indicating a significant difference. The findings of Olapour et al. also supported this observation, stating that the addition of magnesium to lignocaine significantly shortened the onset of motor block.[10]

Regarding the duration of sensory blockade, our study found that in Group I, the mean duration was 585.4 ± 26.4 minutes, whereas in Group II, it was 370 ± 30.1 minutes, which was statistically significant. This finding is consistent with a study conducted by Mukherjee et al. in which the mean duration of sensory blockade in the magnesium group was 456.21 minutes, suggesting that the prolonged duration was due to the addition of magnesium sulfate.[3] Similarly, Lee et al. reported that the mean duration of sensory blockade with a combination of bupivacaine, epinephrine, and magnesium sulfate was 600.60 minutes, further supporting our results.[7]

In our study, the duration of motor blockade was significantly prolonged in Group I (461.5 ± 31.3 minutes) compared to Group II (288.8 ± 16.3 minutes). Haghighi et al. investigated the effect of magnesium sulfate in axillary brachial plexus block and found that its addition to lignocaine significantly increased the duration of motor blockade, aligning with our findings.[11]

In our study, rescue analgesic usage within the first 24 hours, patients in Group I required 150 ± 0.0 mg of Inj. Diclofenac sodium, whereas those in Group II required 213.5 ± 27.6 mg, a statistically significant difference. A study by Mukherjee et al. also found similar results, demonstrating that the magnesium group required fewer diclofenac injections during the first 24 hours postoperatively compared to the control group.[3]

The VAS score was evaluated at different time intervals. At 6 hours, the mean VAS score was 0.0 ± 0.0 in Group I and 1.2 ± 0.7 in Group II, showing a statistically significant difference. At 9 hours, the mean VAS score was 1.0 ± 0.7 in Group I and 3.0 ± 0.0 in Group II, also demonstrating statistical significance. Gupta et al. observed similar trends in VAS scores and recommended rescue analgesia when the VAS score exceeded 4.[12]

Hemodynamic parameters, including systolic and diastolic blood pressure, heart rate, and oxygen saturation, were monitored before and after the block every 5 minutes for the first 30 minutes and then every 15 minutes until the end of surgery. No significant differences were observed between the groups. This aligns with the study conducted by Alarasan et al. where hemodynamic stability was maintained in patients receiving dexamethasone in a low-volume supraclavicular brachial plexus block.[13] Furthermore, no complications were observed in either group during surgery or within the first 24 hours postoperatively, reinforcing the safety of the technique. These results are comparable to the findings of Alarasan et al., who also reported an absence of complications in their study population.[13]

CONCLUSION

The supraclavicular approach to the brachial plexus is popularly used for upper limb surgeries. The plexus is compactly arranged here, thus providing a more consistent and complete block. To fasten the onset and prolong the duration of the block to get the maximum benefit of single shot blocks, various adjuvants have been added to local anaesthetics. The addition of magnesium sulfate to the Bupivacaine has proved to be a better adjuvant in this study, since it fastens the onset and prolongs the duration of sensory and motor blockade significantly and it provides better postoperative analgesia without significant hemodynamic variables and complications.

REFERENCES

1. Imani F. Postoperative pain management. Anesth Pain Med 2011; 1:6–7. https://doi.org/10.5812/kowsar.22287523.1810.
2. Rao L, Jeyalakshmi P, Maale N. The effect of magnesium sulfate as an adjuvant to 0.5% bupivacaine on motor and sensory supraclavicular brachial plexus blockade. Int J Basic Clin Pharmacol 2015:1. https://doi.org/10.5455/2319-2003.ijbcp20150429.
3. 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. https://doi.org/10.4103/2279-042X.145387.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

4. Hebl JR, Dilger JA, Byer DE, Kopp SL, Stevens SR, Pagnano MW, et al. A pre-emptive multimodal pathway featuring peripheral nerve block improves perioperative outcomes after major orthopedic surgery. Reg Anesth Pain Med 2008; 33:510–7. https://doi.org/10.1097/00115550-200811000-00002.
5. Faiz SHR, Rahimzadeh P, Imani F, Bakhtiari A. Intrathecal injection of magnesium sulfate: shivering prevention during cesarean section: a randomized, double-blinded, controlled study. Korean J Anesthesiol 2013; 65:293. https://doi.org/10.4097/kjae.2013.65.4.293.
6. Abdelfatah A, Elshaer A. The effect of adding magnesium sulfate to lidocaine in an interscalene plexus block for shoulder arthroscopic acromioplasty. Ain-Shams J Anaesthesiol 2014; 7:59. https://doi.org/10.4103/1687-7934.128416.
7. Lee AR, Yi H-W, Chung IS, Ko JS, Ahn HJ, Gwak MS, et al. Magnesium added to bupivacaine prolongs the duration of analgesia after interscalene nerve block. Can J Anaesth 2012; 59:21–7. https://doi.org/10.1007/s12630-011-9604-5.
8. Gunduz A, Bilir A, Gulec S. Magnesium added to prilocaine prolongs the duration of axillary plexus block. Reg Anesth Pain Med 2006; 31:233–6. https://doi.org/10.1016/j.rapm.2006.03.001.
9. Ekmekci P, Bengisun ZK, Akan B, Kazbek BK, Ozkan KS, Suer AH. The effect of magnesium added to levobupivacaine for femoral nerve block on postoperative analgesia in patients undergoing ACL reconstruction. Knee Surg Sports Traumatol Arthrosc 2013; 21:1119–24. https://doi.org/10.1007/s00167-012-2093-4.
10. Olapour AR, Mohtadi AR, Soltanzadeh M, Ghomeishi A, Akhondzadeh R, Jafari M. The effect of intravenous magnesium sulfate versus intravenous sufentanil on the duration of analgesia and postoperative pain in patients with tibia fracture. Anesth Pain Med 2017;7: e44035. https://doi.org/10.5812/aapm.44035.
11. Haghighi M, Soleymanha M, Sedighinejad A, Mirbolook A, Naderi Nabi B, Rahmati M, et al. The effect of magnesium sulfate on motor and sensory axillary plexus blockade. Anesth Pain Med 2015;5: e21943. https://doi.org/10.5812/aapm.21943.
12. Gupta D, Mangal V, Kulshestha A, Kalra P. Efficacy of magnesium sulfate as adjuvant to ropivacaine 0.4% for supraclavicular brachial plexus block in patients undergoing upper limb surgery: A randomized controlled trial. J Recent Adv Pain 2017; 3:85–9. https://doi.org/10.5005/jp-journals-10046-0075.
13. Alarasan AK, Agrawal J, Choudhary B, Melhotra A, Uike S, Mukherji A. Effect of dexamethasone in low volume supraclavicular brachial plexus block: A double-blinded randomized clinical study. J Anaesthesiol Clin Pharmacol 2016; 32:234–9. https://doi.org/10.4103/0970-9185.182108.

ISSN (O): 2687-5365; ISSN (P): 2753-6556