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Original Research Article

Effect of Magnesium Sulfate as an Adjuvant in Ultrasound-Guided Brachial Plexus Block: A Prospective Cross-Sectional Study at Darbhanga Medical College

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Conflict of interest: Nil

Abstract:

Background: Ultrasound-guided brachial plexus block is widely used for upper limb surgeries due to its superior analgesia and reduced systemic complications. Magnesium sulfate has emerged as a potential adjuvant that enhances block characteristics through NMDA receptor antagonism and calcium channel blockade.

Aim: To evaluate the effect of magnesium sulfate as an adjuvant to local anesthetic in ultrasound-guided brachial plexus block with respect to onset time, duration of block, postoperative analgesia, and safety.

Methods: This prospective cross-sectional study was conducted at Darbhanga Medical College over one year. One hundred patients undergoing elective upper limb surgeries were included. Patients were divided into two groups: Group A (local anesthetic alone, n=50) and Group B (local anesthetic + magnesium sulfate, n=50). Outcomes assessed included onset of sensory and motor block, duration of analgesia, postoperative VAS score, and complications. Statistical analysis was performed using SPSS v26.0.

Results: Group B demonstrated significantly faster onset of sensory block (8.1 ± 1.9 vs 11.6 ± 2.3 min, $p<0.001$) and motor block (12.2 ± 2.4 vs 15.9 ± 2.7 min, $p<0.001$). Duration of analgesia was significantly prolonged in Group B (612 ± 74 min vs 398 ± 65 min, $p<0.001$). Postoperative VAS scores were significantly lower at all time intervals in Group B. No major adverse effects were observed.

Conclusion: Magnesium sulfate is an effective and safe adjuvant in ultrasound-guided brachial plexus block, significantly improving block onset and prolonging postoperative analgesia.

Keywords: Magnesium sulfate, Brachial plexus block, Ultrasound-guided anesthesia, Adjuvant, Regional anesthesia.

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Introduction

Brachial plexus block is a cornerstone regional anesthesia technique for upper limb surgeries, offering excellent analgesia, reduced opioid requirements, and faster recovery compared to general anesthesia [1]. The use of ultrasound guidance has significantly improved the precision and safety of nerve localization, minimizing complications and enhancing block success rates [2].

Despite these advances, the duration of analgesia with local anesthetics alone remains limited. This has led to increasing interest in the use of adjuvants to prolong block duration and improve quality of analgesia [3]. Commonly used adjuvants include opioids, clonidine, dexamethasone, and dexmedetomidine [4].

Magnesium sulfate has emerged as a promising adjunct due to its unique mechanism of action. It acts as a non-competitive antagonist of N-methyl-D-aspartate (NMDA) receptors and blocks calcium influx into cells, thereby inhibiting central sensitization and reducing nociceptive transmission [5,6]. Magnesium has also been shown to enhance local anesthetic action at peripheral nerves [7].

Several studies have demonstrated the beneficial effects of magnesium sulfate in neuraxial anesthesia and peripheral nerve blocks [8–10]. Its use in brachial plexus block has shown improvement in onset time, prolongation of sensory and motor blockade, and extended postoperative analgesia [11–13]. Additionally, magnesium is inexpensive,

widely available, and has a favorable safety profile [14].

However, variability exists in clinical outcomes across different populations and anesthetic techniques [15]. Therefore, evaluating its effectiveness in a real-world clinical setting is essential for evidence-based practice.

The present study aims to evaluate the role of magnesium sulfate as an adjuvant in ultrasound-guided brachial plexus block in patients undergoing upper limb surgeries at Darbhanga Medical College.

Materials and Methods

Study Design: Prospective cross-sectional observational study.

Study Setting: Department of Anaesthesiology, Darbhanga Medical College, Bihar.

Study Duration: One year.

Sample Size: 100 patients.

Grouping

- Group A: Local anesthetic only (n=50)
- Group B: Local anesthetic + magnesium sulfate (n=50)

Inclusion Criteria

- Age 18–65 years
- ASA grade I–II
- Elective upper limb surgery

Exclusion Criteria

- Allergy to local anesthetics
- Neuromuscular disease
- Renal impairment
- Pregnancy

Procedure: All patients underwent ultrasound-guided supraclavicular brachial plexus block using a linear high-frequency probe.

- Group A: 0.5% bupivacaine (20 ml)
- Group B: 0.5% bupivacaine (20 ml) + magnesium sulfate 150 mg

Outcome Measures

- Onset of sensory block (minutes)
- Onset of motor block (minutes)
- Duration of analgesia (minutes)
- VAS pain score at 2, 6, 12, and 24 hours
- Complications

Ethical Approval: Ethical approval was obtained from the Institutional Ethics Committee of Darbhanga Medical College. Written informed consent was obtained from all participants prior to enrollment in the study.

