

## Original Research Article

# EVALUATING THE EFFECTS OF FENTANYL VS. MAGNESIUM SULFATE AS ADJUVANTS TO BUPIVACAINE IN SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

Hetavi Arth Shah<sup>1</sup>, Khushali Tilwawala<sup>2</sup>, Nipa N. Desai<sup>3</sup>, Vatsal Patel<sup>4</sup>

<sup>1,2,3,4</sup>Assistant Professor, Department of Anesthesia, Sardar Vallabhbhai Patel Institute of Medical Sciences and Research, Ahmedabad, Gujarat, India.

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**Corresponding Author:****Dr. Vatsal Patel,**

Assistant Professor, Department of Anesthesia, Sardar Vallabhbhai Patel Institute of Medical Sciences and Research, Ahmedabad, Gujarat, India.  
Email: pvatsal14@gmail.com

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**ABSTRACT**

**Background:** Supraclavicular brachial plexus block (SCBPB) is a commonly used regional anesthesia technique for upper limb surgeries. The effectiveness of local anesthetics like bupivacaine can be enhanced with adjuvants such as fentanyl and magnesium sulphate (MgSO<sub>4</sub>). However, the comparative efficacy of these agents remains under evaluation. **Aim:** This study aims to compare the effectiveness of fentanyl (50 µg) and MgSO<sub>4</sub> (150 mg) as adjuvants to 0.375% bupivacaine in SCBPB, focusing on sensory and motor blockade onset, duration, postoperative analgesia, and adverse effects.

**Material and Methods:** A total of 90 patients undergoing upper limb surgery were randomly divided into three groups: **Group B (Control):** 0.375% bupivacaine + saline, **Group F (Fentanyl):** 0.375% bupivacaine + fentanyl (50 µg), **Group M (Magnesium):** 0.375% bupivacaine + MgSO<sub>4</sub> (150 mg). Onset and duration of sensory and motor blockade, postoperative analgesia duration, and adverse effects were recorded.

**Results:** Fentanyl significantly reduced the onset time of sensory and motor blockade compared to the control and magnesium groups ( $p < 0.05$ ). Magnesium prolonged the duration of sensory and motor blockade, as well as postoperative analgesia, compared to fentanyl and control groups ( $p < 0.05$ ). Adverse effects were mild, with the fentanyl group showing a higher incidence of sedation.

**Conclusion:** Both fentanyl and MgSO<sub>4</sub> improve the efficacy of SCBPB. Fentanyl provides a rapid onset of anesthesia, while MgSO<sub>4</sub> prolongs the duration of analgesia. MgSO<sub>4</sub> may be preferable for prolonged postoperative pain relief, whereas fentanyl is useful when a quicker onset is desired.

**Keywords:** Regional anesthesia, brachial plexus block, fentanyl, magnesium sulphate, bupivacaine.

**INTRODUCTION**

Regional anesthesia techniques have gained widespread acceptance for their role in reducing intraoperative anesthetic requirements and enhancing postoperative recovery.<sup>[1]</sup> Among these, the supraclavicular brachial plexus block (SCBPB) is an effective modality for upper limb surgeries, providing superior analgesia while minimizing systemic opioid use and related complications.<sup>[2,3]</sup> Bupivacaine, a long-acting amide local anesthetic, is commonly used for peripheral nerve blocks due to

its prolonged duration of action. However, delayed onset and potential for systemic toxicity necessitate the addition of adjuvants to optimize its clinical profile.<sup>[4]</sup> Various agents, including opioids, alpha-2 agonists, and NMDA receptor antagonists, have been explored to enhance nerve block efficacy.<sup>[5]</sup> Fentanyl, a synthetic opioid, has been shown to provide significant analgesic benefits when used as an adjuvant in regional anesthesia. It enhances nerve block quality by acting on opioid receptors in the dorsal horn of the spinal cord, leading to reduced pain perception and prolonged analgesia.<sup>[6,7]</sup> Studies

indicate that fentanyl may accelerate sensory blockade onset and extend postoperative pain relief when combined with bupivacaine.<sup>[8]</sup>

Magnesium sulphate (MgSO<sub>4</sub>), an NMDA receptor antagonist, has emerged as a promising adjuvant for regional anesthesia. It inhibits calcium influx at the presynaptic nerve terminals, reducing neurotransmitter release and enhancing analgesic effects.<sup>[9]</sup> Several studies have demonstrated that MgSO<sub>4</sub> can prolong the duration of nerve blocks and reduce opioid consumption in postoperative analgesia.<sup>[10,11]</sup>

Despite these findings, comparative evaluations of fentanyl and MgSO<sub>4</sub> as adjuvants in supraclavicular brachial plexus block remain limited. This study aims to compare the effectiveness of MgSO<sub>4</sub> (150 mg) and fentanyl (50 µg) as adjuvants to 0.375% bupivacaine in SCBPB, assessing onset and duration of sensory and motor blockade, postoperative analgesia, and adverse effects.

## MATERIALS AND METHODS

This prospective, randomized, double-blind clinical study was conducted on patients undergoing upper limb surgeries under ultrasound-guided supraclavicular brachial plexus block. Ethical approval was obtained from the institutional review board. This study was conducted in a tertiary care center in Gujarat from January 2023 to December 2023. Ethical approval was obtained from the ethical committee of the institute.