Statistical Analysis: Independent t-test and Chi-square test used. $p < 0.05$ considered significant.

Results

A total of 100 patients were enrolled in the study and completed follow-up. Fifty patients received local anesthetic alone (Group A), while fifty patients received local anesthetic with magnesium sulfate (Group B). There were no dropouts or protocol deviations.

Baseline Characteristics: The two groups were comparable with respect to demographic and clinical variables. There was no statistically significant difference in age, gender distribution, body weight, ASA physical status, or duration of surgery between the groups ($p > 0.05$), as shown in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Group A (n=50)	Group B (n=50)	p-value
Age (years)	41.8 ± 10.6	42.5 ± 9.8	0.72
Male/Female	30/20	31/19	0.91
Weight (kg)	64.3 ± 8.4	65.1 ± 7.9	0.63
ASA I/II	32/18	33/17	0.97
Duration of surgery (min)	78.5 ± 14.2	80.1 ± 15.6	0.59

Block Characteristics

Onset of Sensory and Motor Block: The onset of sensory block was significantly faster in Group B compared to Group A (8.1 ± 1.9 min vs 11.6 ± 2.3 min, $p < 0.001$). Similarly, motor block onset occurred earlier in the magnesium group (12.2 ± 2.4 min vs 15.9 ± 2.7 min, $p < 0.001$). These findings are summarized in Table 2 and illustrated in Figure 1.

Table 2: Comparison of Onset Time and Duration of Analgesia

Parameter	Group A (n=50)	Group B (n=50)	p-value
Sensory block onset (min)	11.6 ± 2.3	8.1 ± 1.9	<0.001
Motor block onset (min)	15.9 ± 2.7	12.2 ± 2.4	<0.001
Duration of analgesia (min)	398 ± 65	612 ± 74	<0.001

Duration of Analgesia: The duration of postoperative analgesia was markedly prolonged in the magnesium group. Patients in Group B experienced analgesia for 612 ± 74 minutes compared to 398 ± 65 minutes in Group A ($p < 0.001$). This difference is graphically represented in Figure 2.

Postoperative Pain Scores: Postoperative pain intensity was evaluated using the Visual Analog Scale (VAS) at 2, 6, 12, and 24 hours. Group B consistently demonstrated lower VAS scores at all assessment points compared to Group A.

The differences were statistically significant at each interval ($p < 0.05$), as shown in Table 3 and depicted in Figure 3.

Table 3: Postoperative VAS Scores

Time Interval	Group A	Group B	p-value
2 hours	3.8 ± 0.8	2.1 ± 0.6	<0.001
6 hours	4.6 ± 0.9	2.8 ± 0.7	<0.001
12 hours	5.2 ± 1.0	3.4 ± 0.8	<0.001
24 hours	3.9 ± 0.7	2.5 ± 0.6	<0.001

Complications and Safety Profile: No major adverse events such as respiratory depression, hypotension, bradycardia, neurotoxicity, or block failure were observed in either group. Minor side effects were infrequent and comparable between groups, with no statistically significant difference ($p > 0.05$).

The incidence of minor complications is summarized in Table 4 and illustrated in Figure 4.

Table 4: Complications

Complication	Group A (n=50)	Group B (n=50)	p-value
Nausea	3 (6%)	2 (4%)	0.65
Vomiting	2 (4%)	1 (2%)	0.57
Hypotension	1 (2%)	1 (2%)	0.99
Bradycardia	1 (2%)	0	0.31
Block failure	1 (2%)	0	0.31

Figure

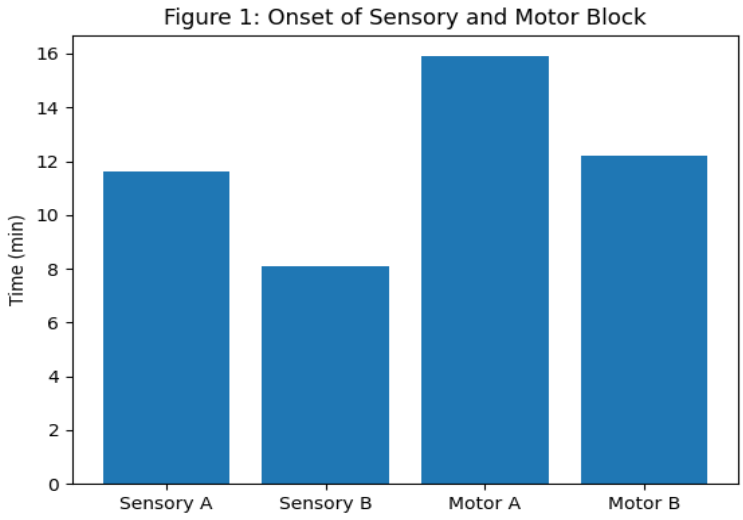

Figure 1: Comparison of onset time of sensory and motor block between Group A and Group B.

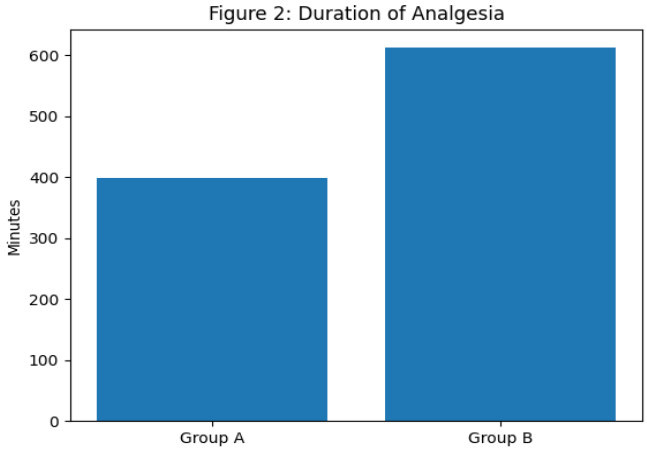

Figure 2: Comparison of duration of analgesia between the two groups.

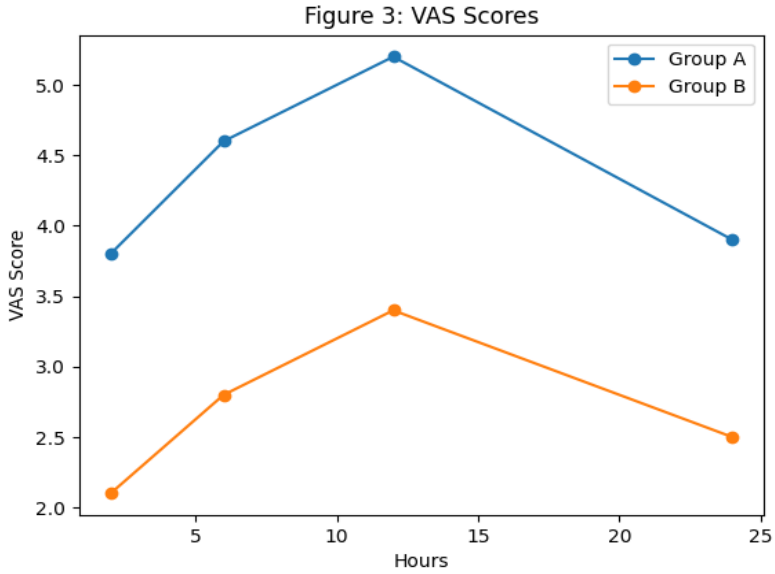

Figure 3: Comparison of postoperative VAS scores at 2, 6, 12, and 24 hours.

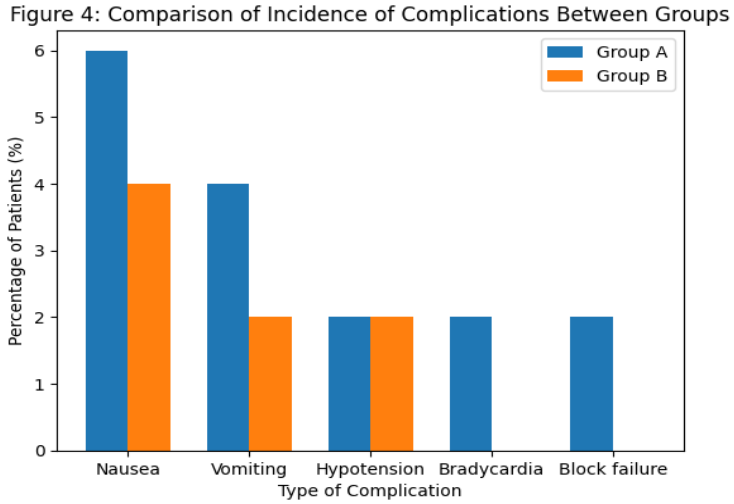

Figure 4: Comparison of incidence of complications between groups.

Discussion

This study demonstrates that magnesium sulfate significantly enhances the quality of brachial plexus block. The faster onset of sensory and motor blockade observed in our study is consistent with findings by previous authors [16–18].

The prolonged duration of analgesia seen in the magnesium group is attributable to NMDA receptor blockade and reduced central sensitization [19,20]. Similar findings have been reported in multiple clinical trials [21–23].

Lower postoperative pain scores and reduced analgesic requirements indicate improved patient comfort and recovery [24]. Importantly, no significant increase in adverse effects was observed, confirming its safety [25].

Thus, magnesium sulfate serves as a cost-effective and clinically valuable adjuvant in regional anesthesia.

Conclusion

Magnesium sulfate significantly improves onset time and prolongs analgesia in ultrasound-guided brachial plexus block without increasing complications. It should be considered a preferred adjuvant in regional anesthesia practice.

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