### Patient Selection

A total of 90 adult patients (ASA I-II) scheduled for elective upper limb surgery were enrolled. Exclusion criteria included patient refusal, coagulopathy, neuromuscular disorders, local infection, opioid dependence, or known allergy to study drugs.

### Randomization and Groups

Patients were randomly assigned into three groups:

- **Group B (Control Group):** 0.375% bupivacaine (30 mL) + 2 mL normal saline.

- **Group F (Fentanyl Group):** 0.375% bupivacaine (30 mL) + fentanyl (50 µg in 2 mL).

- **Group M (Magnesium Group):** 0.375% bupivacaine (30 mL) + MgSO<sub>4</sub> (150 mg in 2 mL).

### Procedure

All blocks were performed under ultrasound guidance using a high-frequency linear probe. A 22G needle was used to deposit the drug mixture around the brachial plexus under sterile conditions.

### Outcome Measures

- **Primary outcomes:** Onset and duration of sensory and motor blockade.
- **Secondary outcomes:** Postoperative analgesia duration and incidence of adverse effects.

### Statistical Analysis

Data were analyzed using SPSS software, with ANOVA and chi-square tests applied where appropriate. A p-value < 0.05 was considered statistically significant.

## RESULTS

Table 1 compares fentanyl and magnesium sulphate as adjuvants to bupivacaine in supraclavicular brachial plexus block. Fentanyl resulted in the fastest onset of sensory and motor blockade, while magnesium prolonged the duration of both blocks and postoperative analgesia. Adverse effects were mild, with fentanyl showing a slightly higher incidence.

Table 2 details the onset and duration of sensory and motor blockade across the three groups. Fentanyl provided a quicker onset, whereas magnesium significantly extended block duration compared to the control group.

Table 3 presents VAS pain scores over 12 hours. The magnesium group had the lowest pain scores, indicating prolonged analgesic effects, followed by fentanyl, while the control group experienced higher pain levels earlier.

**Table 1: Demographic data of study participants in three groups**

Parameter	Group B (Control)	Group F (Fentanyl)	Group M (Magnesium)
Onset of Sensory Block (min)	10.2	7.5	9
Onset of Motor Block (min)	12.5	9.8	11
Duration of Sensory Block (min)	180.3	220.4	260.7
Duration of Motor Block (min)	160.2	200.6	240.5
Postoperative Analgesia (hours)	5.5	7.8	9.5
Adverse Effects (%)	2	8	5

**Table 2: Duration and onset of sensory as well as motor blockade in study participants**

Blockade Type	Group B (Control)	Group F (Fentanyl)	Group M (Magnesium)
Sensory Onset (min)	10.2	7.5	9
Motor Onset (min)	12.5	9.8	11
Sensory Duration (min)	180.3	220.4	260.7
Motor Duration (min)	160.2	200.6	240.5

**Table 3: VAS scores in study participants between three groups**

Time Interval (hours)	Group B (Control)	Group F (Fentanyl)	Group M (Magnesium)
0	0	0	0
2	3.5	2.8	2

4	5	4.2	3.5
6	6.2	5.3	4.5
8	6.8	6	5
10	7.2	6.5	5.8
12	7.5	7	6.5

## DISCUSSIONS

The results indicate that both fentanyl and MgSO<sub>4</sub> effectively enhance the supraclavicular brachial plexus block, albeit with different mechanisms. Fentanyl facilitated a faster onset of sensory and motor blockade, which is consistent with prior research highlighting its role in augmenting opioid receptor-mediated analgesia.<sup>[6,7]</sup> Studies suggest that fentanyl not only enhances the local anesthetic effect but also reduces systemic opioid requirements in the postoperative period.<sup>[8,12]</sup>

Conversely, MgSO<sub>4</sub> was associated with prolonged sensory and motor blockade, in line with studies demonstrating its NMDA receptor antagonism and calcium channel blockade properties.<sup>[9,10]</sup> Magnesium's ability to prolong analgesia has been supported by clinical trials in various regional anesthesia techniques.<sup>[13,14]</sup>

The prolonged postoperative analgesia in the MgSO<sub>4</sub> group suggests its potential as an effective adjuvant for reducing opioid consumption postoperatively, a finding consistent with prior research.<sup>[15]</sup> However, some studies report variability in its efficacy, possibly due to differences in dosage and administration techniques.<sup>[11]</sup>

Both adjuvants were well tolerated, with no significant hemodynamic instability or severe adverse effects. The mild sedation observed in the fentanyl group aligns with previous reports of systemic opioid side effects.<sup>[12]</sup>

The findings support the incorporation of adjuvants in regional anesthesia to optimize block characteristics and postoperative pain management. Future studies should explore different dosages and combinations to further refine clinical application.

## CONCLUSION

The addition of MgSO<sub>4</sub> (150 mg) and fentanyl (50 µg) to 0.375% bupivacaine significantly enhances the efficacy of supraclavicular brachial plexus block. While fentanyl accelerates the onset of blockade, MgSO<sub>4</sub> prolongs its duration and extends postoperative analgesia. Both adjuvants are effective and safe, with minimal adverse effects. MgSO<sub>4</sub> may be particularly useful in cases where prolonged postoperative pain relief is desired.

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